1893.

NEW ZEALAND.

THE GOLDFIELDS OF NEW ZEALAND:

REPORT ON ROADS, WATER-RACES, MINING MACHINERY, AND OTHER WORKS IN CONNECTION WITH MINING.

Presented to both Houses of the General Assembly by Command of His Excellency.

CONTENTS.

	Page
Goldfields, Roads, Water-races, Mining Machinery, and other Works in connection with Mining, Report on, by H. A. Gordon, Inspecting Engineer (C.–3)	1–276
Subsidised Roads and Tracks	1–4
North Island	1–2
Bay of Islands County	1
Road, Tamarere to Puhipuhi	1
Coromandel County	1
Track, Coromandel to Kuaotunu	1
Road, Sea-beach to Kuaotunu	1
Extension Just-in-Time Road, Coromandel	1
Thames County	1
Road, Upper Tararu to Sylvia Mine	1
Ohinemuri County	2
Road, Karangahake to Waihi	2
Bridge over Ohinemuri River at Karangahake	2
Middle Island	2
Roads constructed from Direct Grants	2–4
Road, Terohanga Gorge to Puhipuhi	2
Horse-track, Cabbage Bay to Port Charles	2
Road, Tiki to Mahikarau	2
Horse-track, Coromandel to Kuaotunu	2
Horse-track, Kuaotunu to Mercury Bay	2
Road, Thames to Manaia	2
Horse-track, Puriri to Tairua	2
Road, Havelock to Mahakipawa	2
Track, Mahakipawa to Waikakaho	2
Horse-track, Aorere Valley to Karamea	2
Track, Oparara through Gorge	3
Bridge, Okira Creek	3
Horse-track to Diggings, Cape Foulwind	3
Bridge, Nile River at Charleston	3
Track, Mokihinui to Little Wanganui	3
Track, Burnett's Face to Coalbrookdale	3
Road, Devil's Creek to Big River	3
Road to Painkiller	3
Road, Hampden to Horse Terrace	3
Road, Cobden to Seventeen-mile Beach	3
Horse-track, Hatter's Terrace to Haupiri	3
Track, Grey River to Moonlight	3
Track, Black Ball	3
Great South Road	3
Horse-track, Cascade to Barn Bay	3
Road, Tucker's Flat	3
Road, Dillman's to Larrikin's	3
Horse-track, Gillan's Gully	3
Bridge over Mahinapua Creek	3
Sundry tracks, Westland	3
Bridge, Kawarau River	3
Road, Miller's Flat to Skipper's	3
Road, Arrowtown to Macetown	4
Track, Pleasant Creek Terrace	4
Road up Dart River	4
Tracks, Western Sounds	4
Horse-track, Waiau to Preservation Inlet; and road, Cromarty to reefs	4
Tracks, Stewart Island	4
Artesian well-boring, Maniototo Plains	4
Prospecting Associations	4
Schools of Mines	4–32
Thames School of Mines	5–25
Reefton School of Mines	25–28
Minor schools	28, 29
Otago School of Mines	29–31
Expenditure on schools	32
Water-races	32–37
Waimea-Kumara Water-race construction	32
Waimea Water-race	32, 33
Kumara Water-race	33, 34
Waimea-Kumara Water-race	35
Mount Ida Water-race	35–37
Summary of water-races	37
Statement showing profits and losses on working for fifteen years	37
Gold- and Silver-mining	38–132
Quartz-workings	38, 89
North Island	38–76
Auckland District	38, 39
Puhipuhi	38, 39
Great Barrier Island	39, 40
Coromandel District	40–42
Tokatea Range	41
Scotty's Company	41
Kapanga Company	41, 42
Tiki, Kopukaitahi, Waikoromiko, and Opitonui	42
Owera Company	42
Matarangi	42
Kuaotunu	42–45
Try Fluke Company	43
Cassel Plant	43, 44
Red Mercury Company	44
Great Mercury Company	44
Mariposa Company	44
Just-in-Time Company	44, 45
Mahakirau	45, 46
Thames District	46–49
Thames Drainage Board	48
Tapu	49, 50
Tararu	50
Norfolk Company	50
Shellback	50
Kuranui	50
Hansen's Claim	50
Comers' Claim	50
Hazelbank	50
Moanataiari	50, 51
Moanataiari Company	50
New Alburnia Company	51
Dixon's Extended Company	51
New Whau Company	51
Grahamstown	51, 52
Saxon Company	52
Waiotahi	52, 53
Waiotahi Company	52
Cambria Company	52, 53
Fame and Fortune	53

Page

Quartz-workings—*continued.*
North Island—*continued.*
Waiokaraka and Collarbone 53
Karaka 53
Una Hill and Te Papa 53
North Star Goldmining Company .. 53, 54
Hape Creek 54
Tailings Plant 54, 55
Table of Number of Acres held in Claims and Licensed Holdings in Thames District, with Number of Wages-men and Tributers employed, Quantity of Quartz crushed, and Yield of Gold 55, 56
Crushing-plants at Thames .. 56–62
Cambria Battery 58
Moanataiari Battery 58, 59
Saxon Battery 59, 60
Bull's Battery 60
Hansen's Battery 60
Foreshore Tailings Company 61
Comers' Battery 61
Norfolk Battery 61
Dickson's Battery 62
Sylvia Battery 62
Waiotahi Battery 62
Brown's Tailings-plant 62
Ohinemuri District 62–73
Karangahake 62–67
Crown Company 60
Plant 65
Tramway 65
Battery-site 65
Crushing-battery 65, 66
Stamp-mortars 66
Stamps 66
Cyanide-plant 66, 67
Woodstock Company 67
Ivanhoe and Truro Company 67
Owharoa 67
Waitekauri 67, 68
Lowerie Brothers' New Find 68
Waihi 68–70
Waihi Gold and Silver Company .. 69
Silverton Company 69
Tui Creek 70, 71
Thames Lead- and Silver-mining Company 71
Waiorongomai 71–73
Battery and plant 72, 73
Statement of results of Working Mines in Ohinemuri and Waiorongomai Districts for Year ending 31st March, 1893 73
Comparative Statement of Return for Hauraki District for Years ending 31st March, 1892 and 1893 74
Statement showing the whole of the Quartz-crushing Machines and Appliances for treating Auriferous and Argentiferous Ores in the Hauraki Mining District for the Year 1892–93 .. 75
Table of Tons of Stone and Mullock crushed and yield of Gold from Northern Gold-fields from 1878 to 1892 76
Middle Island 76–89
Marlborough District 76, 77
Waikakaho 76, 77
Collingwood District 77
Reefton 77–83
Comparative Return of Crushings and Yield of Gold 77, 78
Table of Quartz-mining Companies engaged 78–80
Keep-it-Dark Company 81
No. 2 South Keep-it-Dark Company .. 81
Wealth of Nations Company 81
Hercules Company 81
Globe Company 82
Progress Company 82
Cumberland Company 82
Golden Lead Company 82
Big River Company 83
Fiery Cross Company 83
Welcome United Company 83
Lyell District 83, 84
Tyr Connell Company 84
United Italy Company 84
Lyell Creek Extended Company 84
Battery Returns for Year ending 31st March, 1893 .. .. .. 84, 85
Westland District 85
Otago District 85–87
Nenthorn and Barewood .. 85, 86
Bonanza Company 86
Barewood Reefs 86
Old Man Range 86
Crossan and Gray 86
Macetown 86, 87

Page

Middle Island—*continued.*
Otago District (Macetown)—*continued.*
Tipperary Company 87
Shotover 87
Gallant Tipperary Company 87
Skippers' 87
West Coast Sounds 87–89
Wilson's River 87–89
Prospector's Claim 88
Battery Returns, Otago District 89
Statement of Affairs of Mining Companies, as published in accordance with "The Mining Companies Act, 1890" 90–92
Geological Formation of Kuaotunu: Report on, by James Park, Esq., F.G.S., Director, School of Mines, Thames.. .. .. 93, 94
Alluvial Mining 95–132
Middle Island 95–132
Marlborough District 95, 96
Mahakipawa 95, 96
Hibernian Company 95
King Solomon's Mine 95
Golden Gate Company 96
Alice Fell Company 96
Davis and Carr's Claim 96
Wakamarina 96
Nelson District 96, 97
Collingwood 96, 97
West Coast 97–106
Westport District 97–99
Charleston.. .. .. 97, 98
Addison's Flat 98, 99
Grey Valley District 99, 100
Kumara District 100–102
Hokitika District 102–104
Waimea 102
Arahura 102, 103
Humphrey's Gully Company 103
Rimu 103, 104
Craig's Freehold 104
Ross 104, 105
Ross United Company 105
Mont D'Or Company 105
Rangitoto 105, 106
Otago District 106–125
Maerewhenua 106
Waipori 106, 107
Waipori Amalgamated Deep Lead Company 106, 107
Tuapeka District 107–111
Bluespur Company 107–111
Geological Formation of Bluespur 109
Genesis of Bluespur Deposit 110
Local Industry Company 111
Clutha Valley 112–115
Island Block Company 112
Island Block Extended Company 113
Hercules No. 1 Company .. 113, 114
Hercules No. 2 Company 114
Roxburgh Amalgamated .. 114, 115
Bald Hill Flat 115, 116
Mount Buster 116, 117
Guffie and Inder's Claim 116
Scotch and Cornish Company 117
Kyeburn.. 117
Mount Ida 117, 118
Blackstone Hill 118, 119
Black's 119
St. Bathan's 119–121
John Ewing's Claim 119, 120
Eagle and Gray's Claim 120
M. and E. Company's Claim 120
P. Tiernan's Claim 120
St. Bathan's Sludge-channel Company .. 120
Vinegar Hill 121
John Ewing's Claim 121
Hughes' and Morgan's Claim 121
Vinegar Flat 121
Watson and party's Claim 121
Cambrian's 121
Muddy Creek 121, 122
Matakanui and Tinker's 122, 123
Matakanui Company 122
Undoubted Company 122
Reid and party 122
Mountain Race Company 122
Ewing and McConochie's Claim 123
Morgan and Sims' 123
Clyde 123
Bannockburn 123, 124
Cardrona and Criffel 124
Arrow River 124, 125
Shotover 125
Davis Brothers' Claim 125

Page

Alluvial Mining—*continued.*
Shotover—*continued.*
R. Johnstone's Claim 125
Londonderry Terrace Sluicing Company .. 125
Aspinall's Claim 125
Southland District 125–128
Round Hill 125–127
Round Hill Syndicate Company 126
Wilson's River 127, 128
Dredging 128–132
West Coast 128, 129
Taylor's Dredging Company 128
Alexandra dredge 128
Matakitaki dredge 129
Otago District 129–132
Waipori 129, 130
Jutland Flat Company 130
Clutha Valley 130, 131
Shotover 132
Sandhills Company 132
Artesian Well-boring, Maniototo Plains.. .. 132
Geological Explorations of the Northern Part of Westland, by Alexander McKay, F.G.S., Mining Geologist 132–186
Memorandum of Instructions for Mr. McKay 133, 134
Physical Aspect and General Geological Structure of the District examined 134–145
District East of the Main Range .. 134, 135
Northern Part of Westland 135, 136
Physical Characteristics of the Northern Part of Westland 136
Grey River System, Valley of the Arnold River 136–137
Teremakau Valley 137–142
Kapitea Creek 142
Waimea Creek 142
Arahura Valley 142–144
Houhou Creek 144
Hokitika Valley 144–145
Mahinapua Lake and Creek 145
Totara Valley 145
Mikonui River 145
Historical Notes of the Discovery of Gold in the Northern Part of Westland .. 145–149
Examination of the District in connection with the Development of the Mineral Resources of Westland 149–155
Extracts from the Works of previous Observers who have dealt with the Geology of the Northern Part of Westland 155–158
Table of Formations present 158
I. Recent 159–162
Littoral Deposits 161
Ia. Pleistocene 162
High-level Old River-channels and Terraces 162
II. Pleistocene and Younger Pleiocene 162–167
Extended Glacier deposits outside the limits of the mountains 163
River deposits formed prior to the advance of glaciers 164
Marine gravels containing auriferous black-sand leads 166
Marine gravels of Sandy's Hill .. 167
III. Older Pleiocene and Upper Miocene 167–170
Humphrey's Gully beds 168
Old Man bottom (Moutere gravels of Geological Survey classification) .. 170
Brown sands 170
IV. Miocene Marine Tertiary Beds 170
Blue fossiliferous sands and marly clays .. 170
VI. Cretaceo-tertiary 171
X. Trias 171
XII. Carboniferous 171, 172
Metamorphic (mica-schists) .. 172, 173
Plutonic (granites) 173
Concluding Remarks 173–182
Appendix.—List of Minerals and Rock Specimens Collected during the Progress of the Examinations described in the foregoing Report 182–186
Samples Analysed 185–186
Metalliferous Workings 186–188
Manganese 186, 187
Antimony 187
Quicksilver 187
Scheelite 187, 188

Page

Mining Machinery 188, 216
Otis Ore-crusher 188, 189
Carr's Disintegrator 189, 190
Lührig's Concentrating Plant .. 190–196
Mr. Newbery's report on .. 193–196
Grinding-pan for Ore 196
Complete Specifications of recent Inventions in Mining Machinery 196, 203
Improvements in Amalgamating Machines having Rotary Mullers and stationary Pans 197–199
Improvements in Amalgamators .. 199–201
Improved Grinding, Separating, and Amalgamating-pan 201–203
Dredger for the excavation of gold-bearing river-beds, &c. 203
River-dredging in Otago, Paper on, by T. A. Rickards, Esq. 204–207
Electric Pumping-plant at Newton Colliery, Northumberland 207
Shedlock's Process for Refractory Ores .. 207, 208
A New Gold-extracting Process .. 208, 209
Lockwood-Chappel Process: Successful Application of the Treatment 209, 210
Jordan's Patent Centrifugal Gold Process 210, 211
Variations in the Milling of Gold Ores, Otago: Paper by T. A. Rickards, Esq. 211–215
The Present Status of Stamp-milling .. 215, 216
Different Methods of Extracting Gold from Ores 216–222
Gold-amalgamation Methods .. 216, 217
Gold-amalgamation Methods .. 217–222
Some Points in Silver-mining by Amalgamation: Paper by C. H. Aaron, Esq. .. 222–227
Austin's Patent Amalgamator .. 227–228
Fine Gold Extraction, by Reading and Rigby's Patent Amalgamator 228
Chemistry, and Use of the Cyanide Process 228–233
The Cyanide Process in South Africa .. 233–237
Molloy's New Cyanide Process 237
The Cyanide Patents 237, 238
Improvements in the Cyanide Process 238
Specification: Improvements in the Extraction of Gold and Silver from Ores and Compounds containing the same 238, 239
Specification: Improvements in the Extraction of Gold and Silver from Ores and Compounds containing the same, and in Apparatus applicable for Use in the Treatment of such Materials by means of Solvents 239–241
Coal-mining 241–253
Whangarei 241, 242
The Continental Method of Making Coke 242–250
Production of Coke in New South Wales 250–253
Mine-managers' Examinations: Questions used at the last Examinations under "The Coal Mines Act, 1891," and "The Mining Act, 1891" 253–260
List of Mine-managers who have obtained Certificates under the Mining and Coal-mines Acts of 1886 and 1891 260–263
Summary of Works constructed .. 263–275
Statement showing the whole of the Different Classes of Works constructed by the Department, either by Direct Grants or by Subsidies to Local Bodies, during the last Eleven Years (the votes for this purpose having been under the control of the Hon. the Minister of Mines), for the purpose of opening up the mineral belts throughout the colony and also for the development of the mining industry 263–265
List of Works undertaken wholly by the Mines Department, or by Subsidies, in progress on the 31st March, 1893 (Tables) 267–269
List of Works on Goldfields constructed wholly by the Mines Department, or by Subsidies to County Councils, Local Bodies, and Prospecting Associations, and completed prior to the 31st March, 1893 269–275
Water-races, Sales of Water, &c. 276
Appendices:
Appendix I.—Wardens' Reports.
Appendix II.—Statistical Tables, in connection with Goldfields.
Appendix III.—Inspection of Mines.
Appendix IV.—Statistical Tables, in connection with the Working of Coal-mines.

1893.
NEW ZEALAND.

THE GOLDFIELDS OF NEW ZEALAND:

REPORT ON ROADS, WATER-RACES, MINING MACHINERY, AND OTHER WORKS IN CONNECTION WITH MINING.

Presented to both Houses of the General Assembly by Command of His Excellency.

Mr. H. A. GORDON, F.G.S., Inspecting Engineer, to the Hon. R. J. SEDDON, Minister of Mines.

SIR,— Mines Department, Wellington, 8th June, 1893.

I have the honour to submit my annual report, for the year ending the 31st March last, on the different works undertaken and constructed either by the Mines Department or by subsidies paid to local bodies; also, on Schools of Mines; water-races controlled by the department, and generally on the development of the mining industry throughout the colony.

The different subjects are classified under the following heads: "Subsidised Roads and Tracks;" "Roads Constructed by direct Grants;" "Prospecting;" "Schools of Mines;" Water-races;" "Gold-mining;" "Quartz Workings;" "Geological Formation of Kuaotunu, by J. Park, F.G.S.;" "Alluvial Workings, including Hydraulic Sluicing, Dredging;" "Geological Exploration in Westland, by A. McKay, F.G.S.;" "Metalliferous Workings;" "Mining Machinery;" "Variations in Milling Gold-ores;" "Different Methods of Extracting Gold from Ores;" "Amalgamation Appliances;" "Chemistry, and use of the Cyanide Process;" "Coal;" "Continental Method of Making Coke;" "Examination Papers recently used in Mine-managers' Examination;" "Statistical Tables showing the Value of Works Constructed;" and "List of Mine-managers holding Certificates."

SUBSIDISED ROADS AND TRACKS (NORTH ISLAND).

BAY OF ISLANDS COUNTY.

Road, Tamarere to Puhipuhi.—A subsidy to the extent of £241 was authorised for this road some two years ago, and out of this £146 has been paid, leaving a balance of £95 still as a liability should the County proceed with the work; but as there is little or no mining being carried on at Puhipuhi, very little work has been done on this road last year, the total expenditure for the year being £72, of which amount a subsidy of £36 was paid.

COROMANDEL COUNTY.

Road, Sea Beach to Kuaotunu.—This road has been in a bad state every winter since it was constructed. During last winter the road became impassable for drays, and a special grant of £500 was given towards metalling the road; but it took the whole of the grant to keep the road open for traffic, and any metal put on it quickly disappeared into the quagmire. The total cost of the road up to the end of the year was £900: of this amount, £700 was paid in subsidies and grants; and at the end of March there was a liability of £450. Since then the whole of this money has been paid.

Road, Coromandel to Kuaotunu.—There is a considerable amount of horse-traffic on this road. A portion of it is constructed, but there still remains some bad hills, which can be avoided by constructing a road round the foot of them, and through a swamp. The estimated cost of this work is £300, of which amount a subsidy has been authorised to the extent of £150.

Road, Just-in-Time Extension.—This is the extension of a road which was constructed some years ago to the Just-in-Time Mine. The extension is required to allow machinery to be got to Blagrove's Freehold, where the Kapanga Company have been sinking a shaft, and cannot proceed further until pumping machinery is erected. The estimated cost of this extension is £300, of which amount a subsidy to the extent of £150 was authorised, and out of this £75 has been paid.

THAMES COUNTY.

There has been very little paid as subsidies to this county for roads during the last year, as it could not find its portion of the money. A subsidy has been authorised for a horse-track up the Upper Taruru Creek to the extent of £150, but no work has yet been done.

OHINEMURI COUNTY.

Road, Karangahake to Waihi.—There is a very steep hill to go over between Owharoa and the crossing of the Waitekauri Creek on the present line of road, and it was represented that a very good grade could be got by following up the Ohinemuri River for some distance, and up the valley of the Waitekauri Creek. The estimated cost of the deviation was £600. A subsidy was authorised to the extent of £300; plans and specifications were got out for the first section of the work, and approved, but it was afterwards found as they proceeded with the survey that no better grades could be got than on the present line of road, and consequently, after spending £57 10s., this deviation has been abandoned. The subsidy paid on the work was £28 15s.

Bridge over Ohinemuri River at Karangahake.—This is a bridge across the Ohinemuri River to give further facilities to get quartz taken to the crushing-plant which has recently been erected by the Crown Company, and it will give access to the mines, which are all on the opposite side of the river from the present road. Designs for the bridge were prepared by the Public Works Department, and the County Chairman now wishes it to be constructed under one of the Government engineers. It was originally estimated to cost £1,100, and a subsidy of £550 was authorised; but it is now estimated to cost £1,280.

MIDDLE ISLAND.

There have been very few roads constructed on the subsidising principle last year in the Middle Island, the goldfields counties' revenues not admitting of this being done. Very little money has been spent on those roads and tracks which were referred to in my last report under the head of "Subsidised Roads and Tracks," and therefore it is not necessary to again refer to them.

ROADS CONSTRUCTED FROM DIRECT GRANTS.

Road, Terohanga Gorge to Puhipuhi.—This is a continuation of the road from Tamarere to Terohanga Gorge, in the Bay of Islands County. It is constructed from this gorge to Mr. Parson's homestead, which is about two miles and a half from the quartz workings at Puhipuhi. The estimated cost of the work was £800, and of this amount £702 7s. has been paid.

Horse-track, Cabbage Bay to Port Charles.—A horse-track has been completed from Coromandel to Cabbage Bay, and a continuation of this track is in course of construction to Port Charles; about two miles and a half, between the sea-beach at Cabbage Bay and Port Charles, has been completed, but there are still about twelve miles to construct, and through a very rough broken country. An authority for £360 was given towards this work, and of this amount £200 has been paid.

Road, Tiki to Makikarau.—This is portion of the road from Coromandel to Mercury Bay. An authority for £250 was given towards this work, and of this amount £210 has been paid.

Horse-track, Coromandel to Kuaotunu.—This track is being constructed partially by subsidies and partially by direct grant. An authority was given for £200 towards the construction of this track, and the whole of this amount was paid during last year.

Horse-track, Kuaotunu to Mercury Bay.—A horse-track has been constructed from the end of the dray-road coming from the sea-beach at Kuaotunu to Mercury Bay. The cost of this road was £350, and the whole of this money has been paid, and the road completed.

Road, Thames to Manaia.—This is portion of the main road between the Thames and Coromandel. A grant of £500 was authorised towards this road, and the whole of this money has been paid. The road is now in a fairly passable state, but it is very liable to slips on the Thames end, and it causes considerable trouble to the Thames County to keep it in repair.

Horse-track, Puriri to Tairua.—This is a continuation of a horse-track constructed several years ago by the Lands Department, from the Puriri Valley towards Tairua. This track was constructed for about three miles, and as it ended in a dense bush, it never could be utilised. Contracts have recently been let to continue on this track towards Tairua, to the gold-workings on the east side of the range. A grant of £300 was given towards the construction of this track, but none of the money has yet been paid.

Road, Havelock to Mahakipawa.—This is a road along the side of the range facing the Mahakipawa arm of the Pelorous Sound, and crosses over a low saddle and through the marshy flats into Havelock. Arrangements were made with Mr. Cullen for getting through his freehold property some time ago, and a subsidy was previously authorised the Pelorus Road Board if they could find their portion to construct it; but nothing was done until last year, when about three miles and a half of it on the Mahakipawa end was constructed under the supervision of the Public Works Department on the co-operative principle. The cost of the work up to the end of March last was £1,311 9s.

Track, Mahakipawa to Waikakaho.—This is a horse-track from the end of the present one up the side of the Mahakipawa Creek, over the range, to join the track constructed by the Ravenswood Company from the Waikakaho Valley to their quartz-workings on that side of the range. A grant of £150 was authorised for this work, which is now in progress. When completed, it will be a great boon to the miners on both sides of the range, and likely to be the means of further prospecting being done.

Horse-track, Aorere Valley to Karamea.—This track has been under construction for several years, and contracts were let last year to complete it from the Aorere Valley to the mouth of the Heaphy River, a distance of thirty-six miles. The track has also been constructed from the Mokihinui to near Karamea, and from Karamea to near the Kohai Bluff. When the present contracts are completed there will still be about eleven miles to construct between the mouth of the Heaphy River and the Kohai Bluff, to give direct communication along the coast-line from Collingwood to Jackson's Bay. The total cost of this road, including the contracts now in progress, is £29,620 17s. 3d., of which amount £28,202 5s. 11d. has been paid, leaving a liability at the end of March last of £1,760.

Track, Oparara through Gorge.—This is a track to connect the Karamea with the gold workings through the gorge of the Oparara River. The estimated cost of the work is £150, of which £75 has been paid.

Bridge, Okira Creek.—This is a new bridge over what is locally known as Dirty Mary's Creek, on the road from Westport to Charleston. The estimated cost of the work is £100, of which amount £50 has been paid.

Horse-track to Diggings, Cape Foulwind.—This is a road from the railway-line going from the harbour-works to Cape Foulwind, to connect with the diggings which have recently been discovered on the first terrace back from the sea-beach. The estimated cost of a road to connect with all the workings is £400. Of this amount £150 has been paid. A grant of £100 has also been authorised for the construction of a bridge over the lagoon.

Bridge, Nile River, at Charleston.—This is for building new piers and renewing the superstructure of the bridge on the Westport-Charleston road. The estimated cost of the work is £800, of which amount £701 12s. has been paid, leaving a balance of £98 8s.

Track, Mokihinui to Little Wanganui.—This is for repairing damage done by floods, the cost of which was £200, and the whole of the money has been paid.

Track, Burnett's Face, Coalbrookdale.—This is a horse-track to connect the coal workings with the one constructed from Denniston towards Cedar Creek. The cost of the work was £200, which has been paid.

Road, Devil's Creek to Big River.—This is partially for widening the horse-track which has been constructed for several years, and partially for making a deviation so as to give communication to all the claims on the line of reef leading from the Globe to the Big River. The road has been partially constructed on the subsidy principle, and partially by direct grant. The latter amount authorised is £1,750, of which £1,617 19s. has been paid.

Road to Painkiller.—This is a road from the Waitahu River, near the crossing on the short road to Boatman's from Reefton, to the Charles Russell Mine, to enable machinery to be placed on the ground. The cost of the work is estimated at £100, and this amount has been authorised.

Road, Hampden to Horse Terrace.—A horse-track has been constructed between these points for many years, and the Survey Department some five years ago altered it into a dray-road for the first five miles out from Hampden. The rest of the distance to the crossing of the Matakitaki River has been partially completed, and is in progress. The cost of the work, including the contracts in progress, has been £2,850, of which amount £1,965 15s. has been paid.

Road, Cobden to Seventeen-mile Beach.—This road has been constructed for some time, with the exception of one portion which was done last year. The cost of this was £400, and the whole of the money has been paid and work completed.

Horse Track, Hatter's Terrace to Haupiri.—This is the continuation of the track from Hatter's Terrace to Bell Hill, going onwards towards the Kapara River in order to give communication and open up the country. A grant amounting to £800 has been authorised for this work, which is in progress, and £600 of this amount has been paid.

Track, Grey River to Moonlight.—This is a track from the road leading up the north side of the Grey River to the Moonlight Diggings, where considerable mining operations are being carried on. A grant of £300 has been authorised for this work, but no payments have yet been made.

Track, Black Ball.—This is to improve the horse-track to the diggings up the Black Ball Creek; the present track is very steep, and in bad order. The estimated cost of improvements is £250, which has been authorised for this work.

Great South Road.—This is widening the horse-track from the Waitaha River in the Westland County towards the Wanganui River, so as to give facilities for the southern portion of Westland to be opened up. The distance now widened is fourteen and a half miles, and the expenditure on the work up to the end of March last amounted to £2,702 16s. 3d.

Horse-track, Cascade to Barn Bay.—This is a track from the Cascade River, where the road crosses it, to the sea-beach at Barn Bay. When this track is completed it will give facilities for men to prospect the sea-beaches and terraces between this and the Gorge River. A grant of £443 was authorised for this work, and of this amount £411 7s. has been paid.

Road, Tucker's Flat.—This is the continuation of a road from Kanieri into the bush, for the purpose of getting out mining-timber and firewood. The estimated cost of extension is £264, of which £104 has been paid.

Road, Dillman's to Larrikin's.—This is a road through the worked-out ground from Dillman's to foot of the Kapitea Hill, to give facilities to bring goods and mining-timber to the claims in Larrikin's Flat. The estimated cost of the road is £130, which has been authorised for its construction.

Horse-track, Gillam's Gully.—This is a track to open up the country and allow the miners an opportunity to prospect. The cost of the work is estimated at £150, which has been authorised.

Bridge over Mahinapua Creek.—A bridge has been constructed across the Mahinapua Creek, to allow wheeled traffic to pass between the different places and gold-workings on the sea-beach and terraces. The cost of this work has been £503 16s. 10d., which has been paid.

Sundry Tracks, Westland.—Several tracks to different parts of the country have been authorised, but no money has yet been paid on the works.

Bridge, Kawarau River.—This is a renewal of the piers of the Victoria Bridge, on the Kawarau River. The present piers are greatly decayed and might collapse at any time. The work of renewing them is in progress, which is estimated to cost £725; of this amount a subsidy to the extent of £362 10s. has been authorised, but none of it has been paid.

Road, Miller's Flat to Skippers.—This is a road up the side of the range, from Millar's Flat, to join the Shotover-Skipper's Road near the Saddle. When completed, it will afford a ready communication between the Upper Shotover, Skippers, and Arrowtown. The estimated cost of the work is £400, which has been authorised, but none of the money has been paid.

Road, Arrowtown to Macetown.—This is a road along the gorge of the Arrow River to avoid a number of crossings; it joins the road which was constructed to Macetown some nine years ago. The estimated cost of the work is £450, of which £300 has been paid.

Track, Pleasant Creek Terrace.—This is a track which was authorised some two years ago, and has been constructed, but the grades are far too steep to be a serviceable track. A grant of £130 was authorised for its construction, but until such time as the lower portion of the track is deviated, so as to get a good grade into Pleasant Creek, no money will be paid.

Road up Dart River.—It was represented to the Government that the upper portion of the bed of the Dart River was taken up in dredging-claims, and that dredges were going to be constructed to work it. A road was made through places where the drays or sleighs could not follow the river, to allow machinery to be brought on to the ground. The cost of this work was £200, which has been paid; but there is no sign yet of any dredges being constructed to work the riverbed.

Tracks, Western Sounds.—A reconnaissance survey was made by one of the Public Works engineers to ascertain if a road could be constructed between Lake Wakatipu and Milford Sound. The work was put in hand some three years ago, and a line of road from Lake Wakatipu up the side of the Greenstone River to Lake Howden surveyed; a survey was also commenced at the Milford Sound end, and carried up to near the head of Lake Ada. It was deemed desirable to construct this road with prison labour, and forty-five prisoners were sent down to Milford Sound to construct a road from the Sound up to Sutherland's Falls. After being there for about eighteen months they were taken away, as it was found too costly to have the work carried out in this manner. The prisoners made about 40 chains of dray-road and a mile and a-half of horse-track during the time they were there. A party of men were sent down in the beginning of summer last year, and they have constructed a track from the Landing at the head of Lake Ada to about one mile beyond the Poseidon Hut, and they cleared the track from this on to Sutherland's Falls, and put up new bridges, so that visitors or tourists will have no difficulty now in getting from the Sounds to the Falls. They also constructed a foot-track up to the top of the Bowen Falls. The total cost of this work up to the end of March last was £3,618 18s. 8d.

Horse Track, Waiau to Preservation Inlet; and Road, Cromarty to Reefs.—The survey has been carried on during the last year for some three miles nearer the Waiau River from the Preservation Inlet end, and the formation of a horse-track completed to Wilson's River, a distance of seven miles from the Inlet. Contracts are now in progress for metalling portions of the road, and where metal cannot be procured corduroy is being used. The formation is far too soft to admit of horse-traffic, even during the summer months. This road is in the right direction for opening up the country between Preservation and the Waiau, but is of no use to get machinery brought on to work the reefs, which are about three miles further up the gorge of Wilson's River than where the road crosses. A survey is now being made from Kisbec Bay, where the Township of Cromarty is laid out, to the prospector's claim, with the view of constructing a tramway. The worst grade on the line is 1 in 10, and this is only for a short distance. The whole of the line has been located, and it is now being pegged out, the distance being 5 miles 18 chains. The cost of the works in this neighbourhood up to to the end of March last was £2,126 9s. 1d.

Tracks, Stewart Island.—A grant of £200 was authorised to construct tracks in Stewart Island. This work is being done under the supervision of the Survey Department at Invercargill. The expenditure up to the end of March last was £37 16s.

Artesian Well-boring, Maniatoto Plains.—A contract was let to Job Osborne, of Christchurch, to put down a bore to a depth of 500ft. on the Maniatoto Plains, the site selected being near the side of the main road to Dunedin, about 30 chains on the Kyeburn side of the Eweburn Hotel. The contract is completed, and arrangements made with the contractor to bore to a further depth of 150ft. The material gone through is of a very compact character, and would be capable of resisting a strong pressure of water. If a loose porous stratum can be met with, there is a great possibility of an artesian well being got. The contract for the 500ft. bore was £550, of which £281 3s. 6d. has been paid.

PROSPECTING ASSOCIATIONS.

The miners in different goldfields in the colony have formed prospecting associations, and done a great deal of useful work during last year. The greatest interest in this work is being taken by the miners on the West Coast, especially in Westland, of the southern portion of which there is very little yet known about. Almost in every little centre associations have been formed, and money subscribed, to carry on prospecting operations; and subsidies have been given towards this work principally in accordance with Part XV. of the regulations made under "The Mining Act, 1891." Subsidies of the following aggregate amounts have been paid to different associations in each of the goldfields counties—namely: Ohinemuri, £20 1s. 4d.; Inangahua, £171 5s. 11d.; Westland, £659 0s. 11d.; and Otago, £2 1s. 10d.: making a total of £852 10s. that has been paid towards prospecting during the past year. There were several prospecting parties sent out by the Thames Miners' Association, and some of these have recently discovered an auriferous lode, which is considered payable for working. No subsidy has yet been paid to the associations in this county.

SCHOOLS OF MINES.

The schools of mines are continuing to do good work, and more interest seems to be taken in them as year by year passes by. The mine-managers on all the principal quartz-fields now readily acknowledge the necessity and utility of men who intend to follow up mining having a good

technical knowledge on all subjects in connection with metals and minerals, and their extraction from the ores, and more especially the metallurgy of gold and silver. The establishment of these schools at the principal quartz-mining centres affords those who are employed in the mines an opportunity of attending the night classes; and men, in many instances, leave the districts they have been working in for years to go to places where schools are situated in order to avail themselves of the benefits to be derived from the technical teaching there given. It is, however, only in large mining centres where these schools will be well attended. Men following the occupation of miners can neither afford the time nor the money to leave off their work and study these subjects at a university in a large town, and, moreover, many of the students who attend the classes at the schools of mines would not attend classes at a university, even if they could afford the time and money. There is no doubt that the establishment of these schools in mining districts is one of the greatest benefits that ever has been conferred on the working classes, and they are highly appreciated by both young and old. Not only does one find young men in the prime of life studying at these schools, but in many cases men who have passed the prime of life, who have spent the best part of their life underground, are to be seen engaged at their studies, eagerly thirsting for a technical knowledge on subjects which they are fully acquainted with the practical working of.

THAMES SCHOOL OF MINES.

At the Thames School, last year, the average number of students was 105; of this number there were fifty-two registered students, and fifty-three students attending Saturday lectures. During the year there were twenty-one samples of ore tested, in parcels varying from 70lb. up to 2,940lb; the total aggregate weight of ore tested being 22,819lb., or 10 tons 3cwt. 3qr. nearly. The percentage of the assay-value obtained varied from 36·8 per cent. to 95·8 per cent., the average percentage obtained from the whole of the parcels being 78·3 per cent; the lowest percentage of the value recovered being from ore from the Great Barrier Island, containing ruby or antimonial silver, which would only yield up the bullion after chloridizing roasting, but the assay-value showed it to be of too low grade to pay for this being done. Of another parcel of ore from the Silver Queen Mine, Maratoto, only 40·8 per cent. of its value was recovered, the silver existing in the ore in the form of a telluride. According to assay the ore contained about 5oz. gold and 271oz. silver to the ton, of which 94·2 per cent. of gold was recovered, and only 15·4 per cent. of the silver. Experiments in the laboratory showed that 50 per cent. of the silver was volatilised at a bright-red heat in less than two hours.

Mr. Park has been also making sample assays of crushed ore at several batteries, the ore being taken from the splash through the grating at intervals of about every fifteen minutes, and put into a tub, and assay made from the collected ore. From the Alburnia Mine, 27 tons of general quartz was crushed at the Cambria Battery, having an assay-value of £33 4s. 6d. per ton, representing a total value of £897 1s. 6d. From the copper-plates bullion to the value of £30 0s. 7d. was recovered, and from the berdans £432 15s. 5d.; thus showing that 3·3 per cent. of the bullion was recovered from the plates, and 48·2 per cent. from the berdans, or a total saving of 51·5 per cent.

Assay samples were also taken from ore crushed at the Moanataiari Battery in the same manner as those from the Alburnia ore. The quantity of surface-dirt, or mullock, operated on was 700 tons, which gave an assay-value of 14s. 3d. per ton, making the assay-value of the ore £498 15s. The total value of bullion extracted was £103 0s. 7d., being only 20·6 per cent. of its assay-value. A test was likewise made from a sample of 400 tons of quartz and some picked stone, the general stone having an assay-value of £1 10s. 9d. per ton, or £615, and the picked stone £110 6s. 7d., making a total value of £725 6s. 7d. The value of bullion recovered was £374 5s. 11d., being 51·5 per cent of its assay-value. Taking the general quartz without the picked stone, the value of bullion recovered was £263 19s. 4d., or only 42·9 per cent. of its assay-value. A second test was made from the same battery from a parcel of 230 tons of general quartz, which had an assay-value of £1 7s. 9d. per ton, or £319 2s. 6d. The value of the bullion recovered was £163 2s. 10d., being 51·1 per cent. of the assay-value. Also, another test was made from 400 tons of surface-mullock, which had an assay-value of 10s. per ton, or £200, the value of the bullion recovered in this instance being £92 0s. 9d., or 46 per cent. of the assay-value.

Samples were also assayed from the Norfolk Battery, in which 20 tons of quartz from the North Star Mine was crushed, the assay-value of this quartz being £13 14s. 6d. per ton, or £274 10s. The value of the bullion recovered was £110 15s. 6d., being 40·3 per cent. of the assay-value.

It will be seen from this that there is a very large loss in bullion from the present method of extraction. Before these tests were made by Mr. Park the mill managers were confident they were saving at least 75 per cent. of the assay-value of the ore. The samples from the various batteries being taken every fifteen minutes and put into a tub, and when the whole of the parcel of quartz was crushed the tub was forwarded to the School of Mines, and there the material was thoroughly mixed and assay samples taken from this, which ought to give the average value of the ore very correctly. Now that the mill-men know what they are losing it will make them exceedingly careful to see if they can by any other method extract a larger percentage than has formerly been done.

The following is a report by James Park, F.G.S., the Instructor and Director of the Thames School, on the progress made for the year ending 31st March, 1893:—

"I have the honour to report that during the past year the most satisfactory progress has been made in all the branches of study and work undertaken at the school. The attendance has also been well maintained, the average number of individuals having been 105, and for the previous year 111. The large average attendance is a very gratifying circumstance, considering the severe depression which has prevailed at the Thames during the past two years. A very marked improvement has taken place in the work of many of the advanced students, and it is very pleasing

to record that a number of our students are yearly passing into good appointments connected with mining in all parts of the colony, and are, in every case, giving satisfaction to their employers.

"There has been a considerable increase in the number of parcels of ore treated in the experimental plant, and also an increase in the number of assays and analyses performed for the public.

"During the past six months I have furnished many of the Thames mining companies with reports on the proportion of bullion recovered from the ore treated at their batteries by the ordinary amalgamation processes now in use. The preparation of these reports has involved a large amount of work in addition to the ordinary routine work of the school, but the results obtained and the facts elicited have proved of great interest and importance to the whole mining community. These reports are given in full further on.

"In former years the annual examinations were conducted from papers set by myself. This year, at the request of the Committee, the papers were set and the answers examined by examiners appointed by the Government. This new arrangement has proved in every way a success, and the results of the examinations by independent examiners show most conclusively that much good and sound work is being accomplished at the school, and great satisfaction has been expressed by the Committee, the students, and the public. The results and details connected with the examinations are given further on.

"On the 1st of April the Hon. the Minister of Mines appointed Mr. F. B. Allen, M.A., B.Sc., as my assistant, and he has already proved himself a valuable and able teacher.

"The attendance at the different classes is shown in the following tabulated statement:—

"TABLE OF ATTENDANCE for Year ending the 31st March, 1893.

Name of Class.	1892.			1893.
	First Term.	Second Term.	Third Term.	First Term.
Practical assaying	34	38	33	26
Practical chemistry and laboratory practice	25	22	22	23
Theoretical chemistry...	25	22	22	23
Metallurgy of gold and silver	...	21	21	...
Mineralogy and blow-pipe determination	11	10	10	7
Geology and geological surveying	9	9	9	7
Mining, applied mechanics, and hydraulics	15	15	9	13
Land and mine-surveying	20	17	16	15
Mechanical drawing	12	11	9	9
Saturday Lectures.				
Theoretical chemistry...	46	51	53	...
Physics and experimental science	...	...	...	61
Total attendance at all classes	197	216	204	184
Registered students...	59	57	50	43
Total number of individual students	105	108	103	104

"*Practical Assaying.*—This is one of the best attended and most useful classes at the school. The students are not only taught how to go through the operations of making an assay, but they are also taught how to perform them in a thoroughly reliable manner, and with despatch and precision. They are thus able to pass from the school laboratory into the laboratory of a bank or battery, and to at once go about their work intelligently, and in a workmanlike manner. Among the students of this class who have obtained appointments during the year are Mr. A. Kenrick, who was appointed to the responsible position of assayer to the Bank of New Zealand in the place of the late Mr. Max von Bernewitz; Mr. James McLaren, the medallist for the year, who received the position of assistant assayer in the same bank; Mr. J. Robinson, who has been engaged as assayer and assistant to the Lürig Concentrating Works at Tararu; Mr. Bain Hogg, assayer to the New Zealand Crown Mines at Karangahake; Mr. W. O. Bell, assayer to the Silverton Cyanide Extraction Works at Waihi; Mr. George Hilton, who has been appointed constructing engineer to the Cassell Company in the South Island; and Mr. George Heard, who has been placed in the Thames laboratory of the same company.

"*Practical Chemistry.*—Wet assaying merges into chemical analysis; and most of our students now recognise the fact that in order to become expert and reliable assayers they must possess a knowledge of practical chemistry and chemical manipulations. Many of the advanced students of this class have performed many very reliable analyses of rocks, soils, waters, milk, manures, limestones, coals, and complex ores, and the result would compare most favourably with the best work by the advanced students in the university colleges. Some of the more interesting analyses performed in the school laboratory during the past year are given below:—

"*Pitch-coals, Ngunguru Coalfield, forwarded by Mr. G. Wilson, Inspector of Mines; analysed by G. P. Hilton.*

	Sample A.	Sample B.
"Fixed carbon	52·37	52·72
Hydro-carbons	36·73	36·54
Water	7·31	7·42
Ash	3·59	3·32
	100·00	100·00
Evaporative power	6·80lb.	6·85lb.

"*Analysed by J. M. McLaren.*

	Sample C.	Sample D.
"Fixed carbon	54·30	56·60
Hydro-carbons	34·90	32·50
Water	7·30	7·40
Ash	3·50	3·50
	100·00	100·00
Evaporative power	7·06lb.	7·36lb.

"*Remarks.*—These are bright, lustrous coals, somewhat brittle and flakey. The analyses prove them to be superior pitch-coals, well adapted for steam and household purposes. The ash is white or greyish white; and sulphur was found to be practically absent. They frit together, but do not form a coherent coke.

"*Sample E, Bituminous Coal, analysed by Bain Hogg.*

"Fixed carbon	67·20
Hydro-carbon	25·18
Water	5·42
Ash	2·20
	100·00

Evaporative power, 8·73 lbs. Sulphur, trace.

"This is a superior bituminous coal, occurring as a thin layer in the body of the main seam. It forms a fine hard coherent coke. Coal, brittle, shining; ash, white. The presence of this band of bituminuous coal will tend to raise the average quality of the general mass of the coal in the seam.

"*Bituminous Coal, Hikurangi, forwarded by T. P. Moody, Esq., M.E.; analysed by Comyn Ausley.*

"Fixed carbon	49·62
Hydro-carbons	43·54
Water	5·12
Ash	1·72
	100·00

Evaporative power, 6·45 lbs.

"Specific gravity, 1·297. A fairly hard, lustrous, bituminous coal, forming a fine hard coke. The ash is low, and the hydro-carbons unusually high, for this class of coal. This coal is much superior to the average sample of Hikurangi coal.

"*Black-sand, Coromandel, forwarded by J. Thomson, Esq., Rocklands; analysed by J. M. McLaren.*

"Quartz, and insoluble gangue	82·68
Iron oxides (principally Fe_3O_4	10·94
Alumina	3·68
Water, and loss	2·70
	100·00

"This sand was assayed, and showed the following value per ton:—

	Oz.	dwt.	gr.
"Bullion	41	16	20
Gold	30	10	0
Silver	11	6	20

Value, £123 14s.

"*Complex Sulphide, Koputaiauki; analysed by J. M. McLaren.*

"Silica	15·76
Copper	4·10
Iron	23·41
Zinc	16·64
Sulphur	38·12
	98·03

"This ore contained bullion valued at £3 8s. 4d.

"*Ochreous Hematites, New Caledonia, forwarded by Colonial Bank, Auckland; analysed by A. R. Carnie.*

	A.	B.
"Insoluble gangue	53·80	18·08
Iron oxides	29·56	70·86
Water	16·04	10·12
	99·40	99·06

"The sample marked A was a pale yellowish-red colour. Sample B was a dark blood-red colour, and a most valuable ore of iron.

"*Bituminous Coal, Newcastle, N.S.W.; analysed by George Fleming.*

"Fixed carbon	58·36
Hydro-carbons	33·88
Water	2·84
Ash	4·92
	100·00

Evaporative power, 7·58lb.

"Coal, brittle, lustrous, friable. Forms a soft, spongy coke. Ash grey.

"*Spathic Iron-ore, Norfolk Mine, Tararu; analysed by W. Climo.*

"Silica	2·86
Carbonate of iron	97·34
	100·20

"*Complex Sulphide, Norfolk Mine, Tararu; analysed by H. F. Shepherd.*

"SiO_2	2·40
Fe	2·20
Pb	42·60
Zn	26·10
S	25·60
	98·90

"This ore occurs in nests and small pockets in the clayey or mullocky portions of the lode. It frequently contains free gold adhering to the lead crystals.

Complex Sulphide, Tui Mine, Te Aroha; analysed by Bain Hogg.

"SiO_2	17·00
Cu	4·81
Fe	10·33
Zn	30·67
Pb	4·95
S	33·34
	101·10

"*Complex Sulphide, Tui Mine, Te Aroha; analysed by R. Mellett.*

"SiO_2	16·48
Pb	17·78
Cu	11·96
Fe	5·82
Zn	17·15
Cd	Trace.
Al_2O_3	5·00
S	25·70
	99·89

"This ore contains 30oz. of silver, and a trace of gold, to the ton.

"*Complex sulphide, Tui Mine, Te Aroha; analysed by A. T. Day.*

"SiO_2	11·58
Pb	Trace
Cu	1·54
Fe	Trace
Zn	57·38
Cd	Trace
S	28·57
	99·07

"In the part of the lode from which this ore was obtained, the ore is principally composed of zinc blende.

"Pyrolusite, South Wairoa; analysed by A. T. Day.

"SiO_2 ...	2·60
Iron oxides	6·20
MnO_2 ...	89·76
H_2O and loss	1·44
	100·00

"This is a most valuable and pure ore of manganese, and if it exists in abundance, and in a position easily accessible, it could be worked with much profit.

"Psilomelane, Parua Bay, Whangarei; analysed by A. T. Day.

"SiO_2 ...	13·02
Fe_2O^3 ..	15·27
MnO_2 ...	64·61
H_2O ...	5·32
	98·22

"This is a valuable ore, and is being profitably worked.

"Milk, Parawai, Thames; analysed by A. R. Carnie.

"Water ...	87·01
Fat ...	5·32
Caseine and lactose	7·05
Ash ...	0·61
	100·00

Specific gravity, 1·027.

"This milk was forwarded for analysis by a local doctor, as being the cause of lactic fermentation in the bowels of some infants supplied with it. The analysis shows that it was abnormally high in fat, which would explain its injurious effects.

"Milk, Tararu, Thames; analysed by W. Climo.

"Water ...	87·692
Fat ...	3·011
Caseine and lactose	8·337
Ash ...	0·960
	100·000

Specific gravity, 1·035.

"The analysis showed this to be an average normal milk, and not adulterated, as suspected by the purchaser.

"Fire-clay, Ngunguru Coalfield, forwarded by Inspector of Mines; analysed by W. Climo.

"SiO_2 ...	89·55
Al_2O_3 ...	2·15
Fe_2O_3 ...	Trace
$CaCO_3$ ...	Trace
K_2O ...	1·62
Na_2O ...	4·88
	98·20

"Black Slime, precipitated by Zinc from Potassium Cyanide Solution; analysed by W. Climo.

"Si O_2 ...	29·88
Pb ...	0·60
Fe ...	4·29
Cu ...	0·77
Zn ...	30·69
Ag, Au ...	31·17
S ...	2·54
KCN ...	0·02
	99·96

"It was found that by carefully washing through a fine sieve the greater portion of the bullion could be separated from the mine.

Guano, South Sea Islands.

Name of Analyst.	No.	H_2O.	Organic Matter and NH_3.	SiO_2.	$CaCO_3$.	$CaSO_4$.	$Ca_3(PO_4)_2$.	$MgCO_3$.	K_2O.	Na_2O.	Totals.
G. Fleming	1	6·42	17·16	·92	53·37	trace	19·30	trace	0·23	0·32	97·72
H. F. Shepherd ...	2	5·00	23·50	·70	32·10	1·82	31·50	0·72	1·40	5·10	101·84
H. F. Shepherd ...	3	4·00	14·61	·10	56·00	0·39	19·65	trace	1·50	2·70	98·95
W. J. May	4	5·00	13·60	...	38·29	0·90	34·19	3·18	1·39	2·53	98·18
W. J. May	5	6·80	33·81	·36	44·35	...	9·54	0·36	1·46	1·95	98·63
W. Climo	6	2·55	8·90	·10	64·09	...	9·29	8·66	1·58	5·13	100·30
W. Climo	7	4·50	24·51	·70	34·01	0·47	30·17	0·44	1·01	4·16	99·97
W. Climo	8	3·25	22·05	·25	35·02	2·48	26·73	3·51	1·75	4·94	99·98

"The results of the analysis prove these to be inferior guanos, and, being largely composed of comminuted shells, the calcium phosphates are correspondingly low.

"*Rock, Forming Rocky Point, Tararu; analysed by H. F. Shepherd.*

"SiO_2	72·82
Al_2O_3	19·66
Fe O	Trace
Ca O	0·23
Mg O	1·10
K_2O }	4·10
Na_2O }	
H_2O	0·82
	98·73

"This is the yellowish-white splintery fine-grained rock, forming the rocky headland at Rocky Point, half a mile north of Tararu. Mr. Shepherd's analysis corresponds very closely throughout with that performed by Mr. Skey, the Government Analyst.

"*Crystalline Limestone, Takaka, Nelson; analysed by R. Mellett.*

"$CaCO_3$	92·46
$MgCO_3$	Trace
Al_2O_3	4·28
Fe_2O_3	Trace
SiO_2	2·00
	98·74

"This a valuable limestone for building purposes, and also for burning for lime, being what is known to agriculturists and lime-burners as a *fat lime*.

"*Andesite, Kauaeranga Valley.*

	W. Climo.	*J. Taylor.*
"SiO_2	61·56	61·19
Al_2O_3	9·28	10·84
Fe O	6·32	4·95
Ca O	8·75	8·60
Mg O	2·82	3·59
K_2O	0·11	0·19
Na_2O_2	7·01	7·14
H_2O	2·40	2·59
	98·25	99·09

"Mr. Climo and Mr. Taylor have obtained results which correspond very closely. This rock is a very dense black igneous mass, found in the middle and higher parts of the Kauaeranga Valley, where it occurs in fine regular hexagonal prisms of large size.

"*Theoretical Chemistry.*—This class is principally attended by the members of the Practical Chemistry Class. The attendance throughout the year was very high and most regular. The results of the annual examinatien show that a number of the students have acquired an intelligent understanding of chemical philosophy and the general principles of chemistry, which will be of great value to them in the prosecution of their studies in the practical branches of the science. This class was largely attended by State-school teachers.

"*Mineralogy.*—In this class the students have made rapid and sound progress, both in mastering the principles of the science and also in the discrimination of minerals.

"*Geology and Geological Surveying.*—In this class much time is devoted to the study of physical and stratigraphical geology, and to geology as applied to mining. In the field are studied the reading of natural sections, the dip and strike of lodes and strata, and the displacements and effects due to faults, and cross-courses.

"*Metallurgy of Gold and Silver.*—This class was largely and regularly attended from the beginning. Lectures were given by me on the most approved and modern methods of crushing, pulverising, and concentrating of different classes of ore; also, on the extraction of the gold and silver by amalgamation, chlorination, cyanide, and other leaching processes. Special lectures were devoted to the practice of extraction by means of alkaline cyanides used under the Cassell Company's patent. The instruction dealt with the character of the ores suitable for treatment, the treatment of charges by agitation or percolation, quantity and strength of solutions, standardising and estimating the strength of solutions, washing the pulp, precipitating and subsequent melting of bullion. The chemical reactions were fully explained, and the practice was graphically illustrated by working apparatus, including percolation-jars and vats, and an agitation-barrel actuated by a small Pelton-wheel. Special lectures were also given dealing with all the working details of the American or Washoe amalgamation processes, the different chlorination processes, and the reduction of argentiferous lead-ores.

"*Mining and Applied Mechanics.*—The average attendance at this class throughout the year was only thirteen, as compared with twenty-one of the previous year. This decline is very largely due to the large number of service certificates which have been granted throughout this goldfield under the regulations of "The Mining Act, 1891." The miners to whom these certificates have been issued were the men who principally attended this class, but, having secured their service certificates, they do not care to continue, or undertake, a course of study in order to possess certificates by examination. In course of time the attendance should again increase. During the year three students have been sent up for examination for first-class certificates as mine-managers, and two have passed. The results of the last examination, affecting the last candidate, are not yet known. These two, added to the sixteen mentioned in my last annual report, make altogether eighteen students of the Thames School of Mines who have secured first-class mine-manager's certificates in the course of three years.

"*Land and Mine Surveying.*—This is a popular class, and continues to be well attended. During the year a large number of surveys have been completed, the results being in most cases highly satisfactory. In the last term in 1892 a large amount of attention was given to the use of the level and calculation of earth-work. Several roads and water-races were set out and pegged. Most of the students have shown a great aptitude for this work, and several of them have already utilised the knowledge they have acquired in laying-off races and assisting the County Engineer. The teaching of surveying has resulted in much good, and it is gratifying to find that many of my old students, who have secured first-class certificates, are now performing their own surveys in an intelligent and workmanlike manner. In this class a great many lectures are devoted to the mathematics of surveying, until the student becomes thoroughly grounded in the use of logarithms, the solution of triangles, and the mensuration of surfaces.

"*Mechanical Drawing.*—At the end of last year, Mr. E. F. Adams resigned the charge of this class. For the first two months of this year it was under the instruction of Mr. J. Crump, Mining Engineer, and, on his leaving for Waihi, his duty was undertaken by Mr. F. J. Allen, M.A., who will continue the instruction. The average attendance at this class is very small, considering the great importance of a knowledge of drawing to young mechanics and artisans who wish to rise in their occupation.

"*Physics and Experimental Science.*—This class was undertaken for the benefit of State-school teachers and pupils who wish to qualify themselves for D and E certificates. The numerous experiments have proved very instructive and attractive, and the attendanee varies from fifty to sixty, including from fifteen to twenty State-school teachers.

"Annual Examinations.

"These were held at the School of Mines, from the 19th November to the 30th November, under my own supervision, with occasional visits from the secretary and members of the School Committee.

"The examination papers were forwarded by the Under-Secretary for Mines to Mr. Albert Bruce, the secretary of the school, who kept them locked in the safe in his office till the published date of the different examinations, when he handed in the set of papers required for examination shortly before the commencement of the examination. All tuition and instruction were suspended at the school during the period of examination, and every precaution was taken to prevent the students getting access to, or a knowledge of, the contents of the papers before the advertised dates of examination, which were fixed by the Committee.

"At the end of each examination all the papers of answers were collected, and immediately handed to the secretary, who kept them under his charge until all the examinations were completed, when he forwarded them to Wellington. The results of the examinations were published about the middle of January.

"*Rules of Examination.*

"The examinations were conducted under the following rules and conditions:—

"1. No student shall come up for examination unless he has attended the lectures and classes of instruction in the subject of examination for three full terms.

"2. No candidate shall be admitted to the examination-room until the hour appointed.

"3. No candidate shall be allowed to enter the examination-room thirty minutes after the time appointed.

"4. All paper and writing materials shall be supplied by the supervisor.

"5. The candidates are to be seated at separate tables, situated not less than 12ft. apart.

"6. No candidate is permitted to bring into the examination-room any book or other written or printed matter, logarithms excepted.

"7. No communication between candidates is to be allowed in the examination-room.

"8. The supervisor is not to answer any inquiry having reference to any question in any examination-paper.

"9. When the time allowed for any paper shall have expired, the supervisor is to notify the same to the candidates present, and they are immediately to number and give up their papers.

"10. Each paper of questions has to be given out at the specified time, and no packet of examination-papers is on any account to be opened before the hour appointed, when the seal is to be broken.

"11. No certificate shall be issued to any student for passing a written examination in practical assaying and practical chemistry unless he shall have performed in the laboratory in a satisfactory, reliable, and workmanlike manner, and to the satisfaction of the Director, all the assays, analyses, and practical operations involved in working through the syllabus of instruction in these subjects.

"12. No certificate shall be issued to any student for passing a written examination in the metallurgy of gold and silver unless he shall produce satisfactory evidence of his having been actually engaged in a battery, mill, or reduction-works for the extraction of gold and silver for a period of not less than two years. He must also be a reliable assayer of all ores of gold, silver, and lead.

"13. No certificate shall be issued to any student for passing a written examination in surveying until he shall produce a plan of a mining-lease or area, not less than twenty acres in extent, showing the underground workings and their relation to the surface boundaries. The original field-book, and all calculations of co-ordinates and areas, must also be produced.

"As in former years, only a small number of the students, and those too mostly the more juvenile portion of them, presented themselves for examination. Out of 103 individual students only twenty-one came up to be examined.

"Many of the older and more advanced students persistently refuse to come up, the reason they give being to the effect that they attend the school for practical instruction and not for examinations. It has long been recognised in Great Britain that set examinations tend to cramp the scope of the instruction, more particularly in technical schools. Rules 11, 12, and 13 have been specially framed to meet this objection, as it is absolutely necessary that a certificated student from the school shall not only be able to pass a written examination, which he might be able to do from reading, but shall also be able to perform all the practical operations of the subject of examination in a thoroughly reliable manner before he leaves the school. This course has been strictly enforced throughout, and it is to this that I ascribe the great success which has attended our students wherever they have obtained employment.

The following statement shows the result of the examinations:—

Subjects on which Examination Papers were Set.	Number of Students that Sat for Examination.	Number of Students who passed First-class.	Number of Students who passed Second-class.	Number of Students who passed Third-class.	Number of Students who failed to be placed.	Name of Examiners.
Theoretical Chemistry (Senior)	9	4	3	...	2	William Skey, Colonial Analyst.
" " (Junior)	5	2	2	1	...	
Practical Chemistry	8	3	3	2	...	
Practical Assaying	8	3	3	2	...	
Laboratory Practice (Chemistry)	8	1	4	3	...	
" " (Assaying)	8	1	6	1	...	
Geology	6	1	3	...	2	Alexander MKay, F.G.S., Assistant-Geologist.
Mining	3	1	2	...	...	Henry A. Gordon, F.G.S., A.M.I.C.E., Inspecting Engineer.
Pumping and Winding ...	3	...	1	2	...	
Explosions and Ventilation ...	3	1	1	1	...	
Surveying	3	...	...	1	2	
Mineralogy	6	1	3	...	2	
Metallurgy of Silver and Gold ...	9	3	5	...	1	
Battery Practice	9	...	4	5	...	
Mechanical Drawing	5	1	2	1	1	C. H. Pierard and George Wilson.

"The President's medal for theoretical chemistry, and the School of Mines medal for best average in all subjects, fall to James M. McLaren, who secured no less than seven first-class, two second-class, and four third-class certificates.

"The paper set for the junior class in theoretical chemistry was more difficult than the papers in chemistry set for the Senior Service or matriculation Examinations, and may be compared with the first year's university course for the Bachelor of Science degree. The senior chemistry paper was equal to that of the second year.

"The practical assaying and practical chemistry papers were equal to the second and third year's university course. The assaying paper was devoted principally to wet work, and caused some disappointment to several of our students who had qualified themselves for dry assaying only. In the syllabus of instruction posted in the school, assaying was divided into dry work and wet work

and it was generally believed that separate papers would be set for each. Assaying is a subject of great scope and of much practical importance, and I would suggest that two papers should be set instead of one for the examination to be held at the end of this year.

"The paper on metallurgy was of a very practical character, and gave the students ample scope for showing what knowledge they possessed of the subject. It would be considered a difficult one by university students of the third or fourth year. The geology paper was well set, but about twice the length of the papers generally set for three hours. The mining papers were fully up to the standard of those set for first-class mine-managers' certificates, while that on surveying was so long that it was quite impossible to get through it in the time allowed. Surveying is one of our strongest subjects, and in the Government examinations for mine-managers our students have always secured the highest number of marks, but in this case only one of the students who sat for examination managed to secure a place through want of time. The three candidates who sat through the examination—namely, R. Turner, J. M. McLaren, and H. Paltridge—were well able to answer and work out the questions in the paper, except the last two, dealing with the fixing of the meridian and latitude. This would have secured for them second-class places. They had not been taught how to fix a meridian, or determine latitude, this instruction being reserved for authorised surveyors, or more advanced students of the second year.

"*Laboratory.*—The number of assays and analyses performed for the public during the year was 395, most of which were determinations for gold and silver. These involved the writing of 112 separate reports. In the actual performance of these assays and analysis I received much valuable help from Messrs. Carnie, Wells, Taylor, Carpenter, F. Callan, T. Callan, P. Callan, von Rotter, McDermott, Ansley, and Eddowes, all reliable and careful assayers.

"Three separate poison cases were investigated by myself for the Police Department, and reported on; and the number of practice assays of all kinds performed during the year by the different students reached almost 1,500. During the two last terms of 1892, Mr. William Eddowes, an advanced student, took charge of the furnace-room, and the students engaged in dry assaying. I have much pleasure in stating that Mr. Eddowes proved himself a most able and painstaking teacher. His assistance was of great value, and enabled me to devote my time more fully to those engaged in the laboratory at wet assaying and analyses.

"*Coromandel.*—I visited this place in December last, but was unable to get classes together, as almost all the miners had left for Kuaotunu. In accordance with instructions from the Minister of Mines, I visited Kuaotunu, where arrangements are now being made to start a school.

"Experimental Plant.

"Twenty-one separate parcels of ore were treated at the plant attached to the school during the past year, being the largest number since the plant was erected. An abstract of the particulars relating to each parcel, the method of treatment, and the results obtained, are shown in the tabulated statement which follows.

"The drying, roasting, crushing, sampling, assaying, pan-treatment, and cleaning-up connected with the extraction of the bullion, together with the subsequent retorting of the amalgam, melting, refining, and assaying of the bullion, were all effected by the students under my own personal supervision, no outside labour of any kind being employed.

"TABULATED STATEMENT showing Parcels of Ore Treated at the Thames School of Mines Experimental Plant for the Year ending the 31st March, 1893.

Name of Mine and District.	Description of Ore.	Weight of Ore.	Assay-value of Ore per Ton.				Method of Crushing.	Method of Treatment.	Bullion saved.	Percentage recovered from Amalgamated Plates.			Percentage recovered by Hot-pan Amalgamation.			Total Percentage recovered from all sources.		
			Bullion.	Gold.	Silver.	Value.				Gold.	Silver.	Value.	Gold.	Silver.	Value.	Gold.	Silver.	Value.
		Lb.	Oz. dwt. gr	Oz. dwt. gr	Oz. dwt. gr	£ s. d.			Oz.									
Jubilee Mine, Waitekauri	Grey-coloured quartz, containing about 15 per cent. Fe S_2	562	4 10 8	1 10 6	3 0 2	6 10 1	Wet	Copperplates, and pan-amalgamation of tailings	1·4	..	..	1·5	..	..	87·0	..	..	88·5
Kelly's, Tapu Creek ..	Mullocky quartz ..	100	5 0 20	1 1 3	3 19 17	4 16 6	Dry	Pan-amalgation with chemicals	0·22	..	..	..	..	..	89·0	..	..	89·0
Smith, Una Hill ..	Clayey ore, containing large percentage of iron and copper pyrites	1,403	6 13 14	3 15 15	2 17 23	15 11 2	"	Oxidized roasted, and pan-amalgamated	3·6	..	..	..	..	..	90·0	..	..	90·0
Alburnia, Thames ..	Highly mineralised ..	640	89 10 11	44 7 6	45 3 5	184 4 5	"	Chloridized roasted and pan-amalgamation	19·0	..	..	..	..	..	93·2	..	..	93·2
Gem Mine, Waiomo ..	Friable quartz, with silver chloride	320	87 11 10	26 2 10	61 9 0	113 15 0	"	Pan-amalgation	18·25	..	..	..	95·1	86·5	93·0	95·1	86·5	93·0
City of Dunedin, Tararu..	Friable white quartz, with calcite	2,800	2 8 4	1 0 4	1 8 0	4 5 0	"	Pan-amalgamation with chemicals	1·6	..	..	..	61·0	47·0	60·0	61·0	47·0	60·0
Eminence Mine, Thames..	Hard blue quartz ..	2,240	1 13 14	0 3 12	1 10 2	0 18 6	"	Pan-amalgamated	0·4	..	..	..	91·6	28·0	74·3	91·6	28·0	74·3
Royal Oak, Coromandel ..	Hard rusty quartz ..	558	772 1 0	451 6 2	320 14 22	1,845 6 6	"	Pan-amalgamation ..	201·0	..	..	..	95·4	96·3	95·8	95·4	96·3	95·8
Oamera, Great Barrier Island	Hard blue quartz ..	225	47 19 14	7 16 12	40 3 2	37 6 10	"	Pan-amalgamation with chemicals	3·0	..	..	..	91·0	55·0	85·0	91·0	55·0	85·0
Silver Queen, Marototo ..	Hard brown quartz ..	106	276 0 0	5 0 20	217 19 4	60 16 4	"	Pan-amalgamation with chemicals	2·3	..	..	..	94·2	15·4	40·8	94·2	15·4	40·8
New Find, Waitekauri ..	Brown quartz ..	70	32 10 0	2 18 6	29 11 18	16 1 8	"	Pan-amalgamation with chemicals	0·75	..	..	..	88·0	85·7	83·2	88·0	85·7	83·2
Skeen's, Waitekauri ..	Hard brown quartz ..	2,065	14 2 0	3 0 12	11 1 6	13 15 3	"	Pan-amalgamation with chemicals	9·8	..	..	..	81·6	72·5	80·5	81·6	72·5	80·5
Oamera, Great Barrier Island	Very hard greyish blue quartz	2,940	21 16 1	0 3 1	21 2 0	3 17 0	"	Pan-amalgamation with chemicals	7·0	..	..	..	97·1	26·1	36·8	97·1	26·1	36·8
Newsham, Waiorongomai	Brown quartz ..	1,960	14 1 6	2 1 12	11 19 18	10 2 0	"	Pan-amalgamation with chemicals	7·1	..	..	..	69·0	55·4	66·5	69·0	55·4	66·5
" "	" ..	1,880	17 4 3	4 12 2	12 12 1	20 6 2	Wet	Copperplates, and pan-amalgamation of tailings	11·3	30·8	8·7	28·5	54·0	63·1	54·7	84·8	71·8	83·2
Jackson Palmer, M.H.R., Great Barrier Island	" ..	1,660	58 12 0	0 10 21	58 1 3	10 17 8	Dry	Pan-amalgamation with chemicals	41·0	..	..	..	94·0	93·0	93·2	94·0	93·0	93·2
New Find, Waitekauri ..	" ..	90	32 2 9	12 0 2	20 2 7	51 0 8	"	Pan-amalgamation with chemicals	1·1	..	..	..	75·0	91·0	76·3	75·0	91·0	76·3
Norfolk Mine, Tararu ..	Concentrates ..	420	10 16 19	2 0 8	8 16 11	9 7 9	"	Oxidize roasted, and pan-amalgamation with chemicals	1·25	..	..	..	75·0	56·2	72·2	75·0	56·2	72·2
Norfolk Mine, Tararu Creek	" ..	500	16 0 2	1 17 19	14 2 6	9 13 6	"	Raw pan-amalgation with chemicals	1·1	..	..	..	73·0	21·3	61·0	73·0	21·3	61·0
Matarangi, Kuaotunu ..	Yellowish quartz ..	2,180	5 15 23	3 3 0	2 12 23	13 0 0	"	Pan-amalgamation ..	6·0	..	..	..	88·0	87·5	88·0	88·0	87·5	88·0
City of Dunedin, Tararu..	White quartz ..	100	2 8 4	1 0 4	1 8 0	4 5 0	"	Chloridize roasted, and pan-amalgamation	0·1	..	..	..	93·6	71·3	91·3	93·6	71·3	93·6

"Reports on Working Tests.

"*No. 1.*—This was a parcel of 5621b. of ore from the Jubilee Mine, Waitekauri, forwarded for treatment by Mr. Edward Kersey Cooper, the owner. It consisted of grey-coloured crystalline and semi-crystalline quartz, containing about 15 per cent. of base metallic sulphides, which were principally iron and copper pyrites. The ore was crushed wet at the request of the owner, and passed over amalgamated copper-plates. The tailings and blanketings were collected in settling-pits, and afterwards treated by raw hot pan-amalgamation. Samples of the wet pulp were taken from the screen at regular intervals during the period of crushing, dried, sampled, and assayed, in order to determine the original value of the ore. The ore showed the following value per ton:—

	Oz.	dwt.	gr.
"Bullion	4	10	8
Gold	1	10	6
Silver	3	0	2

Value, £6 10s.

"The amalgamated copper-plates saved only 1·5 per cent. of the original assay-value, which may fairly be attributed to the presence of so large a proportion of heavy metallic sulphides, and the finely divided state of the gold in the ore.

"The tailings, slimes, and blanketings yielded by pan-amalgamation 1oz. 6dwt. of bullion, 251·6 fine in gold and 709·4 fine in silver, equal to a value of £1 2s. 3d. per ounce, representing an additional saving of 87 per cent., or a total saving of 88·5 per cent. of the original value of the ore. The results of this test proved conclusively that this class of ore can be successfully treated by pan-amalgamation in charges without the use of chemicals, except when silver is present in paying quantities.

"*No. 2.*—This was a parcel of mullocky quartz forwarded by Mr. Robert Kelly, of Tapu. It weighed 100lb. dry weight, and showed the following assay-value per ton:—

	Oz.	dwt.	gr.
"Bullion	5	0	20
Gold	1	1	3
Silver	3	19	17

Value, £4 16s. 6d.

"The dry pulp was subjected to raw hot pan-amalgamation with chemicals, and yielded 4dwt. 8gr. of melted bullion, 232·4 fine in gold, and 767·6 fine in silver; equal to £1 0s. 10d. per ounce; representing a saving of 89 per cent. of the original value of the ore.

"*No. 3.*—This was a parcel of 1,403lbs. of ore from the Hape Creek side of Una Hill, at the Thames. It was forwarded by Mr. Phillip Smith, a tributer. The ore consisted of a grey-coloured quartz and soft grey clay or pug, containing numerous nodules of solid copper and iron pyrites. The gold existed in a very finely divided state, principally associated with the copper pyrites, fragments of which were found to assay as high as £65 per ton. The ore was dried, then dry crushed, and afterwards subjected to a thorough oxidizing roasting. It showed when sampled the following value per ton:—

	Oz.	dwt.	gr.
"Bullion	6	13	14
Gold	3	15	15
Silver	2	17	23

Value, £15 11s. 2d.

"The roasted pulp was treated by pan-amalgamation in three small charges, and yielded 3oz. 11dwt. of bullion, 601·2 fine in gold, and 372·8 fine in silver, equal to a value of £2 9s. 2d. per ounce, representing a saving of 90 per cent. of the original assay-value of the ore. A parcel of the same ore when treated by the ordinary battery process yielded at the rate of 1oz. 5dwt. to the ton, or about 23 per cent. of the value.

"*No. 4.*—This was a parcel of highly mineralised ore from the Alburnia Mine, Thames. It was forwarded for treatment by Mr. Thomas Radford, the manager. This ore was highly charged with iron and copper pyrites, and also contained a considerable proportion of antimonite. Its colour was mostly dark-blue or black, and it was somewhat clayey and friable. The parcel weighed 763lb. gross weight, and showed an assay-value of £184 4s. 5d. per ton, calculated on dry weight.

	Oz.	dwt.	gr.
"Bullion	89	10	11
Gold	44	7	6
Silver	45	3	5

"The gold existed principally in a very finely divided state, entangled with the base sulphides, and the silver in the forms of stephanite and pyrargyrite—the complex sulphides of silver and antimony.

"The ore was dried, dry crushed, and then subjected to a thorough chloridizing roasting. The loss due to drying, stamping, roasting, and handling reduced the parcel to 640lb., of which 630lb. were treated by hot pan-amalgamation for four hours, and yielded 19oz. of melted bullion, 0·6317 fine in gold, and 0·1160 fine in silver, valued at £2 10s. 10d. per ounce. This represents a saving of 67oz. 11dwt. 2grs. per ton, equal to a saving of 93·2 per cent. of the assay-value. Considering the character of the ore, this must be considered a very satisfactory return.

"*No. 5.*—This was a parcel of brown friable ore from Waiomo, forwarded by Mr. W. Eddowes.

It contained free gold and silver, combined principally with chlorine as horn silver or kerargyrite. The ore weighed 320lb. It was dried, dry crushed, sampled, and assayed with the following results per ton :—

	Oz.	dwt.	gr.
"Bullion	87	11	10
Gold	26	2	10
Silver	61	9	0

Value, £113 15s.

"The dry pulp was treated by raw hot pan-amalgamation with chemicals, and yielded 18oz. 5dwt. of melted bullion, 180·0 fine in gold, and 792·0 fine in silver, equal to a value of 16s. 9d. per ounce, representing a saving of 86·5 per cent. of the silver and 95·1 per cent. of the gold, or 93 per cent. of the assay-value.

"The tailings were carefully sampled and assayed, with the following result per ton :—

	Oz.	dwt.	gr.
"Bullion	7	6	5
Gold	1	5	5
Silver	6	1	0

Value, £5 18s. 10d.

Percentage recovered by amalgamation	93·0
Percentage represented by tailings	5·7
Percentage of value unaccounted for	1·3
	100·0

"This was a very free milling ore, and a large proportion of the bullion can always be recovered by pan-amalgamation, with ordinary care. The unaccounted loss is very low in this test, and shows very close working.

"*No. 6.*—This was a parcel of 2,800lb. of ore from the City of Dunedin Mine, situated in Tararu Gully, Thames. It consisted of a greyish-white friable quartz, veined with calcite. Both the quartz and the calcite frequently possessed a pink or flesh colour, due to the presence of rhodonite, the rose-coloured silicate of manganese. The ore contained gold and silver, the latter in the form of dark-blue sulphide argentite, which occurred mostly in thin wavy parallel lines. The gold existed in an extremely fine state, principally associated with the argentite. The ore was dried, dry crushed, sampled, and assayed, and was found to show the following assay-value per ton :—

	Oz.	dwt.	gr.
"Bullion	2	8	4
Gold	1	0	4
Silver	1	8	0

Value, £4 5s.

"The pulverised ore was treated by raw hot pan-amalgamation, and yielded 1oz. 12dwt. 12gr. of melted bullion, 471·1 fine in gold, and 504·5 fine in silver, equal to a value of £1 19s. 2d. per ounce, representing a saving of 61 per cent. of the gold and 47 per cent. of the silver, or 60 per cent. of the original value of the ore. A large parcel of the same ore was treated at Darrow's battery, and yielded at the rate of 4dwt. of bullion per ton, representing a saving of only 14·4 per cent. of the original value.

"*No. 7.*—This was a ton of moderately hard bluish-grey quartz, containing copper and iron pyrites in small nests and in disseminated grains. It was dried, dry-crushed, sampled, and then assayed, with the following results per ton :—

	Oz.	dwt.	gr.
"Bullion	1	13	14
Gold	0	3	12
Silver	1	10	2

Value, 18s. 6d.

"By raw pan-amalgamation the pulp yielded 8dwt. 8gs. of melted bullion, 344·5 fine in gold, 620·8 fine in silver, equal to a value of £1 9s. 2d. per ounce, representing a saving of 91·6 per cent. of the gold, 28 per cent. of the silver and 74·3 per cent. of the assay-value.

"*No. 8.*—This was a parcel of rich gold-bearing quartz from the Royal Oak Mine, Coromandel. It was forwarded by Mr August Luhrs, a tributer in that mine. The ore weighed 558lb. It was dry-crushed, carefully sampled and assayed, showing the following value per ton :—

	Oz.	dwt.	gr.
"Bullion	772	1	0
Gold	451	6	2
Silver	320	14	22

Value, £1,845 6s. 6d.

"The pulp was raw pan-amalgamated with chemicals, and yielded 201oz. of melted bullion, 576·7 fine in gold and 413·1 fine in silver, equal to a value of £2 7s. 3d. per ounce, representing a saving of 95·4 per cent. of the gold and 96·3 per cent. of the silver, or 95·8 per cent. of the assay-value of the ore. This is an eminently satisfactory result, and goes to prove that when the ore is

rich and free-milling it is easier to save a higher percentage of the bullion than with free-milling poor ores. Mr. Luhrs estimated that he had obtained from 45oz. to 50oz. more than would have been recovered by the ordinary battery process.

"*No. 9.*—This was a parcel of hard bluish-quartz from the new find at the Great Barrier Island. It contained a little free gold and silver, principally in the form of the free-milling chloride. Traces of ruby silver, pyrargyrite, also showed throughout the stone. The ore weighed 225lb. It was pulverized dry, sampled and assayed, showing the following value per ton :—

	Oz.	dwt.	gr.
"Bullion	47	19	14
Gold	7	16	12
Silver	40	3	2

Value, £37 6s. 10d.

"It was raw hot pan-amalgamated with chemicals, and yielded 3oz. of bullion, 236·8 fine in gold and 737·7 fine in silver, equal to a value of 19s. 2d. per ounce, representing a saving of 91 per cent. of the gold and 55 per cent. of the silver, or 85 per cent. of the assay-value.

"*No. 10.*—This was a parcel of 106lb. of ore from the Silver Queen Mine, at Maratoto. It was crushed dry, and showed the following assay-value per ton :—

	Oz.	dwt.	gr.
"Bullion	276	0	0
Gold	5	0	20
Silver	270	19	4

Value, £60 16s. 4d.

"Tests in the laboratory had shown that the silver existed as a telluride, which was not free-milling; however, at the request of the owner, Mr. W. Eddowes, the test was continued. The pulp was subjected to pan-amalgamation with chemicals, and yielded 2oz. 6dwt. of melted bullion, 097·8 fine in gold, and 846·6 fine in silver, representing a saving of 94·2 per cent. of the gold and 15·4 per cent. of the silver, or 40·8 per cent. of the assay-value.

"It is probable that the silver saved was that alloyed with the gold. Cyanide of potassium was found not to attract the bullion. A number of tests in the laboratory with this interesting ore showed that from 40 to 50 per cent. of its value was volatilised at a bright-red heat in less than two hours. These results showed it would be useless to attempt to chloridize roast the ore, without incurring a great loss of bullion.

"*No. 11.*—This was a parcel of 70lb. of brown-coloured qnartz from a new find between Marototo and Waitekauri. It was crushed dry, and showed an assay value per ton of :—

	Oz.	dwt.	gr.
"Bullion	32	10	0
Gold	2	18	6
Silver	29	11	18

Value, £16 1s. 8d.

"It was then raw pan-amalgamated with chemicals, and yielded 14dwts. 16gr. of melted bullion, 105·6 fine in gold, and 874·8 fine in silver, valued at 11s. per ounce, representing a saving of 88 per cent. of the gold, and 85 per cent. of the silver, or 83·2 per cent. of the assay-value of the ore.

"*No. 12.*—This was a parcel of 2,065lb. of moderately-hard yellowish-brown quartz, forwarded by Mr. W. H. Skeen from Waitekauri. It contained free gold and silver in the form of argentite. The ore was dried, dry crushed, sampled, and subsequently assayed, showing an assay-value per ton of :—

	Oz.	dwt.	gr.
"Bullion	14	2	0
Gold	3	0	12
Silver	11	1	12

Value, £13 15s. 3d.

"The dry pulp was then treated by raw hot pan-amalgamation with chemicals, and yielded 9oz. 16dwt. of melted bullion, 230·4 fine in gold, and 749·6 fine in silver, representing 81·6 per cent. of the gold, and 72·5 per cent. of the silver, or 80·5 per cent. of the original value of the ore.

"*No. 13.*—This was a parcel of hard greyish-blue quartz, often flinty and brecciated. It contained only a trace of gold, and silver in the form of the dark-blue sub-sulphide, argentite, and ruby silver or pyrargyrite, the latter in the greater proportion.

"The dry pulp, weighing 2,940lb, was raw hot pan-amalgamated with chemicals, and yielded 7oz. of melted bullion, representing a saving of 97·1 per cent. of the gold and 26·1 per cent. of the silver, the original assay-value per ton of the dry sampled pulp being :—

	Oz.	dwt.	gr.
"Bullion	21	16	1
Gold	0	3	1
Silver	21	13	0

Value, £3 17s.

"The low extraction of the silver was due to the fact that ruby silver is not a free-milling ore, and will only yield its silver after being subjected to a chloridizing roasting, the expense of which the owner did not care to incur in consequence of the low-grade character of the ore.

"*No. 14.*—This was a rusty-coloured, iron-stained quartz, forwarded from Waiorongomai by Newsham and party. It was dry crushed, sampled, and assayed, showing the following assay-value per ton:—

	Oz.	dwt.	gr.
"Bullion	14	1	6
Gold	2	1	12
Silver	11	19	18

Value, £10 2s.

"The dry pulp, weighing 1,960lb., was raw pan-amalgamated with the proper chemicals, and yielded 7oz. 2dwt. of melted bullion, 173·0 fine in gold and 810·1 fine in silver, equal to a value of 16s. 3d. per ounce, representing a saving of 69 per cent. of the gold and 55·4 per cent. of the silver, or 65·5 per cent. of the original value of the ore.

"*No. 15.*—This was a parcel of 1,880lb. of ore from another portion of the same reef as No. 14 was obtained. It showed the following assay-value per ton:—

	Oz.	dwt.	gr.
"Bullion	17	4	3
Gold	4	12	2
Silver	12	12	1

Value, £20 6s. 2d.

"This parcel at the request of the owner was crushed wet, and passed over amalgamated copper-plates, which yielded 2oz. 4dwt. of melted bullion, 540·2 fine in gold and 441·4 fine in silver, equal to a value of £2 4s. 6d. per ounce, representing a saving of 30·8 per cent. of the gold and 8·7 per cent. of the silver, or 28·5 per cent. of the value.

"The tailings and blanketings were treated by raw pan-amalgamation, and yielded 9oz. 2dwt. 12gr. of melted bullion, 228·6 fine in gold and 733·2 fine in silver, equal to a value of £1 0s. 5d. per ounce, representing a saving of 54 per cent. of the gold and 63·1 per cent of the silver, or 54·7 per cent. of the assay-value.

	Gold.	Silver.	Value.
"Percentage recovered from plates...	30·8	8·7	28·5
Percentage recovered by pan	54·0	63·1	54·7
Total recovery	84·8	71·8	83·2

"From these results it is seen that ordinary wet crushing and pan-amalgamation in charges can save a large proportion of the precious metals contained in the ore.

"*No. 16.*—This was a parcel of 1,660lb. of silver-bearing ore from the new find at the Great Barrier Island. It was forwarded by Mr. Jackson Palmer, M.H.R. The ore consisted of greyish-white iron-stained, somewhat friable quartz, containing silver, principally in the form of the free-milling chloride. It also contained a little free gold, existing in the stone in an excessively fine state of division. The ore was dried, dry-crushed, sampled, and assayed, and showed the following value per ton:—

	Oz.	dwt.	gr.
"Bullion	50	8	5
Gold	0	7	13
Silver	50	0	16

Value, £9 0s. 3d.

"The dry pulp was raw hot pan-amalgamated with chemicals, and yielded 41oz. of melted bullion, 009·2 fine in gold, and 974·7 fine in silver, equal to a value of 3s. 8d. per ounce, representing a saving of 94 per cent. of the gold and 93 per cent. of the silver, or 93·2 per cent. of the original assay-value.

"*No. 17.*—This was a parcel of roughly-ground ore from Lowrie's new find at Waitekauri, forwarded by Mr. James Corbett of Hikutaia. It was crushed dry, and showed the following assay-value per ton:—

	Oz.	dwt.	gr.
"Bullion	32	2	9
Gold	12	0	2
Silver	20	2	7

Value, £51 0s. 8d.

"It was raw hot pan-amalgamated, and yielded 1oz. 2dwt. of melted bullion, 330·8 fine in gold and 666·8 fine in silver, equal to a value of £1 8s. 5d. per ounce, representing a saving of 75 per cent. of the gold and 91 per cent. of the silver, or 76·3 per cent. of the value of the ore.

"*No. 18.*—This was a parcel of concentrates from the Norfolk Mine, concentrated by the Lührig vanners under the charge of Mr. G. S. Pitcairn, at the Norfolk battery. These concentrates were forwarded by the company to ascertain if a fair proportion of their bullion contents could be extracted by roasting and amalgamation. They were subjected to a thorough oxidizing roasting in

a reverberatory furnace and afterwards pan-amalgamated. They showed the following value per ton:—

	Oz.	dwt.	gr.
"Bullion	10	16	19
Gold	2	0	8
Silver	8	16	11

Value, £9 7s. 9d.

"The 420lb. treated in the pan yielded 40oz. amalgam, which proved, on a partial analysis, to consist principally of lead amalgam. When refined the amalgam returned 1oz. 5dwt. of melted bullion, 225·8 fine in gold and 745·4 fine in silver, representing a saving of 75 per cent. of the gold and 56·2 per cent. of the silver, or 72·2 per cent. of the value.

"The concentrates contained, in addition to iron pyrites, about 6 per cent. of lead in the form of galena, which was reduced to metal in the reverberatory furnace during the operation of oxidizing roasting, as shown by the following equations:—

$$\text{"}PbS + O_3 = PbO + SO_2$$
$$PbS + O_4 = PbSO_4$$

and—

$$\text{"}2\,(PbO) + PbS = 3Pb + SO_2$$
$$PbSO_4 + PbS = 2Pb + 2\,(SO_2)$$

"The presence of the lead will render it impossible to treat these concentrates profitably and economically by roasting and subsequent amalgamation, since the reduced lead will always find its way into the amalgam and quicksilver, where it exercises a most injurious effect.

"*No. 19.*—This was a parcel of 500lb. of the above concentrates, which were treated by raw pan-amalgamation with chemicals. The return was 1oz. 1dwt. of melted bullion, 348·1 fine in gold and 632·5 fine in silver, representing a saving of 73 per cent. of the gold, and 21·3 per cent. of the silver, or 61 per cent. of the original assay-value.

"*No. 20.*—This was a parcel of moderately hard brown quartz from McNeill's claim at Matarangi. It contained free gold in an extremely fine state of subdivision. It weighed 2,180lb. It was dried, dry crushed, and sampled, and showed an assay-value per ton of—

	Oz.	dwt.	gr.
"Bullion	5	15	23
Gold	3	3	0
Silver	2	12	23

Value £13.

"The ore was then subjected to pan-amalgamation, and yielded 6oz. of bullion, 0·4500 fine in gold, and 0·3795 fine in silver, representing a saving of 88 per cent. of the gold, and 87·5 per cent. of the silver, or 88 per cent. of the assay-value. This is a very satisfactory result, and is of great value, as showing that this ore can be successfully treated by dry crushing and pan-amalgamation in charges.

"*No. 21.*—This was a parcel of 100lb. of ore from the City of Dunedin Mine, situated at Tararu Creek, Thames. It was a portion of parcel No. 6 from this mine, and was subjected to a thorough oxidizing roasting, and then pan-amalgamation in a charge. By this means 2dwt. of bullion were recovered, 416·4 fine in gold, and 443·6 fine in silver, equal to a value of £1 12s. 3d. per ounce, represerenting a saving of 71·3 per cent. of the silver, and 93·6 of the gold, or 91·3 per cent. of the value. The comparative results obtained from the raw and roasted ore are as follows:—

	Gold.	Silver.	Value.
"Percentage of recovery from raw ore	61·0	47·0	60·0
Percentage of recovery from roasted ore	93·6	71·3	91·3
Increase of recovery due to roasting	32·6	24·3	31·3

"Woodstock Refractory Ore.

"Last October two parcels of first-class ore, from the Woodstock Mine at Karangahake, were forwarded by Mr. J. McCombie for experimental tests. Although these tests were conducted on a laboratory scale they involved a large amount of time and careful manipulation, more especially as it was deemed necessary to conduct simultaneous checks of the experiments for comparative purposes, so as to insure accuracy of results. In the performance of these experiments I have to acknowledge much valuable assistance from Mr. A. T. Day, who is a most willing and reliable assayer.

"*No. 1, Free-milling Ore.*—This was a dark-blue, almost black, mullocky clayey ore, containing a large percentage of extremely fine black decomposing iron-pyrites. The ore was carefully dried, pulverised, sampled, and assayed, with the following result per ton:—

	Oz.	dwt.	gr.
"Bullion	56	4	4
Gold	23	1	5
Silver	33	2	23

Value, £97 4s. 3d.

"The dry pulp was then subjected to a careful oxidizing roasting at a dull-red heat. It was found that no loss of bullion was incurred in the operation of wasting. The roasted pulp was then treated by hot-pan amalgamation with chemicals for three hours, and it was found that 91·8

per cent. of the gold, 72·2 per cent. of the silver, or 90 per cent. of the original value had been recovered.

"With a rich ore of this description each additional unit of percentage saved represents about £1 sterling. Three units would cover the cost of roasting, and the subsequent pan-amalgamation would result in an additional saving of from 10 per cent. to 15 per cent., thus leaving an additional profit ranging from £7 to £12 for every ton of roasted ore.

"*No. 2, Refractory Ore.*—This ore was very similar in general physical appearance to the free-milling ore. It was somewhat darker in colour, due to the presence of a larger percentage of accompanying iron disulphide. This ore was supposed to contain tellurium in combination with the gold and silver, but a most careful and exhaustive analysis failed to detect that substance. The ore was dried, pulverised, sampled, and assayed, showing the following assay-value per ton:—

	Oz.	dwt.	gr.
"Bullion	91	17	5
Gold	16	17	18
Silver	74	19	11

Value, £78 16s.

"It was then subjected to a thorough oxidizing roasting at a dull-red heat. It showed no loss due to the roasting. It was then hot pan-amalgamated for three hours, with the result that 73·3 per cent. of the gold, 70·9 per cent. of the silver, and 72·2 per cent. of the value was recovered. At the present time this ore is shipped to Freiberg, in Saxony, to be treated; but I think some experiments should be made on a working scale to determine the best method of extracting the bullion at the mine. Even an extraction of 72 per cent. of the value should leave as large a margin of profit as now obtained by shipping this ore to Germany.

"Saving of Bullion effected at Thames Batteries.

"During the past two months I have made a number of experiments at several of the batteries at the Thames, in order to definitely determine the percentage of value of the ore recovered and lost by the process at present in use on this field. The assay samples were taken with great care, while all the assays were determined and verified by check assays. As the results are of great importance, and have a wider application than the Thames, I give below some of the principal reports furnished to the mine-managers and directors of the companies interested in the experiments.

"*Report on Treatment of Parcel of Alburnia Ore at the Cambria Battery during March.*

"The general dirt treated amounted to eighteen loads, representing approximately 27 tons, and the picked stone 565lb. The total amalgam from all sources weighed 1,549oz., and yielded 595oz. 15dwt. of melted bullion, valued at £2 12s. per ounce, equal to a total value of £1,548 19s.

	Amalgam. Oz.	dwt.	gr.	Bullion. Oz.	dwt.	gr.	Value. £	s.	d.
"Picked stone	949	10	0	417	15	0	1,086	3	0
Amalgamated plates	39	0	0	11	11	0	30	0	7
Berdans	560	10	0	166	9	0	432	15	5
Totals	1,549	0	0	595	15	0	£1,548	19	0

"The ratios of bullion to amalgam in the picked stone and general dirt were 1 to 2·27 and 1 to 3·37 respectively.

"*Value of Ore.*—The assay-value of the general dirt, as taken from the gratings at regular intervals every fifteen minutes during the period of crushing, was as follows:—

	Oz.	dwt.	gr.
"Bullion, per ton	17	12	21
Gold	7	18	19
Silver	9	14	2

Value, £33 14s. 2d.

	£	s.	d.
General dirt, 27 tons at £33 4s. 6d.	897	1	6
Picked stone, bullion recovered	1,086	3	0
Tailings from picked stone and loss	4	15	6
Total approximate value of ore as won from mine	£1,988	0	0

"Calculated from this basis the total percentage of saving from all sources was 76·7 per cent. of the original value of the ore. It should, however, be noted that the picked stone alone represented 70 per cent. of the total value of saving, and as practically the whole value of this stone was recovered, and that by special treatment, its inclusion has the effect of greatly increasing the average percentage of recovery. In order, therefore, to get a fair idea of the recovery from the general dirt by the ordinary battery process, it will be necessary to exclude the value of the picked stone, both from the total value of the ore and total saving. From this new basis of calculation the following results are obtained:—

"General dirt, 27 tons, at £33 4s. 6d. ... ... £897 1s. 6d.

	Recovered. £	s.	d.	Percentage.
From plates	30	0	7	3·3 per cent.
From berdans	432	15	5	48·2 "
Totals	£462	16	0	51·5 "

"Thus the total actual saving of value from the general dirt presented to the battery process for treatment was only 51·5 per cent. of the original assay-value; and it is noteworthy that of this amount only 3·3 per cent. of value of saving was effected by the amalgamated plates. This latter fact is no doubt attributable to the large proportion of decomposing base metallic sulphides contained in the ore. During the treatment of this ore about 5 tons of berdan tailings were collected. These are approximately valued at £17 2s. 9d. After making due allowance for the value contained in these tailings, it would appear that the total loss in the treatment of this small parcel amounted to over £400, all placed beyond recovery by the present mode of extraction. Considering the highly-mineralised and refractory character of the Alburnia ore, the percentages of saving effected by the Cambria battery are remarkably high, and must be the result of much skilful manipulation; nevertheless, it seems a pity to see so large a loss of bullion after the time and expenditure incurred in finding, winning, and carting the ore. The ore is well adapted for concentration with subsequent chlorination, which would extract over 90 per cent. of the assay-value.

"*Report on Percentage of Saving at Moanataiari Battery.*

"These tests extended over the six weeks' run, extending from the 17th March to the 30th April. The particulars relating to the general quartz, and the surface-dirt, crushed during that period were kept separate, in order to be able to determine the percentage of saving effected in each case.

"The assay samples were taken at the gratings at regular intervals of fifteen minutes. The tubs containing the samples were forwarded to the School of Mines, where their contents were thoroughly mixed, sampled, and then assayed.

"The amalgam from all sources was cold-water machine squeezed, thus rendering the ratios of gold to amalgam very uniform throughout.

"The tonnage was obtained from the cubic content of the trucks, the number of trucks, and the actual weight of a cubic foot of the dry ore in each case; and due allowances were made to avoid an over-estimate of the quantity of ore.

"*Surface Dirt, First Test.*—Of the brown oxidized surface-dirt 700 tons were treated, showing an assay-value per ton of:—

	Oz.	dwt.	gr.
"Bullion	0	5	6
Gold	0	3	12
Silver	0	1	18

Value, 14s. 3d.

"The total original value of the ore as won from the mine would, therefore, be 700 tons at 14s. 3d. = £498 15s. The 700 tons yielded 91oz. 15dwt. of amalgam from all sources; and this, when retorted and melted, produced 39oz. 10dwt. of bullion, valued at £2 12s. 2d. per ounce. The proportion of ratio of bullion to amalgam was therefore 1 to 2·32.

"The following tabulated statement shows the amount of amalgam, bullion, value, and percentage of saving from each source:—

	Amalgam. Oz.	dwt.	Bullion. Oz.	dwt.	Value. £	s.	d.
"Plates	71	15	30	18	80	11	11
Berdans	6	0	2	12	6	15	8
Headings	14	0	6	0	15	13	0
Totals	91	15	39	10	£103	0	7

"*Percentage of Saving.*

	Per cent.
"Plates	16·1
Berdans	1·3
Heading	3·2
Total	20·6

First Test, General Quartz and Picked Stone.—This consisted of 400 tons of blue unoxidized quartz, containing about 4 per cent. of base metallic sulphides, principally iron pyrites. It showed the following assay-value per ton:—

	Oz.	dwt.	gr.
"Bullion	0	11	7
Gold	0	7	13
Silver	0	3	18

Value, £1 10s. 9d.

"The total approximate value of the ore was as follows:—

	£	s.	d.
"400 tons at £1 10s. 9d.	615	0	0
Value of specimens	110	6	7
Total	£725	6	7

"During the treatment of this parcel of ore, 376oz. 17dwt. of amalgam was obtained from all sources, yielding 143oz. 10dwt. of melted bullion, valued at £2 12s. 2d. per ounce. The proportion of bullion to amalgam was 1 to 2·62.

"The amount of amalgam, bullion, value, and percentage of saving are shown separately in the following tabulated statement:—

	Amalgam. Oz. dwt.	Bullion. Oz. dwt.	Value. £ s. d.	Percentage of Saving.
"Plates	107 10	41 0	106 18 10	14·8
Berdans	112 0	42 13	111 4 10	15·3
Pans	27 14	10 11	27 10 6	3·8
Headings	18 10	7 0	18 5 2	2·4
Specimens	111 3	42 6	110 6 7	15·2
Totals	376 17	143 10	£374 5 11	51·5

"The actual results of the treatment of the general quartz by the methods adopted in the ordinary stamper-battery can only be arrived at by deducting the value of the specimen stone which was subjected to special treatment. The actual returns from the general quartz, excluding the value obtained from the specimens, are as follows:—

"*Value of Ore.*—400 tons at £1 10s. 9d. = £615.

	£ s. d.	Percentage of Saving.
"Plates	106 18 10	17·3
Berdans	111 4 10	18·1
Pans	27 10 6	4·5
Headings	18 5 2	3·0
Totals	£263 19 4	42·9

Summary of Results.

Description.	Percentage of Savings.
"Surface-dirt	20·6
General quartz and picked stone	51·5
General quartz, excluding picked stone	42·9

"*Second Test, Moanataiari General Quartz.*—For this test 230 tons of general quartz and a quantity of specimen stone were treated, and yielded 355oz. 7dwt. of amalgam, which returned when retorted 117oz. 8dwt. of melted bullion, valued at £308 13s. 4d., or £2 12s. 7d. per ounce. The ratio of bullion to amalgam was 1 to 3·03.

"*Total Approximate Value of Ore.*—The assay-value of the ore per ton was as follows:—

	Oz. dwt. gr.
"Bullion	0 12 6
Gold	0 6 18
Silver	0 5 12
Value, £1 7s. 9d.	
	£ s. d.
"230 tons at £1 7s. 9d.	319 2 6
Approximate value of specimens	145 10 6
Approximate original value of ore	£464 13 0

"*Results of Treatment and Percentage of Saving.*

	Amalgam. Oz. dwt.	Bullion. Oz. dwt. gr.	Value. £ s. d.	Percentage of Saving.
"Tables	101 0	33 7 0	87 13 9	18·9
Headings	16 0	5 6 0	13 18 8	3·0
Berdans	55 15	18 8 0	48 7 6	10·4
Pans	15 2	5 0 0	13 2 11	2·8
Specimens	167 10	55 7 0	145 10 6	31·3
Totals ...	355 7	117 8 0	£308 13 4	66·4

"*Percentage of Saving, excluding Picked Stone.*—Value of ore: 230 tons at £1 7s. 9d. = £319 2s. 6d.

	Value. £ s. d.	Percentage of Saving.
"Tables	87 13 9	27·5
Headings	13 18 8	4·4
Berdans...	48 7 6	15·1
Pans	13 2 11	4·1
Totals	£163 2 10	51·1

"*Second Test, Moanataiari Surface-dirt.*—This test extended from the 17th to the 28th April. 400 tons were treated, and yielded 35oz. 8dwt. of melted bullion, valued at £2 12s. per ounce, giving

a total value of £92 0s. 9d. which was recovered. The assay-value of the ore per ton was as follows :—

	Oz.	dwt.	gr.
"Bullion	0	4	0
Gold	0	2	11
Silver	0	1	13

Value, 10s.

"*Approximate Value of Ore.*—400 tons at 10s. = £200.

Value of Ore.	Recovered.	Percentage of saving.
£	£ s. d.	
200	92 0 9	46

"The percentage of saving effected in this test shows a most marked improvement on that obtained in the first test, and, considering the excessively low-grade nature of the ore, the present result must be considered fairly satisfactory, and an evidence of increased care and skill on the part of those engaged in the battery.

"*Test at Norfolk Battery.*—Two separate tests of two 10-ton parcels were made at this battery, under the most strict supervision. In both tests the value of bullion recovered from the amalgamated copper-plates amounted to 22 per cent. of the original value of the ore. The tailings from one parcel were passed through a double long buddle, and from the other over three Lübrig vanners.

"The concentrates in the buddle contained 57 per cent. of the original value of the ore. They have not been treated up to the present time, but judging from the results obtained at the other batteries it seems unlikely that more than half their value will be recovered by ordinary amalgamation, which would bring the total saving somewhat under 50 per cent.

"*North Star Test.*—The parcel of ore on which this test was made was treated at the Moanataiari battery. It weighed about 20 tons, net dry-weight, and showed the following assay-value per ton :—

	Oz.	dwt.	gr.
"Bullion	5	15	23
Gold	3	6	19
Silver	2	9	4

Value, £13 14s. 6d.

"Twenty tons of ore at £13 14s. 6d. = £274 10s.

"The total return from all sources was 43oz. 16dwt. of melted bullion, valued at £110 15s. 6d., representing a saving of 40·3 per cent. of the original value of the ore.

Syllabus of Lectures and Instruction, 1892–93.

"*Practical Assaying.*

"Fuels, appliances, fluxes, &c., used in the dry assay of ores of gold, silver, lead, tin, antimony, copper, &c. Assay of gold, silver, and lead bullion, and wet assay of ores of iron, copper, lead, zinc, antimony, bismuth, arsenic, manganese, &c. Preparation of pure silver; litharge assay; melting and refining base bullion; amalgamation; retorting. Text-book, Berringer's 'Assaying.'

"*Metallurgy of Gold and Silver.*

"Crushing and pulverising machinery, both wet and dry; concentration and ore dressing; sampling ore, &c. The treatment of gold-bearing ores by amalgamation, chlorination, alkaline cyanides, &c. The treatment of silver ores by amalgamation and by leaching with different solvents, including alkaline cyanides. Text-books, Eissler's 'Metallurgy of Gold' and 'Metallurgy of Silver.'

"*Practical Chemistry.*

"Chemical manipulation; acids; reagents; group reagents; separation of metals; properties of metals; testing solutions; testing rocks and minerals; solution of mineral substances; analysis of simple substances; analysis of compound substances; quantitative analysis of sulphides and complex ores, coals, soils, waters, slags, limestones, &c.

"*Theoretical Chemistry.*

"Principles of chemistry; atoms; molecules; vapour density; quantivalence; chemical formulæ; the elements—their history, occurrence, preparation, properties, and uses; compounds of the elements—their occurrence, preparation, properties, and uses.

"*Mineralogy and Blow-pipe Determination.*

"Systematic mineralogy; properties of minerals—their cleavage, hardness, specific gravity, &c.; optical properties—refraction, reflection, double reflection, polarisation, lustre, phosphorescence; chemical properties—the application of the blow-pipe, supports, reagents, flame reactions, colour tests with borax heads, &c.; isomorphism, pseudomorphism, and allotropy; distribution and paragenesis of minerals; classification of minerals—chemical system, economic system; descriptive mineralogy—non-metallic, division, carbon group, haloids and salts, alkaline earth group, silicates, aluminates, with a description of the principal minerals of each group, aided by hand-specimens; metallic division—a description of the principal ores and compounds of the different metals, their occurrence, hardness, specific gravity, crystallographic form, colour, lustre, streak, composition, uses, distribution, &c.

"Crystallography: The six systems, their axes, typical forms, modified forms, holohedral and hemihedral forms, macles, reading of faces, &c.

"*Geology and Geological Surveying.*

"*Physical Geology.*—The earth as a planet, its form and motions; geological climate; the atmosphere; ocean; solid crust; the interior of the earth.

"*Dynamical Geology.*—Metamorphism; agencies modifying the crust of the earth—atmospheric, aqueous, chemical; weathering; sedimentation; classification of deposits—mechanical, aqueous, organic, and chemical; denudation and erosion.

"*Structural Geology.*—Stratification; jointage; contortion; faults; conformity; unconformity; dip and strike; cleavage; metamorphic rocks; intrusive sheets, bosses, dykes, fissures; formation of quartz-veins, lodes, and metallic deposits; dynamics of lodes; recovery of lost lodes.

"*Geological Surveying.*—The practice of running natural sections; noting dip, strike, and inclination of strata and lodes; mapping geological formations; collection of mineral and rock specimens.

"*Stratigraphical Geology.*—Classification of plants and animals; fossils; blending of species; geological record; the study of characteristics, life, and distribution of formations from archæan to recent times, with special reference to the geology of New Zealand.

"*Mining.*

"Shafts: Selection of site, size, modes of excavation in dry and wet rock, wet sand, and swamp; timbering of shafts; ladders; chambers—size, excavation, timbering; levels and drives—size, excavation, timbering; securing sets or inclines; modes of stoping, height, and timbering of stopes; main passes—size, timbering, division; mullock passes—size, timbering, distance apart. Pumping and pit work—pumps and engines used in metal-mining, force-pumps, plunger-pump, draw-lift, fixing pump-pieces, bearers, friction-rollers, V-bobs, balance-bobs, main rods, flat rods, clacks, buckets, bucket-rod, catches, staples, and glands; thickness of pipes; capacity of pumps. Ventilation—atmospheric pressure, vapour density; ventilation of drives and underground workings by natural and artificial means; furnaces, water-blasts, fans; division of air-courses; noxious gases met with in metal- and coal-mines, their composition and detection. Explosives—their use in quarries and mines, relative strengths, action, gases evolved, composition; charging bore-holes; firing explosives; quantity to be used. Hauling and winding—safety-cages; man-engines; strength of ropes; strength of timbers. Water-power—turbines, pelton-wheels, calculation of horse-power and flow of water from boxes and nozzles.

"Text-book used: Gordon's 'Miner's Guide,' 5s.; Government Printer.

"*Land and Mine Surveying.*

"Adjustments of theodolite, dial, level; chain and steel tapes; traversing with theodolite and dial; connecting survey with standard meridian; ranging lines; division of land; computation of areas by latitudes and departures; reduction of slope-measurements; off-sets; chaining; computation of co-ordinates; balancing survey; plotting survey and off-sets. Mine-surveying: Different methods of connecting underground with surface meridian; magnetic variation; to reduce magnetic meridian to true meridian; conducting underground traverse with theodolite and dial; correcting magnetic survey by method; back- and fore-sights; holing. Mathematics: Equations; logarithms; plane trigonometry; solution of triangles; calculation of last or connecting line; of distance from working-face to nearest point on boundary of lease. Levelling: Recording levels; practice with level and staff; grading roads, tramways, and water-races; plotting and striking grades.

"*Practical Astronomy.*

"The ecliptic; equinoxes; meridians; longitude; latitude; altitude; declination; right ascension; azimuth; use of Nautical Almanac; polar distance; zenith distance; hour-angle; sidereal time; mean time; solar time; parallax; refraction; retardation; acceleration; convergency of meridian; determination of meridian by star- and- sun-observations, by single altitudes; greatest elongation of circumpolar stars; use of star-charts; calculation of hour-angle, azimuth, and altitude of celestial bodies for any time and place; determination of latitude by meridian altitudes; determination of time by star transits and sun-observations.

"*Physics.*

"Fundamental ideas of matter and energy; conditions of matter; gravitation; mechanical powers; sound; light; heat; magnetism; electricity; chemistry; physiology, and health.

"*Mechanical Drawing.*

"Use of scales; printing and lettering; outline drawing; shading; colouring; drawing to scale from copies and objects, portions of machinery, and woodwork, showing plans, elevations and sections.

"*Scale of Charges for Public Assays and Analyses.*

	£	s.	d.
"Bullion assays	0	5	0
Assay of quartz, tailings, or concentrates	0	5	0
Examination and determination of rocks and minerals	0	5	0
Assay of lead- and tin-ores, each	0	5	0
" iron- and manganese-ores	0	10	0
" copper- and antimony-ores	0	10	0
" zinc-, mercury-, and bismuth-ores	0	10	0
" gold- and silver-ores, with parting assay	0	5	0

"*Scale of Charges for Public Assays and Analyses*—continued.

		£	s.	d.
Analysis of limestone and calcareous freestone	complete	1	0	0
	partial	0	10	0
" coals and fuels, each...		0	10	0
" rocks and soils complete		2	0	0
" rocks and soils partial		1	0	0
" fireclays and slags		1	0	0
" manures		2	0	0
" waters complete		3	0	0
" waters partial		2	0	0
" nickel-, cobalt-, and chrome-ores		0	10	0
" concentrates		1	10	0
" complex sulphide ores, &c.		1	10	0

"*Class-fees.*

"Registration or membership for a year, 10s; all class-fees 5s. per quarter for each subject, excepting mechanical drawing, 21s. per quarter.

"Students are supplied with crucibles, glassware, apparatus, chemicals, &c., free of charge, but they must make good all breakages.

"*Experimental Plant.*

"Parcels of gold- and silver-bearing ores, up to three tons, are treated exhaustively, and reported on, from £3 to £5 per ton or part of a ton, according to the nature of treatment required. All expenses connected with the treatment are paid by the school, and the bullion extracted is returned to the owner.

"*Laboratory Fittings and Appliances.*

"During the past year the Committee has added various useful and much-needed pieces of apparatus to the permanent stock of the school, including a small 9in. pelton-wheel and a revolving-barrel for conducting experiments with different classes of ore by amalgamation, chlorination, &c.; also, a small experimental leaching-vat for similar purposes. These proved exceedingly valuable in the practical demonstration of gold and silver treatment for the class on metallurgy. Among other useful apparatus obtained are an Attwood's machine, and a revolving friction-table, used for practical demonstration for the class devoted to physics and experimental science.

"*Governing Body.*

"The Committee for the current year, elected at the annual meeting held in February, are as follows: President, Mr. J. McGowan; Vice-presidents, Messrs. P. C. Hansen and T. A. Dunlop: members, Messrs. George Bull, G. S. Clark, H. W. Moore, J. H. Smith, Dr. Williams; John Watson, treasurer; and A. Bruer, secretary.

"In conclusion, I have, as in former reports, to express my great obligation to the Committee for their ready support and co-operation in forwarding the interests of the school, and for the generous manner in which they have dealt with the funds of the school in procuring necessary appliances and apparatus."

The Thames is remarkably well situated for a School of Mines, the quartz workings being actually inside the town boundaries, and adjacent thereto, so that every workman has an opportunity of attending the night classes at the school without interfering with his daily labours. The young students have also an opportunity of seeing the practical working of the mines. The mine-managers allow them to go at intervals below-ground to, in some instances, make trial surveys and to note the manner the workings are carried on. The test-plant is attached to the school, and so many parcels of stone being tested gives them a greater insight into working of crushing-batteries than ever they could gain from technical teaching illustrated by diagrams. It is very gratifying to find that all the students who passed their examination last year have received appointments in the colony; some as assayers to companies, and some employed by the Cassel Company; while the student who got the highest number of marks has been appointed assayer to the Bank of New Zealand at the Thames.

REEFTON SCHOOL OF MINES.

The Reefton School has also been well attended last year, considering that the mines are situate a good distance from the township; but to compensate for this, Mr. Aitken, the instructor, held regular classes at Boatman's, Progress, and Merrijigs, for the convenience of those who could not attend the classes at the Reefton School. At some of these branch schools there are advanced students who take a great interest in the school, and give instruction in the absence of Mr. Aitken. The number of students attending the schools in the Reefton District last year was 52, as against 34 for the previous year. The instructor also visited Denniston and Brunnerton. At the former place there was very little interest taken in the lectures given by Mr. Aitken, but at Brunnerton the lectures were greatly appreciated.

The following is a report by Mr. Aitken, the Instructor and Director of the Reefton School of Mines, for the year ending the 31st March, 1893:—

"I have the honour to report on the work and progress of the Reefton School of Mines and its numerous branches for the past year, ending 31st March, 1893, which has been the most successful year the school has yet had, as may be seen by the increase of attendance, and the work executed by the students at the last annual examination.

"The classes have been carried on regularly throughout the whole year, and the beneficial results of these institutions are now freely acknowledged throughout the district, and, in fact, all over the West Coast.

"Classes have been established at Progress, Merrijigs, Denniston, Brunnerton, and Boatman's, for the convenience of those who cannot attend the Reefton School; all these have met with fair success, and are still being carried on to advantage.

"The mining and surveying classes still continue to be the most popular, and best attended, notwithstanding an increase of students to the assaying and chemistry classes.

"The following table will show the attendance at the different classes and schools during the past year:—

Name of Class and School.	First Term.	Second Term.
"Reefton, Assaying and metallurgy	16	14
" Practical chemistry	12	13
" Theoretical chemistry	12	13
" Land- and mine-surveying	15	15
" Mining and mathematics	15	18
Boatman's, Mining and mathematics	14	...
Boatman's, Chemistry	...	6
Progress, Mining and surveying	...	20
Merrijiggs, Mining and mathematics	5	4
Total attendance at all classes	89	103
Total number of individuals	46	57

"This does not include Brunnerton, with from fifteen to twenty members, and Denniston with about ten.

"*Practical Assaying and Metallurgy.*—This class is well and regularly attended by students of various occupations, who are instructed in the assaying of gold, silver, lead, copper, antimony, tin, bismuth, chrome, iron, &c., both by dry and wet methods, and in the use and composition of the fluxes and re-agents. Also in the smelting, refining, and valuing of gold and silver bullion, the dressing of copper-plates, and the chemistry of amalgamation. During the year many assays have been made on the numerous heaps of tailings on the field to show their value, and also what percentage can be extracted by mechanical means. The students have also been instructed in testing the purity of the material used, and in sampling, which is very frequently the source of error. The attendance at this class has been good, it now being seen that this knowledge, with chemistry, is required for those engaged in all processes for the extraction of metals from their ores, whether mechanical or chemical.

"*Practical Chemistry.*—This class is attended by almost the same students as attend the assaying, but not as regularly. The work done during the past year has been preparing re-agents and salts, testing for metals and acids, separation and detection of metals, and mineral substances. Qualitative and quantitative analysis gravimetrically, and quantitative volumetrically. Various samples of coal, limestone, and silicates have been analysed. Various samples of tailings and cement were tested by chlorine and cyanide, the latter giving very fair extractions. Cement was also treated in lumps, but, owing to the difficulty in washing the cyanide solution out again, the experiments were only partially successful.

"*Theoretical Chemistry.*—This subject has only partly been treated on during the past year, the work being principally in the principles of chemistry, atoms, molecules, quantivalence, specific gravity, formulæ, properties of gases, solids, and liquids, and the occurrence, preparation, properties, and uses of some of the non-metalic elements, illutrated by various experiments. Text-book, 'Bloxam.'

"*Mining and Mathematics.*—These two subjects being so closely connected with each other are taken together, and the students are instructed in logarithms, elements of plane trigonometry, mining geology, strength of materials, timbering of shafts and drives, chambers, stoping and passes; formation of lodes, leads, and veins; pumping and pitwork-engines, thickness metal in pipes and pumps; hauling and winding engines, horse-power; boilers; ventilation—natural, furnaces, fans, splitting of airways, gases met with in metal and coal-mines, composition and detection; friction; explosives—use, strength, composition gases evolved, charging and firing; water-power wheels, horse-power, measurement of water. The majority of the students attending this class are miners, who take a great interest in the work given, which embraces all subjects necessary for the examination for certificates under "The Mining Act, 1891," excepting surveying. In August, 1892, I sent five candidates for examination: three for mine-managers and two for engine-drivers, all of whom passed first-class. In January, 1893, there were six candidates: two for mine-managers and four for engine-drivers, the result of which is not yet known.

"*Land and Mine Surveying.*—Evidence of the usefulness of this class has already been shown in this district. The practical work performed by some of the students show that they understand the subject. It is attended by most of those who attend the mining and mathematics, and is a subject in which great interest is taken. Instruction is given in the compass, miners' dial, and theodolite with adjustments; also in tabulation of traverses, caleulation of areas, plotting by protractor and rectangular co-ordinates, levelling, and the calculation of heights and distances.

"*Geology and Mineralogy.*—These classes, I regret to say, were discontinued, owing to the small attendance, occasioned by most of the students leaving the town. There is, however, every probability of a start being made again this year.

"*Boatman's.*—The attendance at this school continued to be good until about the middle of the year, when a considerable falling-off took place, and chemistry was taken as the subject instead of

mining. The falling-off was due to a partial collapse of the district, which removed many of the students. There has, however, been some good work done, and four of the students competed in the last annual examination, obtaining a very fair percentage of marks in the subjects taken.

"*Progress.*—This class was started at the foot of the Progress Hill, in August, 1892, for the miners in the Progress and Globe Mines. A building was obtained, and about twenty members enlisted. It was carried on until the end of the year, the students attending regularly, and were instructed in logarithms, plane trigonometry, use and adjustments of surveying instruments, tabulation and calculation of traverses, and calculation of heights and distances. One of the students obtained 45 per cent. in surveying at the annual examination. The class has been started again this year, but the attendance is not so good.

"*Denniston.*—This school was visited in July, 1892, and in January, 1893. The attendance was not so good as expected, and the interest taken in the school does not appear to increase, many of the miners being afraid to attend. Some of the more intelligent, however, attended, and made fairly good progress.

"*Brunnerton.*—In accordance with your instructions, I visited this town during February, 1893, and formed a school of mines with about twenty members. The students throughout the month attended with every regularity, being most eager to come to the classes. Instruction was given in ventilation; gases, composition, detection, and properties; coal-mining, logarithms, and surveying. The classes were held in a small room off the Library, which could not comfortably accommodate the students. They however decided, if a little assistance could be obtained, to erect a school and fit it out; if this was done there is no doubt that a much needed institution would be added in this place, and that a first-class school could be formed.

"*Merrijigs.*—This class has been conducted throughout the year by Mr. B. Sutherland, manager of the Golden Lead, who takes a very great interest in the work, and, although the attendance was not large, there has nevertheless been some good work done in mining and surveying, some of the members coming well up in the last examinations.

"*Laboratory.*—During the past year over 137 assays, meltings, and analyses have been made, which show a considerable increase over the previous year, consisting of 64 fire-assays of gold and silver, 38 berdan tests, 13 bullion assays, and smeltings of gold and amalgam, 4 antimony, 6 tin, 4 analyses, and 8 coal analyses. Many tests and experiments were made on the tailings on the field, and towards the latter end of the year on samples taken from large quantities of cement, which extend along the West Coast. These were assayed by fire and by amalgamation, and many were treated by the cyanide process, the results showing the losses which were taking place, and also the cost of treatment and percentage extracted by the cyanide process.

"Experiments were made to treat the cement in lumps by the cyanide, which were successful in some cases where the cement is porous and poor, but in the closer grained and richer samples the results were not so good, perhaps owing to the great difficulty in washing the stuff clear of solution. The cyanide, however, extracts a very good pecrentage when the cement is crushed, the gold being fine and well suited for this process. The consumption is in some cases rather large, but may be reduced by some preliminary treatment. Experiments are still being made in that direction, but I find some difficulty in getting correct samples sent to Reefton. With regard to the tailings on this field, although crushed somewhat coarsely, experiments show that a very fair percentage can be extracted by the cyanide process, and, as the cost of treatment is not too great, there is every probability that most of the tailings on this field will pay well by the process. The coarseness of the tailings is in my opinion an advantage to a certain extent, notwithstanding that a certain percentage of the gold is enveloped in the quartz and cannot be attacked by the cyanide, because the tailings can be more easily and properly washed; whereas in slimy tailings a certain amount of the cyanide solution containing gold cannot be washed out without much extra trouble and time, entailing a loss of both cyanide and gold. A cyanide plant is now nearing completion on the heap of Welcome tailings lying at Boatman's. These tailings assay nearly 10dwt. per ton, and, although crushed rather finer than the average tailings here, should give a good idea to others of the cost of treatment on a large scale. The plant is apparently constructed to give downward percolation only, but from my own experiments I consider that a slow upward and downward percolation (especially for fine tailings) would give a far better percentage of extraction. There is no doubt that this process has in this district a big field, not only in the tailings, but in the millions of tons of cement which extend along the coast, a great part of which I believe will pay with careful treatment on a large scale.

"There is now a fair stock of chemicals, &c., in the laboratory, and benches have been fixed, with cupboards, which is a great convenience to the students.

"*The School.*—The appliances and arrangements of the school are each year improving. A scientific library has been added, at a cost of about £70, and is stocked with a fair number of scientific papers from various parts of the world. It is well patronised; but so far very few scientific books have been obtained, these however, will, no donbt, be gradually added to. The small berdan erected has been of great service in testing small parcels of stone, although the water-power is insufficient for the work. This requires altering, and the school requires to be lighted better, which I believe will be done as soon as funds permit. The Committee have lately allowed the use of the furnaces and part of the apparatus to the Cassell Company, during the day, for the purpose of introducing the process here. This interferes with the school to a certain extent; but it will, no doubt, be of benefit to the district, and may find employment for students of the school who have gone through a course of assaying and chemistry.

"*Examinations.*—The annual examinations in the various subjects taught were held from 2nd to 13th December, 1892, and the results obtained were highly satisfactory, and are evidence of good work done by the students. The older students, as was expected, headed the list, the papers of J. W. Lee and W. J. Young being done well throughout. The number of candidates were fifty-eight for all subjects, as against thirty-four the previous year.

"*Students.*—Many of the students are now becoming well versed in their respective studies, and have now a chance of reaping some benefit for their labours. One has lately been appointed to take charge of the first plant of the cyanide-process erected here.

"I have lately received instructions to visit Hokitika, Kumara, Greymouth, and Brunnerton for one week in each place every quarter. This breaking of the classes here will no doubt affect the attendance and efficiency of the Reefton School.

"In conclusion, I must thank the Committee for their valuable assistance in every way, and also those who have so kindly kept the classes going at the smaller schools during my absence."

Early in the beginning of last year the Committee of the Thames School of Mines represented to the Government that it would be more satisfactory to both the Committee and instructor if the annual examination-papers were prepared by persons appointed by the Government. This was done last year, and the examinations showed that great progress was being made at the Thames and Reefton Schools. The subjects on which examinations were held were: Theoretical and practical chemistry, practical assaying, mineralogy, geology, metallurgy of gold and silver, surveying, mining, pumping and winding, explosives and ventilation, and mechanical drawing. As the papers were mostly all prepared for advanced students they were only sent to the Thames and Reefton Schools, and the students acquitted themselves very well, reflecting the highest credit on the instructors of both schools.

At the Thames School, the large amount of work that has to be done in connection with assaying for the public, testing parcels of ore at the plant at the school, and teaching, was more than one instructor could attend to, and Mr. F. B. Allen, M.A., has been appointed temporarily as assistant to Mr. Park, and entered upon his duties in the beginning of April in this year.

Minor Schools.

There is a School of Mines at Nelson, and several on the West Coast—namely, Brunnerton, Greymouth, Kumara, Waimea, Hokitika, Rimu, and Ross. The one at Nelson is conducted by W. F. Worley, the Curator of the Nelson School of Mines, who has a class of lads from 10 years to 17 years of age for mineralogy and blow-pipe analysis. An assay class for adults was opened in May last year, but the number attending being only five it was not kept open for more than three months.

The following is Mr. Worley's report on the work done at the Nelson School of Mines during the past year:—

"I have the honour to submit the following report of work done at the Nelson School of Mines during the past year:—The boys' class for the study of mineralogy and blow-pipe analysis has been well maintained. The class consisted of seventeen lads, whose ages ranged from ten to fifteen years. The work done by this class embraced the study of two hundred ore-specimens, and the blow-pipe analysis of iron, lead, copper, tin, manganese, bismuth, antimony, chrome, arsenic, silver, and zinc. The boys were also shown how to pan off wash-dirt, and thus prospect for gold. The elder boys of the class, those who have been working with me for the last two or three years, are now able to identify speedily all the common ores, and to prove their conclusions by blow-pipe tests. An examination was held at the end of the year, when eleven of the boys succeeded in passing satisfactorily. Dr. Cressey of this city offered two prizes, of the value of 20s. and 10s. respectively, to those boys who should do best at the examination. This generous offer was a powerful incentive to the boys, several of whom did so well at the examination that there was considerable difficulty in deciding who were really the best. The first prize of 20s., however, was awarded to Cyril Oakey, and the second prize of 10s. to Frederick Worley; a third prize of 10s., provided by myself, was awarded to Hardy Kitching, as his work was almost equal to that of the second. I have every reason to be well satisfied with the work of this class. The boys are steady, painstaking workers, who, by and by, will no doubt turn to profitable account the knowledge they are now acquiring.

"An assay class for adults was opened in May, but as only five persons joined, it was not kept open more than three months.

"A course of popular lectures on elementary chemistry was given during the winter months, but the attendance was not good, the average number present being about twenty.

"Several assays were made for the public, but none of them call for special mention."

On the West Coast great enthusiasm is displayed by the miners at the schools so as to acquire a knowledge of the different minerals they meet with in following their avocations. During last year Mr. W. Goodlet was appointed to visit the different schools from Brunnerton to Ross, and to give a series of lectures at each school. On his former visit, Mr. Goodlet found rubies in some blocks of detached rock; but these have not yet been found *in situ*. After Mr. Goodlet had finished his visits to the different schools, which occupied four months, he went in conjunction with some miners into the back country, with the view of finding a lode of tin-ore, but was unsuccessful in the search. Mr. Goodlet's lectures at the different schools on the chemistry of minerals were well appreciated by the miners, and although the benefits derived by a short visit to these schools are small in comparison to that in the principal schools, where teaching is continuously carried on, it gives the miners in the different places a slight knowledge of the composition of minerals, and some of them are now able to assay samples and determine the qualitative analysis. This is in itself a great advantage, as it enables them to readily distinguish the different metals and minerals they meet with.

At Hokitika Mr. W. M. Purkis has taken a great interest in the School of Mines, giving instructions in theoretical and and practical chemistry, mineralogy, and blow-pipe analysis. The following is a report by Mr. Thomas H. Gill, the Honorary Secretary to the Committee of the school, for the year ending the 31st March last:—

"I have the honour, by direction of the local School of Mines, to report on the work and progress of our school during the year ending the 31st of March last, and I am pleased to state

that the year just ended has been one of the most successful the school has had since its inception, both in respect to the efficiency and usefulness of the work done, and to the attendance of members. At the commencement of the period under review, in order to bring the benefits of the school within easy reach of all classes of the community, the subscription for the year was fixed as low as possible—viz., 10s. for a family ticket, and 5s. for a single ticket. Under this system upwards of thirty subscribing members were obtained, and the average attendance for the session was twenty-two.

"The income derived from this source, supplemented by proceeds of a public entertainment and by a subsidy of £10, amounted to £34, almost the whole of which, after providing for sundry minor expenses, as fuel, light, advertising, &c., has been either expended or allocated for necessary material and appliances. The school is entirely dependent for instruction on amateurs—the lion's share of the work having been performed by Mr. W. M. Purkiss, to whom members are greatly indebted—although in this connection I must not forget to mention that for a period of two weeks the services of Mr. W. Goodlet were placed at our disposal, and the classes which he held nightly were well attended and highly appreciated. The members met every Thursday evening from May to October, inclusive, in quarters in the Police Camp, kindly placed at our disposal by the Government. These quarters have been comfortably fitted up as a class-room and laboratory, and although very much is still wanting in the way of apparatus and material, a very fair beginning has been made in this direction.

"The work done during the year has comprised theoretical chemistry, practical chemistry, and laboratory practice, mineralogy, and blow-pipe determination. Practical assaying has not been attempted owing to the lack of a suitable furnace, and other necessary appliances. As, however, these have been ordered from London, this very important and essential branch will be taken up during the ensuing year.

"In order to further add to the usefulness of the school, it is proposed that an additional class, to be composed of the elder scholars of the public school, shall be formed. It is thought that by well grounding the rising generation in the principles of chemistry and chemical manipulation, teaching them the elements of mineralogy and blow-pipe analysis, and thereby training their powers of observation, a firm foundation will be laid, upon which, and upon which only. the solid structure of the wonderful science of chemistry can afterward be reared."

OTAGO SCHOOL OF MINES.

The school attached to the Otago University at Dunedin has been subsidised by moneys from the Mines votes for the last eight years, and this is the first year that any report on the work done at the school has come to hand. The following report of Professor Ulrich to the Chancellor of the University is taken from the *Mining Journal*, and shows that considerably more interest is taken in the subjects taught at this school than was done a few years ago. Indeed, it may be said the Otago University owes a debt of gratitude to Dr. Black for the energetic and logical manner in which he disseminated his views on the necessity of those intending to follow up mining having a technical education. His lectures in the different mining centres caused such enthusiasm amongst the miners that local schools were got up at almost every mining centre, and, it may be said that the miners, for the first time in this colony, had an opportunity of witnessing a practical demonstration of the principle and method of testing the different ores met with. At the time the local schools were inaugurated very little interest was taken at the Otago School, there only being some three or four students, and, in some cases, only one student attended the mining lectures; but by his report last year there were nineteen students, showing that it is only by the interest taken in subjects in connection with mining all over the colony that the number of students at this school has so greatly increased. It is only those who can afford the means to attend the University classes that can avail themselves of the knowledge imparted at this school of mines. Whereas on the goldfield centres, such as at the Thames, the men are able to follow their ordinary avocations during the day and attend the school at night, and thereby enabled to earn their livelihood and attend the mining classes at the same time. The Otago School is doing good work, and deserves to be well patronised. The Director is without exception the best mineralogist in the colony, and has the advantage of being practically acquainted with the methods of mining. It is to be hoped that in the future the department will be able to get a yearly report on the work done at this school so as to show how it is progressing.

The Director, Professor H. F. Ulrich, reports as follows:—

"In compliance with the request of the Council I have the honour to submit the following report on the work and results of the School of Mines during the past session (1892):—

"The school was attended with satisfactory regularity by twenty-two students, three of whom were casual students for two special classes only—viz., assaying and general geology, whilst the remaining nineteen were regular registered students, who entered with the intention of going through one or more of the courses of study prescribed in the calendar for the several divisions of the school.

"Before giving an abstract of the work done by these nineteen students, I have to mention that, owing to various circumstances, a number of the students—since the school was first opened—did not hitherto strictly follow the curriculum prescribed in the calendar for the divisions they intended to qualify for. Of the above number, three students, for instance, with the intention of gaining the B.Sc. degree, took other university classes, leaving the missed mining classes for future sessions; whilst several others, indifferent as to finishing the course in three years, took per year one or two classes less than prescribed, thus requiring a fourth year for completion. In former years it has also happened that students took more classes than prescribed during one session in order to have more time for the study of certain subjects during succeeding sessions. Failure in passing the examinations in a certain class and the consequent necessity of attending the same

class a second time has also thrown students out of the prescribed course. It can, therefore, not with strict accuracy be stated that first, second, and third years' students have respectively passed the first, second, and third year's course of the division they have entered for. With this reservation the status of the nineteen regular students of the past session is as follows:—

"Two students, who entered for the past session, passed through the first year's course.

"Five students, who entered for the last year's session, passed through the second year's course.

"One student, P. Marshall, B.A., B.Sc., passed the first and part of the second year's course, and, with the intention of qualifying for the M.A. degree, prepared a paper on a petrographical subject, requiring much microscopic work and chemical investigation.

"One student attended lectures in most of the technical subjects of the mining and metallurgical divisions, but did not enter for the respective examinations.

"Two students of several years' standing require to pass in but one or two subjects more to become entitled to the diplomas and certificates of all the divisions of the school; one of them, P. G. Morgan, M.A., has, in fact, already gained the certificate of the Surveying Division.

"One student, who entered two years ago for the Surveying Division only, has passed the required examinations, and will be entitled to the certificate of this division on presenting satisfactory evidence of having been engaged in six months' practical surveying work.

"Seven students of from three to five years' standing have completed their studies with success in the subjects prescribed for all or several divisions, and have been granted the diplomas of Associateship and the certificates of the respective divisions. These students are: R. H. Walcott (gained the diplomas of Associateship of the Mining, Metallurgical, and Geological Divisions, and the certificates of the divisions of Surveying and of Metallurgical Chemist and Assayer), F. B. Stephens (gained the diplomas of Associateship of the Mining and Metallurgical Divisions and the certificates of the divisions of Surveying and of Metallurgical Chemist and Assayer), Edward A. Paterson (gained the diplomas of Associateship of the Mining and Metallurgical Divisions, and the certificates of the divisions of Surveying and of Metallurgical Chemist and Assayer), W. Fulton (gained the diplomas of Associateship of the Mining and Metallurgical Divisions, and the certificates for the divisions of Surveying and of Metallurgical Chemist and Assayer), G. D. Ahern (gained the diplomas of Associateship of the Mining and Metallurgical Divisions, and the certificates for the divisions of Surveying and of Metallurgical Chemist and Assayer), P. Fitzgerald (gained the diploma of Associateship of the Metallurgical Division and the certificate of Metallurgical Chemist and Assayer; having passed the required examinations, he will also be entitled to the diploma of Associateship of the Mining Division and the certificate of the Surveying Division, on submitting satisfactory evidence of having been engaged for twelve months in practical work in mines, and for six months in surveying work), D. B. Waters (gained the diploma of Associateship of the Mining Division and the certificate of the Surveying Division).

"With these seven students and other five who, I was informed, do not intend to proceed, the school loses this year in all twelve students, ten only remaining; but notice has already been received of four new students, and thus there is some probability of the lost number being made up again for next year's session.

"The attendance of the classes and the results of the annual examinations in the subjects specially belonging to the Mining School are shown in the following table:—

Subjects.	Attendance.	Entered for Examination.	Results of Examination.			
			1st Class.	2nd Class.	3rd Class.	Failures.
Mineralogy	9	8	...	4	4	...
Petrography	7	6	1	2	3	...
General Geology	4	3	1	1	1	...
Palæontology	3	2	...	2	..	...
Mining	9	8	...	6	2	..
General Metallurgy	9	8	1	3	4	...
Special Metallurgy	8	7	3	3	1	...
Assaying, first course	9	9	7	2	...	...
Blowpipe Analysis	8	7	3	4	...	...
Surveying, first course	2	2	...	1	1	...
Surveying, second course	8	8	2	4	2	...
Applied Mechanics, second course ...	6	5	...	3	2	...

"In addition to the classes in the above subjects, students, according to their standing, whether in their first, second, or third year, had also to attend the regular University classes in mathematics, theoretical mechanics, theoretical physics, practical physics, theoretical chemistry, and practical chemistry; and one student, with the object of qualifying for the associateship in geology, also passed through the course in biology. With the exception of two students having failed in mathematics, no other failures are recorded in any of these subjects students respectively attended.

"In compliance with the request of the Council, the Lecturers in assaying and surveying, Mr. Wilkinson and Mr. Begg, announced by advertisement in the newspapers that they would hold evening classes in their respective subjects for students not able to attend the day classes. The result of this step was that for the evening class in assaying two new students entered, but for the

evening class in surveying there was no response. Mr. Begg held, however, two classes—one in the morning, the other in the afternoon—for the convenience of the students.

"The work done for the public during the year in assays and determinations of minerals by the Lecturer in Assaying, Mr. Wilkinson, was as follows:—

Charged for at Fixed Rates.

"March 7th.—Five assays of granite for gold and silver; for Mr. A. Ferguson, Christchurch.
"March 21st.—Assay of sample of iron garnet sand for tin; for Mr. W. Reid, Dunedin.
"April 8th.—Assay of pyrites for gold; for Messrs. Donald Reid and Co., Dunedin.
"July 20th.—Assay of pyrites for gold; for Mr. H. F. Boddington, Fairfield.
"August 8th.—Two assays of two samples of pyrites for gold; for Mr. H. F. Boddington, Fairfield.
"August 29th.—Assays of tailings from Globe Company, Reefton, for gold; for Mr. Thomas Brydone, Dunedin.
"September 9th.—Assays of tin ore; for Mr. T. Lyders, Dunedin.
"September 14th.—Assays of Maharahara copper ore for copper, &c.; for Mr. J. C. Carr, C.E., Napier.
"September 20th.—Assay of steel; for New Zealand Engineering Company.
"September 21st.—Assay of pyrites for gold; for Messrs. Porter and Hocking, Barewood.
"September 24th.—Assays of two samples of pyrites for gold; for Messrs. Donald Reid and Co., Dunedin.
"October 10th.—Assay of pyrites for gold; for Mr. H. F. Boddington, Fairfield.
"October 18th.—Assay of pyrites for gold; for Mr. H. F. Boddington, Fairfield.
"October 25th.—Analysis of limestone; for Mr. Crosby Morris, Dunedin.

Not charged for.

"March 16th.—Assay of pyritiferous quartz for gold; for Mr. Malcolm Ross, Dunedin.
"March 22dd.—Assay of garnet sand and crushed schist for tin: for Mr. J. Allen, M.H.R., Dunedin.
"April 22nd.—Asssys of samples of schist-ore rock and manganese-ore for silver; for Mr. J. T. Koefoed, Milton.
"May 20th.—Determination of iron in asbestos; for Mr. R. Paulin, Ngapara.
"September 16th.—Assays of rock samples for tin and silver; for Mr. Melland, Dunedin.
"September 22nd.—Determination of seven samples of minerals; for Mr. R. Paulin, Ngapara.
"October 10th.—Assay of antimony-ore for silver; for Mr. G. M. Barr, Dunedin.
"A considerable number of gratuitous determinations of minerals and rock samples have also been made by myself during the year; in fact, during the first part of the session hardly a week passed by without one or more such determinations, persons frequently calling at my private house for this purpose. I have hitherto not kept a list of the samples examined, and can, therefore, only mention from memory a few of the cases, as under:—
"Oriental ruby, brought by Mr. W. Goodlet from Rimu, West Coast, Middle Island.
"A collection of some thirty specimens of rocks and minerals from the Island of Borneo.
"Garnets, from the neighbourhood of Oamaru.
"Earthy vivianite (blue iron earth), from the Blue Spur mine near Lawrence.
"A number of samples of mica schist and other rocks impregnated with pyrites, supposed to be silver-ore or gold.
"Rhodonite (bisilicate of manganese), from Nenthorn, &c., &c.
"In conclusion, I may be permitted to mention that our mineral and rock collections have been materially increased by numerous presents during the year, the most important being as under:—
"Professor Black: A collection of some twenty specimens of the ores and other minerals of the mining district of Zeehan, Tasmania, including some valuable crystallized specimens of the rare mineral 'crocoite' (chromate of lead), also crystallized cerassite (carbonate of lead), sphalerite, siderite, &c.
"Mr. W. Goodlet: A fine specimen of the interesting ruby-bearing boulder from Rimu, Westland.
"Mr. A. Hamilton: Fragments of moa bone, studded with small crystals of vivianite; also a number of specimens of the Port Chalmers volcanic breccia, showing inclusions of mica schist, phonolite, &c.
"Mr. L. Neil: A collection of some forty specimens of rocks from the neighbourhood of the Portobello gold-mine, and other parts of the Peninsula.
"Mr. Thomas Esdaile: A number of interesting rock specimens from the neighbourhood of Oamaru.
"Mr. P. Marshall: Rock specimens from Lyttelton Harbour and Wanganui.
"Mr. F. B. Steyhens: A collection of some thirty specimens of interesting rocks from Milford Sound.
"Mr. D. Wilkinson: A number of fine specimens of native copper, cerassite, mimetite, galena, and other minerals from Broken Hill, New South Wales.
"Mr. Cochrane: Twelve specimens of auriferous quartz from as many different mines in the Reefton district; also rock specimens from Cape Foulwind and neighbourhood.
"Mr. J. Mouat: Several fine large pieces of stibnite from the antimony mine, Waipori.
"Most of the mineral specimens have been properly labelled and placed in the large glass cases for inspection by the students, whilst the rock specimens are of great use in determinative petrography."

EXPENDITURE ON SCHOOLS.

The following table shows the expenditure by the Government on Schools of Mines since their inauguration, exclusive of subsidies paid to the University of Otago towards the School of Mines in connection with that institution:—

Financial Years.	Subsidies towards the Erection of Schools of Mines, and Maintenance.	Chemicals and Apparatus, also Mineralogical Specimens supplied to Schools of Mines.	Salaries of Teachers, and Travelling Expenses, &c.	Total Sums paid by the Department towards the Schools of Mines.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1885–86	...	36 19 9	1,223 9 10	1,260 9 7
1886–87	257 16 6	409 1 4	2,716 9 3	3,383 7 1
1887–88	253 15 9	253 14 1	1,714 9 6	2,221 19 4
1888–89	42 10 0	6 12 9	1,139 4 1	1,188 6 10
1889–90	142 2 0	181 14 10	716 3 10	1,040 0 8
1890–91	217 6 6	54 8 0	620 9 9	892 4 3
1891–92	181 14 0	...	689 5 9	870 19 9
1892–93	312 3 4	...	670 1 0	982 4 4
Totals	1,407 8 1	942 10 9	9,489 13 0	11,839 11 10

There has also been given towards the School of Mines attached to the Otago University £3,750, which makes the total expenditure on schools £15,589 11s. 10d. up to the end of March last. The expenditure extends over a period of eight years, which gives an average of £1,948 14s. per annum: but by far the greatest annual expenditure was incurred during the first three years of their inauguration; the total expenditure last year being only £1,232 4s. 4d. The colony is only now beginning to reap the benefit of this technical training of the miners. As stated previously, some of the millmen and managers of mines in the North Island are forced to admit that, in order to know whether a fair percentage of the bullion from the ore is extracted or not, regular and systematic assays will have to be made; and this is now being done, with a result which shows that about 50 per cent. of the value of the bullion is entirely lost, which means that different appliances for saving it will have to be adopted, and lodes containing lower grade ore that have hitherto not been worked at a profit made to give fair returns for the capital expended in opening them out and carrying on mining operations.

WATER-RACES.

Waimea–Kumara Water-Race, Construction.

An extension of the Waimea Water-race has been constructed from the lower end of the pipe-line to the middle branch of the Waimea Creek. This extension crosses Stoney, Akaroa, and Duffer's Creeks, where mining is still going on. In constructing the ditch around the sideling of the range, gold was found in the drift gravel, and this led to parties taking up claims and prospecting the ground in the neighbourhood. This branch of the water-race is 4ft. 6in. wide in the bottom, 3ft. 6in. deep, with a batter of 1 in 4 on the sides, and constructed on a gradient of 8ft. per mile. This gives the race a carrying-capacity of about 26 sluice-heads. This extension will command all the ground in the valley of the middle branch of the Waimea Creek, where there is a likelihood of a good deal of new ground being opened. The length of this extension is 2 miles 10 chains, and the expenditure on the work up to the end of March last was £1,547 5s. 5d.

An extension of the Kumara Water-race Branch along the Kapitea Hill has been surveyed for a further distance of about 40 chains, and its construction is now in progress. This extension was required to supply water to parties having claims at the lower end of the flat. The ground on the upper end at Larrikin's is gradually getting washed away towards the range, and will in a few years be worked out. The expenditure on this work to the end of March last was £723 14s. 6d. The Kawhaka Supply-race was also widened last year, at a cost of £65 10s. 4d.

Waimea Water-race.

There was not a large expenditure incurred in keeping this water-race in repair last year. The fluming at the upper end is the only troublesome portion. A small portion of the boxing had to be replaced, as it broke down, but very little had to be done to the under-structure. The manager was, at the time of my visit, preparing to renew a good many of the trestle-legs during the Christmas holidays. The upper portion of this water-race—namely, that above the pipe-line, was constructed with very little fall—4ft. to the mile—and as there are two pieces of fluming in this portion, each about half-a-mile in length, it requires large boxing to carry the water, and necessitates the under-structure always being carefully looked after to prevent a breakdown taking place, as the most of the original trestles, with the exception of those constructed of rata and kawhaka, are pretty well decayed. The heart of red-pine is now being used as trestle-legs, and some of them have been in for eight years, and show no sign of decay. The flumes between the end of the pipe-line and Stafford are in very fair repair, and have not required much attention during last year. The quantity of water required for supplying the miners at Waimea and Stafford from this water-race does not exceed 14 sluice-heads. The following statement will show the result of the working of this water-race for the year ending the 31st March last:—

WAIMEA WATER-RACE.

Month.	Sales of Water.	Cash received for Sales of Water.	Expenditure.	Outstanding Moneys at the End of each Month.	Number of Men employed.	Approximate Quantity of Gold obtained.	Value of Gold.
1892.	£ s. d.	£ s. d.	£ s. d.	£ s. d.		Oz.	£ s. d.
April	100 9 3	76 2 7	53 3 5	57 15 5	73	249	971 2 0
May	102 0 4	109 3 3	51 8 5	59 10 5	70	255	994 10 0
June	109 19 6	111 14 11	53 4 5	60 2 11	66	275	1,072 10 0
July	83 14 9	93 1 5	64 8 7	60 2 11	66	225	877 10 0
August	82 16 10	83 16 10	64 8 2	59 19 2	69	195	760 10 0
September	98 8 3	107 14 11	61 10 4	58 19 2	66	230	897 0 0
October	81 5 11	85 1 2	59 9 10	57 19 2	69	200	780 0 0
November	88 2 11	72 17 6	70 17 4	57 9 2	64	210	819 0 0
December..	71 5 0	45 2 6	132 5 11	57 17 11	65	170	663 0 0
1893.							
January	46 15 0	80 17 4	112 18 7	56 19 2	67	120	468 0 0
February	65 3 11	68 6 1	62 16 6	56 19 2	66	160	624 0 0
March	85 10 7	71 17 6	71 8 10	56 15 5	59	210	819 0 0
Totals	1,015 12 3	1,005 16 0	858 0 4	..	66	2,499	9,746 2 0

The above statement shows that the sales of water for the year were £1,015 12s. 3d., as against £1,121 16s. 2d. for the year previous; and the expenditure, £858 0s. 4d., as against £784 13s. 10d. for the former year; which shows a decrease in the sales of water last year of £105 3s. 11d., and an increase of expenditure of £73 6s. 6d. The actual profit on the working of the race last year being £157 11s. 11d., whereas for the year previous it was £337 2s. 4d. The value of free water given to the miners as assistance last year in opening out ground, was £14 13s. 1d., and the approximate quantity of gold obtained by those whose claims were worked with water from the race was 2,499oz., representing a value of £9,746 2s. Deducting the value of the sales of water from the value of the gold obtained, it leaves £8,730 9s. 9d. as the earnings of 66 miners for the year, which is equal to £132 5s. 7d. a man per annum, or £2 10s. 10d. per week. Taking the profits last year, they only gave about $\frac{1}{8}$ per cent. on the total cost of construction, which amounts to £120,558 12s. 3d.

KUMARA WATER-RACE.

The portion between the small dam and the mouth of the tunnel has been timbered and lined, and the timber in the floor of the tunnel which was bulged up in centre has been taken up and relaid. In the open ditching on the Kumara end of the tunnel new gauge-boxes have been placed in the race, so that the quantity of water could be gauged that is sent down each branch. The largest quantity of water is supplied on the field from the Kapitea Hill branch. This race has been considerably improved during the year, and about one chain of new fluming had to be constructed, owing to the large quantity of water that this branch race has to convey—namely, about eighty sluice-heads. The extension of this race for about another 40 chains to command the ground further down the flat is in progress.

The low-level race, which supplies water to the claims at the Break, Nardoo Flat, and the Tramway Terrace, has been considerably enlarged, and will now carry thirty sluice-heads to Dillmanstown, and twenty sluice-heads below this point to Nardoo Flat and Kumara. A branch of this race has been constructed to supply claims on the Shallow Lead.

Two deviations have been made on the Ross Terrace branch, and the whole of the fluming on Ross Terrace has been done away with, and siphons substituted in lieu thereof. This deviation has allowed a considerable area of ground to be worked that could not be done so long as the flume was in existence, the ground at this place being about 80ft. deep. It is possible that another deviation of the upper end of this branch will yet have to be made if it is found that the gold goes under the terrace; but it will be a considerable time before this is required. When there is plenty of water—say in wet weather—there is about 130 sluice-heads sent through the tunnel and distributed in the different branches; but when the dams are not running over the quantity sent through is only sufficient to meet the requirements, as in dry weather the water has to be carefully conserved.

The work done in deepening and enlarging Kawhaka Supply Branch has increased the supply into the Loopline Dam considerably. It now fills in about one-half the time that it did previously. Some new fluming had to be put in this race during the year, owing to the bank being carried away by falling timber.

The by-wash at the Loopline had to be re-puddled, and the whole of the by-wash re-lined with boarding an inch in thickness. A new screw has been put on for lifting and lowering the gate, which answers admirably.

The tailings channels are working satisfactorily, but the miners on my visit complained of the cost of the maintenance. The No. 2 Channel is being carried out on the tail-end on a gradient of 4in. to 12ft., and the No. 3 Channel is being carried out on a gradient of 3½in. to the 12ft., both of which work very well, and never block on the outside of the tunnel. The only place where the No. 3 Channel ever blocks is inside the tunnel, near the place where the tail-races from the claims joins it. This blocking could all be done away with if the miners took sufficient care to bring their sluices into the channel with a proper curve, and let them into the side near the bottom. Wherever the material comes into it at a sharp angle, or has a fall into the channel, it retards the velocity of the water, and is bound to cause a block to take place, especially where the miners are sluicing large quantities of bottom-stuff, or fine material. The tail-boxes of No. 3 Channel are

getting a long way out, but the flood which took place in October last carried away a large quantity of tailings, and gives a deal more room. At one place the river came back 250ft. on the tailings-heaps, and carried them away. The channel of the river has altered considerably, and is now much nearer the terrace on the Kumara side than it has been for years past. The river-bed below the bridge is such a great width that it will take a considerable time to raise it much.

The workings are getting gradually nearer the Kapitea Hill, which necessitates some of the tail-races being carried on a very low gradient, in order to be able to sluice into the present tailings channels. The miners have, however, arranged to construct a new channel, to come out in the face of the terrace lower down the river than any of the others, which will relieve the middle channel to a great extent, and make better provision for the deposit of tailings. There is no gainsaying the fact that the richest portion of the ground is getting gradually washed away. Still there is yet a large field to work, which will give employment to a mining population for many years to come.

The following statement shows the sales of water, cost of maintenance, and the approximate quantity of gold obtained by the miners using water from this supply for the year ending the 31st March last:—

Month.	Sales of Water.	Cash received for Sales of Water.	Expenditure.	Outstanding Moneys at the end of each Month.	Number of Men employed.	Approximate Quantity of Gold obtained.	Value of Gold.
1892.	£ s. d.	£ s. d.	£ s. d.	£ s. d.		Oz.	£ s. d.
April	495 17 1	458 16 9	134 2 5	98 12 4	149	744	2,901 12 0
May	505 12 11	529 14 7	153 18 10	102 3 9	149	758	2,956 4 0
June	493 5 10	518 19 1	146 15 4	95 6 0	146	741	2,889 18 0
July	495 13 6	500 17 1	109 15 4	76 5 9	151	745	2,905 10 0
August	602 2 8	675 10 9	145 4 0	84 8 11	156	900	3,510 0 0
September	635 1 3	505 5 0	134 10 1	83 17 11	150	950	3,705 0 0
October	571 1 8	720 17 6	152 3 6	59 3 9	157	850	3,315 0 0
November	458 7 1	297 2 6	137 12 4	123 11 0	155	680	2,652 0 0
December	382 2 1	517 2 2	171 7 6	61 9 3	156	570	2,223 0 0
1893.							
January	390 19 2	212 7 6	177 13 8	107 0 8	141	580	2,262 0 0
February	450 7 6	500 8 9	160 2 11	150 14 0	128	670	2,613 0 0
March	308 10 0	315 4 2	159 5 1	139 3 5	128	460	1,794 0 0
Total	5,789 0 9	5,752 5 10	1,782 11 0	..	147	8,648	33,724 4 0

The above statement shows the sales of water for last year to be £5,789 0s. 9d., as against £6,645 11s. for the former year; and the expenditure on maintenance £1,782 11s., as against £1,584 10s. 11d. for the year previous, showing that the value of the sales of water last year has diminished to the extent of £856 10s. 3d., while the expenditure on maintenance has increased £198 0s. 1d. The profits on the working last year amount to £4,006 9s. 9d., as against £5,474 3s. 5d. for the year previous. The value of free water given to parties as assistance and to open up new claims was £834 3s. 4d., and the approximate quantity of gold obtained by those who were using water from the race was 8,648oz., representing a value of £33,724 4s. Deducting the value of the sales of water from the value of the gold obtained, it leaves £27,935 3s. 3d. as the earnings of 147 miners for the year, being £190 0s. 8d. a man per annum, or £3 13s. 1d. per week, which is only 3d. a man per week less than the earnings for the previous year. The profits on the working last year is about 10 per cent. on the cost of construction, which now amounts to £40,425 11s. 11d.

The following summary shows the result of working this water-race for the last ten years. During that period the value of the sales of water amounted to £70,847 0s. 3d., while the value of water for that period given towards assistance in opening-out claims, for constructing deviations, and towards the construction of No. 3 Channel, or tail-race, amounted to £11,724 5s. 4d.: making the total value of the sales of water and free water given for assistance, &c., £82,571 5s. 7d.; while the total expenditure in connection with the maintenance has been £15,227 16s. 11d.:—

SUMMARY showing the RESULT of WORKING the KUMARA WATER-RACE for Ten Years, from 1st April, 1883, to 31st March, 1893.

Water supplied.	Year.	Rate per Sluice-head per Week.	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	Total Value of Water sold.	Total Value Free for Assistance.	Total Value Free for Deviations.	Total for Construction of No. 3 Channel.	Total Value Water supplied.	Average Number of Sluice-heads supplied Daily.	Expenditure.
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.		£ s. d.
Water sold ..	1883-84	3 0 0	371 16 5	465 2 1	700 2 6	583 9 7	702 7 6	626 16 3	808 10 5	777 3 9	774 17 11	698 2 6	1,064 0 0	774 6 0	8,346 14 11	..	..	..	..	..	..
Free	1883-84	..	46 2 6	44 5 0	183 11 8	108 19 2	108 0 0	85 7 6	244 7 6	172 18 9	63 12 6	103 9 2	86 5 0	139 3 4	..	1,386 2 1	..	..	..	..	..
			417 18 11	509 7 1	883 14 2	692 8 9	810 7 6	712 3 9	1,052 17 11	950 2 6	838 10 5	801 11 8	1,150 5 0	913 9 4	..	..	..	..	9,732 17 0	46·35	2,153 5 5
Water sold ..	1884-85	3 0 0	580 4 4	937 19 4	667 3 11	906 16 10	882 6 10	997 1 5	919 12 3	1,126 11 10	819 17 3	289 4 2	756 9 2	821 0 10	9,704 8 2	..	..	..	..	..	..
Free	1884-85	..	92 5 0	56 19 7	78 18 9	55 13 9	149 0 10	18 11 3	145 13 4	69 3 9	39 15 0	26 12 6	45 3 9	2 16 8	..	780 14 2	..	..	..	..	..
			672 9 4	994 18 11	746 2 8	962 10 7	1,031 7 8	1,015 12 8	1,065 5 7	1,195 15 7	859 12 3	315 16 8	801 12 11	823 17 6	..	..	..	..	10,485 2 4	49·92	1,656 0 1
Water sold ..	1885-86	2 10 0	665 16 0	796 6 9	893 5 3	745 19 7	773 19 10	943 13 5	953 15 6	997 7 8	697 13 5	686 4 0	708 15 8	935 19 7	9,788 16 8	..	..	..	..	..	..
Free	1885-86	..	24 13 9	9 2 0	..	..	23 15 0	31 3 4	22 1 3	18 11 10	18 7 2	49 1 4	1 5 0	13 2 6	..	221 3 2	..	..	..	..	..
			690 9 9	805 8 9	893 5 3	745 19 7	797 14 10	974 16 9	975 16 9	1,015 19 6	716 0 7	735 5 4	710 0 8	949 2 1	..	..	..	..	10,009 19 10	57·20	1,454 19 5
Water sold ..	1886-87	2 10 0	758 0 4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Water sold ..	1886-87	2 0 0	..	19 10 8	488 3 9	315 7 11	599 5 0	643 7 11	682 8 9	686 7 5	562 0 10	345 12 7	673 0 0	747 9 2	6,470 14 4	..	..	..	..	..	..
Free	1886-87	..	..	776 0 11	242 0 11	40 13 9	120 9 7	83 15 10	74 5 0	45 9 2	32 15 0	46 8 9	49 16 8	36 3 4	..	1,547 18 11	..	..	..	..	..
			758 0 4	795 11 7	730 4 8	356 1 8	719 14 7	727 3 9	706 13 9	731 16 7	594 15 10	392 1 4	722 16 8	783 12 6	..	..	..	..	8,018 13 3	56·19	1,398 18 10
Water sold ..	1887-88	2 0 0	535 5 10	679 7 8	167 10 10	656 4 7	684 16 1	694 5 0	591 12 1	710 0 0	535 10 10	519 15 5	670 17 6	734 4 5	7,169 10 3	..	..	..	..	..	..
Free	1887-88	..	26 11 8	40 19 2	15 13 9	23 10 0	47 7 11	4 11 8	34 16 8	42 10 0	27 10 0	28 6 8	19 11 8	15 17 3	..	347 6 5	..	..	..	..	..
			561 17 6	720 6 10	183 4 7	679 14 7	732 4 0	698 16 8	626 8 9	752 10 0	553 0 10	548 2 1	690 9 2	750 1 8	..	..	..	..	7,516 16 8	53·68	982 12 0
Water sold ..	1888-89	2 0 0	490 6 8	338 7 7	532 1 1	626 19 10	667 8 3	542 8 4	702 12 6	664 1 7	395 12 3	465 2 1	623 18 4	667 8 4	6,716 6 10	..	..	..	..	..	..
Free	1888-89	..	107 17 3	90 18 0	87 1 4	75 1 10	32 10 0	16 9 5	38 1 4	13 0 0	34 9 2	58 6 8	90 10 10	74 13 4	..	492 0 0	227 0 0	..	..	..	..
			598 3 11	429 5 7	619 2 5	702 1 8	699 18 3	558 17 9	740 13 10	667 1 7	430 1 5	523 9 7	714 9 2	742 1 8	..	..	..	..	7,435 6 10	53·10	1,024 1 9
Water sold ..	1889-90	2 0 0	401 13 4	495 16 4	256 16 8	377 16 3	353 4 2	237 7 11	318 10 10	293 8 4	159 18 9	219 15 10	248 19 7	186 16 8	3,550 4 8	..	..	..	..	..	..
Free	1889-90	..	45 15 0	55 3 4	43 0 0	92 15 0	105 15 0	93 1 8	41 10 0	103 18 4	105 13 4	48 17 6	54 8 4	71 5 0	..	396 2 6	465 0 0	..	..	..	..
Free, No. 3 Channel	1889-90	..	..	..	..	..	122 19 1	335 1 3	330 11 8	275 8 0	97 13 4	6 0 0	221 18 1	102 11 5	..	..	..	1,492 2 10	..	..	..
			447 8 4	550 19 8	299 16 8	470 11 3	581 18 3	665 10 10	690 12 6	672 14 8	363 5 5	274 13 4	525 6 0	360 13 1	..	..	..	..	5,903 10 0	42·16	1,424 13 3
Water sold ..	1890-91	2 0 0	300 12 6	355 11 11	368 3 2	423 9 0	622 17 11	666 7 1	720 16 1	701 5 10	578 1 8	546 17 11	691 17 11	689 11 8	6,665 12 8	..	..	..	..	..	..
Free	1890-91	..	113 5 0	119 14 2	70 7 11	71 17 6	82 9 7	110 16 8	93 13 9	106 0 10	57 5 5	113 6 8	133 2 6	130 5 10	..	409 5 5	793 0 5	..	..	..	..
Free, No. 3 Channel	1890-91	..	272 11 11	247 3 6	246 17 10	115 2 11	32 2 2	..	..	..	..	..	..	..	..	..	..	913 18 4	..	..	..
			686 9 5	722 9 7	685 8 11	610 9 5	737 9 8	777 3 9	814 9 10	807 6 8	635 7 1	660 4 7	825 0 5	819 17 6	..	..	..	..	8,781 16 10	62·72	1,766 4 3
Water sold ..	1891-92	2 0 0	616 5 10	655 4 11	542 9 1	179 11 11	426 16 1	769 15 5	784 13 8	642 4 2	469 10 0	291 3 9	543 7 6	724 8 8	6,645 11 0	..	..	..	..	..	..
Free	1891-92	..	143 11 5	191 16 8	44 3 6	..	82 16 11	151 14 7	118 10 1	233 1 8	213 11 3	137 0 10	64 11 8	28 9 2	..	996 4 5	413 3 4	..	..	..	..
			759 17 3	847 1 7	586 12 7	179 11 11	509 13 0	921 10 0	903 3 9	875 5 10	683 1 3	428 4 7	607 19 2	752 17 10	..	..	..	..	8,054 18 9	57·53	1,584 10 11
Water sold ..	1892-93	..	495 17 1	505 12 11	493 5 10	495 13 6	602 2 8	635 1 3	571 1 8	458 7 1	382 2 1	390 19 2	450 7 6	308 10 0	5,789 0 9	..	..	..	..	..	..
Free	1892-93	..	44 18 9	80 2 6	72 4 2	61 2 1	43 5 10	38 2 6	44 0 10	66 2 6	157 6 8	91 4 2	77 10 10	64 2 6	..	444 15 8	398 7 8	..	..	..	..
			540 15 10	585 15 5	565 10 0	556 15 7	645 8 6	673 3 9	615 2 6	524 9 7	539 8 9	485 3 4	527 18 4	372 12 6	..	..	..	..	6,632 4 1	47·35	1,782 11 0
															70,847 0 3	7,021 12 9	2,296 11 5	2,406 1 2	82,571 5 7	..	15,227 16 11

NOTE.—The above does not include water for flushing purposes as follows: No. 2 Channel, 10 sluice-heads; No. 3 Channel, 23 sluice-heads. The average number of sluice-heads supplied daily is calculated each year on 280 working-days per annum.

Waimea-Kumara Water-race.

Taking the two water-races previously described as one work, they cannot be said to return a large percentage on the capital invested in their construction, but this is owing to the costly manner in which the Waimea Race was constructed. The total cost of the work up to the present time, exclusive of the cost of the tailings channel at Kumara, which was handed over as a public tail-race for the field to the miners, has been £160,984 4s. 2d.

The following statement will show the result of the working of this water-race, as a whole, for the year ending the 31st March last:—

Month.	Sales of Water.	Cash received for Sales of Water.	Expenditure.	Outstanding Moneys at the end of each Month.	Number of Men employed.	Approximate Amount of Gold obtained.	Value of Gold.
1892.	£ s. d.	£ s. d.	£ s. d.	£ s. d.		Oz.	£ s. d.
April	596 6 4	534 19 4	187 5 10	156 7 9	222	993	3,872 14 0
May	607 13 3	638 17 10	205 7 3	161 14 2	219	1,013	3,950 14 0
June	603 5 4	630 14 0	199 19 9	155 8 11	212	1,016	3,962 8 0
July	579 8 3	593 18 6	174 3 11	136 8 8	217	970	3,783 0 0
August	684 19 6	759 7 7	209 12 2	144 8 1	225	1,095	4,270 10 0
September	733 9 6	612 19 11	196 0 5	142 17 1	216	1,180	4,602 0 0
October	652 7 7	805 18 8	211 13 4	117 2 11	226	1,050	4,095 0 0
November	546 10 0	370 0 0	208 9 8	181 0 2	219	890	3,471 0 0
December	453 7 1	562 4 8	303 13 5	119 7 2	221	740	2,886 0 0
1893.							
January	437 14 2	293 4 10	290 12 3	163 19 10	208	700	2,730 0 0
February..	515 11 5	568 14 10	222 19 5	207 13 2	194	830	3,237 0 0
March	394 0 7	387 1 8	230 13 11	195 18 10	187	670	2,613 0 0
Total	6,804 13 0	6,758 1 10	2,640 11 4	..	213	11,147	43,473 6 0

The above statement shows that the value of the sales of water last year was £6,804 13s., as against £7,767 7s. 2d. for the year previous, and the cost of maintenance £2,640 11s. 4d., as against £2,369 4s. 9d. for the former year, thus showing that the value of the sales of water last year has diminished to the extent of £962 14s. 2d., while the expenditure on maintenance has been increased by £271 6s. 7d.; the actual profits on the working last year being £4,164 1s. 8d., as against £5,811 5s. 9d. for the former year. Taking the profits for the past year it gives nearly 2·6 per cent. on the capital invested in its construction.

Mount Ida Water-race.

This water-race was managed by a Trust since its construction up to the 1st of January last, but the revenue derived from sales of water have never paid the expense of maintenance. This is to some extent due to the great length of the race, which is over seventy miles, and the character of the country through which it is constructed. The whole of the race, with the exception of about 4 chains of fluming and 10 chains of tunnel, is an open conduit following the contour of the ground. It commences at the middle branch of the Manuherikia River, crossing numerous creek-beds in an open ditch, and terminates at Speck Gully, Naseby, being at an elevation at its terminating point of about 2,000ft. above the level of the sea. The race-line for the first twenty-five miles follows the foot of a high range of mountains having steep sides, and every heavy rain and melting of the snow in spring brings down large quantities of shingle or broken rock, and fills up the creek-beds through which the race is constructed; so that after every flood or heavy rain the ditch is filled up with shingle, not only in the creek-beds, but for a considerable distance on the down-stream side of the race. During the early portion of the spring there is plenty of water in these creeks, so that it is not necessary to turn the whole of them into the race. Those near the head are allowed to flow down their beds; but generally about the end of December the water in the whole of them is required to fill the ditch, and, even when the whole of the creeks are turned in, there is not sufficient water for the requirements of the goldfield at Naseby in very dry weather.

The water-race is constructed across the different creek-beds, so that the slightest rain which raises the creeks washes away the lower side of the ditch, and these have to be built up again before any water can be sent down. The leakage at each of these creek-beds was also very considerable. On the 5th of February last the water was turned out of the race from the east branch of the Manuherikia River to Naseby, and a commencement made to clean out the ditch. In many places the ditch was filled up with gravel and sediment from the banks to a depth of 16in. so that when water was available a sufficient supply of water could not be sent down. Piece-work contracts were let to the miners to clean out the race in mile sections, at prices varying from 1s. 6d. to 10s. per chain. At the East Eweburn Creek, where a flume was constructed, the shingle coming down that creek had filled up the bed to within 9in. of the bottom of the flume, so that the first flood would have carried the flume away. A siphon is being constructed across this creek some distance down where the flume was constructed, which will cut off some very bad sidelings and give less trouble in future. At the crossings of the different creek-beds trenches were cut down until an impervious stratum was reached, and a wall of sods built with a stone apron on the lower side to protect the sod-wall and prevent the sods from being washed away. These stone aprons are constructed to a height of 18in. above the bottom of the ditch, and some sods built on the top to raise the water to the proper height; but when a flood takes place the sods will wash off to the level of the stones, but never allow the whole of the water to be cut off. At the lower side of these crossings a gate is placed in the race, to prevent a quantity of shingle being carried down the ditch with the stream. This will have the effect of considerably reducing the cost of maintenance. There is no doubt in many instances siphons would have been preferable, as they would have cut off many of the bad portions of the ditch going round steep sidelings; but the expense of siphons would have been very great, and the down-stream side of the ditch from each of these creeks would always have to be kept in repair to take the water from each of these creeks.

The expense in cleaning out the race and fixing the creek-crossings, as already described, will be very considerable, but unless this had been done it was a hopeless case to expect sufficient revenue from the sales of water to pay the cost of maintenance. As soon as the portion of the race is cleaned out, and repairs completed as far as the east branch of the Manuherikia River, the water from all the streams below this will be turned in and sent down to Naseby, and the water which is being sent down to Blackstone Hill from the upper creeks will then be cut off and the upper portion of the race repaired, and the miners at work at Blackstone Hill can then be employed in doing these repairs.

Contracts have been let for repairing 40 miles 15 chains 79 links of the race. These contracts amount to £894 3s. 6d. The different creek crossings had to be fixed by day-labour. The race purchased from R. Johnstone's estate has been cleaned out and widened, from Johnstone's Creek to the crossing of the Mount Ida Race, so that water can be supplied from this creek when the same is available after supplying the miners at Blackstone Hill. Up to the 31st of March last £343 8s. 9d. was paid on contracts, and £301 16s. 9d. for wages, also 14s. for advertising: making the total expenditure to the end of March last £645 5s. 6d.

The upper portion of the race is still to be cleaned out and repaired, and, as the ditch crosses a number of shingle-beds of creeks, where a large amount of water escapes, unless these are fixed in the same manner as the creek-beds between the east branch of the Manuherikia and Naseby, a regular supply of water cannot be depended on; however, there is no immediate necessity for fixing the head creeks, as these are only required to be turned into the race after the snow gets pretty well off the range—that is, after Christmas. Up to that time there is generally plenty of water available from Sheppard's Creek downwards. The whole of these creek crossings should be fixed as soon as can conveniently be done.

In January last the water-races and water-rights previously held by R. Johnstone was purchased from the Official Assignee—Mr. Johnstone's estate being in bankruptcy—for £1,000. These races receive their supply from the east branch of the Manuherikia River and Hill's Creek, which are both good supplies, and have far more water in them for several months of the year than what Mr. Johnstone's races will carry. Arrangements have been made with the miners at Hill's Creek to pay a certain amount per annum for the first year for the use of the water in these races, they taking their chance of the dry seasons, when there is not sufficient water in the east branch of the Manuherikia River and Hill's Creek, and each party pays the proportion of the amount arranged for monthly. Before finally arranging the price that each party had to pay, the miners came to an agreement among themselves as to the priority of the use of the water. The priority and prices arranged are as follows:—1st right, Charles Rose, one head, £50 per annum; 2nd right, Robert Johnstone, one head, £37 10s. per annum; 3rd right, Wheeler and Wade, one head, £25 per annum; 4th right, Charles Rose, £1 per head per week when required; 5th right, W. Wade, £1 per head per week when required, or a cradle-head, say, 8in., £5 per annum; Dillon Brothers, tail-water, £15 per annum. Arrangements have been made with R. Johnstone to clean out the races and keep them in repair on consideration of receiving one head for three months from the 7th February last, from the high-level race, free of charge, and the use of the water from one of the low-level races, to open out a claim and work it for twelve months. This arrangement will reduce the amount Mr. Johnstone has to pay during the year £25. The revenue, however, from these races will be further reduced the first year, as the water will be turned out of the race during the time repairs are being effected to the upper end of the Mount Ida Water-race; but, during such time as the water is turned off, the men will have an opportunity of going to work in executing the repairs.

The following statement shows the receipts and expenditure on the race, also the approximate quantity of gold obtained, for the year ending the 31st December last, when the works were taken over by the Government:—

MOUNT IDA WATER-RACE, 1892.

Months.	Sales of Water.	Cash received for Sales of Water.	Expenditure.	Amount of Outstanding Moneys at End of each Month.	Number of Men employed.	Approximate Amount of Gold obtained.	Value of Gold.
1892.	£ s. d.	£ s. d.	£ s. d.			Oz.	£ s. d.
January	100 6 3	103 4 1	105 18 2	Amount of outstanding moneys at the end of December last was £1,702 2s. 10d.	An average of about 130.	300	1,155 0 0
February	70 15 0	24 7 6	186 10 10			250	962 10 0
March	50 6 7	85 9 10	181 17 8			200	770 0 0
April	108 15 0	93 16 11	76 7 6			320	1,232 0 0
May	147 13 4	157 8 8	151 8 6			400	1,540 0 0
June	138 1 8	180 16 10	97 19 0			380	1,463 0 0
July	119 3 4	93 7 8	103 7 10			340	1,309 0 0
August	125 15 0	89 13 0	77 13 6			350	1,347 10 0
September ..	137 15 0	105 18 8	113 3 8			400	1,540 0 0
October	158 12 6	151 0 0	71 12 4			450	1,732 10 0
November	129 6 8	110 15 2	118 1 10			350	1,347 10 0
December	109 10 0	156 11 7	118 19 2			310	1,193 10 0
Totals ..	1,396 0 4	1,379 9 11	1,403 0 0	..	..	4,050	15,592 10 0

It will be seen that the sales of water for the past year was £1,396 0s. 4d., as against £1,023 15s. 7d. for the year previous, thus showing an increase in the revenue of £372 4s. 9d. for the year. The expenditure for the last year was £1,403, as against £1,110 13s. 8d. for the previous year, which shows an increase of £292 6s. 4d. Taking the sales of water and the cost of maintenance it shows a loss on the working of the race last year of £6 19s. 8d. In addition to this there were liabilities to the extent of £520 4s. 5d. on the 31st December, which have since been paid by Government, which makes the total loss on the working last year £527 4s. 1d. The average number of miners employed in claims worked with water from this race is 130, and the approximate

quantity of gold obtained by them was 4,050oz., representing a value of £15,592 10s. Deducting the value of the sales of water from the value of the gold obtained, it leaves the average earnings of the miners last year to be about £109 4s. 1d. per annum, or £2 2s. per week each man. The outstanding liabilities, according to the books of the Mount Ida Trust, on the 31st December last, was £1,703 2s. 10d., of which amount there is £763 12s. 6d. standing against names of people, some of whom are dead and some left the district. This leaves the liabilities as £938 10s. 4d. as the utmost that could be got, but it is questionable if some of it will ever be recovered.

The following statement shows the value of the sales of water from the 1st January to the 31st of March, and the moneys received, and the amount expended on maintenance. A portion of this expenditure should have been charged to repairs, as the water was shut off at the beginning of February:—

MOUNT IDA WATER-RACE, 1893.

Months.	Sales of Water.	Cash received for Sales of Water.	Expenditure.	Amount of outstanding Moneys at end of each Month.	Number of Men employed.	Approximate Amount of Gold obtained.	Value of Gold.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.		Oz.	£ s. d.
January ...	96 2 6	120 11 1	97 12 11	1,677 14 3	About 130	300	1,155 0 0
February ...	8 14 2	112 3 10	21 19 8	1,574 4 7		42	161 14 0
March ...	...	63 7 11	21 19 9	1,510 16 8		...	...
	104 16 8	296 2 10	141 12 4	...	...	342	1,316 14 0

In February and March, the maintenance men were employed on construction-works, the water being turned out of the race, and only a small portion of the wages is charged to the maintenance.

SUMMARY OF WATER-RACES.

The following statement shows the result of working the water-races controlled by the Government, and the collatoral advantages derived by their construction. Although the direct revenue has not been so great as was anticipated at the time that their construction was authorised, they have been the means of affording a large population profitable employment for a number of years, and a large amount of gold has been obtained which otherwise could not have been got. It is only by a large supply of water that the most of the auriferous gravel terraces can be made to pay for working. In very few localities will ground pay to drive out and bring the wash-drift to sluices by carts and trucks. And, even where the ground has been suffieiently rich to admit of this being done, in most cases, when water has afterwards been brought on the same ground, it has paid the miners far better the second time by working it in a face by hydraulic-sluicing.

STATEMENT showing the PROFITS and LOSSES on the Working of the WATER-RACES for Fifteen Years.

Name of Water-race.	Value of Sale of Water, including Value of any Gold obtained in Sludge-channel.	Expenditure.	Profit or Loss on Working.	Average Number employed.	Approximate Amount of Gold.	Value of Gold obtained.	Duty received on Gold obtained.	Total Profit or Loss, with Value of Gold Duty added.	Total Cost of Construction.
Waimea-Kumara Water-race and Sludge-channel.	£ s. d.	£ s. d.	£ s. d.		Oz.	£ s. d.	£ s.	£ s. d.	£ s. d.
Fourteen years ending the 31st March, 1892	119,604 12 10	75,068 0 3	44,536 12 7	371	220,109	823,789 6 3	20,728 0	65,264 12 7	..
Year ending 31st March, 1893	6,804 13 0	2,640 11 4	4,164 1 8	213	11,147	43,473 6 0	..	4,164 1 8	..
Totals	126,409 5 10	77,708 11 7	48,700 14 3	360	231,256	867,262 12 3	20,728 0	69,428 14 3	182,949 3 2
Nelson Creek.									
Thirteen years ending the 31st March, 1891	17,364 0 7	15,123 0 7	2,241 0 0	53	32,698	125,069 17 0	3,269 16	5,510 16 0	..
Four months ending 31st July, 1892	213 0 0	292 6 6	*79 6 6	23	245	980 0 0	..	79 6 6	..
Totals	17,577 0 7	15,415 7 1	2,162 13 6	52	32,943	126,049 17 0	3,269 16	5,431 9 6	90,722 10 8
Argyle.									
Thirteen years ending the 31st March, 1891	5,530 16 10	5,455 7 7	75 9 3	17	8,040	30,738 12 0	804 0	933 3 11	14,701 15 3
Mount Ida.									
Fourteen years ending the 31st March, 1892	18,786 1 5	22,373 14 9	3,605 12 4	107	34,411	130,383 0 0	3,176 2	245 15 9	..
Year ending 31st March, 1893	1,396 0 4	1,403 0 0	*6 19 8	130	4,050	15,592 10 0	..	*6 19 8	..
Totals	20,182 1 9	23,776 14 9	*3,612 12 0	108	38,461	145,975 10 0	3,176 2	238 16 1	67,001 9 2
Grand Totals ..	169,699 5 0	123,356 1 0	47,326 5 0	537	310,700	1,170,026 11 3	27,977 16	76,032 3 9	355,374 18 3

* Shows a loss on the working.

GOLD- AND SILVER-MINING.

The results of the mining operations for last year show a decrease of 47,876oz. of gold from the results of the previous year. The yield last year (which has been obtained from the quantity entered at the Customs for export) was 228,659oz., as against 276,535oz. for the preceding year, as will be seen from the following statement:—

Name of District.	Year ending 31st March, 1893.		Year ending 31st March, 1892.		Increase for 1893.	Decrease for 1893.
	Oz.	£	Oz.	£	Oz.	Oz.
Auckland	41,052	165,849	40,525	162,760	527	..
Marlborough	3,055	12,083	7,020	28,026	..	3,965
Nelson	2,792	10,609	5,301	20,192	..	2,509
West Coast	101,636	406,523	118,158	472,672	..	16,522
Otago	80,124	322,403	105,531	423,527	..	25,407
	228,659	917,467	276,535	1,107,177	..	47,876

The foregoing table shows an increase in the Auckland District during last year of 527oz. of gold; but, in reality, this is not the whole of the increased production of bullion, inasmuch as the bullion shipped is taken for the quantity of gold which it contains. According to the battery-returns from the North Island last year, the value of the gold extracted from the ore, the bullion produced, and the value of ore sold, amounted to £189,393 18s. 11d.; whereas the total value for the previous year was £176,070 18s., showing an increase in last year's operations of £13,323 0s. 11d.

With regard to the large decrease shown in the foregoing statement for last year, it must be borne in mind that there was included in the statement for the year ending 31st March, 1892, 18,270oz. of gold which was held back by the different banks in the Middle Island, but which was produced during the year ending 31st March, 1891. Therefore, this amount must be deducted from the decrease shown for the past year, which will make the actual yield last year only 29,606oz. less than that for the previous year. The principal decreases were from the Counties of Inangahua, 13,539oz.; Tuapeka, 7,876oz.; Vincent, 6,564oz.; Lake County, 4,514oz.; and Marlborough, 3,965oz. Some of the other counties also show small decreases.

The returns of silver obtained cannot be ascertained, as it is shipped in the shape of bullion. The only record obtainable is from the Customs returns. These returns show that during last year the banks shipped 22,053oz., representing a value of £3,996. The production of silver is likely to be largely increased, as it is now more sought after than it was in former years. At Waihi and Karangahake a large percentage of silver is in the ores, and it will be extracted by the use of the Cassel plants now in course of erection on each of those fields. Silver-ore has also been discovered at the Great Barrier Island, as well as at Puhipuhi; and although all workings have for the present been suspended at the latter place, there is little doubt that claims will yet be taken up and worked with suitable machinery, none of which has yet been brought on the field.

QUARTZ WORKINGS.

NORTH ISLAND.

AUCKLAND DISTRICT.

Puhipuhi.

This field to some extent resembles Karangahake when it was first opened in 1875. Numbers of people rushed to the place, many of whom had no mining experience whatever, and they embarked in mining returns in the anticipation that a new Eldorado was about to be opened, where everyone would make his fortune with very little work, and that the mere fact of being fortunate to secure ground on the field gave them a property that would realise sufficient money to give them a good start in life. The excitement as to silver being found in a portion of the colony where no mining had previously been carried on was so great that nearly everyone in and about Whangarei readily embarked in mining ventures in the full anticipation that their investment would in a short time return them a hundred-fold.

The prospectors of the field found some fair silver on and near the outcrops of several lodes through their ground; and, although scarcely any of them had much experience in mining, they soon thought that they had gained sufficient to enable them to carry on their operations with success. After opening out on one of the lodes, they found a fair quantity of ore; which, according to assay, showed that it was payable for working if sufficient appliances were on the ground. They however purchased an obsolete plant, part of which had been used for crushing cement, but it had never before been used in the colony for quartz-crushing. They were strongly advised by those who had some knowledge of the subject on no account to erect this plant, as it was not capable of dealing with the class of ore to be treated; but, a small sum only being required, and money being a great object, the prospectors decided to purchase the plant on receiving a guarantee from the seller that it would do the work satisfactorily. Representations were made to the Government as to the urgent necessity for opening up the field by a road. The field, however, being situated partly in the Whangarei County and partly in the Bay of Islands County, there was some difference of opinion as to where the road should be constructed. The result was, however, that a road was laid out and constructed on what is known as the "air-line," which brought the field into more direct communication with the Township and Port of Whangarei. The cost of this road was defrayed by a direct grant of money from the Government, it having been represented that it would only amount to a specified sum; but, unfortunately, the estimate was largely exceeded, and when the road was formed it was found that it

would require a much larger expenditure before it was fit for wheel traffic. So long as the summer dry weather continued vehicles could be driven along the road, but as soon as the winter rains set in it became a perfect quagmire.

After the machinery was erected it proved quite unsuitable for the work it was required to perform, and, unfortunately, as well for the field as for everyone concerned in the venture, the shareholders did not secure the services of persons acquainted with the treatment of the class of ore that had to be dealt with. The whole thing proved an utter failure, and not only injured those who were interested in the venture, but it put such a damper on the field as will take some years to remove. At the present time, should exceedingly rich ore be shown as having been obtained from Puhipuhi, the mere name of the locality would be sufficient to prevent any local capitalist from investing his money. The field has never been properly prospected, and the failure of the original venture has had the effect of stopping all further mining operations. Notwithstanding that, there are good indications that payable lodes may yet be found which will some day be taken up and prove remunerative ventures.

The prospectors have entered into an arrangement with Mr. R. P. Hunt, who is now in London, to take a quarter of the paid-up shares in any company he may float, together with the sum of £1,500 in cash, for their interest in the claim and the machinery. The latest advices are that Mr. Hunt has succeeded in getting Messrs. Riley and Co. to take up one-half of the shares if a mining expert, Mr. Merricks, reports favorably. This gentleman was to leave London in April last to report on this and other mining properties. The new venture is called the "Colonial and General Exploration Company." Two men are at present employed prospecting the ground, but no crushing has been done since June last year.

Another party, called the "Southern Association," have formed themselves into a syndicate for the purpose of trying to float a company to take over the holdings known as the "Ophir," "Kamo," "Kamo Extended," "Dora," "Napoleon," "Jetta," "Kearsage," "The United," "Little Agnes," and "Silver Queen." These holdings are now under offer in London, the promoters proposing to dispose of their interest therein for one-quarter in paid-up shares in any company that may be formed. Mr. Merricks is also to report on these properties. At present there are no men employed on any of the holdings in question. The only other claim or holding on the field which has not been declared forfeited is the "Waipu."

The adjoining ground, known as the Taumatahinau Block, which is the property of Mr. John Cunningham, is also under offer to a party in London. Mr. Merricks is to report on this block also. The great hope entertained in the district is that those persons who are interested in the field will be able to hold out to Mr. Merricks, when he arrives, sufficient inducements to enable him to report favourably on all these properties.

Great Barrier Island.

There are a great many mineral lodes in this island, but heretofore they have not been made remunerative for working. In the early days of the settlement copper was found on the northern portion of the island, and a company was formed to work it. The discovery of the copper lodes was the means of the Barrier Company purchasing some 30,732 acres of the northern portion of the island. After working the copper lodes for some years, the mine was shut up, as the expenses of mining, sorting, and concentrating the ore, and sending it to Europe for treatment, was more than the ore realised. Consequently the company had to suspend their operations. It is said that recently Messrs. Thompson and Lanigan have taken up the copper mine, and that they intend to re-open it and commence work again.

Antimony lodes have also been found in different portions of the island. One of them, near Mount Hudson, was considered some two years ago to be of considerable value, but after opening it out a little the ore gave out, or at least became so small that it would not pay for working; the cost of transit to a harbour where it could be shipped being also great. Lodes of manganese and galena are also found in the island, and very recently auriferous and argentiferous lodes have been discovered.

In the beginning of December last, Messrs. Benjamin and William Saunderson discovered an argentiferous lode on Crown lands in the face of a slip from the range, about one mile inland from the landing at their property at Blind Bay, and 525ft. above the level of the sea, and about 40 chains to the westward of an old volcanic crater, which has at some early period been the seat of igneous action, as pieces of obsidian can be found in the vicinity. There are eleven claims surveyed on the field, and the lode has been traced on the surface for about 40 chains. Three claims have been taken up to the eastward of the prospectors' claim, and two claims to the westward, while the other claims are taken up to the northward and southward of the line of reef which passes through the prospectors' claim.

The prospectors' claim is known as the "Union Jack." The holders have cut the lode in four different places, its width varying from 16in. to 5ft. The direction of the lode is about five degrees to the east of north, and five degrees to the west of south. The richest ore found is on the western end of the lode. A parcel of 3 tons 17cwt. of ore was treated at Mr. Fraser's test-plant at Auckland. The first lot of 27cwt. yielded 244oz., the second lot of 1 ton yielded 227oz., and the third lot of 1½ tons yielded about 230oz., the bullion being worth from 3s. to 3s. 6d. per ounce. Three tons were also sent from the eastern workings: 1 ton to the School of Mines, Thames, which yielded 50oz.; 1 ton was tested by Mr. Young, of Auckland, which yielded a similar result; and 1 ton was treated at Mr. Fraser's test-plant, which yielded 90oz. of silver.

The lode varies considerably in width. On the outcrop on the eastern end it is only about 16in. wide, and in an adit about 30ft. below the outcrop it is about 5ft. in width, but the quartz in the adit does not contain so much silver as it does near the outcrop. The silver is in the form of chlorides and antimonides, the latter being ruby silver. The chloride of silver in the ore is almost in the same form as manufactured chloride of silver. That is shown by dissolving some metallic

silver with diluted nitric acid, and precipitating it with hydrochloric acid; a white powder is thrown down which blackens on exposure to light. The same thing takes place with the ore here when newly broken out. The silver is in a white powdery form in the stone, but after a few seconds' exposure to the rays of the sun it turns purple, and finally to a black colour. By using a blow-pipe, with a little soda on the face of the stone, it is very soon coated with minute globules of metallic silver. Some of the chloride specimens are extremely rich near the surface, and the country rock, which is composed of tufaceus sandstone, trachyte, and decomposed aphanite slates, but principally of tufaceous sandstone, has small leaders and veins running through it joining on to the main lode, some of which have very rich ore; but so far as yet proved, the rich stone in the Prospectors' Claim is near the outcrop, and where they have cut the lode in the adit level the stone is of low grade.

To the westward of the Prospectors' Claim is the Silver Queen Claim. Some trenching is done in this ground, and the lode cut in the bed of a small creek, where it is from 20in. to 2ft. in width, being considerably mineralised, having small veins of iron pyrites running through; but the ore appeared of very low grade. A ton of the ore was forwarded to the Thames for treatment, but as the average samples only assayed 22oz. of silver to the ton, the proprietors did not consider it worth treating. Directly adjoining the Silver Queen comes the Nil Desperandum Claim. An adit has been put in for a few feet, and the lode cut is similar to that in the Silver Queen; but although the distance between the place where the lode was cut in the creek in the Silver Queen ground is only about 40ft. from where it is cut in the adit in the Nil Desperandum Claim, the stone taken out to grass from the latter ground looks better, and seems to contain more silver. This is the most westward claim taken up on Crown lands, and about 800ft. above sea-level. About 30 chains further to the westward the Kauri Company have had three men prospecting for a considerable time; they succeeded in getting some very fair stone near the surface, but the lode seemed to get of a more rubbly character as it went down, and contains less silver.

To the eastward of the Prospectors' is the Ada Claim, locally termed the "Gas-works." There is an adit driven here for some 35ft. and three leaders have been cut through, each of them being from 14in. to 16in. in thickness. All of these leaders contain silver, principally in the form of ruby silver, but the grains of this silver through the ore are very finely distributed, showing it not to be very rich. The width between the leaders that have been cut is about 14ft., but it is not yet known whether this is the same lode or not that goes through the Prospectors' Claim. The height of this adit is about 550ft. above sea-level. The workings were commenced in this claim about the 1st April last.

There is an outcrop of a parallel lode to the prospectors' further northwards, but no work has yet been done here to test its value beyond making some assays from the outcrop, which have proved it to contain silver. Beyond the claims already mentioned there is no work done. The effect of the discovery is that those persons who have secured ground on the line of reef, and especially those near the Prospectors' Claim, think that they have got a valuable property, and look forward to the time when they will either get good returns from the mine or sell it at a handsome profit. It may, however, be well to observe that there is no great excitement about this "find" yet, and, after what Puhipuhi has passed through there will be little chance of men investing largely in mining on this field until it is better proved. There is ore which will pay to work on and near the outcrop, but so far as is known at present the quantity is very limited, and until the lode is proved to at least 200ft. in depth, very little can be said respecting it. In some parts of America the ruby silver increases in richness as it goes down, but this has not yet been the experience in this colony, and even were the lode tested to the depth mentioned it would not prove conclusively that it was a valuable property. The lode would have to widen out and retain a high average value before it would be justifiable to erect machinery on the ground for treating the ore.

Several lodes and leaders containing argentiferous ore appear to exist in this locality, and numerous small veins running through the country rock containing rich specimens of silver chloride can be found, but how far these will continue to go down is a question which cannot at present be determined. The lode appears to be broken and disturbed near the outcrop, and it is difficult to say whether it will dip southwards or northwards. In some of the claims the lode dips slightly in one direction and in others slightly in another. The blocks of stone in the lode would, however, lead me to the supposition that at the time the adjacent extinct volcanic crater was in action the whole of the surrounding country was shaken up considerably. Leaders of quartz containing argentiferous ore are found in Mr. Saunderson's property as well as on the face of the cliffs fronting the bay. Lodes and leaders of quartz highly mineralised running in every direction are to be found, but they are generally of no great width. At present nothing more can be said of this field than that there are good indications that a payable lode is likely to be found. It is not a place for strangers to rush to, as most of the Crown lands on the line of known lodes are taken up as claims; and if the lode continues in the same direction it will pass out of Crown lands into Mr. Saunderson's freehold to the eastward and the Kauri Company's property to the westward. There is a considerable area of Crown land in the vicinity, but the present line of reef only goes through a small corner of it. Then are ten leases surveyed of 15 acres each, and one for the prospectors of 30 acres.

Coromandel District.

There was a falling-off last year in the production of gold from this district, principally at Coromandel proper; the Kapanga Company, which is the principal company in the district, having been unsuccessful in its operations during the past year. A large portion of this district, which is to all appearances auriferous and argentiferous, has, however, never been prospected. The rough broken nature of the country, which is covered in many parts with heavy bush and dense underscrub, without roads or tracks, makes prospecting a very laborious undertaking, and few miners care to go far into the bush owing to the difficulty of getting provisions. A large extent of the country towards Cape Coromandel has been very little explored, there being no tracks to guide

explorers. Persons visiting this part of the colony cannot help admiring the pluck and energy of men who have settled, with their families, at such an outlying place as Port Charles, near the Cape, the only outlet from which is a bush-track through to Cabbage Bay, which in winter-time is almost impassable. Judging from the formation of the country generally, it is likely that auriferous and argentiferous lodes exist, but at present it is only by mere chance that they are discovered, as very few people travel through this part of the Coromandel district.

Tokatea Range.—An average of thirty-six men have been employed in claims on this range, namely: fifteen wages-men, and twenty-one men working on tribute. Two hundred and fifty-one tons of quartz was crushed from the claim where the wages-men were employed, which yielded 164oz. 16dwt. of gold, or only equal to about 10oz. 19dwt. 9gr. of gold per man for the year. The tributers crushed 46 tons of quartz, which yielded 555oz. 10dwt. of gold, equal to about 26oz. 9dwt. of gold per man for the year. These are considerably less than the earnings of the men on this range for the previous year. The largest return from any of the mines on this range last year was obtained by five tributers in the Royal Oak Mine, 1ton 9cwt. 20lb. of quartz having yielded 256oz. of gold. This mine is the property of Mr. Witheford, of Auckland, who has let it in two sections—one to three men, at 5 per cent. tribute, and the other to a party of two tributers. These tributers have the whole of the mine from the No. 3 level upwards, but no work is being carried on below the No. 3 level, as Mr. Witheford contemplates forming a company to work the ground below this level, which, he states, is almost intact, there being payable stone carried down to the No. 6 level, thus giving about 340ft. of backs. The Tokatea Company has recently sold their property, including the crushing plant, to a syndicate in Auckland for £300.

Scotty's Company.—This company was referred to in my last report as having taken up the ground formerly held by the Corby Company. The company carried on operations for eight months last year on wages, but in December last they let the mine to three men at 10 per cent. tribute. The same lode, known as "Scotty's," which has yielded a large quantity of gold in the Kapanga Mine, goes through the ground held by this company; but instead of sinking a shaft to prospect it at the same depth where the gold was found in the Kapanga Mine, they have been working from an adit-level near the surface. There is a good prospect of payable stone being discovered in this mine below the level where they have been working, but the company's capital either being exhausted, or owing to the difficulty of getting in calls, it has been decided not to test the ground to a greater depth at present. The average number of men employed in this mine last year was nine, namely: four wages-men and five tributers. There was 110 tons of stone crushed, which yielded 97oz. 18dwt. of gold.

Kapanga Company.—This company holds three mining properties—namely, the Kapanga, Coromandel, and Blagrove's Freehold. The workings carried on in the Kapanga Mine last year were not a financial success. Only 74 tons of stone was crushed from this mine, which yielded 89oz. 6dwt. gold, representing a value of £261 6s.; while the expenditure amounted to £5,753 13s. 5d., showing a direct loss of £5,492 7s. 5d. Of this amount, the sum of £1,357 13s. 6d. was expended in sinking the shaft to a further depth of 38ft., the average cost of sinking being £35 14s. 6d. per foot. The shaft is now down to a depth of 608ft., and a chamber opened out at the 600ft. level, from which the company were driving a crosscut to strike the Kapanga Lode, which, it is expected, will be cut at about 200ft. from the shaft. The foot-wall branch of Scotty's Lode was cut in the shaft at the 600ft. level, which was driven on for some 90ft. at the time of my visit. After getting in about 4ft. from the shaft, this branch of the lode broke up into two leaders, one of which followed the direction that Scotty's Lode runs on at the upper levels, and the other branched off at an angle of about 70°. A few colours of gold were seen in the stone at the bottom of the drive, but this is under-foot and cannot be tested at the present time. The manager (Mr. W. H. Argall) states that this lode is characteristic of the lodes in the Kapanga Mine, being nothing but a mass of soft mullock in between two well-defined walls, interspersed with loose quartz-stones. There is nothing solid about the lode, the soft mullock being neither more nor less than a description of puggy material containing quartz grit, which in some places on the upper levels contain a good deal of loose gold. The hanging-wall branch of Scotty's Lode was expected to be cut at about 140ft. in from the shaft, and at about 60ft. distant from the Kapanga Lode; but it was cut 90ft. from the shaft, and therefore there is a possibility that it will not join with the Kapanga Lode until a considerable depth is reached.

According to the dip of the hanging-wall branch of Scotty's Lode on the upper levels, and the dip of the Kapanga Lode, they ought to join at about 200ft. below the present level of the shaft; but, judging by the dip of the foot-wall branch, which is about parallel with the dip of the Kapanga Lode, it is hard to say whether these lodes will ever join. The class of country gone through is favourable for the existence of gold in the lodes in the bottom level, the ground being also more solid than it was on the upper levels. The lodes in this mine are extremely patchy; one never knows when a pocket of rich ore may be struck, which may cut out as fast as it makes. A great deal of care and supervision has accordingly to be exercised when working lodes of this character. Should the Kapanga and Scotty's Lodes join, there will probably be found a rich patch of stone near the junction, which will help to repay the shareholders for their outlay; and it would be a great pity, now that these lodes are closing together, not to see what the stone at the junction is like.

Although the Kapanga and Scotty's Lodes have always been referred to as separate lodes, it is questionable whether such is really the case. They may have been one and the same lode further to the northwards, having branched off before getting into the Kapanga ground; and it may yet be found that they will join again further to the southward, as well as to the dip in Kapanga Mine. The Kapanga Lode carries the best gold generally on the hanging-wall side, while the best gold in Scotty's is on the foot-wall side, there being very little difference in the character of the stone in both lodes. The foot-wall branch of Scotty's Lode which was struck in the shaft at the 600ft. level is bearing more easterly than when found at the upper levels,

the bearing being S. 70° E., and dipping to the south-west at an angle of about 45 degrees. The lode averages about 1ft. in thickness, and is composed of pug or clay of a dark-grey colour, detached pieces of quartz, carbonate of lime, iron and arsenical pyrites, and a little mica. The hanging-wall branch of the lode is very small, having a slight dip to the east, whereas the general dip of the lodes on the upper level is westerly.

A few men are employed on Scotty's Lode at the 300ft. level, and at the time of my visit they had come upon a patch of rich specimen-stone; but at the place where it was found the lode is all stoped out, there being only a small block left, which was considered valueless when the other portions of the lode were taken out.

At Blagrove's Freehold a shaft has been sunk to a depth of 93ft., but before further sinking can be commenced pumping machinery will have to be erected. It is also intended, if further capital can be raised, to place a winding-engine on the ground.

As regards the future prospects of the Kapanga Mine, the manager states that, looking at the nature of the rock and the general appearance of the reef at the 600ft. level, and also taking into consideration the fact of having met with a little gold at the bottom of the drive, he has recommended the company to sink deeper. He, however, qualifies his statement in the following words:—"If the Kapanga and Scotty's Lodes continne their underlie, as in the upper levels, by sinking the shaft another 200ft. they should be cut at 600ft. from the shaft; where the two lodes will join, and where it is expected very rich ore will be found."

The Kapanga Company was reconstructed in 1886, and from July in that year to April, 1893, the company's expenditure in New Zealand, exclusive of expenses of the London office, amounted to £60,715 14s. 2d. During the same period they crushed 7,585 tons of quartz, which yielded 14,959oz. 1dwt. of gold, representing a value of £44,023 3s. 4d., showing a clear loss of £16,691 10s. 10d. This represents the loss on working the Kapanga Mine only; but the same company owns the Coromandel Mine. The expenditure on that mine, exclusive of the purchase of machinery in England, since the company purchased it in January, 1887, to April, 1893, amounted to £22,951 8s. The quartz treated during the same period was 222 tons, which yielded 463oz. 19dwt. of gold, representing a value of £1,389 1s. 6d., showing a loss on the working of £21,562 6s. 6d. It will be seen from the foregoing statement that the company has expended in the colony, exclusive of the expenses of the London office and purchase of machinery in England, the sum of £83,667 2s. 2d. Against this they have received from the proceeds of the mines £45,413 4s. 10d., leaving a direct loss on the expenditure in the colony of £38,253 17s. 4d. Previously to the last reconstruction of the company, many thousands of pounds of English capital were spent in developing the workings in the Kapanga Mine without the shareholders getting any return of their capital.

The manager estimates that £10,000 will be required to sink the shaft to a further depth of 200ft., and, as the whole of the present capital is almost expended, the company will have again to be reconstructed, and fresh capital subscribed before work can be proceeded with. Under these circumstances the manager intends to make application to the Government for some assistance in prosecuting this work. The average number of men employed on wages last year by the company was forty-four, and nine men working on tribute in the Coromandel Mine. Taking the whole of the quartz crushed from the Kapanga and Coromandel Mines last year, 286 tons were got by wages-men, which yielded 177oz. gold, and 48 tons by tributers, which yielded 127oz. 7dwt. gold; making the total gold return 304oz. 7dwt., as against 1,634oz. 8dwt. for the previous year.

Tiki, Kopukaitahi, Waikoromiko, and Opitonui.

Very little work has been done at either of these places. An average of thirteen men has been employed, who got about 3½ tons of stone, which yielded 213oz. 19dwt. gold, giving an average of about 16oz. 9dwt. per man for the year.

Owera Company.—This company's claim is in the Kauri Syndicate's property, the syndicate holding one-half of the claim. There is a condition in any lease issued by the syndicate that they have the option of having one-half of the interest, on their paying the prospectors one-half the cost of carrying on prospecting operations and in opening up the mine. On my previous visit this company had completed the erection of a crushing-battery of ten heads of stamps, a rock-breaker, and one berdan, driven by water-power, and a tramway connecting the mine with the crushing-battery. During last year 1,496 tons of stone was crushed, which yielded 1,921oz. gold; the company having on an average twelve men employed. The gold is of very low value, and although there is a considerable body of stone, the company cannot carry on mining operations without incurring a loss on the working; and it is now said that if the company cannot let the mine on tribute they will shut it down. Crushing has been discontinued, and most of the wages-men have been paid off.

Matarangi.—A party of miners who have taken up abandoned workings at Matarangi have succeeded in finding payable stone, which was forwarded to the Thames and crushed at the Moanataiari Battery, and yielded 100oz. of gold.

KUAOTUNU.

There are a number of auriferous lodes in this district, containing principally low-grade ore. The lodes are large, but the whole of the ore, with the present crushing-plants, will not pay to take out and treat; only a small portion of the stone is taken out of the large lodes at present. This is a field, however, where there is a fair prospect of its being remunerative for working for many years, especially if there was a cheap motive-power obtainable to work the crushing-plants. Mining matters are, however, much duller than on my former visit; a good deal of dead-work has to be done in opening up fresh leads in some of the claims, and this, together with the small percentage of gold saved by the battery process of treatment, make it a hard matter to make both ends meet. Some new ground has been opened out in the Waitaia Block, but not sufficient work has been done to determine whether the lodes will continue to carry sufficient gold to pay for working as the lode

goes down. There is, however, a quantity of stone near the surface which may pay to take out and treat. Some of the ground on the range between the Kuaotunu Township and Waitaia Creek has again been taken up, and some fair samples of stone are being obtained from the claim known as the "Black Jack," but there is very little work being done on this portion of the field. During last year 10,093 tons of stone was crushed, and 2,760 tons of tailings treated, which yielded 8,483oz. 13dwt. and 1,023oz. 4dwt. of gold respectively, representing an aggregate value of about £25,944. The average number of men employed in the claims on wages was 135, and seven men worked as tributers. Taking the average number of men employed in the mines, and the quantity of gold obtained, gives an average of 66oz. 15dwt. 2gr. for each man employed on wages; the quantity of gold obtained by tributers, being 694oz. 18dwt., is equal to 99oz. 5dwt. 10gr. of gold for each man employed on tribute. The area of ground held in many claims at Kuaotunu is about 194 acres 2 roods, and the total number of men employed, including tributers, being 142, shows that there is on the average one man employed to every 1 acre 1 rood 19 perches. Further on in this report will be found some interesting geological notes on the Kuaotunu Mining District by J. Park, Esq., of the Thames School of Mines.

Try Fluke Company.—This company has been working continuously since the field was first opened, and the lode still continues to carry gold as it goes down, although not nearly so rich as it was at the surface. This company has recently purchased the Carbine Mine, the price paid for it being £250. The company is working two lodes in the Try Fluke Mine; one of them is from 18in. to 2ft. in thickness, and the main Try Fluke reef is from 3ft. to 8ft. in thickness. During last year they crushed 4,116 tons of stone at the battery, which yielded 2,186oz. of gold, being an average of about 10dwt. 15gr. of gold per ton. Fifteen hundred and fifty-two tons of tailings have also been treated, which yielded 550oz. of gold, or about 7dwt. 3gr. of gold per ton.

In my last report reference was made to the loss of gold by this company, and the amount that was daily being carried away with the water. The company has at last become aware of the fact that some change in the treatment is required; they accordingly entered into an arrangement with the Cassel Company to erect one of their plants to treat their tailings. At the annual meeting of the company, held on the 31st January last, the chairman of directors stated that the cost of a 30-ton Cassel plant was £640, and for the first five weeks' work gold to the value of £825 was obtained from the tailings. At first when they commenced this process the cost of treatment was about 7s. per ton, but it has now been reduced to about 4s. per ton. The balance-sheet of the company for the year ending the 31st December last showed that 4,910 tons of stone had been crushed, which yielded 2,377oz. 3dwt. of gold, representing a value of £6,123 19s. 3d., and that for the same period the wages, cost of cartage, and everything connected with the mine, amounted to £2,576; the expenses in connection with working the crushing-battery being £1,963. This shows that the cost of mining was 12s. 4d. per ton, and the cost of crushing 9s. 3d. per ton, making a total of £1 1s. 7d., being the total cost of mining and crushing, exclusive of the cost of working the Cassel plant; and during the five weeks the Cassel plant was at work the expenditure for wages and supplies amounted to £202 0s. 10d. Adding this to the original cost of the plant—namely, £640, makes a total of £846; whereas the value of the gold obtained was £825, so that the first five weeks' work paid for the cost of the plant, less £21. It is said that 95 per cent. of the gold in the tailings was saved; this, however, may be taken for what it is worth. Considering the extremely fine gold there is at Kuaotunu, and the coarse sand in the tailings, it is doubtful if so high a percentage could be recovered unless the sand had been repulverised. It may stand in the same category as the assays made at the Te Aroha Syndicate Company's plant at Waiorongomai, where the tailings were assayed before going into the vats, and also assayed after the cyanide solution had been filtered through, which gave high results by merely taking the percentage of the assay-value; but when the bullion was produced, it was found it came a long way short of the quantity it ought to have been, judging by the assays. When all the circumstances are known, the same thing might apply at Kuaotunu. When the particles of gold are in so finely divided a state as they are in the ore at Kuaotunu, and the sand not finely pulverised, a very high percentage could hardly be expected. Be that as it may, it is certainly a step in the right direction, and, no doubt, many of the other companies will soon follow the mode of treatment adopted by the Try Fluke Company, as the ore on this field is particularly adapted to treatment by the Cassel process.

Cassel Plant.—The Cassel plant at the Try Fluke Company's works consists of four working tanks, each 12ft. wide, 16ft. long, and 4ft. deep, having a filter-bed of 3in., covered over with a coarse cloth. The depth of ore in the tanks is about 3ft. 6in., and about six tons of 0·25 per cent. cyanide solution is used. This is what is termed the strong solution. The tap allowing the filtrate to flow away is so regulated as to take about twenty-four hours to filter through this solution, after flowing through six compartments with filter boxes, which are filled with fine zinc-turnings. The solution passes into a sump, 18ft. long by 14ft. wide and 4ft. deep, and from this it is pumped into the tank again, which forms the second solution. The latter solution is allowed to filter through as fast as possible, and, after going through the boxes filled with zinc, it flows into another sump of the same dimensions as those already mentioned. The ore is then washed with pure water, that is, water is allowed to filter through the ore, to wash out any of the cyanide solution remaining in it, after which the material is shovelled out of the tanks and run on to the waste-heap. The second solution in the sump, previously referred to, is pumped up into a reservoir placed at a higher level than the working tanks. This reservoir is 10ft. long, 8ft. wide, and 5ft. deep, the solution being made up to the required strength before again being used. The company tried to run the tailings direct into the tanks from the battery, but they found that the amount of slimes in the ore prevented the cyanide solution from filtering, and they were at the time of my visit making arrangements to allow the tailings to flow into a large pit, from which they would be lifted into the cyanide working tanks. They intended to make experiments with the working of the slimes, so as to get over the question of filtration. This seems at the present time to be the weak point in

the Cassel process. The royalty paid for the use of the Cassel process is 7½ per cent. of the value of the bullion extracted, which, however, does not include the value of the gold recovered by the ordinary battery process.

Red Mercury Company.—This company's operations last year were on the east and west branches of the Red Mercury Reef. The latter branch is stoped out, and in about four months' time the stopes on the east branch will be finished on the present level. A contract has been let for the construction of 500ft. of a lower level, which will give about 130ft. of backs. This level is now constructed for a distance of 240ft. The company purchased the crushing-plant formerly belonging to the Kuaotunu Company, which is erected in the flat at the junction of the roads to the Try Fluke and Just-in-Time Mines, which is about 50 chains from the end of the aërial tramway leading down from the mine. The crushing-plant consists of ten heads of stamps (American pattern), four pans, two settlers, and some berdans, which are driven by a powerful steam-engine. This is by far the best reduction-plant on the field. The price paid for the whole of the plant and building was £1,400. During the past year 2,291 tons of quartz was crushed, which yielded 2,307oz. 2dwt. of gold, and the average number of men employed during the year was twenty-four.

Great Mercury Company.—The operations of this company last year were confined to stoping on the Try Fluke Reef, and working out the stopes on the Red Mercury Reef. All the lode above the present level has been worked out, and another level is being constructed, which, when completed, will give about 100ft. of backs. This level was at the time of my visit constructed for a distance of 100ft. It is expected to cut the eastern branch of the Red Mercury Lode at about 190ft., and the western branch at 450ft. An average of twenty-four men were employed in this mine during last year.

In referring to this company last year it was stated that the manager, Mr. Pettigrew, assured me he was getting 87 per cent. of the gold out of the ore from his principle of pan treatment. This was questioned by me at the time as a most unlikely result. It has since been proved that he was getting only a very small percentage of the bullion in the ore. The company has now abandoned the use of the pans, having erected a Cassel plant to treat the pulverised ore after leaving the copper-plates. They have erected three working tanks, each 16ft. long, 12ft. 6in. wide, and 3ft. 6in. in depth. There are also two solution tanks, each 16ft. long, 12ft. 6in. wide, and 5ft. in depth; one of these is for the strong solution, or first filtration, and the other is for the second filtration or weak solution. The reservoir for making up the solution is 10ft. long, 9ft. wide, and 4ft. 3in. deep. About from seven to ten tons of solution is used for seventeen to eighteen tons of ore, and the strength of the solution used is from 0·3 to 0·6 per cent. Great difficulty has been experienced in treating the slimes from this company's ore, as the latter is very mullocky. The saving from the slimes does not amount to more than about 33 per cent. of the bullion they contain. The company is now endeavouring to allow the slimes to go into a large pit to settle. The ore is crushed wet, and after passing over the copper-plates it flows into a pyramidal box, having a pipe in the bottom which allows the heavy portion of the tailings or pulverised ore to pass through, and run into one of the cyanide working vats, the slimes with a great portion of the water passing over the top of the pyramidal box into the pit referred to. After the working vat is filled up, the water is drawn off, and the ore turned over by hand to loosen it, so as to prevent a coating of slimes interfering with the filtration. The present method of filtration is very unsatisfactory, and it appears to be the weak point in the Cassel system of treatment. Where there are slimes they absorb the cyanide, and hold the cyanide of gold which cannot be washed out of them. However, by the method at present adopted most of the slimes are separated from the pulverised ore, and a fair percentage of the bullion is extracted.

An average of thirty-three men were employed by this company during last year, and 2,312 tons of quartz was crushed, which yielded 2,304oz. gold; 1,190 tons of tailings were also treated at the Cassel plant, which yielded 461oz. 11dwt. gold, making the total gold returns 2,765oz. 11dwt.

Mariposa Company.—This company erected a crushing-plant last year, consisting of ten heads of stamps and three of J. Fraser's pans; but, after they started crushing it was found that only a small percentage of the bullion could be saved, hence crushing was discontinued for a time, and an arrangement has now been made to erect a Cassel plant to treat the tailings from the quicksilver tables with a cyanide solution. An average of twelve men were employed by this company last year. They have been working on the same line of lode as the Try Fluke Company, which is about 4ft. wide in their ground, and the ore averages by the ordinary battery process from 12dwt. to 15dwt. of bullion per ton. Only 300 tons of ore was crushed last year, which yielded 171oz. bullion, principally gold.

Just-in-Time Company.—This company has let their mine on tribute to Captain Richards, the late manager, who has had an average of five men employed. He has crushed 276 tons of quartz, which yielded 321oz. 18dwt. gold. There is no crushing-machine attached to this mine, the quartz being crushed at Curtis's Battery. This battery at the time of my visit to the field changed hands, Mr. Abbot being the purchaser for £600.

The foregoing are the principal mining properties at Kuaotunu, but there are several other companies and parties of miners who have obtained a good deal of gold, amongst which may be named the "Kuaotunu," "Irene," "Otama," "Black Jack," "Waitaia, "Invicta," "Excelsior," and others. A new claim has recently been opened in the Waitaia Block. This is called the "Aorere," and is held by a syndicate of nine persons. Ten tons of stone was crushed from this claim, which yielded 13oz. 13dwt. of gold, worth £2 13s. per ounce. The lodes, however, in this portion of the Kuaotunu field do not look so permanent as those running through the Try Fluke, the Mariposa, Red, and Great Mercury, Companies' claims. There are a number of lodes, some of which are very large, in different parts of the field containing gold, but it requires a cheap method of reduction and treatment to make them remunerative for working. Scarcely any work had been done in the Black Jack Claim, which was taken up when the field was first opened, until last year, when three men got out 37½ tons of quartz, which yielded 154oz. 10dwt. of gold, being 4oz. 2dwt.

9gr. of gold to the ton. In the Irene Claim eight men got out 333½ tons of stone, which yielded 275oz. 17dwt. of gold; but at the time of my visit work in this claim was discontinued, owing to some dispute as to the ownership.

Only one man was at work in the Waitaia Claim at the time of my visit. A new low-level has been constructed, and a small leader cut, on which the man was at work, but, judging from its size and quality of the stone, it will not pay to work. The Otama Claim, on Comers' Block, has been worked principally by two tributers, who got out 19 tons of stone last year, which yielded 373oz. of gold. Taking the whole of the quartz crushed on the field last year—namely, 10,093 tons, the yield of gold was 8,483oz. 13dwt., being an average of about 16dwt.19gr. of gold per ton. There was also 2,760 tons of tailings treated, which yielded 1,023oz. 4dwt. of gold, being an average of a little over 7dwt. of gold per ton.

The following statement shows the area of ground held in mining claims in the Coromandel district; the number of men employed as wages-men and tributers respectively; the number of tons of stone and tailings treated, and the yield of gold therefrom, for the year ending the 31st March, 1893:—

Locality and Name of Mine or Company.	Area of Land held.	Average No. of Men Employed.		For Owners.		For Tributers.		Tailings.	
		Wages-men.	Tributers.	Quartz crushed.	Gold obtained.	Quartz crushed.	Gold obtained.	Quantity treated.	Gold obtained.
	A. R. P.			Tons cwt. lb.	Oz. dwt.	Tons cwt. lb.	Oz. dwt.	Tons.	Oz. dwt.
Coromandel County.									
Tokatea Range—									
Tokatea	14 2 0	..	9	..	..	43 6 0	162 14	..	..
Royal Oak	10 2 27	..	5	..	..	1 9 20	296 0	..	..
Bismarck	11 1 38	..	3	..	..	0 6 106	79 19	..	..
Harbour View	5 0 0	..	2	..	..	1 4 1	16 17	..	..
Rob Roy	3 0 0	..	2	85 10 0	23 10	..	..	..	..
Mayn's (Blow)	5 0 0	2	..	105 0 0	17 1	..	..	..	..
W. Mayn's Claim ..	6 0 0	2	..	2 0 38	31 8	..	..	..	..
Blue Peter	3 0 0	1	..	8 0 0	10 18	..	..	..	..
Sundry claims	20 0 0	10	..	50 0 0	81 19	..	..	..	..
	78 2 25	15	21	250 10 38	164 16	46 6 15	555 10	..	..
Kapanga—									
Kapanga and Coromandel..	108 0 3	44	9	286 0 0	177 0	40 0 0	127 7	..	..
Scotty's..	29 1 20	4	5	110 1 38	97 18	..	..	..	..
Colthurst's Claim ..	2 0 0	1	..	9 10 0	28 7	..	..	..	..
Premier	5 0 0	1	..	3 10 0	11 6	..	..	..	..
	144 1 23	50	14	409 1 38	314 11	40 0 0	127 7	..	..
Tiki—Castle Rock	3 0 0	2	..	0 2 54	31 0	..	..	..	..
Kopukaitahi—McDonald's ..	6 0 0	1	..	0 0 42	5 17	..	..	..	..
Waikoromiko—Dyer ..	10 0 0	3	..	1 0 57	14 11	..	..	..	..
" Lillis's ..	10 0 0	2	..	2 10 0	127 6	..	..	..	..
Opitonui—Little's	10 0 0	3	..	0 16 10	15 0	..	..	..	..
" Ryan	10 0 0	2	..	0 0 6	20 5	..	..	..	..
Owera	10 0 0	12	..	1,496 0 0	1,921 0	..	..	..	..
Mahakirau	12 0 0	4	..	..	..	..	..	..	..
Matarangi—Ocean View ..	14 2 30	6	..	34 0 0	100 0	..	..	..	..
Sundry claims	20 0 0	10	..	25 0 0	50 0	..	..	..	..
	105 2 30	45	..	1,559 9 57	2,284 19	..	..	..	..
Kuaotunu—									
Try Fluke	19 0 7	32	..	4,116 0 0	2,186 0	..	..	1,542	550 0
Kuaotunu	15 0 0	5	..	250 0 0	191 10	..	..	..	..
Red Mercury	14 0 0	24	..	2,291 0 0	2,307 2	..	..	..	..
Great Mercury	28 0 0	33	..	2,312 0 0	2,304 0	..	..	1,190	461 11
Just-in-Time	8 2 24	..	5	..	..	276 0 0	321 18	..	..
Mariposa	4 2 6	12	..	300 0 0	171 0	..	..	..	..
Irene	7 2 0	8	..	333 10 0	257 17	..	..	..	..
Otama	20 1 20	2	2	4 0 0	50 0	19 0 0	373 0	..	..
Black Jack	10 1 3	3	..	37 10 0	154 10	..	..	..	..
Waitaia..	30 0 0	3	..	50 0 0	71 7	..	..	..	..
Invicta	8 0 0	2	..	30 0 0	26 2	..	..	..	..
Excelsior	9 0 20	3	..	74 0 0	19 7	..	..	28	11 13
Sundry claims	20 0 0	8	..	..	50 0	..	..	..	..
	194 2 0	135	7	9,798 0 0	7,788 15	295 0 0	694 18	2,760	1023 4
Totals	523 0 38	245	42	12,017 1 21	10,553 1	381 1 6	1377 15	2,760	1023 4

Mahakirau.

On my former visit to this field some three years ago, Mr. Reynolds and party were prospecting a small leader of quartz, from which some very rich specimens were obtained. This leader is on the side of the range facing the Mahakirau Creek, about four miles above Mr. Hooker's farm in the Mahakirau Valley, and is about eight miles from Mercury Bay. Since that time Mr. Reynolds has

been prospecting in different places along the same range, and about the end of last year he discovered gold in a deposit of clay alongside the same creek, about two miles nearer Mr. Hooker's farm. The claim is now known as "Bryce and party," and at the time of my visit there were four men at work, but previously to this only two men were employed. The place where they are working is on an old slip from the range, where there is a considerable depth of yellowish-red clay, intermixed with quartz-grit and small quartz-stone; but a very good prospect of loose gold can be got by puddling the clay. The deposit greatly resembles the clay found on Bendigo Flat in Victoria, which was all washed away with puddling-machines; but at the same time it is not so tenaceous, being more easily puddled than the Victorian clays, the largest stones of quartz found in the deposit being from 3in. to 4in. in diameter.

The clay is cut out with adzes and picks, and wheeled to a box or square trough, where it is puddled with a spade; and when every trough-full is reduced to fine sharp grit, and stones, the material is thrown into another small box adjoining the puddling-trough, the stones being taken out. The residue of the fine sharp grit is amalgamated in this box with quicksilver by hand. The amalgamated material then passes over a series of riffles, where the amalgam is collected. All stones are picked out and examined to see whether they contain gold. Indeed, it may be said they are all laid aside to be crushed. The fine material which will not pass through a sieve or hopper (having holes of about one-tenth of an inch in diameter) is stacked for crushing. At the time of my visit 38lb. of stone from this deposit were crushed at one of the batteries at Kuaotunu, which yielded 37oz. 10dwt. of melted gold, having a value of £2 18s. 2d. per ounce, which represented a total value of £109 1s. 3d. This, together with the value of loose gold obtained, from the 1st January to the end of April by the two men employed, amounted to £153 13s. 9d.

From the appearance of the slip on which the men were working it must have come from a considerable distance—in all probability from the top of the range, as it is of considerable dimensions. The quartz-grit, where the gold is found, is not all through the deposit, but is in layers. Any person looking at the face of the cutting where the men are at work could, however, hardly distinguish any difference in the appearance of the clay.

On the opposite side of the creek, and about 400 yards higher up, a large quartz-lode is opened out by Messrs. O'Brien and Kelly, the outcrop of which is about 342ft. above the sea-level. The lode here is about 15in. in thickness. They have constructed a level about 75ft. under the place where they first cut the lode, which was found at the lower level fully 5ft. in thickness, but of a rather broken character. The stone contains a large percentage of iron and arsenical pyrites, which is said to be fairly rich in gold, but, judging from its appearance, one would class it as very low-grade ore. There are some bands in the lode which contain free gold, but the greater portion is heavy, mineralised stone. Five tons were sent to be treated at the Moanataiari battery at the Thames, which only yielded 1oz. 11dwt. of gold, representing a value of £2 15s. 6d. The lode requires to be driven on in the lowest level for some distance into the hill to ascertain whether it will develop into a more compact body. At present it has the appearance of a blow. If it should maintain its present width, very little gold in the stone would make it payable for working.

At the present time there are about thirteen men working and prospecting in the district, and from the character of the rock in this locality there appears to be a fair prospect of a payable field being found. The bush is very thick and the undergrowth dense on these ranges. Where there are no tracks it makes prospecting a very arduous undertaking. The miners here are very desirous of having a bush-line cut along the top of the range, between the Kaimarama and the Mahakirau Creeks, on to Manaia, to allow them to get back into the ranges for prospecting.

Thames District.

There seems to have been a general depression in mining on the Thames Goldfield last year. The best of the stone in the claims on the upper levels has been worked, and the large expense in connection with the drainage of the deep levels prevents prospecting from being carried on at greater depths. There are still large quantities of stone above the 500ft. level, which will take a number of years to work out; and this is about as deep as any of the present companies can work their claims. The great cry of the people here at present is to prospect the deep levels, and every company on the field are anxious to have this done; but they have not the means to carry the operation into effect, the ground below the 500ft. level is therefore practically useless to any of the present holders of the ground; but the moment a scheme is brought forward to try and get a large company to undertake the work a large value is set upon the deep ground, notwithstanding its being worthless to the present companies on account of not being able to work it.

Several meetings have been held, and committees formed, to digest a scheme for prospecting the deep levels, but none of them have as yet brought about a practical result. The present companies which hold ground on the Thames, if they are sincere in their intentions of getting a company formed to undertake a work of this description, must be prepared to deal liberally, and offer every facility to induce men to put capital in the venture. For instance, if the deep ground is worthless to the present holders, this is one great reason that they should give it up without any remuneration. If such were done, there is a great chance of it being taken up by a large company, and the ground thoroughly prospected; and if the ground were given by the present holders, say all below the 500ft. level, without remuneration, any company taking it up should do the whole of the drainage at their own cost, and the present claim-holders would therefore be benefited by this arrangement to a great extent: it would free them from drainage-rates, thereby enabling them to work lower-grade ore at a profit than can be done at present.

There seems to be a great many different opinions on this field as to the best and most economical method of prospecting the deep levels: some advocate the use of the diamond-drill as being the cheapest mode of accomplishing this object; but very few of the mining men, and more especially the mining-managers, think that the use of diamond-drills would satisfactorily test the deep levels, and there can hardly be two opinions on this when the scheme is fully considered. The

diamond-drill is an excellent machine for boring for coal through rock of a moderately uniform character; but in using them through rock having alternately hard and soft seams, as generally met with where auriferous and argentiferous lodes exist, the inclination of the drill is to run towards the side where the seam is softest, and instead of the bore going in its initial direction, it may be many feet out of the line when it is down. Diamond-drills have not been used with success in Australia in prospecting for auriferous lodes from the surface, but they could be used successfully in cross-cutting —that is, a horizontal bore can be put through the strata of the rock to cut the lode; whereas in boring vertically the strata is in general highly inclined, and the tend of the drill is to follow the soft veins when they are leading in or near the same direction as the initial direction of the bore.

In reference to the rock at the Thames, it is not stratified, and, therefore, the same objections would not have the same weight as though it was proposed to bore through schist rock; but there are in several places hard dykes or bands lying at high inclinations, which would have the effect on the bore as a highly-inclined stratified rock. The diamond-drill would be useful to test what depth there is of tufaceous sandstone, or whether it is overlying the schist rock at a moderate depth; and there is a possibility of the bore striking a lode, but the chances are remote, and, even if it should do so, the difficulty then is to know the thickness of a lode the drill passes through. If it was to strike a leader only 4in. thick, and follow down the centre of that leader for some distance, the core might show sufficient gold to pay for working if the lode be of moderate thickness, but not if it is only a small leader. A good many bores may be put down before ever a lode is struck, and a large expenditure made in boring without any good result. The boring is undoubtedly cheapest in the first instance, but it is misleading, and nothing certain as to correct results.

The mine-managers advocate the sinking of a shaft to the depth of, say 2,000ft. on the southern end of the lodes in the Queen of Beauty ground. The strike of the reefs is southwards, being shallow and near the surface in the Kuranui Hill, and gradually getting deeper, going in the direction of the Queen of Beauty Mine. This scheme would involve an expenditure of about £100,000 to sink the shaft, erect machinery, and to prospect the ground by drives and uprises. Notwithstanding this large capital, there is a great probability of it being a profitable mining venture, seeing the large quantities of rich ore which have been taken out of the upper levels. By sinking a shaft it would conclusively prove whether the field was worth working or not; and by prospecting it with a diamond-drill, it would mean that if it did not find an auriferous lode after putting down a few bores the tendency would be to put a damper on any company undertaking to prospect the ground thoroughly at a future time.

Another scheme is to extend the Moanataiari Tunnel and prospect the back-country. This would prospect the deep levels as well as sinking on the flat. The whole of the ground on the face of the hill, and on the flat where Grahamstown stands, was one time at a much higher elevation, and came by a slide from the top of the range. This is plainly seen by the Moanataiari Slide. The difficulty is to locate the place where the slip originally came from. Mr. Park, the Director of the School of Mines, who has devoted a great deal of time to this subject, thinks that the Moanataiari Slide may have come down from 600ft. to 800ft., or even more. Therefore, by going into the back-country by the extension of the tunnel the deep levels would be tested. But the same difficulty exists here as in the flat. The ground where this extension of the tunnel would have to go through is held in claims, and therefore it would be a difficult matter to arrange about its extension. The present companies would be the only ones directly benefited by gold being got, and the present tunnel is the property of the Moanataiari Company, who are using it daily to take the quartz from their workings to the crushing-battery. Arrangements would have to be made with this company before anything could be done in the matter of formulating any scheme to carry on mining operations from this tunnel. There is no doubt by carrying this adit or tunnel back into the hill it would test deeper levels than could be done by sinking; but there is a possibility of it cutting through the auriferous belt in going back into the range. In order to cut across the different known lodes the direction of the adit would have to be slightly altered, more in a northerly direction, in order to cut through the Golden Age, Reuben Parr, Orlando, Watchman, Star of the South, Sons of Freedom, Dixon's, and other reefs; but in whatever direction this adit were extended it would pass through claims held by different companies, and arrangements would have to be made with each of them before finally devising any scheme to test the back-country and deep levels from this tunnel or adit.

The whole of the ground in the vicinity of the Thames is held in a network of claims by different companies, and each company considers their ground more valuable than the other, so that there is no hope of any definite scheme being submitted until a great many of these companies have amalgamated their interests. At the time of my visit to the field some gentlemen represented to me that an attempt would be made to amalgamate the Queen of Beauty, Saxon, May Queen, Victoria, and the Cambria. If such can be done, there is a possibility of some feasible scheme being formulated to test the deep levels on Grahamstown Flat. Some people are in favour of the shaft being sunk in the Queen of Beauty ground, as the strike of all the lodes from the Kuranui Hill is in this direction. The present pumping plant is considered far too expensive to work if a great depth had to be sunk. The present shaft is 640ft., and lately the pump has only been keeping down the water to the 400ft. level, and this can be done by working an 8ft. stroke, making three and three-quarter strokes; and it is said the water can be kept down to the 640ft. level by working the pump five strokes per minute.

The following data as to the quantity of water to be lifted gives some idea of the power that would be required if a shaft were put down to the depth of 2,000ft., as proposed by some of the mining men in this district. Assuming that it required five strokes on an 8ft. stroke to keep the water down, the diameter of the pump being 24in.; then the quantity would be as follows: $G = 0{\cdot}034$, $d^2\ l\ w$, when G = the number of gallons discharged per minute, d = the diameter of the pump in inches, and w = the number of strokes per minute = $0{\cdot}034 \times 576 \times 8 \times 5 = 783$ gallons per minute; but when it is working at the 500ft. level, $3\frac{1}{2}$ to $3\frac{3}{4}$ strokes a minute is sufficient to keep down the water. If $3\frac{3}{4}$ strokes be taken, then on the same basis the quantity of water lifted would

be $0{\cdot}034 \times 576 \times 8 \times 3\frac{3}{4} = 587$ gallons per minute. The actual horse-power required to lift the former quantity of water from a depth of 640ft. would be about 152, but to this would have to be added three-tenths to overcome friction: then the actual power required would be $152 \times 45{\cdot}6 = 197{\cdot}6$ horse-power. To lift the lesser quantity of water from a depth of 500ft. the horse-power would only be 71·, or, adding three-tenths to overcome friction, the actual power required is about 113·6. The pump was working to a depth of 500ft. during three months of last year, as stated by the manager in his report to the Drainage Board at the last annual meeting in January last, and for nine months at the 400ft. level, which would only require 81·3 horse-power to lift the water to this height. The expenses in connection with working the pump during the year was £3,956 0s. 8d., which is about £329 13s. 5d. a month; the fuel and cartage alone coming to £2,324 16s. 9d. per annum, or about £193 14s. 9d. per month. This shows that the cost of the fuel alone is equal to about 1s. 5d. per day for every horse-power required to lift the water.

Assuming that there is not a large increase in the quantity of water at the deep levels—that it possibly would not exceed 800 gallons per minute—the horse-power required to lift this quantity from a depth of 2,000ft. would be $\frac{800 \times 10 \times 2}{33} = \frac{16,000}{33}$ = say, 485 horse-power, and three-tenths added for friction $= 485 \times 145{\cdot}5 = 630{\cdot}5$ actual horse-power required. If steam power were employed to do the work, and engines could be procured which would use 25 per cent. less fuel per horse-power than the present engine, then the cost of fuel per annum would be about £11,972; and assuming that two pumps were used to lift the 800 gallons per minute as referred to, then the diameter of the pump would $= \sqrt{\frac{400}{8 \times 5 \times {\cdot}034}} = 17{\cdot}15$in. $+ \frac{1}{4}$ area. This shows that it would require two pumps 19in. in diameter; but, if the speed were slightly increased, two pumps 18½in. in diameter would be sufficient. It is not, however, safe to calculate on only a slight increase in the quantity of water in going down, and it would be safer to provide pumps of 20in. in diameter.

It is very evident, when the project comes to be analysed, that it will require a very large amount of capital to sink a shaft to a depth of 2,000ft. on the Thames field, and to construct drives to prospect the ground. The large amount of rates that the few companies have to pay for drainage at the present time falls very heavy on them.

The following is the balance-sheet of the Thames Drainage Board for the year ending the 31st of December, 1892, which shows the amount of each company's contribution and the expenditure for the year:—

Receipts.

	£	s.	d.
Cash balance from last balance-sheet	336	11	8

Mining Companies.	Arrears due on Last Year's Balance included in assessment.			Assessment.			Less Rebate.			Amount received.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Saxon	..			1,052	2	0	350	14	0	701	8	0
Waiotahi	..			780	0	0	260	0	0	520	0	0
Victoria	40	0	0	506	4	0	155	8	0	350	16	0
NewMoanataiari ..	..			472	10	0	157	10	0	315	0	0
May Queen	..			462	0	0	178	10	0	283	10	0
Cambria	..			403	4	0	134	8	0	268	16	0
Hazelbank	..			403	4	0	151	4	0	252	0	0
New Manukau ..	96	0	0	240	0	0	48	0	0	192	0	0
Trenton	116	0	0	221	0	0	10	10	0	210	10	0
Caledonian	64	0	0	114	8	0	24	8	0	90	0	0
Kuranui No. 2 ..	30	0	0	124	10	0	31	10	0	93	0	0
Kuranui No. 3 ..	11	0	0	80	6	0	20	4	3	60	1	9
	357	0	0	4,859	8	0	1,522	6	3	3,337	1	9

	£	s.	d.
Total mining companies	3,337	1	9
Thames Borough Council	240	0	0
Thames County Council	235	0	0
Coal, and miscellaneous	44	13	5
Craig, deposit	75	0	0
	£4,268	6	10

Expenditure.

	£	s.	d.
Coal, per Smith	1,024	11	9
Coal, per Craig	943	6	1
Coal, per Dickey and Verran...	93	19	6
Coal, per Nicol	70	1	0
Wages	866	19	7
Foundry work and ironmongery	262	17	1
Cartage	192	18	5
Water supply, timber, and gas	116	10	9
Board fees and travelling-expenses	195	10	0
Salaries, insurance, advertising, &c.	142	1	6
Miscellaneous accounts	43	5	0
Balance	312	6	2
	£4,268	6	10

Liabilities.

	£	s.	d.
Craig, deposit	75	0	0
Sundry creditors	282	11	7
	£357	11	7

Assets.

	£	s.	d.
Cash balance	312	6	2
Contributions due 31st December, 1892	190	0	0
Saxon G.M. Company (coal)...	10	4	9
	£512	10	11

The produce of gold from the Thames District has been less this year than for the former one, the total quantity of gold and bullion obtained being 35,420oz. 9dwt., as against 38,576oz. 6dwt. for the previous year, thus showing a decrease in the yield of 3,250oz. 17dwt.; the largest decrease being at the mines at Grahamstown. The total quantity of gold produced from the mines here last year, exclusive of the gold obtained from the tailings, was only 816oz. 9dwt., as against 5,150oz. 16dwt. obtained for the year previous. This shows a decrease in the yield of 4,334oz. 7dwt. from the mines within the Borough of Thames. There has also been a considerable falling-off in the yield of gold from Tararu, owing to the stoppage of operations at the Sylvia Mine.

The following statement will show the comparative results of mining operations in different localities in the Thames District for the last two years, ending the 31st March in each year:—

Name of Locality.	1891-92.						1892-93.					Gold Increase.	
	Number of Wages-men and Tributers employed.	Tons of Quartz crushed.	Yield of Gold.	Tons of Mullock crushed.	Yield of Gold.	Bullion or Gold from Tailings.	Number of Wages-men and Tributers employed.	Tons of Quartz crushed.	Tons of Mullock crushed.	Yield of Gold.	Bullion or Gold from Tailings.	1891-92.	1892-93.
			Oz. dwt.		Oz. dwt.	Oz. dwt.				Oz. dwt.	Oz. dwt.	Oz. dwt.	Oz. dwt.
Tapu ..	7	73	219 12	..	..	..	10	36	176	246 7	..	..	26 15
Tararu ..	56	3,500	1,160 12	..	..	*9,864 0 / 2,705 0	38	4,220	..	529 7	†3,985 / 839 0	1,866 0	..
Shellback ..	5	71	104 16	..	..	..	11	144	..	151 19	..	..	47 3
Kuranui ..	69	2,835	2,594 12	21,953	1,170 5	..	75	2,654	13,173	3,804 19	..	..	40 2
Moanataiari	188	16,858	8,209 16	..	..	..	221	19,822	6,257	10,070 6	..	..	1,860 10
Grahamstown	115	11,891	5,150 16	..	..	..	57	588	1,000	816 9	..	4,334 7	..
Waiotahi ..	128	6,365	5,848 8	..	..	..	125	6,313	500	7,162 1	..	..	1,313 13
Waiokaraka	25	2,482	2,068 9	..	..	..	23	867	..	546 4	..	1,522 5	..
Karaka ..	25	723	1,183 2	..	..	..	45	1,700	..	1,643 1	..	..	459 19
Una Hill and Te Papa ..	50	1,639	2,189 14	..	..	..	41	825	..	1,214 9	..	975 5	..
Hape Creek..	29	372	333 2	..	..	..	25	868	..	575 10	..	..	242 8
Puriri ..	6	263	220 16	..	..	..	2	44	..	31 10	..	189 6	..
Tairua ..	3	124	91 19	..	..	..	3	45	..	65 0	..	26 19	..
Tailings ..	18	..	1,343 12	..	..	3,981 15	..	..	..	..	4,478 12	..	496 17
Total ..	724	47,196	30,719 6	21,953	1,170 5	6,686 15	676	38,131	21,106	26,857 2	5,317 12	9,545 7	4,487 7

* The 9,864oz. of bullion represents a value of £7,874 5s., which would be equivalent to 2,705oz. of gold.
† The 3,985oz. of bullion represents a value of £2,182 11s. 8d., which would be equivalent to 839oz. of gold.

Tapu.

There are still a few miners working at the Tapu, but very few of the claims, with the exception of D. Sheridan's, pay for working. People keep working on with the anticipation of coming on a few pounds of rich specimen-stones, which is characteristic in the lodes in this district; and these in many instances give the shareholders sufficient hope to carry on mining operations for a considerable time without getting any stone that will pay for working. Some very rich patches of stone have been found in this district, but so far the lodes do not seem to carry gold sufficient to pay for working to a great depth below the surface. Notwithstanding that this has so far been the case in the belt of country near the Hauraki Gulf, there is a prospect of finding lodes further back in the range, between the East Coast and the Hauraki Gulf, equal to any that have been yet found on this peninsula. Recently a new discovery has been made by J. F. McMahon and W. Bullen, in a spur branching off what is known as the Kaka Range, about three miles up the Tapu Valley, and about one mile back on the western side of the Tapu Creek. This discovery was made on the 8th December last, and a lode opened up in two places near the surface, where a few tons of stone was being taken out at the time of my visit to forward to the Thames as a trial crushing. The place where they are taking out the stone is about 780ft. above sea-level; and the County Council has made a sledge-track up to their workings to enable the men to get their quartz brought down to the valley of the Tapu Creek, where there is a dray-road.

The lode is from 6in. to 1ft. in width, and there is also a leader branching away from the lode carrying fair gold; but the workings are so near the surface, and the lode being small, it is questionable if it will carry gold down to a great depth. There is not sufficient work done to prove whether the discovery is of much value. The rock adjoining the lode is a soft tufaceous sandstone, and the formation is what the miners would call a kindly-looking country to find payable lodes in. It

is also on the same belt of country where the Waiomo lodes exist, and in all probability this belt will be traced in the direction of Kuaotunu. The gold is somewhat similar in character to that found at Kuaotunu, being extremely fine, and will be difficult to save by the ordinary battery process of treatment. There has scarcely been any prospecting done in this belt of country, and it is only by chance that any lodes have been struck. It is only by men following the avocation of gum-digging that lodes in the back ranges are likely to be discovered. The whole of the Hauraki Peninsula is auriferous, less or more, and large lodes of quartz are cropping out here and there, but the difficulty of access precludes any reasonable quantity of the ore being conveyed to a crushing-battery for treatment. The mere fact of a few rich specimen-stones being found is no criterion that the lodes will pay for working, and, until such time as this new find is prospected at a deeper level, very little can be said regarding it, beyond the fact that it is in a belt of country where auriferous lodes are likely to exist.

Tararu.

There has been a considerable falling-off in the yield of gold from this locality. Last year there was 4,220 tons of quartz crushed, which yielded 529oz. 7dwt. of gold, and 3,985oz. 5dwt. of bullion, of a value of £2,182 11s. 8d., which is equal to about 839oz. of gold. This makes the total gold obtained to be 1,368oz. 7dwt., as against 3,865oz. 12dwt. for the previous year. The Sylvia Company have been unsuccessful in carrying on operations last year, and had to close down their works. The result has been that the whole of the valuable plant, mine, and aërial tramway was sold by the mortgagee for about £600, the purchaser being Mr. Darrell of the Thames.

The *Norfolk Company* have been steadily carrying on operations, but not with success, the ore being of a very refractory character. They crushed 1,700 tons of stone for a yield of 392oz. of gold. Several parties have been prospecting lodes at the head and upper portion of Tararu Creek, with the view of opening up fresh ground; but, although some fair specimens have been got in this locality, nothing is yet definitely known as to the value of any fresh discovery.

Shellback.

There are about eleven men working in this locality—namely, six wages-men and five tributers, but, taking the quantity of gold obtained last year, namely, 151oz. 19dwt., or 13oz. 16dwt. 6gr. of gold per man for the year, it shows that the mines in this locality must have been worked at a loss.

Kuranui.

This is a locality in the Thames District likely to continue to give small returns for a large number of years. The whole of the Kuranui Hill is a network of auriferous quartz-veins and leaders. During the last year there was 13,173 tons of mullock crushed, which yielded 3,032oz. 3dwt. of gold, and 1,514½ tons of quartz was crushed, yielding 772oz. 16dwt. of gold. There are three gold-producing claims in this locality—namely, Hansen's, Comer's, and the Hazelbank.

Hansen's Claim.—There have been eight wages-men and fifteen tributers at work last year in this claim, which got 2,906 tons of mullock, and 762½ tons of quartz, yielding respectively 136oz. 6dwt. and 490oz. 11dwt. of gold; the mullock averaging about 21·7gr. of gold per ton.

Comers' Claim.—There was 10,267 tons of mullock crushed from this claim, which yielded 663oz. 10dwt. of gold, being an average of 1dwt. 7gr. of gold per ton; and 154 tons of quartz, yielding 186oz. 6dwt. of gold.

Hazelbank.—This is the ground which formerly was held by the old Caledonian Company, and where one of the richest deposits of gold was found that has ever been discovered in New Zealand. It is still a gold-producing claim. During last year there were twenty-seven men employed on wages and five men as tributers; and 1,738½ tons of stone was crushed, which yielded 2,328oz. 6dwt. of gold, being an average of 72oz. 15dwt. for every man employed in the claim.

Moanataiari.

There has been a considerable amount of work done in this part of the Thames District; the principal gold-producing company last year in this locality being the Moanataiari, New Alburnia, Dixon Extended, and the New Whau. There was 19,822 tons of stone crushed, and 6,257 tons of mullock treated, from the claims in this part of the field, which yielded 10,070oz. 6dwt. of gold, as against a yield for the former year of 8,209oz. 16dwt. There were, however, thirty-three more men employed in the mines last year than for the previous one. Taking the amount of gold produced for the year and the number of men employed, it gives an average of 45oz. 16dwt. 8gr. of gold for every man employed, as against 43oz. 13dwt. 9gr. for 1892.

Moanataiari Company.—This company is the largest employer of labour in the Thames District, there being eighty-eight men employed on wages, and fifty-seven on tribute, in connection with the mine last year. The position of the ground the company holds, and the long adit-level from the ocean-beach back into the hill, gives them the key to a large area of the back country, as the ground can be worked far more cheaply from this adit-level than it could possibly be from shafts; the cost of transit of the quartz to the crushing-battery being a great element in the saving itself. It is a part of the district where a considerable amount of gold will be got for many years, and the extension of their adit-level will always open up fresh ground. During last year they crushed 11,734 tons of stone and 5,257 tons of mullock for themselves, which yielded 5,039¾oz. of gold; and 2,752½ tons of stone was crushed for tributers, which yielded 1,390oz. of gold.

New Alburnia Company.—This company promises to be one of the principal gold-producers on the field for the ensuing year. The mine is well opened up, and arrangements have been made to lease the Saxon battery to crush the quartz. A great deal of the stone cannot, however, be termed free-milling ore. Some of the tailings were recently operated on by Mr. Pitcairn, the manager and agent for the Lührig Concentrating Company, which showed that a considerable saving would be effected by the use of their machines, as the ore is adapted for concentration, as will be seen from his report to the Alburnia Company on the treatment of 10¾ tons of ore, as follows:—

"I have the honour of submitting the following report on the parcel of ore sent to the Norfolk Battery for treatment by the Ore Dressing and Gold Extraction Company's plant. The general dirt sent amounted to six railway loads, or seven cart-loads, or, approximately, 10 tons 15 cwt. (dry). The ore was crushed in the ordinary five-stamper box, a punched screen, 250 holes to the square inch being used. The pulp was passed over amalgamated Muntz-metal plates, three in number. Immediately below each plate there is a small ripple, each of which was cleaned out at regular intervals. The material obtained, "skimmings" or "ripplings," was ground in berdan pans in charges. The remainder of the pulp was passed *directly* into the Lührig pump, and delivered to the classifier for classification prior to concentration on the concentrators. It must be mentioned "no blankets" were used, hence no blanket-washings were forthcoming for grinding in the berdans. This fact, of course, reduces the percentages of saving effected by the berdans in treating this parcel. Underwritten is the tabulated result of the crushing:—

	Value per ton. £ s. d.	Total Values in Material treated. £ s. d.	Per cent.
"Crude ore, 10¾ tons	3 14 6½	= 40 1 4	= 100.00
Received from plates 6dwt., value	...	= 0 15 8	= 1·95
Received from skimmings, 7oz. 7dwt. ...	...	= 19 2 2	= 47·69
Concentrates, 3¾ tons	5 2 0¾	= 19 2 9	= 47·76
Tailings, 5 tons...	0 3 4	= 0 16 8	= 2·07
Unaccounted, loss	...	= 0 4 1	= ·50
		£40 1 4	= 99·97

The berdan tailings are taken from the settling-pits, and concentrated, and of course added to the concentrates. In a mill properly arranged this could be made to work automatically. From the above result it is noticeable that by the present battery system on the Thames the percentage of saving is equal to 49·64 per cent., whilst by the addition of a simple concentration process 47·76 per cent. more of the original assay-value is recovered, *i.e.*:—

	£ s. d.
"Value of ore treated	= 40 1 4
Present battery process yields only	19 17 10
Loss	= 20 3 6
Of this loss concentrators save	19 2 9
Loss reduced to	£1 0 9

The concentrates from this parcel of ore consisted of iron-pyrites, which appeared semi-decomposed and porous. Their appearance was quite dull, and lacked the lustre of rich pyrites; indeed, there is a great difference between their value and those from the late crushing, yet it may be considered as payable for concentration, and subsequent extraction of the bullion."

Mr. Park, the Director of the School of Mines, Thames, made assays of samples of crushed ore taken from the splash of the screens about every quarter of an hour, during the time this company was crushing 27 tons of quartz at the Cambria Battery. These samples were all put into a tub and forwarded to the School of Mines, where they were thoroughly mixed and assayed, the result being that the value of the quartz was £33 4s. 6d. per ton; or the total value of the 27 tons was £897 1s. 6d. Of this amount, the value of the bullion recovered from the copper-plates was £30, or 3·3 per cent.; and from the berdan, £432 15s. 5d., or 48·2 per cent.; making the total saving 51·5 per cent. This shows a loss of 48·5 per cent. of the value of the bullion in the ore. Mr. Park made these assays free of charge in order to give the managers of the mines accurate information as to the actual percentage of the bullion they were saving. During last year this company had sixteen men employed on wages and eight men on tribute, and crushed 349 tons of stone for themselves, which yielded 215oz. 10dwt. gold. They also crushed 222 tons for the tributers, which yielded 220oz. gold.

Dixon's Extended Company.—This company work the whole of their claim on tribute, eight men being employed; last year 2,560 tons of stone was crushed for a return of 628oz. gold. The stone is easily got, and is sent down to the battery which is erected at the side of the Tararu Creek by an aërial tramway.

New Whau Company.—This company has been fairly successful last year in carrying on its operations. It had four men employed on wages and five men as tributers, and crushed 1,800 tons of stone, which yielded 590oz. gold.

Grahamstown.

This is the low-lying portion of the field, and where the people in the district wish to have the deep leads tested. It includes the whole of the ground on the flat, taking in the Big Pump shaft, the ground held by the Victoria, Saxon, and Queen of Beauty Companies. The falling-off in the yield of gold on this part of the field last year has been greatly felt by the business people in the town, and has given the appearance to the Thames District of being in a more depressed state than

what it really is. Although the mines in the heart of the township have not produced much gold last year, those in other portions of the district show an increased yield, so that this counterbalances the evil to some extent; but no doubt, unless something fresh be discovered, the yield of gold must necessarily get less in course of time. The whole of the area held in claims, licensed holdings, &c., in the Grahamstown portion of the field is only about 52 acres, and this has been almost continually worked for the last twenty years, giving employment to a large population, and it may be said that the workings have been principally confined to above the 500ft. level. Some workings have been carried on from the Big Pump shaft on the 640ft. level, and down to a depth of 720ft. in the Queen of Beauty Mine. From this latter mine, at the depth mentioned, some very rich specimens of stone were shown me, proving that the gold is still continuing to go down. The strike of the auriferous lodes all trend from the Kuranui Hill in a southerly direction. Hence gold will be found at a greater depth in the Queen of Beauty ground than that further northwards, unless some new lodes be discovered at a greater depth in a different formation. Operations have been resumed in the Queen of Beauty on the upper levels. The owner of this mine, Mr. T. A. Dunlop, has erected a winding-engine of considerable power, sufficient to wind to a depth of 1,500ft. or more. This is really where a deep shaft should be put down, if the deep leads are to be tested. The present shaft is in fair condition and sunk to a depth of about 750ft., but it would have to be widened if it were used for a pumping- and winding-shaft to test the deep levels. The advantage of using this shaft for drainage is that it would allow ground to be worked in a much shorter period of time than what could be done if a new shaft had to be sunk, and it would open up a good deal of country which is known to be payable for working, in the Saxon, Trenton, and Queen of Beauty ground.

Saxon Company.—This company, prior to last year, had been for three years previous the largest gold-producing mine on the Thames. During those three years 45,800 tons of stone was crushed, yielding 24,345oz. gold, representing a value of £66,346 10s., of which amount £12,500 was paid in dividends. During the last year the mining operations were not carried on with a profit, and now the work is principally done by tributers on the Nos. 1, 2, 3, and 5 levels. According to the company's balance-sheet for the year ending December last, they obtained 1,110oz. 15dwt. gold, representing a value of £3,123 13s. 4d.; and they received for crushing for other people or tributers £148 10s. 6d., making the total receipts, exclusive of those received from calls and sale of forfeited shares, £3282 19s. 10d.; and their expenditure was: on wages and other expenses in connection with the mine, £4,6021 3s. 2d.; on wages and other expenses in crushing-battery, £953 10s. 5d.; office expenses, £2610s. 3d.: making a total of £5,817 3s. 10d.

This shows a direct loss on the working of the mine last year of £2,534 14s. This was met with calls, and sales of forfeited shares, which amounted to £1,257 9s. 3d., and cash balance of the previous year's transactions (£1,070 4s. 5d.), making £2,327 13s. 8d; the balance between this and the loss on working being a standing liability. The nominal capital of this company is £50,000, of which £7,916 13s. 4d. is called-up. Taking the year ending the 31st March last, there was 408 tons of stone crushed, which yielded 337oz. 12dwt. of gold.

Waiotahi.

There was a slight increase in the yield of gold from the mines in this portion of the district last year, the principal gold-producing companies being the Waiotahi, Cambria, and Fame and Fortune. The total number of tons of quartz crushed from mines in this part of the field was 6,318, and 500 tons of mullock, which yielded 7,162oz. 1dwt. of gold; and 125 men were employed in connection with the mines.

Waiotahi Company.—This is one of the best-conducted mining companies on the Thames field. It is held by only a few people, and shares are not traded in. It may be said to be a mining company conducted on a purely commercial basis, and it always gives the shareholders sufficient dividends to be good interest on the money they have invested. The manager always seems to have sufficient ground open, so that he can regulate the monthly returns to be always about the same. By this means he is able to always have a certain number of men employed in dead-work in opening up new ground. The ruin of a great many mining companies is the principle they adopt in having all hands engaged in working on faces where gold is to be got, which gives large returns for a certain time, and finally comes to a standstill until new levels are opened up and the dead-work done. This has a tendency to raise the price of shares at the time when the dividends are the largest; new shareholders take the place of those who have had the principal dividends; and when the mine discontinues to be a dividend-paying one, and money is required to do dead-work, the calls can not be got in, and companies are, in some instances, put into liquidation, which, if the workings had been carried on in a systematic manner, would have continued to be paying ventures. This has been the success of the Waiotahi Company. The manager is not interfered with by his directors in any way, and he works the mine in the most economical manner, and makes it a steady-paying concern. During last year 2,298 tons of quartz was crushed, which yielded 2,578oz. gold, and thirty-four men were employed.

Cambria Company.—This company are working their mine on Nos. 2 and 3 levels, and also on the intermediate level between the two. There are numerous leaders and veins all running through the tufaceous sandstone, similar to those worked in the Waitahi Mine, and a considerable percentage of the gold obtained comes from those leaders. The balance-sheet of this company for the year ending the 16th December last shows that 1,600 loads of quartz was crushed, which yielded 2,220oz. 6dwt. of gold, representing a value of £6,087 17s. 11d., and moneys received for crushing for the public £1,777 15s., making the total receipts in connection with the mine and battery £7,865 12s. 11d. The expenditure for same period was for wages and general charges in connection with the working of the mine, £4,183 18s. 11d., less £117 12s., being rebate from Drainage Board, making a net expenditure of £4,066 6s. 11d.; wages and expenses in connection with the crushing-battery

£2,248 16s. 11d., making the total expenditure for the year £6,315 3s. 10d.; thus leaving a balance of profit on the year's transactions of £1,550 9s. 1d. Out of this dividends were paid to the amount of £1,117 10s. By analysing the balance-sheet it will be seen that a large proportion of the quartz must have come from stringers, by the cost of mining: as for instance, take the money expended in connection with working the mine, £4,066 6s. 11d., it shows the cost of getting the quartz to be nearly £2 10s. 10d. per ton. Taking the year ending the 31st March last, there was 2,277 tons of stone crushed, which yielded 2,001oz. 3dwt. of gold, representing a value of about £5,503. The mining operations are all carried on by wages-men, there being about thirty-three men on an average employed for the year. The total amount of dividends paid by this company is now £80,475, which has returned to the original shareholders, £2 9s. per share. The total amount of calls made by this company is £1,676 5s.

Fame and Fortune.—This is a company or syndicate of gentlemen in England, represented by Mr. Kersey Cooper, who is now at home trying to raise more capital on this and other properties. Previous to his leaving for England he had not been for some time successful in getting sufficient gold to meet the expenditure, and he let the mine in sections on tribute, having only four wages-men last year while thirty-two men were employed on tribute. The wages-men were principally opening up the mine and prospecting; these men got 49½ tons of stone, which yielded 25oz. of gold; and the tributers crushed 949½ tons, which yielded 1,791oz. 19dwt. of gold. Taking the gold obtained by the tributers it gave an average of 54oz. 6dwt. per man employed for the year.

Waiokaraka and Collarbone.

The only company in this portion of the Thames District who obtained much gold last year was the May Queen. As mentioned in my last report, this company amalgamated with the Trenton Company, and removed the Trenton machinery, and erected it on the Queen of May shaft, from which mining operations on No. 3 level are now being carried on. This level is 417ft. below the surface, and as deep as they can go for water. The lode they are working on is about 3ft. wide. Their mining operations last year have been carried on at a loss. According to their balance-sheet for the year ending the 22nd February last, 511 loads of quartz was crushed, which yielded 491oz. 6dwt. gold, representing a value of £1,375 8s.; also money received from sale of tailings, £18 18s. 3d.: making the total receipts in connection with the proceeds of the mine, £1,394 6s. 3d., and the expenditure in connection with the working of the mine for same period was £4,079 8s. 2d; thereby showing a loss on the working of £2,685 1s. 11d.; but portion of this expenditure was for removing the machinery from the Trenton shaft, and erecting it on the Queen of May shaft. Their actual liabilities at the date of balance-sheet amounted to £1,394 2s. 6d. The balance between this and the loss on working was received from calls and other sources. The capital of the company is £29,500, of which £3,441 13s. 4d. is called up. A great deal of dead-work was done last year, and the company is now in a fair way of being able to work the mine at a profit. During the year ending the 31st March last they crushed 823½ tons of quartz, for a yield of 494oz. 6dwt. of gold, and had an average of twelve wages-men employed.

Karaka.

There has been an increase in the quantity of gold obtained in this portion of the district last year, as well as in the number of men employed. The companies here have only employed a few men on wages, who are principally shareholders; the workings to a large extent being carried on by tribute. During last year, there were seventeen wages-men employed, and twenty-eight tributers. The former got 350 tons of quartz, which yielded 904oz. 16dwt. of gold; and 1,350 tons was crushed for the tributers, which yielded 738oz. 5dwt. of gold. This shows that the mining operations have not been carried on with great success. The largest employers of labour in this part of the district are the Lone Hand Company, but they have not met with much success. The battery returns show that, for the year ending the 31st March last, they crushed 735 tons of quartz, which yielded 502oz. gold, there being two wages-men and twelve tributers employed. According to this company's balance-sheet presented, at their last annual meeting, they had crushed 466 loads of quartz during the previous twelve months, which yielded 546oz. of gold; ont of this 111 loads of stone was taken on wages, which yielded 182oz. 11dwt. of gold; and 355 loads were taken out by the tributers. which yielded 363oz. 9dwt. of gold. The value of the gold obtained by the company, and the tribute percentages, including the sale of tailings, amounted to £636 10s., and their expenditure for same period was £813 18s. 6d., thereby showing a loss on the workings of £177 8s. 6d. The nominal capital of the company is £15,000, in 30,000 shares of 10s. Each, of this capital, £500 is given to promoters in paid-up shares, and calls on the remaining shares have been made to the extent of £1,450.

Una Hill and Te Papa.

There has been a falling-off in the yield of gold from claims in this portion of the district last year, the quantity obtained by both wages-men and tributers being 1,214oz. 9dwt., as against 2,189oz. 14dwt. for the previous year. There were twenty-five men employed on wages, and sixteen on tribute. There is a considerable amount of mineral in the ore in this locality carrying bullion, which is principally lost by the present process of treatment. In April last 12½ tons of tailings from the North Star Company was sent to the Lühring Concentration Works at the Norfolk Battery, Tararu Creek, and the following report of Mr. Pitcairn on the results speaks for itself:—

"To the Directors of the North Star Gold-mining Company, Auckland.

"Dear Sirs,—

I herewith beg to forward results of the concentration of 12½ tons of your company's tailings from the recent crushing of thirteen loads of quartz at the Moanataiari Mill, Thames:—

—	Bullion.	Gold per ton.	Silver per ton.	Value per ton.	Total Values.
	Oz. dwt. gr.	Oz. dwt. gr.	Oz. dwt. gr.	£ s. d.	£ s. d.
Tailings, 12½ tons	2 18 19	0 8 4	2 10 15	1 19 0	24 7 6
Concentrates, 2¼ tons	10 5 19	1 17 12	8 8 7	8 11 0	19 4 9
Refuse, 10 tons	0 4 21	0 1 15	0 3 6	0 6 10	3 8 4
Loss	...	...	...	...	£1 14 5

"The percentage of minerals in the tailings = 18 per cent. The percentage of saving effected by concentration = 78·9 per cent.

"The concentration of this ore, from the above results, may be considered satisfactory, but a few remarks must be made as to the time when concentration must begin. The above 12½ tons were collected in long buddles, where the refuse from 20 tons of quartz ought to have been all deposited.

	Total Value in Quartz treated.	Per Cent.
Twenty tons quartz, value £13 15s. per ton .·. = ...	£275 0 0 =	100
Gold got from places and berdans = ...	115 9 0 =	41·9
Tailings ought .·. = ...	£159 11 0 =	50·1

"Hence the total value of the 20 tons of tailings passing from the tables, blanketings, and berdans, = £159 11s., or £7 19s. 6d. per ton.

"A certain quatity of these tailings, as skimmings and blanketings, were treated in berdans, the refuse or waste from which assayed as follows:—

—	Bullion per ton.	Gold per ton.	Silver.	Value per ton.
	Oz. dwt. gr.	Oz. dwt. gr.	Oz. dwt. gr.	£ s. d.
I.	4 1 16	2 1 12	2 0 4	8 11 0
II.	4 0 0	1 19 4	2 0 20	8 1 8

"The sample from which the above assays were made was almost pure iron—very, very fine—and it is worthy to note that the finest particles are the most valuable.

"The difference in the value of the tailings which were collected in the pits, and that which they ought to be by calculation from the original value, and that value received as gold, is simply astonishing, and goes to prove that the very fine particles have been carried out of the pits by the large amount of water necessary to pass such heavily mineralised ore over plates; indeed, the percentage of saving is remarkably good considering the class of ore.

"It is, nevertheless, absurd to treat such ore by the ordinary battery process, without concentrating the tailings immediately; they leave the plates or blanketings and by treating in such a manner 85 per cent. of the original value of the ore would be obtained.

"To verify the above statement, look at the following figures:—

"Twelve and a half tons settled from 20 tons, and assayed only £1 19s. per ton; whereas by calculation from the original value, these 12½ tons ought to be £159 11s., ÷ 12½ tons, = £12 15s. per ton.

"Hence, we treated 62·5 per cent. of the bulk, containing 152 per cent. of the value, thus proving conclusively concentration must be introduced immediately the tailings pass from the blanketings.

"An analysis of the concentrates proved them to be pure iron, with a small percentage of silica."

This report is born out by Mr. Park, of the School of Mines, who made assays from samples taken at intervals during the crushing of the 20 tons of quartz referred to, which Mr. Park states the assay-value to be £274 10s. The total return from all sources, after going through the ordinary battery process of treatment, was 43oz. 16dwt. of melted bullion, valued at £110 15s., which represented a saving of only 40·3 per cent. of the assay-value.

Hape Creek.

There has been a slight increase in the yield of gold from this part of the field last year, the operations being principally carried on by twenty-two tributers, only three men being employed on wages. The total quantity of quartz crushed, 868½ tons, which yielded 575oz. 10dwt. of gold.

TAILINGS PLANT.

The principal tailings plants on the Thames are those belonging to Mr. Brown of Tararu, and those belonging to the Foreshore Tailings Company. The plant at Tararu consists of McKay pans, which, without exception, are the best grinding pans yet introduced into the colony, and if properly worked, and the mullers slightly lifted when the quicksilver is added, these pans when working in charges will do as efficient work as any yet on the field; but while admitting this, there is a considerable loss in bullion with all pans which cannot be avoided.

The Foreshore Tailings Company have a plant of twelve Watson-Denny pans, which have a continuous discharge. This principle of grinding-pan is held to be more convenient to use, as the tailings from the tables can be run directly into them; but neither these nor any of the continuous discharge grinding-pans save a large percentage of the bullion. Indeed, until recently on this field, mill-men and mine-managers would not credit that they were losing so much gold, they being always satisfied they were at least getting 75 per cent. of the assay-value of the bullion. But the recent assays made for several companies by Mr. Park shows the necessity of a systematic sampling

and assaying being done at every crushing-battery. The Foreshore Tailings Company use small hydraulic elevating-jets to lift the tailings from the foreshore, and bring the material in small sluices to a pit at the back of the building where the pans are erected. When the tailings are removed from the pit by hand-labour and stacked, another small elevator lifts the tailings from where they are stacked and delivers the material into a distributory chute which feeds each pan. No manual labour is required in handling the tailings beyond lifting them out of the pit or box at the back of the building, the elevating-jets being half an inch, and the elevating-pipe three inches in diameter. The total quantity of tailings treated in the Thames District last year was 19,309 tons, which yielded 4,478oz. 12dwt. of gold, being an average of about 4dwt. 15gr. of gold per ton. If careful assays were made of these tailings previous to treatment it would be found there is not a large percentage of the value of the bullion recovered.

The following table shows the number of acres held in claims and licensed holdings in the Thames District; the number of wages-men and tributers employed by the different companies, quantity of quartz crushed, and the yield of gold and bullion therefrom:—

Locality and Name of Mine.	Area.	Average Number of Men employed.		For Owners.			For Tributers.		Tailings.	
		Wages-men.	Tributers.	Quartz crushed.	Mullock.	Gold obtanied.	Quartz crushed.	Gold obtained.	Quantity treated.	Gold obtained.
Thames County.	A. R. P.			Tons cwt. lb.	Tons.	Oz. dwt.	Tons cwt.	Oz. dwt.	Tons cwt.	Oz. dwt.
Tapu—										
Sheridan's ..	20 3 4	5	..	21 0 0	..	204 12	..	..	..	..
Great Republic ..	5 0 0	1	..	..	176	8 5	..	..	..	..
Sundry claims ..	..	3	..	14 0 0	..	29 9	..	..	..	..
Puru—						..	..	..	..	..
Tahu's Claim ..	..	1	..	0 0 38	..	4 1	..	..	..	..
	25 3 4	10	..	35 0 38	176	246 7	..	..	..	..
Tararu—										
Norfolk	30 0 0	12	..	1,700 0 0	..	392 0	..	..	..	..
Sylvia *	179 3 0	24	..	2,400 0 0	..	104 7	..	..	..	..
City of Dunedin ..	26 2 0	2	..	120 0 0	..	33 0	..	..	..	..
	236 1 0	38	..	4,220 0 0	..	529 7	..	..	..	..
Shellback—										
Nordenfelt ..	15 3 31	2	..	80 0 34	..	91 13	..	..	..	..
Waitemata ..	15 0 0	..	1	..	..	..	29 0	10 13	..	..
Mountain Flower ..	13 1 26	..	4	..	..	..	30 0	24 13	..	..
Sundry claims ..	..	4	..	5 0 60	..	25 0	..	..	..	..
	44 1 17	6	5	85 0 94	..	116 13	59 0	35 6	..	..
Kuranui—										
Hansen's	14 3 10	8	15	..	2,906	136 6	762 10	490 11	..	..
Comer's	13 1 37	14	6	..	10,267	663 10	154 0	186 6	..	..
Hazelbank ..	16 1 23	27	5	1,150 10 0	..	2,232 7	588 0	95 19	..	..
	44 2 30	49	26	1,150 10 0	13,173	3,032 3	1,504 10	772 16	..	..
Moanataiari—										
Moanataiari ..	94 3 26	88	57	11,734 0 0	5,257	5,039 15	2,752 10	1,390 0	..	..
Alfred	10 1 5	1	10	35 0 0	..	78 17	132 0	189 5	..	..
Freedom	6 1 10	..	2	..	..	..	70 0	46 15	..	..
Orlando	15 0 0	6	..	66 0 0	..	39 13	..	..	..	..
Calliope	10 3 0	..	2	..	..	..	11 0	12 5	..	..
New Whau ..	3 2 8	4	5	100 0 0	..	190 0	1,700 0	400 0	..	..
New Alburnia ..	15 1 0	16	8	349 0 0	..	1,466 11	222 0	220 0	..	..
Dixon's Extended ..	3 2 18	..	8	..	..	..	2,560 0	628 0	..	..
New Chum ..	5 0 0	2	..	1 2 48	..	57 5	..	..	..	..
Sundry claims ..	..	12	..	89 1 0	1,000	312 0	..	..	..	..
	164 2 27	129	92	12,374 3 48	6,257	7,184 1	7,447 10	2,886 5	..	..
Grahamstown—										
Saxon	17 1 21	9	20	349 0 0	..	215 10	59 0	122 2	..	..
Victoria	34 1 30	14	6	120 0 0	..	208 5	60 0	52 7	..	..
Sundry claims ..	..	8	..	..	1,000	218 5	..	..	19,309 0	4,478 12
	51 3 11	31	26	469 0 0	1,000	642 0	119 0	174 9	19,309 0	4,478 12
Waiotahi—										
Waiotahi	19 3 15	34	..	2,298 0 0	..	2,578 11	..	..	..	..
New Manukau ..	3 0 15	4	3	110 0 0	..	153 17	400 0	140 16	..	..
Cambria	15 2 17	33	..	2,277 0 0	..	2,001 3	..	..	..	..
Fame and Fortune ..	55 0 11	4	32	49 10 0	..	25 0	949 10	1,791 19	..	..
Golden Age ..	2 3 34	..	2	..	..	..	69 0	65 10	..	..
West Coast ..	6 1 0	2	..	54 0 16	..	52 10	..	..	..	..
Bright Smile ..	5 0 0	1	..	11 0 0	..	25 8	..	..	..	..
Sundry claims ..	..	10	..	100 0 13	500	327 7	..	..	..	..
	107 3 12	88	37	4,899 10 29	500	5,163 16	1,418 10	1,998 5 0	..	..

* Also bullion, 3,985oz. 5dwt.; value £2,182 11s. 8d.

Locality and Name of Mine.	Area.	Average Number of Men employed.		For Owners.			For Tributers.		Tailings.	
		Wages-men.	Tributers.	Quartz crushed.	Mullock.	Gold obtained.	Quartz crushed.	Gold obtained.	Quantity treated.	Gold obtained.
Thames County—con.	A. R. P.			Tons cwt. lb.	Tons.	Oz. dwt.	Tons cwt.	Oz. dwt.	Tons cwt.	Oz. dwt.
Waiokaraka and Collarbone—										
May Queen ..	29 2 27	12	..	823 10 0	..	494 6	..	..	..	..
Crawford's Special	78 0 0	7	1	..	..	..	4 10	6 18	..	..
Sundry claims ..	..	3	..	39 0 0	..	45 0	..	..	..	..
	107 2 27	22	1	862 10 0	..	539 6	4 10	6 18	..	..
Karaka—										
Adelaide	12 0 30	..	9	..	..	..	130 0	169 13	..	..
Lone Hand ..	27 2 35	2	12	168 0 0	..	132 0	567 0	370 0	..	..
Claremont ..	1 0 0	2	..	4 13 14	..	266 9	..	..	..	..
Christmas Eve ..	5 0 0	1	..	0 0 55	..	20 12	..	..	..	..
Hokianga ..	2 0 36	2	..	50 0 0	..	56 9	..	..	..	..
Karaka	10 0 0	...	7	..	..	..	653 0	198 12	..	..
Iona (McWilliams)	5 0 0	3	..	0 0 85	..	61 15	..	..	..	..
Enterprise ..	3 0 0	1	..	30 10 0	..	17 7	..	..	..	..
Sundry claims ..	..	6	..	97 0 90	..	350 4	..	..	..	..
	66 0 21	17	28	350 5 20	..	904 16	1,350 0	738 5	..	..
Una Hill and Te Papa—									..	..
Dives	21 3 15	..	6	..	..	..	67 10	86 0	..	..
Occidental ..	21 0 9	6	..	90 1 12	..	381 16	..	..	..	..
Pride of Karaka ..	14 3 24	..	2	..	..	..	66 0	69 18	..	..
Magnolia	17 2 30	6	4	300 0 0	..	134 10	63 0	49 12	..	..
Homeward Bound ..	3 0 22	2	..	16 0 0	..	30 15	..	..	..	..
North Star ..	30 0 0	6	4	48 0 0	..	133 0	77 0	198 8	..	..
Just-in-Time ..	2 0 0	1	..	63 0 0	..	13 12	..	..	..	..
Sundry claims ..	..	4	..	34 10 8	..	116 18	..	..	..	..
	110 2 20	25	16	551 11 20	..	810 11	273 10	403 18	..	..
Hape Creek—										
Consols	29 3 31	..	20	..	..	..	805 10	480 17	..	..
Souvenir	14 2 10	..	2	..	..	..	43 0	34 13	..	..
Sundry claims ..	..	3	..	20 0 0	..	60 0	..	..	..	..
	44 2 1	3	22	20 0 0	..	60 0	848 10	515 10	..	..
Puriri—										
Puriri	4 0 0	2	..	44 0 0	..	31 10	..	..	..	..
Tairua—										
Bonnie Scotland ..	5 0 0	3	..	45 0 0	..	65 0	..	..	..	..
Totals* ..	1013 1 10	423	253	25,106 11 25	21,106	19,325 10	13,025 0	7,531 12	19,309 0	4,478 12

* Also bullion, 3,985oz. 5 dwt., value £2,182 11s. 8d.

Crushing Plants at Thames.

The Thames is the principal goldfield in the North Island, where large returns from the mines have been obtained, and the place where the greater portion of the reduction-plants have been erected. The character of the gold, and the large percentage of metallic sulphides in the ore, have made the whole of it of a semi-refractory character, while in some cases very refractory ores are found rich in bullion according to assay; but the method of dealing with it on a large scale fails to extract a fair percentage of its value. A great number of improvements have been made in the methods of extracting the bullion from the ores, but still there is plenty of room for further improvement. It is an easy matter to state that a plant is not constructed on such a principle as to be capable of extracting a fair percentage of the bullion, but it becomes a more difficult matter to show the most economical method of treating the ore so as to obtain the precious metals it contains.

During the last year an American mining engineer, Mr. T. A. Reckards, visited the Thames, and the outcome of this visit is that he wrote a couple of articles in the *Mining and Engineering Journal* of New York, condemning all the appliances in use, without giving any inkling of the method which ought to have been adopted to remedy the defects. He gives some very wholesome truths in reference to the field when he states:—

"Few mining districts have had so brief but brilliant record, and few, perhaps, have lost such a large proportion of the gold extracted from the mines. Milling is conducted under the difficulties presented by ores of very variable and very complex composition; but, so far, the efforts made to overcome these difficulties have been of the most elementary kind. It is for this reason that the tailings-mills are to-day among the most profitable undertakings on the field, and that the mining industry of the place is at a lower ebb than its history has ever known."

"There are about five hundred heads of stamps and three hundred and fifty berdan spans at work in the district of Hauraki. The mills are, without exception, old, and date ten to seventeen years back. The work done in them is most incomplete, since, notwithstanding the fact that the ore contains a large percentage of sulphides, there is no attempt made at concentration. Ordinary wet crushing is supplemented by the use of blankets, the washings from which are treated by pans—methods which do not prevent the tailings from carrying away a large percentage of the value of the ore. The tides, in their ebb and flow, are concentrating the material which they receive, and are giving a daily lesson to the careless mill-man, a lesson unappreciated by him, but readily understood by the prospectors of the tailings-plants, who are making money by the treatment of the sands.

"Briefly stated, the method of milling consists in catching all the free gold—that is, all the gold that can be arrested by means quite unsuited to the character of the ore—and allowing the remainder to go to enrich the sea-beaches. The character of the ore, and the lode-formation in which it occurs, partially helps to explain a state of things which calls for severe criticism."

Mr. Rickard goes on to point out the method adopted in our mills, and states,—

"The mortar-boxes are faulty in design, since they are too roomy; there is unnecessary space in and around the dies, seeing that no amalgamation takes place inside. The pulp is discharged upon amalgamating-tables 7ft. long and 4½ft. wide; these are in three divisions, of which the upper two are lined with plates. The first length is 2½ft., inclusive of a well 2½in. wide; this well contains mercury. The next length of table is 18in. . . . The mortar-box is not a gold-saving appliance, but merely a crusher. The first amalgamation takes place on the outside plates. These are made not of copper but of muntz-metal. They are roughly cleaned up every four hours. The wells containing the mercury are of little assistance: wells, *per se*, are unsuited to ores containing a notable proportion of sulphurets, which prevents contact with the gold in the pulp passing over it. . . .

"The depth of discharge or issue: The distance from the top of the die to the bottom of the screen or grating, in all the mills, is regulated by the wearing-down of the dies. It varies from nil with new dies, to a maximum of 5in., and will average from 2½in. to 3in. The importance of having a depth of discharge suited to the particular mode of working aimed at, and the particular ore treated, is a point quite unappreciated."

While admitting that many of Mr. Rickard's strictures are just, his statements in some respects do not coincide with facts. At the time he visited the Thames, there was one of the most complete concentrating plants erected by the Sylvia Company, where the whole of the sulphurets were saved and treated by the cyanogen process. Again, when he states that the stamps are old, and out of date, there is no doubt but some of them are old and antiquated; but the same thing happens in some of the mining districts in America, where they ought to be more advanced in gold-milling ores than we are here, and therefore it is purely a matter of pounds, shillings, and pence—of removing the old machinery and replacing it with new. All the new crushing-batteries now being constructed are on the same pattern as those constructed at the Pacific Ironworks in San Francisco; and, if these are from ten to seventeen years old, it clearly proves that the mining men of the Pacific Slope prefer them to the newer patterns.

With reference to the discharge from the mortars, this is invariably 4½in. in depth from the top of the dies to the bottom of the screens, when the dies are new, and not nil, as represented by Mr. Rickard. He has, however, pointed out several of the weak points in our method of milling, amongst which is the absence of stone-breakers. There is scarcely a mill-man here but admits that the use of stonebreakers would greatly increase the capacity of the mills; and, no doubt, many of them would be used in our old quartz-mills if they could be advantageously attached. All the new mills have stone-breakers and Challenge ore-feeders; but the difficulty in attaching these to the old mills is that the floor in front of the stamps-mortar is on the same level as the roads and streets, where the most of the crushing-batteries at the Thames are erected, and, consequently, the whole of the machinery would have to be shifted to a fresh site before a proper gravitation method in connection with the different stages of treatment could be adopted.

It has been my aim for several years to call the attention of mine-proprietors and battery-managers to the great loss of gold that has been going on, and also to the value of rock-breakers being attached to each battery, and it has borne some fruit, as more steps are taken every year to save a larger percentage of the bullion in the ore, and erect improved reduction machinery. It is, however, a question deserving further attention, not only in New Zealand, but also in other mining countries where ores have to be crushed extremely fine before the bullion can be extracted, as to whether stamps are the most economical appliance for the reduction of auriferous and argentiferous ores. By this system, as for instance at Waihi, where the ore is crushed dry until it passes through a screen having 3,600 holes to the square inch, there is a great power wasted, as a great deal of the ore would be sufficiently pulverised to pass through a 60-mesh even if a grating or screen having 240 holes to the square inch were used in the first instance. This really means that it is a loss of power to crush at one operation the whole of the material sufficiently fine for the purpose of after-treatment. If one-third of the material that came through a 15-mesh screen would go through a 60-mesh, then this should be separated from the coarser particles, and the balance again pulverised.

Every field has different classes of ore; and we find in New Zealand that a mill-man may be everything that can be desired when dealing with ores that he has been accustomed to, but if he is removed to another district, although his previous experience assists him to a large extent, he finds that he has a great deal to learn. There is no country in the world, not even in the Nagyag and Veraspotap Mines in Transylvania, referred to by Mr. Rickard, where there is such a combination of metallic sulphides amongst the ore, and the gold in such a finely-divided state in the quartz, as at the Thames. Both the gold and silver, in many instances, are as finely-divided as in their precipitation from a solution of cyanide of potassium where they were dissolved. The whole of the lodes and country rock is thoroughly impregnated with acid-water. So strongly impregnated is the water

with acid, that in some places the water dropping on an iron rail will soon cut it through. The quartz requires to be crushed to the finest powder before the particles of comparatively fine gold adhere to the mercury; and the tailings-plants referred to by Mr. Rickard are either working the tailings coming from batteries where there is means of treating them profitably, or else coming from the foreshore, where they were deposited in the early days of the field. There is no single grinding and amalgamating process that has yet been tried at the Thames which will extract a fair percentage of the bullion; even in some of the tailings-plants they only extract about 50 per cent. of its value. Were the quartz clean, and clear of metallic sulphides, and the gold in a fairly coarse state, the difficulty of saving it by amalgamation would be very little.

There is no doubt the sulphurets requires to be separated from the sand before the latter is ground up in pans, as the grinding up of sulphurets only sickens the mercury and renders it in an unfit state for amalgamation. The whole of the tailings should be concentrated, and only the waste gangue ground up. If this were done, the particles of gold in the grains of silica would be liberated, and adhere to the quicksilver, while the sulphurets could either be roasted before being ground up or treated by another process.

The whole system of treatment, however, hinges on the actual value of the ore. If it is of low grade it will not admit of a costly process being used; and, on the other hand, if rich in bullion it should be treated accordingly. In Freiberg, Saxony, where labour is cheap, it cost over £3 per ton if the ore is at all refractory; and unless it had a considerable value, such methods as adopted there could not be used with our ores. Almost every mining company on the Thames are becoming alive to the necessity of having their ores carefully sampled and analysed, and this will eventually lead to greater attention being given to the extraction of the bullion.

The following is a description of the principal crushing-plants on the Thames field, and the motive-power used in working them, giving the percentage of the theoretical power employed:—

Cambria Battery.—This battery consists of twenty-one heads of stamps, each 600lb. in weight, which are lifted 8in. high, making seventy blows per minute; thirteen berdans 3ft. 6in. in diameter, making twenty-eight revolutions per minute; and one of J. C. Fraser's pans, making forty revolutions per minute. The whole of these are driven by a Pelton water-wheel 5ft. in diameter, having a jet 2¼in. in diameter, under a head, the pressure being equal to 58lb. per square inch, which makes the discharge from the jet to be 2·40 cubic feet per second. This is equal to 34·4 theoretical horse-power. Taking the lift and speed of the stamps, this is equal to 17·8 theoretical horse-power, and assuming the berdans absorb 5·2-horse power, and the pan 4·0-horse power, then the percentage that the Pelton wheel gives is equal to $\frac{27}{36\cdot4}$ = 74·2 per cent. The dies or shoes are placed in the mortar when new 4in. below the bottom of the grating, and before the shoes are worn out they are 6in. below the bottom. The gratings used have from 180 to 220 holes to the square inch, and are made of charcoal-iron and punched. There are four plates coated with mercury on each table, the one at the foot of the first drop being 12in., the second one 18in., and the third one 2ft. wide. These are of muntz-metal; and there is a fourth plate at the end of the ripples, 12in. wide, consisting of copper, coated with mercury; after these are the ordinary blanket-tables. In working with the berdans they use 10lb. of quicksilver in each; and in Fraser's pan they use 40lb. of mercury. The waste from the blanket-tables all flows into longitudinal boxes, which are termed buddles, and in these the tailings are deposited, and when full are cleaned out and either re-ground in the buddles and pans, or sold, as the case may be, to those having a tailings-plant.

Moanataiari Battery.—This is the largest crushing-battery on the field. It consists of forty-one heads of stamps; twenty-one berdans, 4ft. 6in. in diameter, going at a rate of twenty-four revolutions per minute; and four pans—namely, two of Watson-Denny, one of Price Bros., and one of J. C. Fraser's. The following are the weights of the stamps, taking the shoes as half-worn—namely:—

	Light Stamps.	Heavy Stamps.
Heads	228lb.	228lb.
Three-quarter weight of new shoes	126lb.	126lb.
Stem or shank	220lb.	220lb.
Disc or tappet	43lb.	118lb.
Total weight	617lb.	692lb.

There are twenty stamps, each averaging 617lb., and twenty-one stamps averaging 692lb. The lighter stamps have a drop of 6in., and the heavier ones 8in., and they were making seventy-six blows per minute. These are exerting a force equal to 36·68-horse power—namely:—

$$\frac{(617\times20\times38)+(692\times21\times50\frac{2}{3})}{33000} = \frac{1,292,420}{33,000} = 39\cdot16\text{-horse power.}$$

This crushing-battery of stamps is driven by a Pelton hurdy-gurdy water-wheel 6ft. 8in. in diameter, having a water-jet of 2⅝in. in diameter under a pressure of 60lb per square inch, which is equal to a hydrostatic head of about 138ft.; and as a jet of 2⅝in. will discharge under this head 3·4 cubic feet per second, the theoretical horse-power of the water is $\frac{3\cdot4\times60\times62\cdot5\times138}{33,000}$ = 53·32 horse-power; therefore $\frac{39\cdot16}{53\cdot32}$ = 73·4 per cent. that the Pelton wheel gives of the theoretical power of the water, inclusive of friction in working of the stamps. The twenty-one berdans are driven by a Pelton wheel 3ft. 6in. diameter, having a water-jet of 1⅛in. in diameter, under a pressure of 54lb. per square inch, which is equal to a hydrostatic head of 124·4ft., and the discharge from the jet under this head would be about 8·32 theoretical horse-power; therefore, each berdan takes about 0·4 theoretical horse-power. The four pans are driven by a Pelton wheel, 6ft. 8in. in diameter, having a water-jet of 1½in. in diameter under a pressure of 60lb.

per square inch, which is equal to a hydrostatic head of 138ft., which would discharge about one cubic foot per second; therefore, $\frac{60 \times 62{\cdot}5 \times 138}{33,000} = \frac{517,500}{33,000} = 15{\cdot}68$ theoretical horse-power, being equal to each pan requiring 3·92 theoretical horse-power to work them. It may be mentioned that the manager, Mr. George Clark, went to considerable trouble to obtain all the information respecting this battery, and wherever he was not certain of the measurements he made them, so as to get at accurate results. The speed that the berdans was travelling at was twenty-four revolutions per minute, and the pans forty revolutions.

In respect to the size of the mortar, it was about 11½in. wide, and the dies and shoes had a face of 9in. in diameter; therefore, there was a space of 2½in. in the mortar in width more than was taken up by the dies. The gratings used are of charcoal-iron, having 175 holes to the square inch, and the bottom side of the grating is 4in. above the top of the dies when the latter are new, and 6in. when the dies get worn; the total depth of the grating being 10½in. by 4ft.—that is, there are two gratings in each mortar 2ft. x 10½in. The tables are 5ft. in width, and have one muntz-metal quicksilvered plate, 20½in. wide, at the upper end of each table, and thence pulverised material passes down over the blanket-tables 18ft. in length.

In regard to the crushing capacity of the battery, 434 tons of quartz was crushed in twenty-eight days, with five heads of stamps, which is equal to $\frac{434}{140} = 3{\cdot}1$ tons per head per day; and in crushing surface-material, twenty heads in eleven days crushed 816 tons, which would be $\frac{816}{220} = 3{\cdot}7$ tons per day. The manager could not give me more data than this as to the capacity of the mill, as it is kept crushing small parcels for the public, in addition to the quartz from their own mine. He, however, gave me interesting details in reference to the expense of working the mullock from the surface, on the same principle as that on which Messrs. Hansen and Comer have been working for the last two years.

The result of excavating the mullock on the surface, hauling it 1,250ft. to the crushing-battery, and crushing it, for four months ending the 31st of March last, was as follows:—

Month.	Tons.	Value of Gold obtained. £ s. d.	Total Cost of Getting and Treatment. £ s. d.
December.	1,190	148 4 0	113 12 0
January	970	142 15 3	124 11 9
February	1,583	251 12 4	164 5 2
March	1,224	196 1 1	183 0 5
Total	4,967	£738 12 8	£585 9 4

This shows that the actual cost of working this mullock was 2s. 4¼d. per ton, and the profit in working this material in four months was £153 3s. 4d. The profit is not great, but it shows that there is a possibility of a great deal of the surface ground being yet worked, and afford profitable employment to those who are willing to carry on surface operations.

Saxon Battery.—This battery consists of thirty-three stamps—that is, two batteries of six stamps each, two batteries of ten stamps, and one stamp for crushing specimen-stone. Twelve of the stamps are 650lb. each, ten stamps 500lb. each, and ten stamps 700lb. each, with one stamp for crushing specimens. These have a drop of 7in., and make from seventy-five to eighty blows per minute. There are eight berdans, 4ft. 6in. in diameter, making twenty-three revolutions per minute, having two drags; there are also two of Watson-Denny pans, and one of Price Bros.' pans, which travel at the rate of forty-five revolutions per minute. There is a Pelton wheel, 6ft. in diameter, for driving the stamps, having a water-jet of 2¼in. in diameter, under a pressure of 60lb. to the square inch, which is equal to a hydrostatic head of 138ft. The theoretical power of the water under this head, taking the discharge from the jet as being 2·4 cubic feet per second, is as follows: $\frac{2{\cdot}4 \times 60 \times 62{\cdot}5 \times 138}{33,000} = 37{\cdot}63$-horse power; and the power required to work the stamps with eighty blows per minute, having a drop of 7in. is $\frac{(650 \times 12 \times 46\frac{2}{3}) + (500 \times 10 \times 46\frac{2}{3}) + (700 \times 10 \times 46\frac{2}{3})}{33,000}$ = 28·00-horse power, and $\frac{28{\cdot}00}{37{\cdot}63} = 74{\cdot}4$ per cent. the Pelton wheel gives of the theoretical power of the water. The single stamp is only used when specimens have to be crushed.

The eight berdans and three pans are driven by a Pelton wheel, 3ft. 6in. in diameter, having a water-jet of 1¾in. diameter, under a pressure of 52lb. to the square inch, which is equal to a hydrostatic head of 120ft. The discharge from a 1¾in. jet, under this head, is 1·39 cubic feet per second; the theoretical horse-power is, therefore, $\frac{1{\cdot}39 \times 60 \times 62{\cdot}5 \times 120{\cdot}0}{33,000} = 18{\cdot}9$. Taking then the ratio found in working the berdans at the Moanataiari Battery, it would show that the berdans used 4·06 of the theoretical horse-power, and the three pans 14·89, which is equal to 0·5 of a horse-power for each berdan, and 4·96 horse-power for each pan. The gratings used are of charcoal-iron, having about 200 holes to the square inch, and are set so that the bottom of them are 4in. above the top of the dies in the mortar when the latter are new, and 1½in. space between the edge of the die and the side of the mortar where the grating is placed. The quicksilver tables are covered with silvered muntz-metal at the bottom of the first drop for a length of 10in., and at the bottom of the two other drops for a length of 4ft. each; afterwards there are blanket tables 12ft. in length.

In regard to the work done by the pans, those who have had a long experience in working them find that they get a higher percentage of the gold from the pulverised material if the heavy concentrates are taken out of the pans, say every twenty-four hours, and again treated in the berdans.

The crushing capacity of the stamps is said to be about 1½ tons to each stamp with ordinary quartz every twenty-four hours.

Bull's Battery.—This crushing-battery consists of twenty-three heads of stamps, but only thirteen stamps were used at the time of my visit. This battery is unique on the field. It was arranged as follows: Three mortars having four stamps, three having three stamps each, one having two stamps; and one having a single stamp for crushing specimens. The weight of the stamps working at the time of my visit was as follows:—

Seven stamps of 538lb. each	= 3,766lb.
Six " 448lb. "	= 2,688lb.
	6,454lb.

The seven stamps were, when newly shod, 598lb. each; six stamps, 508lb. each, but, as the shoes were about half-worn, about 60lb. per stamp has to be deducted—viz., 780lb. These stamps are lifted seventy-three times a minute, with a drop of 10in. each time. The power absorbed would therefore be $\frac{6,454 \times 60 \cdot 8}{33,000} = 11 \cdot 90$ horse-power. There are also ten berdans, 3ft. 6in. in diameter, making twenty-eight revolutions per minute. The same Pelton wheel that drives the stamps works the berdans. Thus, the power that these berdans use could not be accurately ascertained. But assuming that they require the same power to work them as those at the Moanataiari Battery—namely, 0·4-horse power for each berdan, this would be 4-horse power required for them, which, added to 11·9, makes the total power required to work the battery 15·9-horse. The Pelton wheel used for driving this battery is 6ft. in diameter, and has a water-jet of $1\frac{3}{16}$in. in diameter under a pressure of 52lb. per square inch, which is equal to a hydrostatic head of 120ft. The quantity of water discharged, therefore, from this jet would be 1·512 cubic feet per second, and $\frac{1 \cdot 512 \times 60 \times 62 \cdot 5 \times 120}{33,000} = 20 \cdot 62$ theoretical horse-power. The percentage, therefore, that this Pelton is giving of the power of the water is $\frac{15 \cdot 9}{20 \cdot 62} = 77 \cdot 1$ per cent., which seems high. Nevertheless, the weight of stamps, drop, and number of drops per minute were taken as accurately as possible.

The gratings used have 195 holes to the square inch, and the bottom of the screens or gratings stands 4in. above the top of the dies in the mortar. The quicksilver tables have first a strip of copper-plate, 7in. wide, coated with mercury, at the bottom of the first drop, and afterwards there are two plates, 2ft. in width each. The pulp after passing over these plates goes through what is termed a "save-all," and finally over blanket-tables.

In connection with this battery there is a small dynamo driven by a Pelton wheel 2ft. in diameter, having a water-jet of ½in. in diameter, under a pressure of 42lb. per square inch. The discharge of water would therefore be 0·103 of a cubic foot per second, and $\frac{0 \cdot 103 \times 60 \times 62 \cdot 5 \times 96 \cdot 7}{33,000} = 1 \cdot 13$ theoretical horse-power, which generates sufficient electricity for eight incandescent lamps.

In regard to the expense of wear and tear in this crushing-battery, Mr. Bull supplied me with the following particulars: During the year ending the 31st December last he crushed 3,872 tons of quartz, and the expenditure on heads and shoes for the battery was £30 1s. 1d.; but during the same period he received £7 1s. 1d. for old iron. Therefore the net cost of shoes and dies was £23, or about 1·42d. per ton of quartz crushed. The expenditure on berdans for the same period was £35 18s. 3d, less amount received for old iron, £8 2s. 8d., which leaves the net expenditure £27 15s. 7d. or 1·72d. per ton of ore treated.

Hansen's Battery.—This crushing-battery consists of twenty head of stamps and ten berdans. The stamps have an average weight of about 600lb. each, and they have a drop of 8in., making seventy-five blows per minute. Therefore the force required to work these is $\frac{600 \times 20 \times 50}{33,000} = 18 \cdot 18$-horse power. The stamps are driven by a Pelton water-wheel 6ft. in diameter, having a jet of $1\frac{3}{16}$in., under a pressure of 60lb. per square inch; this is capable of discharging about 1·6 cubic feet of water per second, and, as the pressure is equal to a hydrostatic head of 138ft., this would be $\frac{1 \cdot 6 \times 60 \times 62 \cdot 5 \times 138}{33,000}$ = 25·1 theoretical horse-power, and $\frac{18 \cdot 18}{25 \cdot 1} = 72 \cdot 4$ per cent. that the Pelton wheel gives of the theoretical power of the water.

The berdans are driven by a small Pelton wheel 3ft. 6in. in diameter, having a water-jet of $\frac{7}{16}$in. in diameter, under the same pressure as the former jet; therefore the theoretical power of the water would be as follows: The discharge from this jet is about 0·377 of a cubic foot per second; then, $\frac{0 \cdot 377 \times 60 \times 62 \cdot 5 \times 138}{33,000} = 5 \cdot 9$ theoretical horse-power, which is equal to 0·59-horse power to each berdan.

The grating used in this battery has 225 holes to the square inch, and the bottom of these stand 4in. above the top of the dies. The splash-board in front of the grating is covered with a muntz-metal plate, and coated with quicksilver. There are two strips of silver plates on each table, 12in. and 9in. respectively in width; and thence the pulverised material passes over the blanket-tables.

This battery has been crushing surface mullock for several years, and Mr. Hansen informed me that he can make 1s. 6d. per ton pay all expenses of getting the material and treating it at this battery. He carries on all his operations by tribute: some are on the surface mullock, and some of the tributers are working the old ground, by taking about 2ft. off each side of the walls where the lode has been stoped out. In the latter working it takes from 3dwt. to 4dwt. to pay all expenses—that is, from 8s. 3d. to 11s. per ton. The place where Mr. Hansen is working is in the ground formerly held by the prospectors of the Thames Goldfield, and was known as the Shotover Claim, from which a large quantity of gold was obtained.

Foreshore Tailings Company.—This is a Melbourne company, who about three years ago erected a plant of Watson-Denny pans, with the view at first of getting these pans introduced on the field. Previous to this company erecting their plant, Messrs. Bowden and Climo had a tailings-plant of berdans for many years, and they sold these to the present company, together with any rights they held to the tailings on the foreshore. All the berdans were removed from the buildings, and a plant of twelve Watson-Denny pans substituted. Seven of these pans are driven by one of Bowden and Climo's water-wheels, similar in construction to the Pelton hurdy-gurdy wheel, only the buckets have a slightly different shape. The water-jet used on this wheel is $1\frac{9}{10}$in. in diameter, under a pressure of 60lb. per square inch, the discharge from this jet being equal to about 1·781 cubic feet per second. Therefore, $\frac{1{\cdot}781 \times 60 \times 62{\cdot}5 \times 138}{33{,}000} = 27{\cdot}9$ theoretical horse-power, which is equal to 3·98-horse power required to work each pan. The other five pans are driven by another of Bowden and Climo's wheels, having a jet of $1\frac{7}{10}$in, which is capable of discharging, under the pressure already referred to, 1·42 cubic feet per second, and $\frac{1{\cdot}42 \times 60 \times 62{\cdot}5 \times 138}{33{,}000} = 22$ theoretical horse-power. This shows that, although a nozzle $1\frac{7}{10}$in. was used, a smaller jet could be used to do the work, as the same pans only required 3·98-horse-power to work them at their proper speed when seven of them were driven by the use of a $1\frac{9}{10}$in. jet. The water, therefore, used on the jet of $1\frac{7}{10}$in. diameter must be throttled to a certain extent, or else the five pans would be driven at a much higher speed, as a jet of $1\frac{5}{8}$in. under a hydrostatic head of 138ft. would give sufficient power to work them.

In regard to the actual efficiency of these pans, it cannot be said that they extract a large percentage of the gold in the tailings, as the percentage of gold obtained in very few cases exceeded 50 per cent. of the assay-value. The reason given for this is that, although they are a good pan if cleaned out at intervals, say, every twenty-four hours, for continuous grinding and amalgamating they do not give a high percentage, on account of the quantity of concentrates that collects in the bottom of the pans, which tend to sicken the mercury and destroys its properties for amalgamation. The mine and battery managers on the Thames consider that a much higher percentage of gold is obtained by cleaning the sulphurets out of the pans once a day, and completing their treatment in berdans.

It is interesting to see the principle adopted by this company for collecting and forwarding the ta lings from the foreshore to their plant. This is done by small hydraulic-elevators, having a gas-pipe 3in. in diameter as an elevator, and a jet $\frac{1}{2}$in. in diameter. There is a series of these elevators used, and the tailings are conveyed for a considerable distance from the foreshore in chutes, to the back of the building where the pans are erected, and deposited in a long box, which acts as a tailings-pit; this is emptied by manual labour, and the material again elevated into distributing chutes to feed each pan. There is very little manual labour required in connection with this tailings-plant; water is made to do the most of the work, hence it does not require a large quantity of gold to leave a fair margin of profit on the working of these pans.

There is another plant of five of the Watson-Denny pans erected in a building alongside the Moanataiari Battery, belonging to Mr. Judd, but these were not at work at the time of my visit. They are driven by a Pelton wheel, having a water-jet of $1\frac{3}{4}$in. in diameter, which would be equal to 1·4 cubic feet being discharged per second, and this would show that each of these pans required about 4·4 theoretical horse-power to work them. It may be, perhaps, that the same cause operates as that referred to in the five pans of the Foreshore Company—namely, the water may be to some extent throttled, that is, the valve is not fully open.

Comers's Battery.—This crushing-battery consists of twenty heads of stamps, having an average weight of 600lb. each, which have a drop of 8in. and making sixty-five blows per minute, and five berdans, making twenty-eight revolutions per minute. These are driven by a Pelton water-wheel, 6ft. in diameter, having a jet of $1\frac{8}{10}$in. diameter, under a pressure of 57lb. to the square inch, which is equal to a hydrostatic head of 131ft. The jet will therefore discharge about 1·54 cubic feet of water per second, therefore $\frac{1{\cdot}54 \times 60 \times 62{\cdot}5 \times 131}{33{,}000} = 22{\cdot}9$ theoretical horse-power. The power required to drive the stamps will be $\frac{600 \times 20 \times 43{\cdot}34}{33{,}000} = 15{\cdot}7$, and assuming that the berdans require 0·4-horse power each, then the actual horse-power required to do the work of this battery is 17·7, and $\frac{17{\cdot}7}{22{\cdot}9} = 77$ per cent. of the theoretical power. This battery is wholly employed in crushing surface material. The gratings or screens used have 140 holes to the square inch, and about 500 tons a week goes through the battery, which is equal to 4·16 tons a day for each stamp. This material has to be put through quickly, but the loss of gold in the thick, muddy water flowing over the tables must be very considerable; probably not more than 25 per cent. of the gold in this material is recovered. The pulp flows over two sheets of muntz-metal coated with quicksilver, each 2ft. wide, and thence passes over blanket-tables. The height of the bottom of the grating above the top of the dies is $4\frac{1}{2}$in. This seems to be the uniform height on the Thames field in all the batteries.

Norfolk Battery.—This battery is situate at the lower end of Tararu Creek, and consists of forty heads of stamps and six berdans. The stamps are about 700lb. each, and make fifty-six blows per minute with $6\frac{1}{2}$in. drop. These are driven by an overshot water-wheel 40ft. in diameter. There was no way of measuring the quantity of water accurately that this wheel was using, to calculate the percentage of power it was giving for the quantity of water used. The ordinary gratings and quicksilver-tables are used, the latter being 5ft. 9in. in width, and have three strips of muntz-metal, coated with mercury, across them, each strip being 14in. in width. From the quicksilver-tables the pulp passes over blanket-tables. Judging from the class of ore they were treating at the time of my visit, which contained copper-pyrites and zinc-blende, a very small percentage of the bullion is extracted—possibly not more than 25 per cent.

Dickson's Battery.—This battery is erected at the side of Tararu Creek, about one mile up from the Norfolk Battery. It consists of twenty heads of stamps, ten of which are said to be 700lb. each, and ten of 500lb. each, having a drop of 8in., and making seventy-five blows per minute. There are also seven berdans and two Watson-Denny pans. These are driven by a Pelton water-wheel, 6ft. in diameter; but the diameter of jet and pressure was not accurately ascertained, so as to to make a comparison of the power required to work the plant.

Sylvia Battery.—This battery was at the time of my visit closed up, as well as the mine, the ore being of too low-grade to pay the expense of treatment. This is to be regretted, as there has been a large expenditure on this plant; and it can truly be said to be the most complete concentrating-plant that has yet been erected in the Thames District; but it is questionable if the ore could be so cheaply concentrated as by the Lührig vanners. A detailed description of this plant was given two years ago, and there is no further need to recapitulate it here; suffice it to say that the material, from the time that it went to the stamps, passed down step by step through the jiggers, convex- and concave-buddles, by gravitation, no manual labour being required until the concentrates had to be removed to the different positions where they were stacked.

Waiotahi Battery.—This is the only crushing-battery on the Thames which is driven by steam-power. It consists of twenty heads of stamps, ten of which are 600lb. in weight and ten of 700lb. each, with a very light stamp for crushing specimens. There are also three berdans 3ft. 6in., and one berdan 4ft. in diameter, making twenty-three revolutions per minute. The stamps have a drop of 7in., and make about sixty blows per minute. The gratings have 240 holes to the square inch, and the capacity of the stamps is about 30cwt. a day for each stamp. The gold is saved on the ordinary quicksilver- and blanket-tables, there being two sheets of copper coated with mercury on the first tables before the pulp gets on to the blanket-tables.

Brown's Tailings Plant.—This plant is erected at the lower end of Terrace Creek, and has been kept steadily at work for the last fifteen or sixteen years. It consists of McKay pans and settlers. It is fully acknowledged by all mining men that the McKay-pan is one of the most effective grinding-pans yet made, and it is really a question whether these pans when properly worked are not equal, if not superior, to the Watson-Denny, Price Brothers, and J. C. Fraser's, or any other pan having a continuous discharge, for extracting the bullion from the tailings. My own opinion is that they are equally as good as any pan yet in use on the Thames for saving gold, and far superior to any pan in use as a grinder. The disadvantage these pans have is, that the ore has to be worked in charges, and they flour the mercury considerably, if grinding and amalgamating are carried on simultaneously. The grinding has to be done prior to the mercury being added to the charge, and then the muller lifted before amalgamation is commenced. No amalgamating-pan yet tried in the Thames District extracts a large percentage of the bullion from the ore, the combinations of metallic sulphides together with the gold being in an extremely fine divided state in the ore, it requires special treatment to effect a large saving.

Ohinemuri District.

Mining operations in this district were more vigorously carried on last year than they have been for several years previously, and some fresh discoveries have been made between Waitekauri and Marototo, which prove that large auriferous lodes exist which are likely to prove remunerative for working. There is a large extent of country between Waitekauri and Marototo, and also between Waihi and Whangamata, where in some instances large lodes are known to contain gold, but never have been properly prospected. The most part of this locality is covered with heavy forest and dense undergrowth, so that, unless the lodes actually project above the surface, or can be seen in the beds of streams, it is by a mere chance that any one discovers them. It is a part of the district where there are no roads or tracks, and there is great difficulty in carrying provisions and swags through the bush to carry on prospecting operations. This, together with a very rough, broken country, precludes the miners from venturing far away from any known workings, as it is a very easy matter, when turning and twisting about in the bush, to lose their way, unless they systematically blaze a track as they go on. The same thing can be said about the country up towards the head of the branches of the Waitawheta Creek, where lodes exist carrying gold, silver, and other minerals. A good deal of prospecting has been done from time to time near the workings at Karangahake, Waitekauri, Owharo, and Waihi. The latter places being on a plain, destitute of timber, prospecting is a comparatively easy undertaking. The mines at Karangakake and Waihi, and in the vicinity of Waitekauri, are looking much better than they were a few years ago, and several of them promises to be good properties, which will repay the proprietors good interest on the capital expended on them.

During last year there was 22,771 tons of quartz crushed, which yielded 1,722oz. of gold, and in addition bullion to the value of £61,117 13s. 4d.; while ore was sold to the value of £2,221 10s.; thus making the value of the mining produce last year to be about £67,544, as against £31,111 as the value of the produce for the former year; while last year there were 380 men employed in and about the mines.

Karangahake.

This was the first place where gold was discovered in the Ohinemuri District. A rush took place about eighteen years ago, and the field was proclaimed in March, 1875, when arrangements were made with the Natives to throw open the land for mining; but the returns from the field were so small that very soon the most of the miners left Karangahake to seek their fortunes elsewhere. Indeed it may be said the field was almost deserted for some years, until a revival in mining took place in 1882, about the same time as the Te Aroha field was opened, and a number of claims and licensed holdings were taken up, some of which were partially prospected, and some of the ground was held as a mere speculation in the hope that someone with capital would come along and purchase the holders' interests. The gold in the lodes at Karangahake is in a very finely-divided state, and always in combination with silver, so that only a very small percentage of the precious metals can be recovered by the ordinary crushing-battery treatment. At the time the second rush took place

there was one crushing-battery erected at the junction of the Ohinemuri River and the Waitawheta Creek; but this crushing plant was of very little use except for ore containing free gold, and at that time the absence of any roads or tracks made it a difficult undertaking to get any ore taken to the battery for treatment.

On the construction of a track around the base of the Karangahake Hill it gave facilities to prospect the ground, and several lodes were found on the surface which were considered to be payable for working. One of these was discovered in the Adeline Company's ground, which was worked for some time and gave very good returns. Several companies spent considerable sums in prospecting, and numbers of lodes were discovered containing gold and silver, and apparently the surface indications showed that large quantities of ore could be obtained if a suitable plant was erected for treating it. At length a gentleman, Mr. Railey, appeared on the field, who arranged to erect a plant on the side of the Waitawheta Creek, which, he stated, would save both the gold and silver in the ore, and that he had been working the same description of a plant in Mexico, and saved a very large percentage of these metals. This gave a large impetus to mining on the field, and steps were taken, simultaneously with the erection of the plant, to get a tramway constructed from the track along the base of the mountain to connect with Mr. Railey's battery. Shares in the different mining companies on the field rose in value, and everyone thought that a new era had dawned which promised to bring prosperity and enable the different lodes to be worked with profit. The principle upon which Mr. Railey proposed to treat the ore was by first crushing it by stamps, and allowing the pulverised material to flow into a series of tailings-pits, about twelve in number, so as to settle all the sediment from the water before allowing it to run to waste; and the tailings and slimes from these pits were treated in charges in pans with a little salt and sulphate of copper, the temperature of the water used in the pans being raised to from 120° to 180° Fahr. It was found, however, that this mode of treatment was not suitable for the class of ore found on this field, only a small percentage of it being recovered by this process, the gold being in the ore in a very finely-divided state, resembling the finest flour. Even with all the settling-pits a large proportion of it was carried away with the muddy water, after passing through the different pits. The plant having proved a failure, it necessarily had the effect of prospecting operations in the different mines being discontinued.

About the same time that Railey's plant stopped crushing, an English company or syndicate purchased the Crown Mine, and they arranged with the McArthur-Forest Company—who were perfecting plants to extract both gold and silver from the ore by a solution of cyanide of potassium—to erect one of them at Karangahake. This arrangement being made, the new Crown Company erected two Lamberton mills, which were considered by the English company as the best class of dry-pulverising machinery; and the accounts that came from England as to the capacity of these mills were so encouraging that many thought a new era was going to be opened up and that these mills would soon supersede the stamps, and their erection was watched with a deal of interest. As the ore had to be dried previous to being pulverised by these mills, kilns were constructed, and a cyanogen plant erected, and the ore pulverised so that it would pass through a 40-mesh grating. But it was found that the capacity of the mills was only about two tons of ore per day for each mill, the ore on the surface levels not being of high grade. The manager of the company discarded the dry crushing and used them for wet crushing; but this proved an utter failure, as it increased the wear and tear on the mills, and the pulverised wet pulp could not be leached with the cyanide solution, as the wet slimes prevented the solution from filtering. Another plant, having agitators and screw presses, was erected by the Cassel Company to treat the wet pulp, but in the meantime the mills were kept going, and the ordinary tables used to collect the gold. The percentage saved, however, was so small that wet crushing had to be discontinued. Having all these drawbacks to contend with, and the surface ore of low grade, the company came almost to a stand-still; the manager was either recalled, or resigned, and a local man put in charge of the works. After prospecting for some time he found a lode of good ore outside the company's ground, at the bottom of the Waitawheta Gorge, and the mill was kept going on ore from this lode up to August last, when the Lamberton mills got worn out beyond repair, and, as the company were erecting a larger plant by this time, crushing operations were suspended until the new plant is completed.

This company has done a considerable quantity of work in opening out their mine. Although the crushing operations have been suspended, they have been employing a considerable number of men in the mine opening out the levels. The expenditure on the mine averaged, up to the time of my visit, about £450 per month. In Mr. McConnell's (the manager of the Crown Company) report to the directors of the company in November last, he states that crushing with the old plant commenced towards the end of July, 1891, and was carried on successfully until August of the same year, when, during a heavy fresh in the river, part of the dam was carried away, and caused operations to be suspended with this plant for some months. After repairing the dam they resumed crushing, and, with the exception of a few break-downs owing to the dilapidated condition of the plant, they had a continuous run for six months up to August, 1892, when the machinery broke down beyond repair. Every effort was made to crush as much ore as possible with the old mill, but the quantity treated never exceeded 100 tons per month. The total amount of ore crushed and treated from the lode in the Whitawheta Gorge was 614 tons, which yielded bullion to the value of £8,270, being an average value of £13 9s. 4d. per ton, and about 94 per cent. of the assay-value was saved.

The bottom level in the Waitawheta Gorge is in for a distance of 400ft. on the south side of the creek, and 132ft. on the north side, and the level above this is in for a distance of 137ft. on the north side with 50ft. between the levels, and 500ft. on the south side with 100ft. between the levels. The lode is 8ft. wide in places, but in one place it is only about 3ft. in width, but this is only for a short distance. The whole of the ore in the lode is said to be payable for working, but only about 4ft. on the hanging-walls side has been broken out, as there is not room to stack the quartz in this gorge outside the levels. At the end of the present levels on the south side of the creek there is an

extremely rich band of stone on the hanging-wall side of the lode, about 12in. in width, which assays at a rate of from £337 to £487 per ton; but taking the assay-value of the general ore stuff it goes from £11 7s. to £14 10s. per ton. The rich band referred to does not extend far back in the level, but in general the stone assays better close to the hanging-wall than in other portions of the lode. Any one visiting this mine cannot fail to be impressed with its value. The quantity of ore that is now in sight will give the shareholders handsome returns for working. The shot of gold in this mine has been proved to have a length of 700ft., and it is still continuing on the south end, but on the upper level they have come to a cross course, which may have the effect of cutting out the gold, although there is no appearance of this taking place yet. It may be said this is the longest shot of gold that has been proved to run continuous in any lode in New Zealand, and the lode is richer in the bottom level than it is on the upper one, which holds out a great hope that the gold will continue to go down to a considerable depth. The bottom level is at least 600ft. below the surface, and shows rich ore under-foot, and the lode getting wider. On the upper levels some very hard bands of rock were gone through; but on the lower levels, strange to say, the hard rock cuts out, and a soft tufaceous sandstone takes it place, having small leaders and veins of quartz here and there through it. The lode is also better defined on the lower levels, and the quartz more compact. There is none of the loose rubbly stone found in the lode that was in the upper levels. The present appearance of the lode shows that it is likely to go down carrying gold to a considerable depth.

Taking the manager's report to the directors of the 22nd November last, he states that No. 4 adit is 124ft. above the creek level, and had at that time been driven on the reef 314ft. After the first 80ft. the lode pinched very small for 60ft., but made again, and has continned intact up to the present time, averaging 3ft. in thickness, with an approximate value of from £5 to £7 per ton. He gives the assay-value of samples taken from the lode at the end of this level on the date of his report as follows: From foot-wall—Gold, 1oz. 11dwt; silver, 1oz. 7dwt. 18gr.: value, £6 7s. per ton; from across the face of the lode—Gold, 1oz. 4dwt. 12gr.; silver, 2oz. 16dwt. 4gr.: value, £5 2s. per ton.

The No. 5 adit is 72ft. below No. 4, and the thickness of the lode in this level averages about 6ft.; and the assay-value of the ore broken out ranged from £8 to £12 per ton.

The No. 6 adit level, on the south side of the creek, is on a level with the gorge tramway, and therefore will be used as the main adit to work the stopes above this level. The lode in this level averages from 7ft. to 8ft. in thickness, and the assay-value of the ore broken out is given at from £15 to £20. The manager gave the directors the result of the assay samples taken from the face of the adit on the date of his report, as follows: From centre of lode—Gold, 3oz. 6dwt. 23gr.; silver, 1oz. 19dwt. 4gr.: value, £13 7s. per ton. Hanging-wall—Gold, 3oz. 16dwt. 18gr.; silver, 2oz. 10dwt. 15gr.: value, £15 10s. per ton. Foot-wall No. 1—Gold, 2oz. 15dwt. 22gr.; silver, 1oz. 15dwt. 22gr.: value, £10 15s. per ton. Foot-wall No. 2—Gold, 13oz. 19dwt. 7gr.; silver, 10oz. 2dwt. 12gr.: value, £57 6s. per ton.

The No. 6 adit, on the north side of the creek, has been driven on for 115ft. For the first 70ft. the lode averaged 7ft. in thickness, and the assay-value of the ore varied from £4 to £30 per ton. For the remaining distance driven the thickness of the lode varied from 2ft. to 5ft., and towards the end of this adit the lode broke into several branches.

In reference to the assay-value of the ore, Mr. McConnell takes promiscuous samples at short intervals from the different faces, and crushes up each sample before making any halving or quartering for assay, and he states that by taking samples in this manner during the time that the stone was being crushed at the old mill he got, in treating 614 tons, 94 per cent. of the assay-value; which shows that average samples of the ore must have been taken, and also that by careful assaying the value of a lode is accurately ascertained. It is gratifying to learn that other companies are now beginning to see the value of having their ore carefully assayed, and, although the result shows that they are losing a large percentage of gold and silver, it will eventually have the effect of their adopting a different method of treatment. This is specially referred to in my remarks on the Thames field.

The balance-sheet of the Crown Company for the year ending the 31st May, 1892, shows the capital of the company to be £65,000, in shares of £1 each, of which 47,673 shares have been issued, with 18s. per share called up, and 200 shares fully paid up; making the total number of shares issued 45,873, and the amount due for patent-rights acquired from the Cassel Gold Extracting Company, payable in fully paid-up shares, £11,468, and to sundry creditors £712 19s. 9d. Their assets are set down as follows:—

	£	s.	d.
Purchase of property from the old company	35,000	0	0
Patent rights acquired from Cassel's Company	11,468	0	0
Value of plant, &c., acquired from old company	666	16	0
Expended to the 31st May on new operations, and re-erection of plant, &c.	3,650	15	4
Stock of materials on hand	194	18	11
Funds in bank	1,762	14	4
Sundry debtors	81	5	0
Reconstruction expenses	227	10	8
Making a total of	£53,052	0	3

It is gratifying to find that in the case of this company, unlike many of the English companies, there does not appear to have been a large proportion of the capital absorbed in promoters' shares, and that the cost of management in the Glasgow office is small in comparison to some of the London offices, as, for instance, the Blue Spur, and Round Hill Company, in Otago. The receipts and expenditure for the year ending the 31st March, 1892, were as follows:—

PLAN OF 40 HEAD DRY STAMPER BATTERY.

ERECTED BY THE

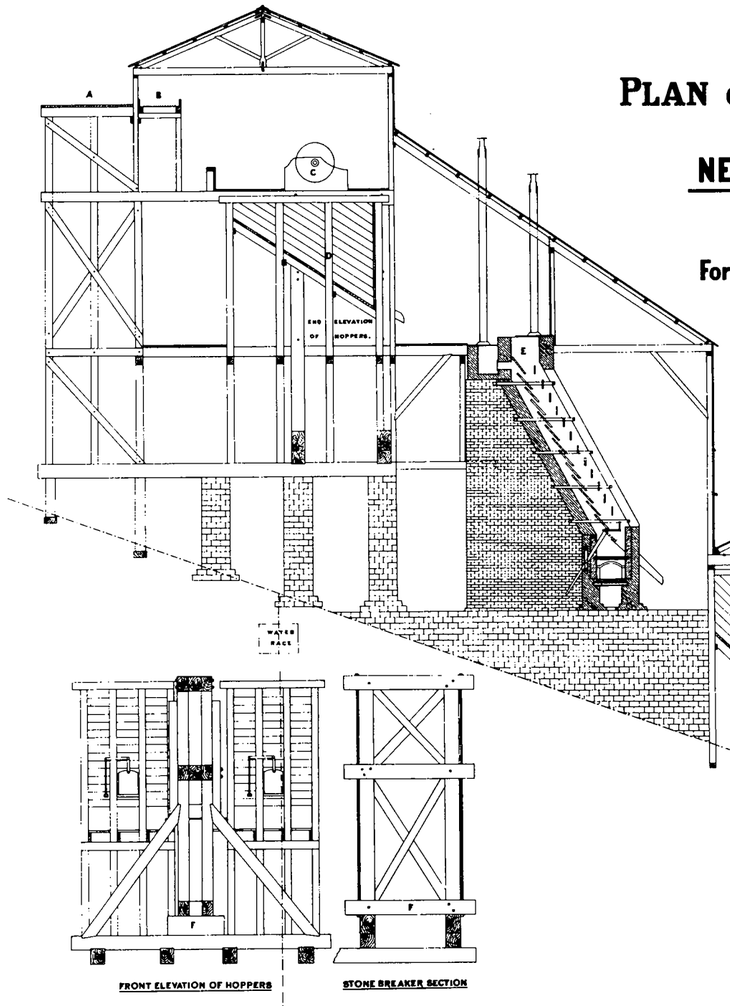
NEW ZEALAND CROWN MINES Co.

—KARANGAHAKE.—

For treatment of Gold & Silver bearing Ores

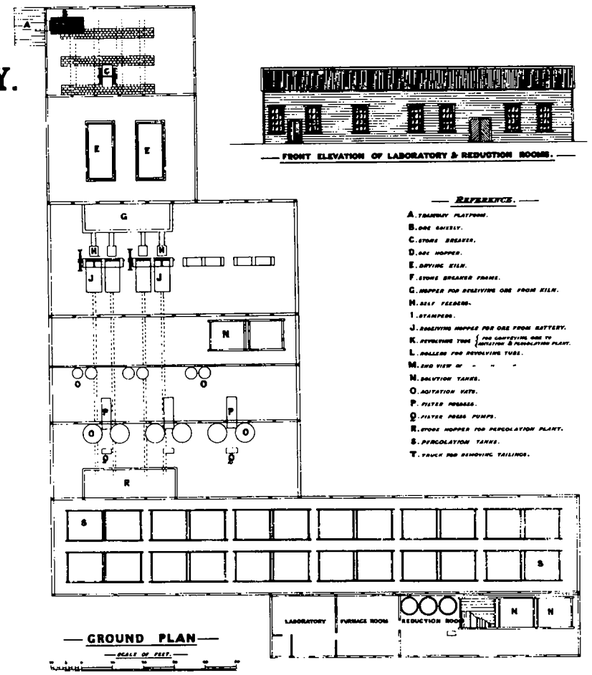
by the

McARTHUR-FORREST PROCESS.



FRONT ELEVATION OF HOPPERS

STONE BREAKER SECTION



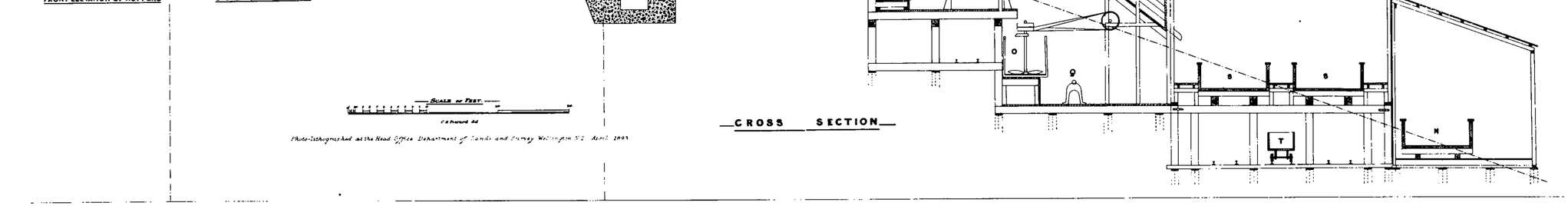
GROUND PLAN

SCALE OF FEET.

FRONT ELEVATION OF LABORATORY & REDUCTION ROOMS.

REFERENCE.

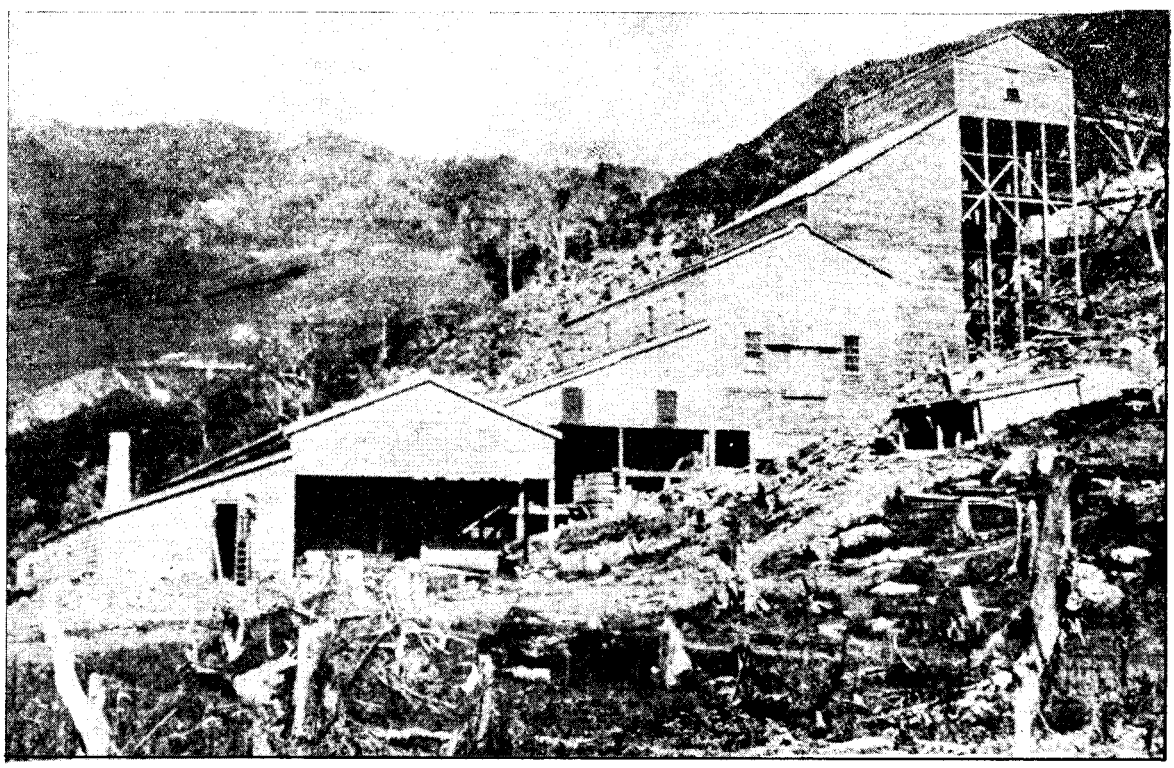
A. TRAMWAY PLATFORM.
B. ORE BASTELY.
C. STORES BREASTS.
D. ORE HOPPER.
E. DRYING KILN.
F. STONE BREAKER FRAME.
G. HOPPER FOR DELIVERING ORE FROM KILN.
H. BELT FEEDERS.
I. STAMPERS.
J. DELIVERING HOPPERS FOR ORE FROM BATTERY.
K. REVOLVING TUBS { FOR CONCENTRATING ORE TO AMALGAMATING & PERCOLATING PLANT.
L. ROLLERS FOR REVOLVING TUBS.
M. END VIEW OF " " "
N. SOLUTION TANKS.
O. AGITATION VATS.
P. FILTER PRESSES.
Q. FILTER PRESS PUMPS.
R. STORE HOPPER FOR PERCOLATION PLANT.
S. PERCOLATION TANKS.
T. TRUCK FOR REMOVING TAILINGS.



CROSS SECTION

SCALE OF FEET.

Photo-lithographed at the Head Office Department of Lands and Survey Wellington N.Z. April 1893



N.Z. Crown Mines Co's Reduction Works Karangahake.

	£	s.	d.
Bullion extracted from 383 tons 16cwt. of ore: Gold, 1,126oz. 16dwt. 15gr.; silver, 1,171oz. 10dwt. 5gr.: value	4,720	7	8
Expenditure—			
Mining, crushing, and ore treatment	3,928	15	1
Transport charges, freight, insurance, rent, and taxes	162	8	7
Management, travelling expenses, and employés' passage-money to colony	750	3	11
Expenses of Glasgow office	231	6	7
Total	£5,072	14	2

This shows a loss on the working for the year of £352 6s. 6d., a loss which is entirely due to extra expense incurred in working with a defective plant, and in sending men out from Europe to work the cyanide plant.

According to this balance-sheet the cost of crushing 384 tons of ore by the Lamberton mills was £484 2s. 11d., which is equal to £1 5s. 3d. per ton, and the cost of treatment of the pulverised ore was £1,253 13s. 1d., being equal to £3 5s. 3d. per ton; while the cost of mining, including surface labour and stores, is set down at £2,190 19s. 1d, which is equal to £5 14s. 1d. per ton. This would make the total cost of mining, pulverising, and treatment equal to £10 4s. 7d. per ton, which would clearly show that unless very rich ore was obtained it would be impossible to carry on operations. The manager, however, informed me that the statement is very misleading, inasmuch that during the year a large quantity of cyanide was purchased, which is at the present time in stock. On my calling Mr. McConnell's attention to the statement in the balance-sheet and the heavy cost of working a cyanide plant, he wrote me as follows: "The statement you refer to in the balance-sheet is extremely misleading. There is no doubt the cost at the old site was excessive, but that was certainly not the fault of the process, but owing rather to the unhandy way our plant was constructed, and also to the fact that though our output never exceeded 30 tons per week a full staff had to be employed. Then, again, immediately before the date of the statement referred to a quantity of cyanide was bought from the Cassel Company, and has evidently been charged by the head office, Glasgow, under the heading 'Treatment of Ores,' whereas this cyanide was actually used in the treatment of ore after the 31st May." He further states that "the actual average consumption of cyanide amounted to 0·2 per cent., equal to 9s. per ton, reckoning 70 per cent. cyanide, as supplied by the Cassel Company, at 1s. 5d. per pound. The labour in a well-constructed plant would not amount to more than 2s. or 2s. 6d. per ton at the most. He estimates that with the new plant the whole expense of drying, pulverising, and treatment will be not more than 20s. per ton."

Unless an explanation of the balance-sheet were given it would show that the use of the cyanide process was prohibitive, except the ore was extremely rich. No company would think of going to the expense of erecting a plant and paying royalty if the actual expense in treating the pulverised ore was £3 5s. 3d. per ton. This company deserves every encouragement. They have expended about £15,000 in plant and machinery; and from the appearance of their mine, the quantity of ore in sight ought to recoup all their expenditure within the next twelve months. During the year ending the 31st March last they crushed 349 tons of stone, which yielded 45oz. gold and 3,266oz. bullion, worth £2 per oz. The average number of men employed by this company last year at their mine, and in connection with the construction and erection of their works, was 112.

Plant.—Included under the head of plant may be classed a water-race and tramway. The water-race is taken from the Ohinemuri River in the Karangahake Gorge, about one mile above the battery-site. The water is taken from the river by means of a short tunnel through a rocky point. The bottom of the tunnel being a little below the bed of the river there is no need for any dam or weir to turn the water into the race. From the end of this tunnel the water is conveyed in a wooden flume 4ft. wide and 2ft. deep, having a carrying capacity of twenty-four sluice-heads of water. At the upper end of the flume it is covered over on the top, and is secured to the rock, so that in time of freshes or floods in the river the water flows over the top of the fluming. This top covering is carried down to such a distance as to admit of the flume being a sufficient height above flood-level before the boxing is left open on top. The boxing is laid along the face of the hill for the whole of the distance, on stringers laid on the ground, with the exception of trestle-work where the flume crosses the Waitawheta Creek. The actual head of water at the battery-site on the jets of the Pelton wheels is 69ft.

Tramway.—A narrow-gauge tramway was constructed by the Woodstock Company some years ago up the gorge of the Waitawheta Creek, from the Ivanhoe Battery, for some distance. The Crown Mines Company arranged with the Woodstock Company for the use of this tramway, and extended it up the Waitawheta Gorge for a distance of 30 chains—namely, 13 chains on the south side of the creek, thence by a bridge across the creek, and 17 chains of tramway on the north side to their mine; again on the lower end of the Woodstock tramway they extended it for 30 chains, to the site where their crushing-plant is erected. This tramway, for a portion of the distance up the Waitawheta Gorge, is cut out of a perpendicular rocky cliff, having the rock overhanging the tramway, but at a sufficient height above the line to admit of a horse being used, if necessary, to haul the trucks from the mine to the battery. The expenditure on this tramway is said to be about £1,300.

Battery Site.—The battery-site is situated on the side of the terrace on the south side of the Ohinemuri River, about 30 chains below the junction of the Waitawheta Creek. The foundations are cut out on the slope of the side of the hill, so that all the material is passed down stage after stage by gravitation as it is dealt with.

Crushing-battery.—The crushing-battery consists of a Lamberton rock-breaker, and twenty heads of stamps of the American pattern, 900lb. each stamp. The building where the rock-breaker is placed is on trestle-work 45ft. in height, strongly braced together. The ore as it is brought into the building is first dumped on to a grizzly, and what will not go through the bars of

the grizzly runs down to the rock-breaker, and is broken up to a maximum size of 2in. in diameter, and then falls into the same hopper where the fine material goes that passes through the bars of the grizzly. It then passes from this hopper into the drying-kilns, which are built of brick, the hot air being confined in a long flue, having a series of steps to prevent the ore from travelling down too fast before it gets thoroughly dried. There is a cast-iron plate at the bottom of this flue which can be turned, to allow of the dried ore to pass down into a large hopper, made of steel-plates $\frac{5}{16}$in. thick, from which the Challenge ore-feeders are fed. These kilns are only for drying the ore, and not in any way to calcine it. There are two of these kilns built on a stone foundation, and placed about 6ft. apart; the foundation going all the way across. The kilns themselves stand about 30ft. in height, the step-flue being at an angle of about from 30° to 40° from the vertical. There is a furnace at the bottom, where either coal or firewood can be used to dry the ore.

Stamp-mortars.—There is first a concrete foundation put in for the stamps, and on the top of the concrete the stamp-mortars are each placed on the end of a log of kauri, each 18ft. in length, 4ft. 8in. one way, and 2ft. 2in. the other. These are firmly embedded in the concrete, and all bolted together so as to form a solid block of timber standing on end, having a length of 18ft. 8in. by a width of 2ft. 2in., and on this the four mortars are placed. They are fitted with screens, having the top standing outwards at a slight angle, and held to the face of the mortars by means of a long wedge, the gratings being 30-mesh, equal to 900 holes to the square inch.

Stamps.—The stamps are similar to those used by the Waihi Company, and are fitted with the latest appliances for raising and holding them up, the cams and tappets being all constructed on the American type by Price Brothers, of the Thames. They are intended to make about ninety-two blows per minute, having a drop of 6in. The guides and framing are made of wood, and the framing and erection reflects credit on the contractor. Each ten-head battery is driven by a separate belt, and there is further provision made so that twenty additional stamps can be erected should they at any time be required. The pulverised material from the stamps falls into a chute and is conveyed into another set of hoppers at a lower level than the stamp-mortars, and from these hoppers the pulverised dust is taken to the leaching-vats.

Cyanide Plant.—This consists of twenty-four wooden vats, each 11ft. long by 9ft. wide and 3ft. 9in. deep. In the bottom of these vats there is a false bottom, or grating, placed about 3in. above the ordinary bottom, and on this false bottom a filter-bed is placed, about 4in. in thickness, the bottom layer being of coarse quartz-gravel, and gradually getting finer up to the top, the last coating being fine sand, having a coarse cloth placed over the top of the filter-bed to prevent the sand from being disturbed as the vats get cleaned out after every charge of pulverised ore. There are also fourteen agitators, eight of which are 5ft. deep by 4ft. 9in. in diameter, and six of them 6ft. deep, and 5ft. 6in. in diameter. The agitators and vats are all made of kauri timber, the staves of the agitators being 3in. in thickness, and the vats being made of partly 3in. and partly 4in. timber, and all bolted together. Into each of these vats are placed three pipes, under the false bottom, so that the first, second, and third solutions can be drawn off into separate channels. On one side of each vat there is a door, which can be opened to admit of the material being sluiced out after the whole of the cyanide solution is completely washed out of the ore, the solution passing through a long series of boxes filled with zinc-shavings, which precipitates both the gold and silver in the form of a blackish powder. There are also three concrete sumps, each 15ft. by 12ft. and 6ft. deep, capable of holding about thirty tons of the cyanide solution; this is pumped up to the vats on the floor above as required. It is in these concrete sumps where the solution is always made up to the proper strength before being used.

It is also proposed to use a vacuum pump to assist the filtration of the solution through the pulverised material in the vats, and by this means Mr. McConnell hopes to be able to leach the ore in about half the time he was able to do so at the old plant. However, this has yet to be tried. Where there are a great deal of slimes in the ore, it is very difficult to filter even with a vacuum pump. This proved to be the case at the Sylvia Company's plant at Tararu Creek, where Dr. Scheidel adopted this method to assist the leaching.

Annexed are plans of the company's plant, to which the following description or reference applies. The explanation of the plans was handed me by Mr. McConnell, the manager:—

"At point *A* the ore is delivered at the battery, and tipped on to grizzly, *B*; the fines pass through and are conveyed to hopper, *D*; the roughs pass over the grizzly on to the stone-breaker floor, and are passed through stone-breaker, *C*, and fall into hopper underneath, marked *D*; the drying-kiln *E* is charged from this hopper. The ore, after passing through the kiln, being perfectly dry, is run into an iron hopper *G*, from where it is automatically fed into stampers *I*, by self-feeders, *H*; the ore, after passing through the stampers, is received in hoppers *J*, and then conveyed by means of revolving tube *K*, either into truck for conveying ore to agitation-cylinders for treatment, or, if the ore can be better treated by percolation, to store-hopper, *R*, in connection with percolation plant, from where it is trucked along the top of and tipped into percolation tanks, *S*, for treatment.

"The plant is so arranged that the ore, after it is delivered above the stone-breaker, falls from the stage by gravitation, requiring the least possible handling, and thereby reducing the cost of labour to a minimum.

"Water-power: By means of a 4in. by 2in. fluming the water is taken from a point in the Ohinemuri River above Karangahake, and conveyed to the battery a distance of 85 chains, giving a fall there of 70ft., which, with three Pelton wheels, 140-horse power can be obtained. The diameter of the water column is 44in.

"Crushing Machinery: One Lamberton stone-breaker, capable of reducing 70 tons of ore per day fine enough to feed into stamps; and twenty heads of 9cwt. dry stamps, erected by A. and G. Price, which are guaranteed to crush 30 tons of ore per day sufficiently fine to pass through a 30-mesh screen.

"Percolation Plant: This plant consists of twenty-four tanks, capable of holding each a charge of 7 tons of finely-pulverised ore. The bottom of each tank is covered with a sand-and-gravel filter. The finely-pulverised ore is trucked from the store-hoppers and tipped into the tanks. A dilute solution of cyanide is then run on to the top, and allowed or assisted to percolate through the body of the ore. As the solution percolates it is carried away from underneath the filters by means of iron pipes, and allowed to run through a series of boxes filled with zinc-turnings. The cyanide in the solution having a much stronger affinity for gold and silver than the baser metals, dissolves these precious metals in its course through the ore, and again deposits them in the form of a black slime on the zinc-turnings. This black slime is collected and melted down into bars direct.

"Agitation Plant: This plant consists of sixteen wooden tubs fitted with revolving paddles, in which the ore and cyanide solution are agitated together until the gold and silver is dissolved. The solution is then filtered, and the bullion deposited on the zinc-turnings, as already described."

Woodstock Company.—There does not appear to be much energy displayed by this company in carrying on extensive operations. There is some very rich ore in their ground which cannot be treated by the ordinary battery process; and it is questionable if the Cassel process will give a large percentage of the bullion. It is said that the company propose to send a large parcel to Freiberg, Saxony, for treatment. In some portions of the lode the gold is in a tolerably fine state, although alloyed with silver. Taking the returns for the year ending the 31st December last, 100 tons of ore were said to be treated by battery and pan-amalgamation, and gave 565oz. bullion, representing a value of £1,397, which is equal to £2 9s. 5d. per ounce. If the quantity of stone treated be correct, then the average value of the ore is £13 19s. 5d. per ton. This represents about 70 per cent. of the assay-value of the ore. The manager, Mr. McCombie, carefully assays the ore in the lode as it is broken out, and thereby knows its exact value. He was one of the first men in this district who was alive to the necessity of those who were interested in mining being fully acquainted with the character of the different compounds in ores, and ascertaining their correct value. During the year ending the 31st March last, this company sold 51 tons of ore at £40 per ton, and crushed 110 tons of quartz, which yielded 467oz. of gold. They had an average of ten men employed during the year.

Ivanhoe and Truro Company.—There were two wages-men and four tributers employed by this company last year, but the operations have not been carried on with much success. They crushed 220 tons for themselves, which yielded 138oz. of gold; and 115 tons for the tributers, which yielded 109oz. of gold.

Owharoa.

There is only one claim being regularly worked here—namely, the Smile of Fortune, the other works in the locality being of a prospecting character. During last year the Smile of Fortune Company had ten wages-men and three tributers employed. They crushed 480 tons of stone for themselves, which yielded 168oz. of gold, and 130 tons for the tributers, which yielded 68oz. of gold. This is a locality where some very rich stone has been got, and it is thought that fresh discoveries will yet be made further back into the terrace than this company's workings.

Waitekauri.

There is very little mining being carried on in the old workings. Mr. Russell, who purchased Mr. Brown's plant some two years and a half ago, has disposed of his property again to the Komata Gold-mining Company, of which he is still manager. During last year he has crushed a considerable quantity of stone from the Komata Mine, which is connected with the crushing-battery, and has got good returns. There has been very little work done in the old Waitekauri Mine: the stone from the large lode proved of too low grade to pay for working. At Komata the lode varies from 6ft. to 10ft. in width, and it has been proved to contain ore payable for working to a depth of 250ft., and for 300ft. along the lode. Mr. Russell states that the quantity of gold increases 50 per cent. for every 100ft. they go down. He gives the value of the ore as £8 per ton. There seems, however, to be a difficulty in extracting a fair percentage of the gold from the ore, but this company has arranged to erect a Cassel plant, and treat it by the cyanogen process.

A very large expenditure has already been made on this plant since it was purchased from Mr. Brown, and arrangements were being made at the time of my visit to make other alterations, and so modify it to treat the ore by a solution of potassium cyanide. The plant consists of a rock-breaker, thirty heads of stamps, a number of berdans, six combination-pans, and settlers. The stone is brought from the mine and dumped on a grizzly, and the coarse pieces go into an American rock-breaker, which has an eccentric action and breaks the ore to a maximum size of 2in. in diameter. It then falls into a hopper, thence into ore-feeders which feed the stamps. The pulverised material passes out of the stamp-mortar through a 40-mesh grating, and flows over tables covered with copper-plates coated with mercury; thence into a chute, and lifted up 30ft. by a vertical elevator, having chain-links and buckets. This runs into four wrought-iron tanks, being 8ft. square on the top-side for a depth of 3ft., and then tapered in to 2ft. square in the bottom, their total depth being 6ft. The overflow from these tanks runs over a large area of blanket-tables before getting into the pit or dam where all the tailings are stacked. The sand goes into the berdan-plant, from which it is again elevated, and runs into eight wooden tanks, each 15ft. by 10ft., and 3ft. in depth; and from these the material goes into combination-pans and settlers; from the latter the water and pulp are lifted by an elevator-wheel, and the tailings deposited in the dam or pit where they are all stacked.

It is now proposed to treat the material after it has been through the berdans with a solution of potassium cyanide; and, to effect this, two large circular vats are to be constructed 16ft. in diameter and 7ft. deep, made of kauri timber, 4in. in thickness in the bottom, all dowelled together, and the staves of 9in. by 3in., rebated to receive bottom, and bound together by round iron-hoops $\frac{7}{8}$in. in diameter, made in two halves, and drawn together by a strong screw-bolt. Mr. Russell anticipates to be able to leach the pulverised material to a depth of 4ft. in each of these vats, which

is very doubtful. As soon as these vats and solution-tanks are constructed, the combination-pans and settlers will be dispensed with. By adopting this mode of treatment Mr. Russell will get a good percentage of the gold from the plates and berdans, and will only have to pay royalty on the value of the gold and silver recovered by the Cassel process, the royalty being 7½ per cent. on he value of the bullion recovered.

There is no gainsaying the fact that the cyanide of potassium is a good re-agent for gold, and undoubtedly the best agent for extracting gold, especially where the latter is in a very finely divided state amongst the ore; but the royalty charged is prohibitive, and it will never be largely used until it is lowered. If the Cassel Company would have been content with about 2 per cent. royalty, the process would have been almost universally adopted by every company in New Zealand. In the number of the *Engineering and Mining Journal* of New York, of February the 18th of this year, there is a notice given that the Attorney-General of Transvaal has disallowed their patent in South Africa, and it is thought that the day is not far distant when steps will be taken to test its validity in the English Courts. The company is therefore standing in its own light by exacting a large royalty, as its use from that cause will be very limited; whereas if a moderate royalty were charged there would be very few crushing-plants in New Zealand but would use the process. During the year ending the 31st December last, Mr. Russell crushed from the Komata and Waitekauri Mines 2,000 tons of quartz, which yielded 6,680oz. of bullion, representing a value of £5,632; and the average number of men employed is given in as sixty.

Lowerie Brothers' New Find.—This is likely to prove a valuable discovery. It is situate about five miles up the Waitekauri Creek, above the Komata Company's crushing-plant, and at an elevation of about 530ft. above the store near the crushing battery at Waitekauri. It is held by a great many of the miners that prospecting will never be carried on until the country is opened out by tracks, and this is, to a great extent, correct; but the new discovery of Lowerie Brothers is an exception to this. In trying to reach the scene of their operations one cannot help admiring the pluck and energy of the men in forcing their way through a dense bush, where everything had for a long time to be carried on their backs, crossing and recrossing the Waitekauri Creek about nine times, travelling over steep spurs with dense undergrowth entwined with supplejacks, rendering swagging a very laborious undertaking.

The lode is found on both sides of the creek, or at least it shows that it is on both sides, although the main lode in the Prospector's Claim has not yet been cut on the west side. On the east side of the creek there is a large outcrop, the lode varying from 6ft. to 10ft. in thickness, the quartz being of a dull-white amorphous character, having twisted bluish veins running parallel with each other, presenting an appearance of ore which contains both silver and gold. The stone near the outcrop contains more oxide of iron than it does where it is broken out in the drive. According to average assays of samples that have been made of the heap of ore lying at the mouth of the adit, its value is said to vary from £5 to £10 per ton. This is said to be assays taken at the instigation of Dr. Scheidel, who was said to have made an offer to the prospectors to purchase the property. About 6 chains down the creek from the outcrop another lode of mullocky material was discovered, being clay and quartz intermixed with oxides of iron and manganese in large proportions until it gives the lode a blackish-brown appearance. A trial crushing of five tons was taken from this lode and sent to the Moanataiari Battery at the Thames, when it yielded by the ordinary battery process 70oz. gold, worth £2 12s. 6d. per oz.; this was at the rate of 14oz. gold to the ton, having a value of £36 15s. The ore from this lode, which is from 3ft. to 4ft. wide, does not appear to have been picked to any extent, as there was very little of it lying about broken out at the time of my visit. This manganese lode runs almost parallel with the other, or it is going in such a direction as to join the main lode at a very acute angle. The whole face of the hill on the east side of the line of the main lode is full of loose blocks of stone containing gold and silver, and the surface clay also contains in many places fair prospects of gold. The face of the terrace appears to have been a slip from the out-crop of the main lode. An adit has been constructed for 50ft. on the western side of the creek, through a soft tufaceous sandstone, with the view of intersecting the main lode; but they expected to have to go another 15ft. at the time of my visit before cutting it. This new find was discovered in September last by Messrs. Lowerie Brothers, Dickson, and Corbett.

Another auriferous lode has been discovered by Birney and party about half-way between Loweries' and Waitekauri, but this being some distance off the track a visit could not be made to it except by putting in another day at Waitekauri. It is on the same belt of country which runs from Waitekauri towards Whangamata, and contains numerous quartz lodes. There appears to be a great future for this portion of the country for mining. Scarcely any prospecting has been done, and when one sees the nature of the country that the prospector has to travel over, it is not to be wondered at. There is little or no level land, it is nothing but a series of ridges and gorges; no sooner are you over one than another stares you in the face. These, with the dense undergrowth, fallen timber, supplejacks, and lawyers (*Robus australis*), renders progress very difficult when one has a swag to carry.

Waihi.

Amongst all the quartz-mining districts in the colony there is not one deserving more attention than that of Waihi. Auriferous lodes were first discovered here by a prospecting party subsidised by Government, and several claims were taken up on the Martha Reef. A company was formed about twelve years ago to work this reef. A crushing-battery was erected at the side of the Ohinemuri River, worked by water-power, and a tramway was constructed to connect the mine with the crushing-battery. This company struggled on for several years, and managed to get sufficient gold to pay working-expenses, but not to return any of the capital expended to the shareholders. The stone was quarried out on the surface for a long time, no timber being required, the lode being over 60ft. in width; but in carrying on the cutting into the hill the sides appeared to be too treacherous to admit of men working with safety. Year after year passed by, and the report of the manager was

that the stone only averaged from 4dwt. to 6dwt. to the ton, and it was just as much as he could do to make the mine pay for working. Finally, an adit-level was constructed, and the lode driven on for about 500ft., but the results of the crushing from this level was even more disappointing than that on the surface. It got so poor that it could hardly pay working-expenses by employing men on wages. The mine was then let on tribute, with but very little better results. Indeed, this mine was considered of very little value. The same stereotypical answer was always got from the mine-manager when inquiries were made as to the saving of the gold at the battery, "They were losing very little, and they looked on their gold-saving appliances as being as good as any in the district."

After the Waihi Company had erected a very expensive crushing-plant to treat the ore from the Union and Rosamond Mines, which at that time were the only mining properties belonging to the company, Mr. T. H. Russell, who was superintending the crushing operations, saw that these mines were not capable of supplying a sufficient quantity of ore to keep the plant fully employed: and, indeed, the large expenditure on this plant, with the continued alterations from time to time, would have placed the company in liquidation had they not got a better mining property. However, Mr. Russell, in casually examining the Martha Mine, and getting different parcels of the ore, taken promiscuously, analysed, found that the ore was very rich in both silver and gold, and, instead of the ore containing only 4dwt. and 6dwt. to the ton, some of it was worth nearly £100 per ton. He consequently made the Martha Company what they considered an excellent offer for their property, which was accepted, and this property at the present time is one of the best in the colony.

Waihi Gold and Silver Company.—This company have completed the low-level adit in the Martha mine. It is 1,460ft. in length, 7ft. high, and 7ft wide in the clear. It is carried in a straight line for the whole of the distance, and on a uniform grade. The adit is well timbered. Throughout portions of it, where the ground was heavy, the sets of timber are put close together. The lode in the lower level is of the same character as that found on the smithy level, and varies from 18ft. to over 60ft. in width. This low-level gives 60ft. of backs. The ore from this lode is said to be worth, on an average, about £4 per ton, but there is a difficulty in extracting a fair percentage of the value of the bullion it contains. The company are also working on the surface, quarrying away the lode by taking a greater width of it than the Martha Company had done. This mode of working always enables them to get sufficient ore to keep their battery fully employed. The lode has been proved for from 400ft. to 500ft. in length.

In the Union Mine the shaft has been sunk to a depth of 125ft., and the lode opened out at this level. It varies from 2ft. to 5ft. in width, and contains a larger percentage of gold than the Martha lode, and a higher average in the extraction of the bullion is obtained. The water in this mine is lifted by a 10-inch pump to the level of the tailrace, which is constructed to the Ohinemuri River to carry away the water used on the Pelton wheels.

The ores from both mines are still dried in open kilns, some of it being partially calcined. The cost of this is said to be 2s. per ton. The ore from the kiln is then brought in trucks and hoisted up with a hydraulic ram to the upper floor, and goes through the rock-breaker and thence to the stamps, the latter being fed with Challenge ore-feeders. In my last report a description was given of the erection of thirty heads of stamps, which were used for wet-crushing, and the whole of the water and pulp lifted by an elevator-wheel and run into tanks. This system has been abandoned, and all the stamps—sixty heads—are now used for dry-crushing. When the alterations were made from wet to dry-crushing with the last thirty heads of stamps which were erected, new mortars were put in, having back and front delivery; but the back delivery makes very little difference in the discharge. The other battery of thirty heads has only a front delivery, and this battery pulverised the same quantity of material as the other. The grating used is a 60-mesh wire screen.

The Bohm plant to treat the ore with potassium cyanide, referred to in my last report, was erected, but it did not prove a success. The cylinders used were too long and narrow, containing as they did some 10ft. in depth of ore, that the solution had to be forced through. The effect of this was that the solution could not be made to percolate through the whole of the ore, but passed up between the cylinder and the ore, the solution being forced into the cylinder by a pump at a pressure of 120lbs. per square inch. This pressure should have been sufficient to force the solution through, but as the pulverised material offered a much greater resistance than the junction between the material and the side of the cylinder, the solution went through the weakest spot, and had little effect on the ore in the centre. However, the process so far has proved a failure owing to the mechanical construction of the plant.

For the year ending the 31st December last they crushed 18,279 tons of stone, which yielded 25,456oz. of bullion—namely, 9,998oz. 9dwt. of gold and 15,457oz. 14dwt. of silver; the average value of the bullion for the year being £1 14s. 5d. per ounce. This represents a value of £43,805 10s. for the year. The total value of bullion produced by this company up to the 31st December last is said to be about £90,658; and taking the average percentage of bullion extracted from the ore, it would show that the value of the bullion sent amongst the tailings into the wash-head and those run away would amount to something like £35,000. Taking the year ending the 31st March last, the company crushed and treated 18,279 tons of stone, and got 29,681oz. 10dwt. bullion, representing a value of about £48,809. The average number of men employed by this company last year was about one hundred and fifty. They have recently disposed of all their tailings, and all that will accrue up to November next, to the Cassel Company for, it is said, £5,000, which is going to erect a plant to treat them. The company has also arranged with the Cassel Company to erect a small cyanide plant, and to treat a portion of the dry pulverised ore by the Cassel process. They are also going to erect an Ottis ore-crusher, which is guaranteed to crush 20 tons of ore a day, and only requires 10-horse power to work it.

Silverton Company.—This company has been working on the outcrop of the lode by quarrying the stone, and, after assorting it, sending the best portions to the battery. They have been engaged during the last year in constructing a low adit-level, but the work has not been carried on very energetically. A great deal of the surface stone is of low grade, and this, together with the large

expenditure they have been to last year, in the purchase and alterations in their crushing-plant, have for a time put a damper on the prospects of the company. The chairman of directors, at the annual meeting on the 29th December last, spoke very hopefully of the state of the mine. In a block of ground that had been opened up the ore was of a white, open formation, and it was a question whether this was worth saving. He tested this ore by assay, and found it to have a value of £26 18s. 6d. per ton, made up largely of silver. The cost of carting the quartz to the battery was from 3s. to 4s. per ton, but a tramway could be constructed for about £400, which would reduce the transit of the quartz from the mine to about 1s. per ton.

The five heads of stamps referred to in my last report as being erected, and used instead of a rock-breaker, was not a success. When the ore was soft, and well broken up, the five heads of stamps could break up far more of the ore than the ten-heads battery could crush, and when the quartz was hard, and in large pieces, the five heads could not break it fast enough, consequently the five-heads used instead of a rock-breaker has been removed, and the ore is now hand-fed into the crushing-battery. The plant is similar to that which was erected at Waihi for wet crushing, but the company have found that they cannot save a sufficient proportion of their bullion by this process, and are now using the Cassel process by converting the tanks that were formerly used as settling tanks into vats for leaching the ore. Judging by their construction, and *modus operandi*, they will not get a large percentage of the bullion by this process. They were treating the tailings at the time of my visit; the crushing operations being suspended for a time.

During the year ending December last, they got 493ozs. of gold, representing a value of £1,107 4s.; but their expenditure was,—

	£ s. d.	£ s. d.
For wages of workmen employed in mine	...	515 9 0
For wages of workmen employed in battery ...	...	269 3 10
For carting and freight...	...	157 4 4
Mine requisites, and survey, &c.	...	77 7 9
Total	...	1,019 4 11
Erection of battery	501 19 8	
Battery requisites	533 3 2	
Battery foundry-work	449 4 3	
Insurance	16 10 8	
		1,500 17 9
Water-race and dam	...	390 1 7
Constructing low-level adit	...	270 0 9
Office expenses, &c., ...	...	84 8 0
Directors' fees and travelling-expenses	...	133 0 0
Making a total of	...	£3,397 13 0

This shows a deficiency of £2,290 9s. on the year's transactions; but if the first four items and the last two be only taken—namely, £1,236 12s. 11d., it would only show an actual deficiency on the working for the twelve months of £129 8s. 11d. During the year ending the 31st March last, 800 tons of ore was crushed, which yielded 500oz. of gold. The average number of men employed during the year being twelve.

Tui Creek.

A considerable amount of work has been done at Tui Creek in opening out the Champion Mine, but it appears the refractory class of ore met with does not hold out sufficient inducement to the prospectors to erect a plant to treat the ore; indeed, they are at their wit's end to know the description of plant that would treat the ore most successfully and economically. When the Te Aroha Gold and Silver Company erected their plant at Waiorongomai, it was thought that a new era had dawned, and that it would deal successfully with the class of ore from the Champion Mine. The Champion Company, on the strength of this, constructed an aërial tramway from their mine to the flat, and sent down some 35 tons of ore to get treated at Waiorongomai; but it was found that the plant there was only capable of extracting about 30 per cent. of the value of the bullion, and therefore no further trials were made. Some small parcels were treated by the Crown Company, who extracted a fair percentage of the bullion by the cyanogen process, but the plant being erected in an inaccessible place, and the company not being prepared to treat ores in quantity for the public, nothing has been done beyond doing a little work now and again in the mine for the purpose of preventing a forfeiture of the claim from taking place.

The chairman of the company, Mr. J. B. Montgomerie, London, has, in conjunction with Mr. Parks, been experimenting with the view of perfecting a process to treat it successfully, but nothing has yet come of it. In the directors' report at the annual meeting of the company in London, over twelve months ago, the following paragraph occurs: "The chairman, who has devoted much time and attention to the subject of treating the ore, is confident that the process has now been thoroughly developed, and that it will considerably cheapen the cost of treatment, and satisfactorily deal with the company's ore. Designs and estimates for a suitable plant have been prepared, and the directors are now considering the best means of obtaining the necessary capital for erecting the same, which they hope to submit to the shareholders at an early date." This report was submitted to the shareholders on the 29th January, 1892, but nothing further has been heard about this process. Their balance-sheet up to the 31st August, 1891, shows that the capital is nominally £75,000, of which £43,000 has been given to vendors in fully paid-up shares as part payment for the property; 13,323 shares have been issued, and £10,826 5s. paid upon them. The purchase of the mine was £45,000; cost of additional land as a machine-site, and purchase of May Bell Claim, £167 9s.; amount expended in mining and general outlay, including London office expenses, up to the 31st August,

1891, £9,773 11s. 2d.: making the total expenditure up to that date, £54,941 0s. 2d., and the amount of capital paid-up, and given to vendors in paid-up shares, was £53,826 5s.. In addition to this there was £2,496 15s. due on calls. This makes the total capital issued to be £56,323, so that the available money at the date already mentioned was only £382.

It will be seen from this that unless the balance of the shares can be issued, or money raised on debentures, the company cannot go on. There is a large lode in the Champion Company's ground containing some valuable ore, but portions of it is very complex, having combinations of lead, zinc, copper, silver, and gold. Some of the ore has been sent Home to either Swansea or Freiburg, Saxony, for treatment, but the cost of treatment and charges was too much to make the mine a profitable venture by treating the ore at these places. Seeing that the Crown Company are now erecting a public crushing-plant to treat ore by the cyanogen process, it is possible that some of it will be sent there for treatment. The mine-manager, Mr. C. A. Cornes, states that the cost of mining and delivering the ore on the flat at the end of the aërial tramway will not exceed 8s. per ton; so that if a plant were erected in close proximity to this which could treat the ore at a moderate price very poor ore could be made remunerative for working.

The Thames Lead- and Silver-Mining Company.—This is a small company or syndicate of gentlemen in England who, in conjunction with Messrs. Cornes and Broadbent, have subscribed a certain amount of capital to prospect and work a galena lode on the eastern side of the range from Tui Creek, and also open out and prospect the continuation of the Champion Lode, which runs through their ground. The capital of this company is divided into 155 shares of £35 each, of which the whole of the shares are allotted, and the actual workable capital is £3,500; the balance being held as promotors' shares, fully paid-up. Mr. Broadbent is the gentleman in New Zealand representing the syndicate, and he states that he can dispose of the galena at £8 per ton in London or Swansea, and that a company has offered to take 2,000 tons of it per annum.

The galena lode at the outcrop is about 2ft. in thickness, and contains very little quartz through it. In some places it appears to be almost pure PbS., containing 86 per cent of lead. To take the whole of the lode that is visible, it may be said to contain about from 60 to 70 per cent. of galena; but there is so little work done that one cannot express an opinion as to whether it will continue along the lode for any great distance or go down to any great depth. Mr. Broadbent is, however, satisfied that there is sufficient in sight to justify the expenditure of constructing a road to enable it to be got to the top of the Tui Saddle; and when once it is there he expects to be able to make arrangements with the Champion Company to send it down by their aërial tramway to the flat. The company has contributed £50 to the County Council funds towards the construction of this road, and the Government has authorised a subsidy of a similar amount. The distance the ore will have to be brought from the mine to the top of the Tui Saddle when the road is completed will be about 45 chains, and the mine is about 320ft. below the saddle, the latter being about 2,300ft. above sea-level.

According to assays made by Mr. Broadbent, the galena contains from 6oz. to 17oz. of silver to the ton, which will increase its value to some extent, say, if the average quantity of silver was 10oz. to the ton, this would increase the value of the lead to the extent of £1 10s. per ton. The lode is situate on the fall of the range into the Maungakino Creek, a tributary of the Waitawheta. It is in a belt of country full of mineral lodes which have scarcely been prospected. Some licensed holdings were taken up here about five years ago, amongst which was the Ruakaka, where some very fair silver ore was found. If it is once opened up by a road there is a great probability of some good discoveries being made in this locality.

Waiorongomai.

There are only three claims being worked on this field—namely, the Silver King, the New Find, and the Premier—ground which formerly belonged to the New Era Company. The two first mentioned claims are worked by the Te Aroha Syndicate Company, who are the proprietors of the only crushing-plant there is in the district. In the New Find ground the syndicate have eighteen men employed. They are taking about 12ft. in width of the lode; that is, prior to the syndicate holding this ground a portion of the lode from 4ft. to 6ft. in the centre was taken out to a depth of about 320ft. below the outcrop. The syndicate are now taking out 6ft. on each side of the old workings and making it pay; they are down for a distance of 100ft. below the surface, the workings being open all the way down, and consequently all the surface-water follows them down.

In the lower level of this claim the lode is over 30ft. in thickness. The level has gone through it and into the hanging or western wall for a distance of about 40ft., and here an interesting formation occurs, which if followed up may lead on to a much richer shot of gold being found in the lower levels than has heretofore been worked. The country rock on each side of the lode down to a depth of 320ft. has been extremely hard, having a blue indurated sandstone appearance. However, at the western end of the lower level there is a very soft formation comes in, having a slight inclination eastwards. The same thing occurs at Karangahake; the country rock is very hard in the upper levels in the Crown Company's mine, and underlying this hard rock is a soft tufaceous sandstone formation, and the gold in the lode is getting better as it goes down. The same thing is likely to apply to the main lode in the Te Aroha Range, which is a continuation of the range coming from Karangahake, and if it is found that the soft rock underlies the hard there is every probability of the lode containing more gold.

About 400ft. northwards from the lower level in the New Find another level was constructed by the Te Aroha Gold and Silver Company, which is about 200ft. lower than the one in the New Find ground. A crosscut could easily be constructed from this level, following the lode southwards, or in the hanging-wall, where the driving is said to be good, until such time as it was underneath the shot of gold found in the New Find ground. The lode should be cut at intervals to see the class of ore it contains. If this were done there is a strong probability of the syndicate coming on better stone than they are at present working. It is well known that gold is found in

all the lodes in shots and ledges; and in New Zealand these shots do not, as a general rule, extend for a great distance along the lodes, and between these shots the lode, although not actually barren as regards bullion, contains so small a quantity that it will not pay for working. Therefore, although the lode where cut through in the Canadian ground,—which is the place where the lowest adit was constructed by the Te Aroha Gold and Silver Company,—did not prove to be payable for working, it may be found payable underneath the workings in the New Find Mine, about 400ft. further to the southwards.

The more one examines the country in this locality the more one is impressed of the probability of rich shots of auriferous and argentiferous ore being found in different places in the main lode, which can be traced along the range for a distance of nearly three miles. When Messrs. Firth and Clarke sold their plant and ground to the Te Aroha Gold and Silver Company, it was thought to be a good thing for the district, as it was the means of a large expenditure being made in the locality, and it was anticipated that the main lode would be prospected in different places; but instead of being a blessing it has proved a curse, and put back the development of the field for many years. The company referred to did no prospecting. They employed an American metallurgist to erect a most expensive plant, one which was not suitable to deal with the class of ore on this field. When the plant was completed this proved to be the case, and the company, after expending some £60,000, had to suspend operations without prospecting their mining property, which will one day yet prove a valuable investment to those who hold it. The class of ore there was to deal with is quite different from any the American experts had been accustomed to treat, and they were as much at sea in reference to the proper method of treatment as our mill-men would be with American ores. It is a strange thing, but nevertheless true, that, notwithstanding the many mining experts we have had from America, which is the largest mining country in the world, all of them have proved failures in dealing with our ores.

The large reduction, concentrating, and smelting plant erected by the Te Aroha Gold and Silver Company is a thing of the past. The smelting and roasting furnaces have been taken down, the concentrating plant removed, and only twenty heads of stamps are now used where formerly sixty heads were erected. About twelve months ago all this property was sold to Messrs. Adams and Wicks for the sum of £3,200. The former of these gentlemen purchased his partner's interest, and formed the whole into a local company or syndicate. In addition to the New Find Mine they hold the ground formerly held by the Silver King Company as an ordinary claim, and have four men employed in it, and they are getting some very fair ore, containing about 1oz. of gold and 20oz. of silver.

Battery and Plant.—The battery and plant belonging to the Te Aroha syndicate consists of twenty heads of stamps, nine cyanide leaching-vats, and four solution-tanks, together with the zinc precipitating boxes and one berdan. The stamps are said to be 900lb. in weight, having a drop of 9in., and making sixty blows per minute, which require a power $= \frac{900 \times 20 \times 45}{33{,}000} = 24{\cdot}5$-horse. These stamps are driven by a Pelton water-wheel, 6ft. in diameter, having a jet of $1\frac{3}{4}$in. in diameter under a pressure of 98lb. per square inch, which is equal to a hydrostatic head of 225ft. The theoretical power of the water would therefore be as follows: The jet is capable of discharging 1·878 cubic feet of water per second, therefore $\frac{1{\cdot}878 \times 60 \times 62{\cdot}5 \times 225}{33{,}000} = 40$ theoretical horse-power and $\frac{24{\cdot}5}{48} = 51$ per cent. of the theoretical power of the water. This is by far the lowest percentage that any Pelton wheel gives in the district, and shows that the water must be throttled in the valve which would account for this.

The ore as it comes from the mine is dumped on to a grizzly, and what will not pass through the bars of the grizzly goes into a rock-breaker, and is reduced to a maximum of 2in. in diameter, when it falls into a hopper which feeds four Challenge ore-feeders. The screens used are made of charcoal-iron, and punched, but the holes are as fine as a 40-mesh grating. The pulverised material on coming through the gratings flows over copper-plates coated with mercury for a distance of 4ft., and then flows into vats, which are used for leaching with a solution of cyanide of potassium, each vat being 10ft. by 10ft. by 5ft. There is a filter-bottom made on a false bottom of the vat, on the top of which is placed a coarse cloth, and Mr. Adams found by conducting this process that better results were obtained by placing a layer of coarse quartz-sand on the top of the cloth, as that prevented the slimes from getting down, and tended to make the cloth pervious to filtration. He runs the tailings into the vat to a depth of about 20in., and allows the water to filter through previous to putting in any cyanide solution. As soon as the water has filtered out of the tailings he digs the sand over, as though he were digging ground, for the purpose of loosening it and also of mixing the slimes thoroughly through the pulverised sand. He then closes the taps of the pipe below the false bottom, and puts on a six-tenth cyanogen solution to a depth of 6in. all over the vat, and allows it to saturate for, say sixteen hours; after which he opens the tap in the pipe below and allows the liquor to filter through the sand and through boxes containing zinc shavings. This liquor runs into a tank, and is again pumped up into the vat and leached through the sand a second time, after which the sand is washed with water, so as to get the whole of the cyanogen solution out of it. Mr. Adams states that the first solution, containing 0·6 per cent. of potassium-cyanide, after it is leached out, contains about 0·35 per cent. of this chemical; and the strength of the second solution is only perceptibly affected by the second leaching, inasmuch that it brings with it portion of the cyanogen left in the ore after the first leaching.

The value of the material he is leaching varies from 8dwt. of gold and 2oz. silver to the ton to a considerably less quantity of bullion, and the percentage of bullion saved varies considerably. Mr. Adams cannot account satisfactorily for this, but thinks a great deal is due to sufficient care not being taken in conducting the operations. The actual cost of leaching, he states, is about 6s. per ton. The quantity of solution used is one ton and a half to between seven and eight tons of ore.

When he first started this process of treatment he used to have a much greater depth of pulverised material in the vats; but he found that this did not leach satisfactorily, owing to the quantity of slimes, and therefore reduced the depth of sand to 20in., which, he states, gives good results.

The solution, after being used, is pumped up into the tank and made up again to the required strength. It is tested by evaporating a small quantity of the solution, say 10oz., in an evaporating dish, and finding the quantity of potassium-cyanide it contains, and then an extra quantity of crude cyanide is added to bring it up to the required strength. There is no getting away from the fact that there is a certain loss of cyanagon due to its decomposition by the oxygen in the air, and probably this decomposition is greatest when the liquor is trickling out of the pipe which leads from the bottom of the vat to the tanks containing the zinc-shavings; and in treating any ores having an acid composition they would tend to decompose the cyanagon and liberate hydrocyanic acid. This process is only yet in its infancy, and no doubt will be considerably improved on yet as regards the method of application. The cost of the crude cyanide is about 1s. 6d. per pound.

STATEMENT showing the RESULTS of Working the Mines in the OHINEMURI and WAIORONGOMAI DISTRICTS for the Year ended 31st March, 1893:—

Locality and Name of Mine.	Area.	Average Number of Men employed.		For Owners.		For Tributers.		Tailings treated.		Value of Ore sold.
		Wages-men.	Tributers.	Quartz crushed.	Gold obtained.	Quartz crushed.	Gold obtained.	Quantity.	Gold obtained.	
	A. R. P.			Tons.	Oz. dwt.	Tons.	Oz.	Tons.	Oz. dwt.	
Ohinemuri County—										
Maratoto—Maratoto	18 2 10	3	..	83	..	..	..	..	..	576oz.; 5s. per oz.
Karangahake—										
Ivanhoe and Truro	42 0 0	2	4	220	138 0	115	109	..	..	51 tons; £40 per ton.
Woodstock	30 0 0	10	..	110	467 0	..	..	..	..	3,266 oz.; £2 per oz.
Crown	116 0 0	112	..	394	45 0	..	..	..	..	5½ tons; £33 per ton.
Talisman	30 0 0	2	..	..	..	..	..	..	..	
Earl of Glasgow	27 0 26	3	..	5	28 0	..	..	..	..	
Diamond	9 3 12	2	..	4	27 0	..	..	..	..	
Imperial	10 2 14	1	..	3	15 0	..	..	..	..	
Sundry Claims	..	2	..	6	26 4	..	..	..	..	
Owharoa—Smile of Fortune ..	12 3 2	10	3	480	168 0	130	68	..	..	
Waitekauri—Jubilee	103 0 15	8	..	140	102 0	..	..	..	..	
Waitekauri North—Golden Cross	26 0 20	6	..	2	29 0	..	..	..	..	
Komata—Komata Gold-mining Company	60 0 0	50	..	2,000	..	..	..	..	..	6,680 oz.; £5,632.
Waihi—										
Waihi	422 0 0	150	..	18,279	..	..	..	..	..	29,681oz. 10 dwt.; £48,809 1s 1d.
Silverton	83 0 38	12	..	800	500 0	..	..	..	..	
Totals	991 1 17	373	7	22,526	1,545 0	245	177	..	..	
Piako County—										
Waiorongomai—New Find ..	31 0 36	16	4	853	540 0	186	60	1,650	297 14	
Newshams	5 0 0	3	..	480	280 0	..	..	..	..	
Totals	36 0 36	19	4	1,333	820 0	186	60	1,650	297 14	

COMPARATIVE STATEMENT of RETURN for HAURAKI DISTRICT for the Years ended 31st March, 1893 and 1892 respectively.

Name of County.	Area.	Average Number of Men employed.		For Owners.						For Tributers.		Tailings.	
		Owners and Wages-men.	Tributers.	Quartz crushed.	Mullock.	Gold obtained.	Bullion.	Value.	Ore Value.	Quartz crushed.	Gold obtained.	Quantity Treated.	Gold obtained.
							1893.						
	A. R. P.			Tons cwt. lb.	Tons.	Oz. dwt.	Oz. dwt.	£ s. d.	£ s.	Tons cwt. lb.	Oz. dwt.	Tons.	Oz. dwt.
Coromandel	523 0 38	212	42	12,022 1 21	..	10,553 1	..	..	..	381 6 15	1,377 15	2,760	1,023 4
Thames ..	1,013 1 10	423	253	25,106 11 25	21,106	19,325 10	3,985 0	2,182 11 8	..	13,025 0 0	7,531 12	19,309	4,478 12
Ohinemuri .	991 1 17	449	7	22,526 0 0	..	1,545 0	40,203 10	61,117 13 9	2,221 10	245 0 0	177 0	..	..
Piako ..	36 0 36	19	4	1,333 0 0	..	820 0	..	..	..	186 0 0	60 0	1,650	297 14
Total ..	2,564 0 21	1,103	306	60,987 12 46	21,106	32,243 11	44,188 10	63,300 5 5	2,221 10	13,837 6 15	9,146 7	23,719	5,799 10
							1892.						
Coromandel	668 0 23	*240	36	12,203 1 40	..	11,170 16	..	..	..	391 10 0	875 15	435	144 13
Thames ..	945 1 30	568	156	39,331 12 62	21,953	27,461 12	9,864 7	7,874 5 0	..	7,865 0 40	4,427 19	17,000	3,981 15
Ohinemuri .	697 3 8	319	9	13,503 0 0	..	610 11	20,673 5	25,974 15 0	2,581 0	362 0 0	411 8	..	..
Piako ..	86 2 32	21	8	680 0 0	..	365 4	..	..	..	917 0 0	305 3	1,125	308 5
Total ..	2,398 0 13	1,148	209	65,717 13 102	21,953	39,608 3	30,537 12	33,849 0 0	2,581 0	9,535 10 0	6,020 5	18,660	4,434 13

	1893. £ s. d.	1892. £ s. d.
Estimated value of gold	123,872 3 6	139,640 18 0
Value of bullion	63,300 5 5	33,849 0 0
Value of ore sold	2,221 10 0	2,581 0 0
	£189,393 18 11	£176,070 18 0

Increase for 1893 .. .. £13,323 0s. 11d.

It will be seen that, taking the whole of the mining operations in the North Island last year, the value of the gold and bullion is £13,323 more than for the year previous. The following comparative statement will show at a glance the district in which the increase has largely taken place :—

—	1891–92.		1892–93.		Increase for 1892–93.		Decrease for 1892–93.	
	Gold.	Value of Bullion and Ore sold.	Gold.	Value of Bullion and Ore sold.	Gold.	Value of Bullion and Ore sold.	Gold.	Value of Bullion and Ore sold.
	Oz.	£	Oz.	£	Oz.	£	Oz.	£
Coromandel ...	12,191·20	...	12,954·00	...	762·80	...	...	...
Thames	35,871·30	7,875·25	31,335·70	2,182·60	...	...	4,535·60	5,692·65
Ohinemuri ...	1,021·95	28,555·75	1,722·0	63,339·20	700·05	34,784·00	...	...
Waiorongomai ...	978·60	...	1,177·70	...	139·10	...	...	...
	50,063·05	36,431·00	47,189·40	65,521·80	1,601·95	29,090·80	2,873·65	5,692·65

It will be seen from the above statement that there has been a decrease last year in the actual quantity of free gold obtained to the extent of 2,873oz. 13dwt., but that there has been an increase in the value of bullion obtained to the extent of £29,090 16s. It will, however, be observed, by referring to the table in which the estimated value of the gold is given for 1892 and 1893, that the value last year was £15,768 14s. 6d. less than for the former one.

STATEMENT showing the whole of the QUARTZ-CRUSHING MACHINES and APPLIANCES for treating Auriferous and Argentiferous Ores in the HAURAKI MINING DISTRICT for the Year 1892–93.

Locality where Machine is situated.	Name of Machine.	Number of Rock-breakers.	Number of Stamps.	Number of Ore-crushers and Lamberton Mills.	Number of Berdans.	Number of Pans.	Number of Settlers.	Number of Mortars.	Number of Retorts.	Number of Furnaces for Gold-melting.	Number of Furnaces for Assay purposes.	Number of Plants for Cyanide Process.	Concentrating Plant.	Driven by Steam-power.	Driven by Water-power or Hand-power.
															w. h
Coromandel County—															
Coromandel ..	Kapanga	..	10	..	2	..	..	1	2	..	..	..	..	1	..
" ..	Telephone ..	..	15	..	1	..	..	1	2	..	..	..	..	1	..
" ..	Corby	..	9	..	8	..	..	1	2	..	..	..	..	..	1 0
Tokatea	Tokatea	..	15	..	2	..	..	1	5	..	..	..	..	1	..
Opitonui ..	Lanigan's ..	1	10	..	2	..	..	1	2	..	..	..	..	..	1 0
Owera	Owera	1	10	..	4	..	..	1	2	..	..	..	..	..	1 0
Kuaotunu ..	Try Fluke ..	..	11	..	3	2	..	1	2	..	..	1	..	1	..
" ..	Great Mercury ..	..	10	..	1	4	2	4	1	..	1	1	..	1	..
" ..	Red Mercury ..	..	10	..	1	4	..	1	2	..	..	..	..	1	..
" ..	Curtis's	..	10	..	2	4	..	1	2	..	..	..	..	1	..
" ..	Mariposa ..	..	10	..	1	3	1	1	1	..	..	..	..	1	..
		2	120	..	27	17	3	14	23	..	1	2	..	8	3 0
Thames County—															
Tapu	Pepper's	..	15	..	3	..	..	3	3	1	..	..	..	..	1 0
" ..	Bulls's	..	6	..	2	..	..	1	1	..	..	..	..	1	..
Waiomo ..	Monowai	1	..	..	1	4	2	1	1	..	..	..	..	..	1 0
Karioi	Bone-mill ..	..	3	..	..	1	..	1	1	..	..	1	..	1	..
Tararu	Sylvia	..	10	..	1	..	..	1	1	1	1	1	1	..	1 0
"	Dixon's	..	28	..	7	2	..	1	1	..	..	..	..	..	1 0
"	Norfolk	..	40	..	6	..	..	..	2	..	..	..	1	..	1 0
Karaka ..	Claremont ..	..	..	..	1	..	..	1	1	..	..	..	..	..	1 0
" ..	Taylor's	..	6	..	3	..	..	1	1	..	..	..	..	..	1 0
" ..	Lovatt's	..	..	..	20	4	..	1	3	..	1	..	..	..	1 0
" ..	Karaka	..	5	..	2	1	..	1	1	..	..	..	..	..	1 0
Otunui	Eureka	..	12	..	4	..	..	2	1	..	..	..	..	1	..
Puriri	Puriri	..	6	..	2	..	..	1	1	..	..	..	..	..	1 0
"	Gillon's	..	16	..	4	..	..	1	1	..	..	..	..	..	1 0
Tairua	Bonnie Scotland ..	..	20	..	6	..	..	2	1	..	..	..	..	1	1 0
		1	167	..	62	12	2	18	20	2	2	2	2	4	11 0
Thames Borough ..	Brown's	..	..	..	4	8	4	..	2	..	..	..	..	..	1 0
" ..	Berry's	..	1	..	3	..	..	1	2	..	..	..	..	..	1 0
" ..	Horne's	..	..	..	1	3	..	1	2	..	..	..	..	..	1 0
" ..	Kuranui	..	20	..	10	..	..	1	1	..	..	..	..	..	1 0
" ..	Moanataiari ..	..	41	..	21	1	..	3	4	..	..	..	..	..	1 0
" ..	Onslow	1	..	..	2	9	..	..	..	1	..	..	..	..	1 0
" ..	Comer's	..	20	..	5	..	1	2	..	..	..	..	..	..	1 0
" ..	Bawden's	..	..	..	2	13	..	..	1	1	..	..	..	..	1 0
" ..	Saxon	..	33	..	8	3	..	2	2	1	1	..	..	..	1 0
" ..	Cambria	..	21	..	13	1	..	1	2	..	..	..	..	..	1 0
" ..	Waiotahi ..	..	21	..	5	..	..	2	2	1	..	..	..	1	..
" ..	Fame and Fortune	..	21	..	16	..	..	1	2	..	..	..	..	..	1 0
" ..	School of Mines ..	..	2	..	1	1	1	1	2	1	1	..	..	..	1 0
" ..	Bank of New South Wales	..	..	..	..	..	..	2	..	2	1	..	..	..	0 1
" ..	H. P. Stark ..	..	..	..	..	..	..	..	..	..	1	..	..	..	0 1
" ..	Bank of New Zealand	..	..	..	..	..	..	2	..	3	..	..	..	..	0 1
" ..	M. von Bernewitz ..	..	..	..	..	..	..	..	..	..	1	..	..	..	0 1
" ..	Pahau Street ..	..	..	..	4	2	..	1	1	..	..	..	..	..	1 0
" ..	Bulls's	..	23	..	14	..	..	2	6	1	1	..	..	..	1 0
" ..	Fairmile	..	..	..	1	..	..	1	..	..	1	..	..	..	0 1
		1	203	..	110	41	6	23	29	11	7	..	..	1	14 5
Ohinemuri County—															
Maratoto ..	Maratoto	..	..	..	..	2	1	1	2	1	..	..	..	..	..
Paeroa	C. Rhodes ..	1	..	..	..	..	..	2	1	1	1	..	..	..	0 1
Karangahake ..	Crown	2	20	..	..	16	8	..	..	..	..	1	..	..	1 0
" ..	Ivanhoe	..	4	..	..	2	1	1	2	1	..	..	..	..	1 0
Owharoa ..	Smile of Fortune ..	..	15	..	2	..	..	1	2	1	..	..	..	..	1 0
Waitekauri ..	Waitekauri ..	1	30	..	..	6	3	1	4	..	..	1	..	..	1 0
" ..	Jubilee	..	10	..	5	2	1	1	2	..	..	..	..	1	..
" ..	Mangakara ..	..	9	..	3	..	..	1	2	..	..	..	..	..	1 0
Waihi	Waihi	2	60	..	..	16	8	2	6	1	1	1	..	1	1 0
"	Silverton	..	15	..	1	2	1	1	3	..	..	1	..	..	1 0
		6	163	..	11	46	23	11	24	5	2	4	..	2	7 1
Piako County—															
Waiorongomai ..	Te Aroha	1	20	..	..	..	..	2	4	1	1	1	..	..	1 0
City of Auckland ..	Young's	..	2	..	..	2	2	1	2	..	1	..	..	1	..
" ..	Bank of New Zealand	1	..	..	..	1	1	2	6	4	2	..	..	..	1 0
" ..	Stanley Street ..	..	..	1	1	2	2	2	2	1	1	..	..	1	..
		1	2	1	1	5	5	5	10	5	4	..	..	2	1 0
	Totals ..	12	675	1	211	121	39	73	110	24	17	9	2	17	37 6

The following table shows the number of tons of stone and mullock crushed, and the yield of gold, from the northern goldfields since the returns have been supplied to the Mines Department. The Thames returns include the Ohinemuri District up to 1886–87 :—

District.	Number of Tons of Quartz and Mullock crushed or sold.	Yield of Gold.	Average Yield of Gold per Ton.
		Oz.	Oz. dwt. gr.
Coromandel—			
1st April, 1880, to 31st March, 1881 ...	720	4,960	6 18 0
" 1881, " 1882 ...	3,358	7,352	2 4 0
" 1882, " 1883 ...	2,907	7,577	2 12 0
" 1883, " 1884 ...	1,043	4,018	3 17 0
" 1884, " 1885 ...	456	3,201	7 0 0
" 1885, " 1886 ...	550	3,382	6 3 0
" 1886, " 1887 ...	305	4,170	13 13 0
" 1887, " 1888 ...	1,923	6,774	3 10 5
" 1888, " 1889 ...	2,149	8,090	3 15 7
" 1889, " 1890 ...	1,690	6,708	3 19 9
" 1890, " 1891 ...	5,650	9,838	1 14 19
" 1891, " 1892 ...	13,029	12,191	0 18 17
" 1892, " 1893 ...	15,163	12,954	0 17 2
Totals	48,943	91,215	1 17 7
Thames—			
1st April, 1878, to 31st March, 1879 ...	41,917	57,207	1 7 7
" 1879, " 1880 ...	33,017	59,576	1 16 2
" 1880, " 1881 ...	32,405	53,154	1 12 19
" 1881, " 1882 ...	30,698	45,803	1 9 20
" 1882, " 1883 ...	25,867	43,311	1 13 12
" 1883, " 1884 ...	34,228	54,878	1 12 2
" 1884, " 1885 ...	31,496	37,705	1 4 4
" 1885, " 1886 ...	35,998	61,540	1 14 4
" 1886, " 1887 ...	34,827	38,142	1 1 22
" 1887, " 1888 ...	32,819	35,949	1 1 11
" 1888, " 1889 ...	47,363	35,796	0 15 3
" 1889, " 1890 ...	60,753	33,817	0 11 14
" 1890, " 1891* ...	61,756	38,113	0 12 8
" 1891, " 1892 ...	86,150	45,735	0 10 15
" 1892, " 1893 ...	78,547	35,322	0 8 22
	667,841	676,048	1 0 5
Ohinemuri—			
1st April, 1887, to 31st March, 1888 ...	2,388	3,406	1 8 13
" 1888, " 1889 ...	3,795	3,679	0 19 9
" 1889, " 1890 ...	4,773	8,564	1 15 21
" 1890, " 1891 ...	9,902	†12,914	1 6 2
" 1891, " 1892 ...	13,865	‡23,659	1 14 2
" 1892, " 1893 ...	22,771	§43,405	1 18 3
	57,494	95,627	1 13 6
Te Aroha—			
1st April, 1883, to 31st March, 1884 ...	4,262	4,629	1 1 17
" 1884 " 1885 ...	11,042	9,506	0 17 5
" 1885 " 1886 ...	6,552	4,489	0 13 17
" 1886 " 1887 ...	4,743	3,658	0 15 10
" 1887 " 1888 ...	7,166	2,918	0 8 3
" 1888 " 1889 ...	1,381	1,113	0 16 3
" 1889 " 1890 ...	4,894	‖20,416	4 3 10
" 1890 " 1891 ...	280	557	1 19 18
" 1891 " 1892 ...	2,722	979	0 7 5
" 1892 " 1893 ...	3,169	1,178	0 7 2
Totals	46,211	49,443	1 1 9
Grand totals from North Island ...	820,489	912,333	1 2 5

* This includes 50,856 tons of mullock crushed the last two years. † The gold obtained includes 42,331oz. bullion. ‡ Includes bullion, 22,737oz. § includes bullion, 41,683oz. ‖ Is bullion worth only 11s. 6d. per ounce ?

MIDDLE ISLAND.

MARLBOROUGH DISTRICT.

Waikakaho.

A large expenditure has been made at Waikakaho by the Ravenswood Company in opening up the quartz-reefs and erecting machinery, but the result of working has proved very unsatisfactory. There is a large body of stone carrying a little gold ; but no one who prospected the quartz taken out

and stacked ready for crushing at the time the battery and aërial tramway were being constructed would have anticipated the small return obtained from the first crushing. Several parcels were crushed with nearly the same result; and what was termed the low-grade portion yielded nearly as much per ton as that in which a good deal of gold could be seen. The last crushing of 275 tons is said to have only yielded 35oz. gold, being about 2dwt. 13gr. of gold to the ton. Some samples of the ore from this company's claim were sent to the Cassel Company and treated by them, which showed it to be payable ore for working; and there is a probability of the lodes in this locality being yet worked remuneratively. The company have a first-class plant on the ground; but it is very questionable if they have any one in their employ who understands properly the system of extracting the gold from the ore by amalgamation and battery treatment. The company have exhausted all their available capital and have suspended operations. The total quantity of ore crushed was 950 tons, which yielded 112oz. 10dwt. gold.

Collingwood District.

There is only one quartz-mine of any note being worked in this district—namely, that belonging to the Johnston's United Company, and situate in Bedstead Gully. The lode in this mine is different from any other quartz lode in the colony. It lies almost horizontal in places, or at a very slight inclination, and here and there it dips down for a few feet nearly vertical and runs flat again. At the places where the lode dips away there are always good patches of gold, but the general character of the stone is very poor. According to the battery returns for the year ending the 31st March last, 5,547 tons of stone was crushed for a yield of 1,097oz. gold, being an average of nearly 3dwt. 23gr. of gold per ton. The most of the lode is worked out on the present level, and it will take a considerable sum to construct a new one, and it is questionable if the present company will undertake it.

Reefton District.

The returns from this district for last year show a considerable falling-off in the yield of gold. During the year ending the 31st March last, 37,693 tons of quartz was crushed, which yielded 20,171oz. gold, representing a value of £80,894 5s. 1d.; whereas for the previous year there was 35,562½ tons of quartz crushed, which yielded 23,390oz. gold, representing a value of £93,885 5s. 1d., showing a falling-off in the yield of gold last year of 3,219oz., representing a value of £12,991. There have been calls made during the year to the extent of £18,799 15s. 10d., and £16,900 has been paid in dividends. The following comparative statement is taken from tables prepared by Mr. Hindmarsh, of Reefton, on the number of tons of stone crushed and yield of gold therefrom for the years 1891 and 1892 :—

Name of Company.	Year ending 31st December, 1892.			Year ending 31st December, 1891.		
	Gold.	Quartz.	Dividends.	Gold.	Quartz.	Dividends.
	Oz.	Tons.	£	Oz.	Tons.	£
Globe	4,651	9,452	7,200	3,654	8,190	3,600
Progress	4,035	10,085	1,200	3,452	6,130	2,400
Cumberland	3,484	3,067	4,200	2,901	3,300	4,200
No. 2 Keep-it-Dark	1,996	2,889	2,200	2,876	4,360	5,400
Big River	1,965	1,219	2,400	3,507	1,512	9,600
Golden Lead	872	4,633	...	448	1,640	...
Energy (private company)	656	808	...	420	912	...
Fiery Cross	626	762	...	2,401	1,818	5,643
Fiery Cross tailings	145	...	...	...	...	...
Keep-it-Dark	573	1,710	...	1,056	3,258	1,000
Gallant	454	1,192	600	93	221	...
Golden Fleece	382	210	...	...	...	...
Inglewood	373	444	...	440	600	...
Inkerman	312	651	...	1,317	1,908	500
Venus (tribute)	250	419	...	405	670	...
Welcome	210	182	...	84	28	...
Welcome, tailings	85	...	...	...	...	...
Wealth of Nations	147	556	...	339	1,155	...
Wealth of Nations, tailings	112	...	...	116	...	...
Royal (tribute)	140	169	...	90	114	...
Homeward Bound	55	17	...	159	45	...
A1	43	3	...	124	6½	...
Hercules	40	100	...	214	383	...
Golden Treasure	...	...	...	66	140	..
Golden Point	...	...	..	36	3	...
Hard To Find	...	...	...	17	60	...
Result	...	...	...	15	15	...
Totals	21,636	38,561	17,800	23,204	36,468½	32,343
Alluvial gold—						
Purchased by banks	4,185	...	...	4,113	...	...
Other sources, say	900	...	...	900	...	...
Totals	26,721	38,561	17,800	28,217	...	...
From 1872 to 1892	544,023	578,885	526,851	...	...	...

Total value of gold yield, including that obtained from alluvial workings, as given by Mr. Hindmarsh, since 1872, £2,127,384.

Notwithstanding that there has been a large decrease in the yield of gold last year from this district, the quantity obtained is 5,580ozs. more than was produced in 1885–86, and 3,624oz. more than was obtained in 1883–84. The large decrease last year is due in some measure to some of the mines having suspended operations, and the mines at Boatman's, which formerly were large gold-producers, having been worked out at their present levels. The Inkerman Company had either to go into liquidation or be sold by the mortgagee, the present proprietor of this company being Mr. E. W. Mills. The Keep-it-Dark Company, which formerly obtained a considerable quantity of gold every year, did not get sufficient to pay working expenses last year; indeed, the whole of the mines in the vicinity of Reefton have the lodes at their upper levels pretty well taken out, and, the profits on the workings having been divided from time to time without laying by a reserve fund, the present shareholders, of whom many purchased their shares far above their normal value, have not the means of carrying on prospecting operations at the lower levels to see whether fresh discoveries will be made at greater depths than hitherto worked.

That portion of the district which lies between Devil's Creek and the Big River is now likely to come to the front, though there is still a great part of this portion of the country where little or no prospecting has been carried on; and even on the supposed line of reefs that the Gallant Scotia, Sir Francis Drake, Happy Valley, Cumberland, and Golden Lead Companies are working, there are a number of licensed holdings held on which no work has been done. It is in this part of the district where fresh developments are likely to take place, as auriferous lodes are now known to exist, and there is still a stretch of about six miles between the Kaiapoi holding and the Big River where no claims have yet been taken up.

The following statement will show the comparative returns from the mines in this district for the last eleven years, ending the 31st March in each year:—

Year.	Calls made.	Dividends declared.	Number of Tons of Quartz crushed.	Yield of Gold.	Value of Gold.	Yield per Ton.
	£	£	Tons.	Oz.	£ s. d.	Oz. dwt. gr.
1882–83	61,345	32,600	18,928	19,194	74,856 12 0	1 0 7
1883–84	49,456	16,500	23,433	16,547	64,533 6 0	0 14 3
1884–85	29,333	34,100	34,349	23,997	93,588 6 0	0 13 23
1885–86	24,565	14,500	27,198	14,591	56,904 18 0	0 10 18
1886–87	21,596	33,450	23,930	21,143	83,171 15 5	0 17 14
1887–88	30,432	17,550	24,403	16,775	66,030 11 5	0 13 18
1888–89	38,919	16,688	28,564	18,663	72,720 18 0	0 13 4
1889–90	27,531	18,250	32,394	17,780	69,676 12 1	0 10 16
1890–91	20,404	27,325	39,643	23,347	91,998 8 10	0 10 19
1891–92	25,956	30,743	35,562	23,390	93,885 5 1	0 13 3
1892–93	18,800	16,900	37,693	20,171	80,894 5 1	0 10 16

It will be seen from this that there are only four years in this period in which the yield of gold was more than in the present one, and although the yield per ton has fluctuated every year, still it shows very little variation last year from the former ones.

The following is a statement showing the different companies that have been engaged in mining in the Reefton District since it was opened, showing the amount paid in calls; dividends received; the number of tons of stone crushed; the yield of gold therefrom; and the value of the gold produced:—

Name of Company.	Calls made.	Dividends declared.	Stone crushed.	Yield.	Value.
	£ s. d.	£ s. d.	Tons.	Oz.	£ s. d.
All Nations	400 0 0	...	...	...	...
Alston	100 0 0	...	...	...	...
Alexandra	600 0 0	...	394	168	651 0 0
Argosy	1,687 10 0	...	...	...	...
Argus	500 0 0	...	82	105	407 6 4
A1	350 0 0	9 0 0	167	...	660 17 1
Ajax	...	2,504 0 0	6,890	6,441	24,958 17 6
Anderson's Creek	...	475 0 0	6,791	5,363	20,780 12 6
Big River	3,500 0 0	4,200 0 0	2,144	2,905	11,579 0 11
Big River Extended ...	2,400 0 0	9,600 0 0	2,497	4,792	18,075 7 0
Bannockburn	450 0 0	...	...	...	...
Britannia Extended ...	104 3 4	...	...	...	...
Blue Sky	300 0 0	...	...	...	...
Britannia Quartz Company ...	416 13 4	...	...	...	...
Band of Hope	...	...	390	25	96 5 0
Boatman's Creek	...	...	138	122	472 15 0
Chicago	600 0 0	..	...	..	...
Cumberland	2,400 0 0	10,800 0 0	7,582	7,732	31,407 19 8
Caledonian Extended ...	651 0 0	...	...	...	...

QUARTZ-MINING COMPANIES engaged in the REEFTON DISTRICT—*continued.*

Name of Company.	Calls made.	Dividends declared.	Stone crushed.	Yield.	Value.
	£ s. d.	£ s. d.	Tons.	Oz.	£ s. d.
Caledonian	...	2,250 0 0	546	2,052	7,951 10 0
Dauntless Extended ...	550 0 0	...	...	...	...
Durham	800 0 0	...	...	...	...
Dillon	350 0 0	...	...	...	...
Eureka Extended	10,195 0 0	...	...	...	...
Eureka	5,666 13 4	...	...	...	...
Eclipse	100 0 0	...	...	...	...
Empress	1,850 0 0	...	...	...	...
Exchange	2,200 0 0	...	...	...	...
Energy	...	...	4,211	2,197	8,645 11 9
Edinburgh	100 0 0	...	...	...	...
Energetic	...	21,900 0 0	59,080	30,811	119,322 7 8
Eldorado	...	...	478	653	2,530 7 6
Great Eastern	1,103 0 0	...	...	...	...
Fiery Cross Extended ...	4,824 10 0	9,243 0 0	8,372	7,894	31,436 3 4
Fraternal	300 0 0	...	...	...	...
Frying-pan	687 10 0	...	...	...	...
Gallant	3,900 0 0	600 0 0	1,981	650	2,589 4 6
Globe	14,775 0 0	40,000 0 0	60,033	30,410	120,462 0 0
GoldenTreasure	19,000 0 0	4,300 0 0	9,179	5,858	22,773 14 1
General Gordon	1,500 0 0	...	...	...	...
Golden Point	7,350 0 0	...	1,005½	333	1,295 16 10
Golconda	200 0 0	...	...	...	...
Golden Hill	1,900 0 0	...	39	9	36 7 1
Guide	100 0 0	...	...	...	...
Golden Lead	4,600 0 0	...	8,010	1,637	6,535 8 1
Golden Bar	400 0 0	...	...	...	...
Golden Arch	...	...	149	139	538 12 6
Golden Ledge	...	...	1,831	552	2,039 0 0
Golden Fleece Extended ...	6,773 0 0	55,000 0 0	25,087	31,753	123,070 12 0
Hercules	3,900 0 0	1,700 0 0	1,388	1,244	4,867 8 6
Homeward Bound	8,725 0 0	...	62	213	859 13 7
Happy Valley	3,150 0 0	...	127	29	110 19 1
Hudson	100 0 0	...	...	...	...
Hard to Find	1,650 0 0	...	60	17	67 0 0
Hopeful Extended	2,103 2 6	40,425 0 0	12,898	21,129	81,698 0 7
Heather Bell	...	...	60	10	40 0 0
Inkermann	18,105 6 8	4,000 0 0	28,492	11,968	46,272 10 7
Inglewood Extended ...	3,150 0 0	2,700 0 0	9,103	5,693	22,047 0 0
Inangahua Low-level Tunnel	5,456 0 0	...	...	...	...
Independent	...	...	2,345	1,179	4,568 12 6
Italian Gully	...	...	879	512	1,984 0 0
Invincible	...	1,050 0 0	564	657	2,545 17 6
Imperial	...	...	811	468	1,813 10 0
Just in Time	11,667 13 4	15,666 0 0	12,459	15,384	59,832 2 10
Keep-it-Dark	3,125 0 0	108,033 0 0	112,194	59,596	232,010 6 5
Keep-it-Dark No. 2 ...	4,100 0 0	9,200 0 0	8,983	6,104	24,288 19 6
Kapai	800 0 0	...	...	...	...
Lord Edward	2,096 0 0	...	...	...	...
Lone Star	5,200 0 0	...	220	75	291 12 0
Londonderry	200 0 0	...	...	...	...
Lone Hand	850 0 0	...	...	...	...
London	250 0 0	...	...	...	...
Lady of the Lake	...	...	10	3	11 2 6
Lankey's Creek	...	...	680	73	277 19 3
Merrijigs	2,000 0 0	...	...	...	...
Maori Chief	100 0 0	...	...	...	...
Mount Morgan	150 0 0	...	...	...	...
Multum in Parvo	150 0 0	...	...	...	...
Mammon	...	...	15	15	60 0 0
Murray Creek	753 0 0	...	...	...	...
New Era	250 0 0	...	...	...	...
Nil Desperandum	11,112 3 4	287 10 0	6,858	3,393	13,165 7 7
New Britannia	437 0 0	...	...	...	...
New Golden Point ...	1,000 0 0	...	...	...	...
North Venus	200 0 0	...	...	...	...
National	1,200 0 0	...	...	...	...
No. 2 South Larry ...	...	...	7,514	4,129	13,999 17 6

QUARTZ-MINING COMPANIES engaged in the REEFTON DISTRICT—*continued.*

Name of Company.	Calls made.			Dividends declared.			Stone crushed.	Yield.	Value.		
	£	s.	d.	£	s.	d.	Tons.	Oz.	£	s.	d.
O.K.	100	0	0	...			...	...	...		
Oi Polloi...	100	0	0	...			...	...	...		
Oriental	...			...			3,360	1,190	44,603	2	6
Prince of Wales	150	0	0	...			...	...	...		
Progress	3,900	0	0	8,400	0	0	35,550	15,578	71,052	18	10
Pandora	2,400	0	0	...			699	364	2,611	3	2
Phœnix Extended... ...	700	0	0	4,533	6	0	2,190	2,918	11,272	11	10
Prima Donna	600	0	0	...			...	...	...		
Perseverance	...			...			57	19	73	12	6
Pactolus	...			1,000	0	0	108	498	1,929	15	0
Queen	50	0	0	...			...	...	...		
Reward	250	0	0	...			...	...	...		
Reform	3,090	0	0	...			704	445	2,145	15	6
Royal	1,850	0	0	...			277	229	915	8	7
Resolution	500	0	0	...			...	...	...		
Rise and Shine	150	0	0	...			...	...	...		
Rainy Creek Extended ...	6,739	0	0	...			1,782	209	809	0	0
Sir Francis Drake... ...	10,950	0	0	...			3,990	820	3,088	1	2
Scotia	4,443	10	10	3,000	0	0	594	1,284	5,062	17	6
Specimen Hill	9,103	6	8	...			2,238	1,168	4,073	6	6
Supreme	4,649	6	8	...			417	51	170	10	0
Sir Charles Russell ...	2,600	0	0	...			17	34	119	10	0
South Wealth of Nations ...	1,750	0	0	...			...	...	...		
South Hopeful	4,315	0	0	...			48	52	217	1	9
Stanley	100	0	0	...			...	...	...		
Success	300	0	0	...			...	...	...		
St. George	600	0	0	...			15	35	140	14	1
Southern Cross	...			...			21	43	166	12	6
Triumph	1,150	0	0	...			...	...	...		
United Devonshire ...	1,778	7	8	...			...	...	...		
Union	...			...			600	64	248	0	0
United Inglewood and North Star	...			...			1,591	821	3,181	7	6
United Band of Hope ...	...			...			160	49	187	17	6
Venus Extended	4,000	0	0	3,300	0	0	7,938	5,358	20,770	11	9
Victoria	...			...			1,422	717	2,778	17	6
Venus	700	0	0	600	0	0	2,466	1,419	5,524	2	6
Victory	...			...			1,155	905	3,506	17	6
Vulcan	...			400	0	0	919	586	2,077	0	0
Wealth of Nations Extended	6,500	0	0	...			4,077	2,007	7,883	2	0
Welcome	11,100	0	0	110,250	0	0	26,886	63,465	247,817	3	1
Walhalla Extended ...	1,437	0	0	...			238	354	1,396	5	3
Wealth of Nations ...	13,975	10	0	35,100	0	0	47,800	28,756	111,411	18	7
Welcome United	600	0	0	...			...	...	...		
	291,028	14	4	510,596	16	0	559,943	431,073	1,623,244	10	10

It will be seen from this that 559,943 tons of quartz has been crushed for a yield of 431,073oz. of gold, representing a value of £1,623,244 10s. 10d., while the money paid in calls amounts to £291,028 14s. 4d., and the dividends received, £510,596 16s.; which shows that there was £219,568 1s. 8d. more received in dividends than paid in calls. This may appear strange at the first sight to those who have invested their money in mining ventures in the Reefton District and lost it; but it must be remembered that very few people residing out of the district have taken up and held on to the original shares. The ground was first principally taken up by people residing in the place, who then formed a company and received a certain number of promoters' shares fully paid up, the outside shareholders having to pay the whole of the calls; while the dividends were distributed amongst the contributory shareholders and promoters. But the loss in mining ventures is not due to this to any great extent; it is due more to people purchasing shares far above their normal value: as for instance, the Keep-it-Dark shares were purchased at one time at £5 a share, while the money paid-up on each share was only 3s. 1½d.; and, again, £7 was paid for a share in the Welcome Company, when the money actually paid-up per share was only 5s. 9d. A great many may have lost money in mining ventures, but the most of it has been lost by purchasing shares for more than was actually paid up on them, and therefore the loss could not be attributed to or debited against a speculation in which the money was not actually used in developing the mines.

The question of proving the deep levels will have to be faced in this district very soon. Gold-bearing stone of a payable character has been proved to exist about 1,000ft. below the outcrop, and in the case of the Keep-it-Dark the lode has been worked down to a depth of 700ft. from the mouth of the shaft, but it would be over 1,000ft. to the outcrop on the hill. The Golden Fleece

shaft is down to a depth of about 720ft., and rich stone was got in that mine on the upper levels, although it did not go down to a great depth; but it is probable that fresh lodes will be discovered at lower levels, or in any case the present lodes may make again, and carry good gold-bearing stone. The stone in the upper levels in the claims in Murray Creek and Crushington localities are pretty well worked out, and the same may be said in regard to Boatman's. There is some new ground about Pain-killer, between Murray Creek and Boatman's, that is likely to turn out well; but sufficient prospecting has not yet been done there to prove whether it will be of any extent or not.

The following is a description of the state of the mines belonging to the principal gold-producing companies in the Reefton district for the past year; and as each company is referred to in the Inspector of Mines' report, and partly in the Warden's report, it is not necessary for me to again refer to the workings in each separate mine:—

Keep-it-Dark Company.—This company was for many years one of the greatest gold-producing companies in the Reefton District, but of late years they have done little more than pay expenses of working. According to their balance-sheet for the year ending the 20th December last, the total quantity of quartz crushed from their mine was 113,664 tons, which yielded 60,425oz. 9dwt. 7gr. of gold, representing a value of £234,422 14s. 7d. Of this, there was 1,643 tons crushed for the year ending December last, which yielded 558oz. 16dwt. of gold, valued at £2,216 0s. 10d., and the amounts received for crushing for other companies for the same period was £1,397 16s. 2d., making a total revenue from their mine and plant for the year £3,613 17s.; and the expenditure in connection with mining, crushing-battery, taxes, directors' fees, and other expenses, for the same period was £4,749 11s. 5d., wnich shows a direct loss on the working of £863 14s. 5d. for the year. The total amount of dividends paid by this company is £105,166 13s. 4d., and the total amount paid up in calls is £3,125, and the outstanding calls £222 17s.

The working last year has been carried on from the battery level, where an uprise was constructed for 184ft., and a block of stone taken out, and also between the No. 4 and No. 5 levels. There is a considerable quantity of stone at the low levels not taken out, as it is of too low grade to pay for working. On the No. 5 level, which is the deepest one, a winze was sunk for 37ft. on the lode, but at this depth the quartz pinched out. The question that the directors are now considering is the advisability of sinking the main shaft, and proving the ground to a greater depth. In reference to this the mine-manager, Mr. Raymond Fitzmaurice, in his annual report to the shareholders, states: "I wish to lay before the shareholders the future working of the mine, either to sink the main shaft or No. 2; in either case you will require an engine, as the water-wheel is too slow. If you should think of sinking the main shaft, nothing less than 500ft. will be any good, as the No. 2 shaft has prospected the ground 250ft. deeper. It will cost about £4 10s. per foot, and a drive of 600ft. at, say £1 10s. per foot, and will take about two years to complete. The No. 2 shaft is about 60ft. from the line of reef; you would require an air-winch to wind. The company have a compressor and air-pipes. I could haul from the No. 2 shaft 100ft. more, but it would be very slow work." It will be seen from what Mr. Fitzmaurice states that it would in any case be two years before the deep levels could be tested, and that the cost of sinking and driving would be about £3,150, which seems a small amount for the work he proposes to do; but, in addition to this, it is likely that a pumping and winding-engine would have to be erected.

During the year ending the 31st March last, 1,550 tons of stone was crushed for a yield of 470oz. gold, representing a value of £1,880, which is equal to 6dwt. 1½gr. of gold to the ton. If there was plenty of quartz, even of this grade, it should, with good appliances and the mine properly opened out, pay remuneratively for working.

No. 2 South Keep-it-Dark Company.—This company has not met with much success in carrying on their mining operations last year. Prospecting has been carried on by extending the Hercules level, but nothing payable was found. Quartz was stoped out between No. 2 level and the Hercules level, but the quantity of stone here was very limited. An uprise was constructed from No. 2 level, about 450ft. north of the main shaft, and a small run of stone met with. After following it up for a distance of about 70ft., a larger lode was disclosed, containing a fair amount of gold, and this lode appears to be of considerable extent. This company have purchased the adjoining mine from the Pandora Company for £500, and now contemplate sinking the main shaft and opening-out another level. According to the company's balance-sheet for the half-year ending the 24th March last, the total yield of gold from their mine amounted to 5,914oz. 13dwt. 13gr., representing a value of £25,516 6s. 1d., out of which dividends have been paid to the extent of £8,600. There was 539 tons of quartz crushed, for the six months referred to in the balance-sheet, which yielded 500oz. 14dwt. 9gr. of gold, representing a value of £1,994 17s. 3d.; and the expenditure in connection with working the mine for the same period, including the cost of crushing the stone, taxes, and directors' fees, &c., was £1,866 9s. 2d., which shows a profit on the workings of £128 8s. 1d. During the year ending the 31st March last, the returns from the crushing-battery shows that this company had 2,097 tons crushed at the Keep-it-Dark Battery, which yielded 1,502 oz.of retorted gold.

Wealth of Nations Company.—The auxiliary winding-shaft has been sunk to a depth of 150ft. below the 200ft. level, and a level opened out at the bottom of this shaft. Two new blocks of stone were met with in this level, but the crushings from the same show that it was of too low grade to be profitably worked. Payable stone has been found in an intermediate level, 250ft. below adit, but the extent of it is not yet known. A lower level is now in course of construction to test this block. During the year there was 721 tons of stone crushed, which yielded 218oz. of gold, representing a value of £872; and tailings were treated, which gave 99oz. of gold, representing a value of £396.

Hercules Company.—This company have completed the sinking of their shaft to a depth of 561ft., and have commenced to open out a level at this depth. It is expected to cut the lode in about 100ft. from the shaft, when it is anticipated that payable stone will be found. According to this

company's balance-sheet for the six months ending the 28th February last, the value of the gold obtained was £161 1s., the result from the crushing of 40 tons of quartz.

Globe Company.—This company is still continuing to be a large gold-producing one, and likely to continue so for some time to come. The principal workings last year have been carried on between No. 1 and No. 2 levels on the eastern lode. The No. 1 level has been extended for a further distance of 100ft., with the view of cutting another block of stone found on the surface, but so far no beneficial result has been got. The main shaft has been sunk to a depth of 125ft. below the No. 4 level, and another level constructed, which cut the lode at 216ft. from the shaft, it being about 4ft. 6in. in thickness. This level will give about 162ft. of backs. A considerable amount of prospecting and opening out has been done last year, which proves this property to be a good investment. During last year there was 9,297 tons of stone crushed, which yielded 3,584oz. of retorted gold, representing a value of £14,356, of this amount £2,700 was paid in dividends.

Progress Company.—This company's property adjoins that of the Globe, and promises to be a valuable investment for those interested in it. A considerable expenditure was incurred in opening out new levels. The main shaft has been sunk to a depth of 150ft. below No. 3 level, and a winze has also been sunk in the level, at some distance from the shaft, to the same depth. A chamber has been constructed at the bottom of the shaft, and a connection made between the bottom of the winze and the chamber. In constructing this drive the lode was cut through, having a width at this point of about 34ft., all of which is good payable stone. There is an intermediate level between No. 3 and No. 4, where the lode shows to be about 14ft. in thickness. Taking the present prospects in this company's mine, it will take a considerable time to work out the payable ore in sight. At one time, when the lode was not met with in No. 3 level, it became a question whether it had not been cut out; but now that is definitely determined, and good returns are anticipated for the next twelve months. According to their balance-sheet for the six months ending the 31st January last, the value of the gold obtained for that period was £6,192 6s 1d., and the expenditure in connection with the mine and management of the company was £7,129 11s. 8d, which at that time showed that there was a loss on the six months' operations of £937 5s. 7d. The nominal capital of this company is £12,000, of which amount £2,400 has been paid to the promoters in paid-up shares, and £4,500 has been paid in calls. The total value of gold obtained up to 31st January last was £58,161 7s. 9d., of which amount £8,400 has been paid in dividends. The total expenditure in connection with the property since the company was formed is £60,007 8s. 7d. During the year ending 31st March last there was 9,695 tons of stone crushed which yielded 3,870oz. of gold, representing a value of £15,515, out of which dividends were paid to the extent of £1,200.

Cumberland Company.—This company has been very successful in carrying on their operations last year. Indeed, it is the most prosperous mining company in the Merrijigs locality of the Reefton District. A winze was put down from the No. 1 intermediate level, but on sinking 27ft. the lode was heaved, and the sinking of the winze was suspended. An uprise was constructed from the lower level to meet the winze, and when this was completed a cross-cut was made from the uprise at 35ft., down from the top of the winze, and a good lode was intersected, and has since been driven on for a distance of 102ft. About three months' crushing from this level gave a profit on the workings of about £3,000. According to their balance-sheet for the year ending the 31st March last, gold to the value of £16,703 was obtained, and the expenditure for the same period in mining operations and general expenses amounted to £8,449 17s. 5d., exclusive of outstanding liabilities at the beginning of the year, which were paid, amounting to £1,887 12s.; and dividends were paid to the extent of £6,600. This company was formed in July, 1890, with a capital of £24,000, of which £2,400 is paid up; and since their formation they have obtained gold to the value of £30,610 18s., and paid dividends to the extent of £10,800. Plans are now being prepared for the erection of a Cassel plant to treat the tailings. There is about 3,000 tons of tailings stacked, which is said to have an assay-value of from 16dwt. to 19dwt. per ton.

Golden Lead Company.—At the time of my visit to this company's mine they were working from a level about 174ft. below the crown of the hill, and which is constructed for a distance of about 400ft. A lower level with all connections has been constructed, the length of the main level being 432ft. The following is an extract from the mine-manager's (Mr. B. Sutherland's) report to the annual meeting of the shareholders: "This level with all connections has been constructed during the past twelve months. The total length of main level is 432ft., and the course of the lode having an easterly trend has brought the present end of the tunnel perpendicular with No. 1 level above; and about 100ft. distant from O.K. winze. There is an additional length of 72ft. of prospecting main level, which branches off to west of the lode being worked. Some very good specimen-stone was got here, but going under-foot. Winze and uprises from bottom-level total 206ft., and cross-cutting totals 80ft. Stoping from both levels totals five hundred fathoms for the year. You will see from the foregoing that we have 1,270ft. to the A1 boundary not tested in any way; all we know is that there is gold at both ends, and gold got on the surface, along the course of lode. A tunnel from O.K. Gully of about 950ft. would test this portion of the mine at a depth of about 300ft. under our present bottom level; and the water in O.K. Gully would serve for ventilating purposes. The gold got in branch level below is something altogether new and distinct from the lode being worked. As the water below this level is heavy, we could only test it for say 15 or 20ft. below the level (except at a serious cost) until drainage is provided. The working experience gained during the year proves that we are not at a sufficient depth to get permanent steady country, there being many heaves and slides with lode underlying at various angles and in different directions."

The auriferous quartz in this mine is in small veins and leaders, but these occur in what may be termed a defined lode. During the year ending the 31st October last they crushed 3,774 tons of quartz, which yielded 764oz. 8dwt. 9gr. gold, representing a value of £3,058 10s. 11d.; and the expenditure in connection with the working of the mine, crushing-battery, and aërial tramway, &c., for the same period was £3,542 9s. 11d., thus showing a loss on the working for that period of

£483 19s., which had to be made up from calls. During the year ending the 31st March last, 5,439 tons of stone was crushed, which yielded 937oz. gold, representing a value of £3,745 16s. 10d.

Big River Company.—This company carried on mining operations very successfully last year; but the former proprietors passed through many vicissitudes of fortune, sometimes having a broken lode and very little gold, and sometimes on good stone. The lodes in this direction appear to be very patchy. The work done last year can be seen from the report of the mine-manager, Mr. George Black, to the shareholders at their last half-yearly meeting: "The No. 3 level going north has been extended 30ft., making a total distance of 136ft. from the chamber. A cross-cut has been driven from the end of this level in a north-easterly direction to a distance of 65ft. to prospect for the stone cut through in the winze. An uprise has also been put up from the end of this level to connect with the winze sunk from No. 2 level. The height of the rise is 70ft. perpendicular, at the top of which we opened out on both sides of the winze, and have stoped up to within 20ft. of No. 2 level. On the block met with 55ft. from the chamber we stoped up for a height of 70ft., where the stone gave out, after which we did a considerable amount of prospecting in the hope of picking it up again, but failed to do so; fair stone has been left on this block along the floor of the level. No. 3 level has been extended south 143ft. towards the old reef, making the total distance 238ft. from the chamber. At a distance of 180ft. a cross-cut was put in to the westward a distance of 15ft., and at 220ft. another was put in in the same direction 30ft. without finding stone. The number of tons crushed up to December 3rd was 959, giving 1,520oz. of melted gold. At the battery a Pelton wheel and four berdans have been erected, other necessary alterations have been made to the machinery, and everything in connection with the battery and plant is now in first-class working order." During the year ending the 31st March last 1,441 tons of stone was crushed, which yielded 2,555oz. gold, representing a value of £10,215 10s. 3d., out of which £4,200 has been paid in dividends.

Fiery Cross Company.—This company has not met with success last year. Indeed, unless the stone is moderately rich at the lower levels it cannot be made to pay on the principle the low levels are opened up; and they cannot be tested to a much greater depth unless at a great expense. The principle of winding from auxiliary shafts in the levels is slow, and far more expensive than working directly from the main shaft; but many devices are adopted to save a few pounds at the time, even if it costs more in the long-run. During last year calls to the extent of £806 5s. have been made, and 180 tons of stone was crushed, which yielded 145oz. of gold, representing a value of £584 8s. 6d. All work in the mine is suspended, as the quartz is said to be all taken out on the present levels.

Welcome United Company.—An amalgamation has at last taken place of the Homeward Bound, the Eureka, and Welcome Companies, and prospecting will be carried on from the Eureka incline tunnel. Mining has been at a standstill in these companies' mines for some time. The Welcome Company on getting down to the lower level found the lode broken up, and not carrying sufficient gold to pay for working, and no work has been carried on for some time. During the time the mine was worked, gold to the value of £247,857 was obtained, and the lode passed into the Homeward Bound and Eureka Companies' ground; but neither of these companies could find stone payable for working. The three mines are now amalgamated, and the money contributed in calls by each of these companies have been as follows: The first Eureka Company went into liquidation after spending £5,666 13s. 4d., and the second company spent £10,195; making a total expended by the Eureka Companies of £15,861 13s. 4d; calls made by the Homeward Bound, £8,825; calls made by the Welcome Company, £11,100; Welcome United Company, £600: total, £36,386 13s. 4d.

Neither the Eureka nor Homebound Company ever received back any of the capital they invested, but the Welcome Company paid £110,250 in dividends. The work now proposed to be done is to connect the Eureka incline-tunnel with the No. 9 or lowest level in the Welcome Mine, and sink a shaft in that level to a depth of 250ft., thence take in a level from this so as to cut the lode on the boundary of the Welcome and Homeward Bound Mines, about 1,400ft. below the outcrop on the surface, which will test the deep levels in this part of the district.

Lyell District.

The principal mine in this district is the United Alpine, in which mining operations have been very successfully carried on last year. The workings have been carried on from the No. 7 or lowest level, which had to be constructed for a distance of about 240ft. before cutting the lode. This level now enables the lode to be worked to a depth of about 1,000ft. below the outcrop on the surface. A winze has been sunk from this level to a depth of 100ft., carrying stone of a payable character the whole of the distance, and it gets richer as it goes down. It is intended to open out a level from the bottom of this winze, and wind up the stone with an air-winch. The present appearance of this mine shows that there is a large body of stone of a payable character that can be worked from the No. 7 level, and the company will be enabled to pay dividends for a long time to come from the ore in sight. According to the company's balance-sheet for the six months ending the 29th April last, the value of the gold obtained for that period was £10,425 5s. 5d., and the expenditure in connection with the mine and crushing-battery for the same time was £7,043 17s. 4d., and £2,800 was paid in dividends. This company was formed in October, 1874, with a nominal capital of £48,000, of which £16,000 in paid-up shares were given to the shareholders; and during the nineteen years that the company has been in existence calls have been paid to the extent of £24,933 6s. 8d., and £54,666 13s. 4d. has been paid in dividends.

It is very gratifying to find that the lode is improving as it goes down. If a few lodes were proved to contain stone of a payable character at the deep levels it would give a new life to some of the mines, and hold out inducement for men to embark their capital in mining ventures. The mine-manager, Mr. John Wilcox, in his report to the shareholders at the last half-yearly meeting, made the following remarks in regard to the winze previously referred to: "The winze from No. 7 level has been sunk 100ft. since starting, and so far no water worth mentioning to contend with. We are taking 8ft. of stone in sinking, and as the foot-wall has not been touched yet, I

cannot say what size the reef is, but possibly it will prove to be over 16ft. in width for the distance sunk. The stone shows gold freely right through, and when opened out on will, I believe, exceed expectations. . . . . The prospects of your mine at present are better than at any time since I took charge, and a continuation of dividends may be expected."

The stone is not rich, but it is the great body of it and the ease with which it is got that makes it pay. The quantity of stone crushed for the six months referred to was 5,455 tons, which yielded 2,822oz. 18dwt. 4gr. of retorted gold, being an average yield of about 10dwt. 4gr. of gold per ton. The wages, goods, and timber for the mine for the period referred to amounted to £5,271 1s. 2d., and the wages, goods, and plant for battery for same period was £825 16s. 3d. The average cost, therefore, of mining was about 19s. 3d. per ton, and crushing about 3s. 3d. per ton, making the total cost of mining and crushing £1 2s. 6d. per ton; but if the total expenditure of the company, including rates, taxes, directors' fees, &c., is taken, it would amount to about £1 5s. 9d. per ton. The company have a large quantity of tailings stacked, and they have made application to the Cassel Company for permission to use the cyanide process; but as this company is erecting a plant at Boatman's, no steps will be taken towards the erection of a plant at the United Alpine Battery until the results of the treatment of the tailings at Boatman's are known. During the year ending the 31st March, 11,110 tons of stone was crushed, which yielded 6,292oz. of retorted gold.

Tyr Connell Company.—This company have purchased the crushing-battery and licensed holding belonging to the Crœsus Company, and have been working in their old claim last year on leaders, in which some very rich stone is occasionally got. They had 26 tons of stone crushed last year, which yielded 346oz. of gold.

United Italy Company.—This company is working their mine on tribute. The tributers have done a considerable quantity of work last year without getting much reward for their labours; they have constructed an adit for a distance of 600ft., and cut a leader which it is considered will prove payable for working, and they are now engaged in getting out stone. They crushed 20 tons of stone during the year for a yield of 24oz. of gold.

Lyell Creek Extended Company.—The operations of this company last year have consisted in extending their adit-level, which is constructed for a distance of about 3,000ft. It is expected to cut the Alpine Lode; but so far no lode has been got, but the indications are said to be getting more favourable for a lode to be found. A contract has recently been let to extend the adit 200ft., and when this distance is constructed it is intended to get a proper survey made, so as to determine the distance it will have to be continued before cutting the Alpine Reef. The company was formed in August, 1881, with a nominal capital of £24,000, of which £12,000 was given in scrip to the shareholders; and calls have been paid to the extent of £8,491 1s. According to the last balance-sheet submitted to the shareholders, they have expended £8,683 14s. 8d. since the formation of the company, of which amount £497 10s. 11d. was expended during the six months ending 22nd of December last.

The following table is compiled from the returns forwarded to the Inspector of Mines by the different crushing-machine owners, showing the number of tons of stone crushed, and the yield of gold therefrom. It may, however, be premised that in some instances these returns differ to some extent from the gold obtained by companies, as shown in their balance-sheets for the year ending the same period, which shows that either the one or the other is not altogether reliable:—

BATTERY RETURNS for the Year ending the 31st March, 1893.

Battery.	Quartz Crushed.	Amalgam.	Retorted Gold.
	Tons Lbs.	Oz.	Oz.
Waikakaho—Ravenscliffe	950 1344	...	112·10
Collingwood—Johnstone's United	5,547 0	2,603	1,097
Reefton—			
Venus Extended	1,336 0	3,064	1,039
Wealth of Nations	721 0	735	217
Wealth of Nations, tailings	...	407	112
Minerva	332 0	203	83
Inglewood Extended	520 0	1,430	467
Golden Fleece	320 0	1,150	426
	3,229 0	6,989	2,344
Boatmans—			
Welcome	48 0	259	71
Welcome, tailings	749 0	484	160
Homeward Bound	41 0	47	14
Homeward Bound, tailings	36 0	66	18
Fiery Cross	150 0	452	146
Fiery Cross, tailings	183 0	640	162
Argus	31 0	121	38
Argus, tailings	31 0	68	21
Mr. Boardman	0 198	1·30	0·10
	1,269 198	2,138·30	630·10

BATTERY RETURNS for the Year ending the 31st March, 1893—*continued.*

Battery.	Quartz Crushed.		Amalgam.	Retorted Gold.
	Tons	Lbs.	Oz.	Oz.
Crushington—				
Keep-it-Dark	1,550	0	1,574	478
Keep-it-Dark No. 2 South	2,097	0	4,596	1,502
Pandora	53	0	20	6·10
	3,700	0	6,190	1,986·10
Devil's Creek—				
Globe	9,297	0	10,994	3,539
Inkerman	392	0	451	167
Progress	8,484	0	10,638	3,688
Supreme	402	0	190	17
	18,575	0	22,273	7,411
Merrijigs—				
Golden Lead	5,439	0	2,666	936
Sir F. Drake	224	0	203	64
A1	3	448	101·5	44
Exchange	45	1120	3·10	0·16
Cumberland	3,952	0	12,664	4,339
	9,663	1568	15,637·60	5,383·16
Big River	1,444	0	7,690	2,603
Lyell—				
Alpine	11,110	0	16,734	6,292
Tyr Connell	26	0	659	346
United Italy	20	0	60	24
	11,156	0	17,453	6,662
Grand totals	55,534	870	80,973·90	28,228·46

WESTLAND DISTRICT.

Very little has been done towards developing the quartz workings in the Westland District, although a good deal of prospecting has been done at Taipo, Donnelly's Creek, Cedar Creek, Constitution Hill, and Rangitoto; but so far nothing of any large extent has been found. During the last year a few tons of stone were got up Donnelly's Creek, which gave a return showing that the leaders found were well worth prospecting. Mr. C. Porter has been working on a leader which varies from 1in. to 10in. in thickness near the junction of the two branches of Donnelly's Creek, and altogether he took out 45 tons of stone, which yielded, he informed me, 52oz. gold. Mr. Porter is now engaged in constructing a lower adit-level to work the leader to a greater depth. Moraline and party are prospecting higher up the left branch, and constructing an adit-level into the range, but the chances of striking a payable lode at the place where they are working is not great.

At Cedar Creek a prospecting drive was, at the time of my visit to this locality, being put in from the end of the lower adit-level in the William Tell Claim; but this work has been suspended for the present. Judging from the character of the country rock, there is a probability of stone of a payable character for working being found in this ground.

At Constitution Hill, Antonio Zala has been prospecting for years, and during an interview with him on my visit to Ross he stated that he first cut a leader in the face of the hill, and drove on it for some 65ft., finding a little gold in the stone. During last year he was engaged in constructing an adit-level about 300ft. lower than the first drive he put in, and had about 140ft. to go to cut the leader he found higher up the range. There are numerous quartz leaders and veins in this locality where the colour of gold is occasionally seen in the stone, and there are several large quartz lodes where no gold can be seen; but no prospecting has been done beyond that by Antonio Zala, who has been working there for the last five years.

OTAGO DISTRICT.

Nenthorn and Barewood.

There is now very little quartz-mining being carried on at Nenthorn; at the same time it is a place which ought to afford a good livelihood to a number of working-men. There are numerous auriferous leaders and veins of quartz in this locality running almost parallel with one another, which would pay working-men to take out and select stone for crushing but which would never pay a company to work. The mere fact of so many companies starting quartz-mining operations, and

rushing into the erection of machinery before testing the quantity of payable ore in their claims, was the means of killing the field and preventing men from trying to further prospect the ground. When once a place gets a bad name, unless it be some men residing in the locality, very few from other parts of the colony would care to go and spend money and time in visiting the field to examine it. The Crœsus Company had to suspend operations on account of the stone not carrying sufficient gold to pay the expense of working. This ground was again worked by a small party of miners with payable results. According to the returns furnished the department, the Crœsus Battery crushed 426 tons of stone last year, which yielded 403oz. of gold, namely:—

Surprise Claim	132	tons, which yielded	240	oz.	gold
Crœsus Claim	129	" " "	79	"	
Eureka Claim	75	" " "	36	"	
Blue Slate Claim	30	" " "	18	"	
Jacob and Party's Claim	60	" " "	30	"	

Bonanza Company.—This company's mine is situate between Nenthorn and Deepdale, and has been giving good returns to the shareholders ever since it was opened. The lode varies from 1ft. to 3ft. 6in., and it has been worked along the lode near the surface for a distance of 800ft. A shaft has been sunk on the eastern workings to a depth of 140ft. The lode here has a greater thickness than it has on the top levels: it is also richer, and said to be the best stone in the mine. Sinking this shaft could not be proceeded with, owing to the quantity of water to contend with, and it is contemplated to construct an adit-level from near a creek running parallel with the lode, which is expected will cut the reef at from 800ft. to 900ft., and will be about 400ft. below the workings at the shaft referred to. The crushing-plant belonging to this company consists of a Huntington roller-mill, 3ft. 6in. diameter, and grinding-pans, which are driven by a portable engine, using about seven tons of coal per week when working, which costs, delivered on the ground, £2 7s. per ton.

Barewood Reefs.—There have been several miners working the quartz lodes at Barewood, and, according to the battery returns from this locality, 1,970 tons of stone was crushed, which yielded 659oz. of gold. This is a locality where very little attention has heretofore been given, and it is gratifying to find the returns for the last year so encouraging.

Old Man Range.

There is a large extent of auriferous country in this range. The surface gravel is in most places greatly intermixed with quartz drift, and some good specimens of gold in quartz are found occasionally in carrying on hydraulic-sluicing operations on the face of the range. This was the case in the locality where White's Reef is now being worked; the surface gravel was first washed off, which gave good returns of gold for working, and, on the rock being laid bare, the reef on which work is now carried on was exposed to view. The proprietors of this claim, originally held by White's Reef Company, are Messrs. Syme Brothers. They have been carrying on operations steadily, and during last year they crushed 130 tons of stone, which yielded 119oz. of gold. They are now engaged in constructing a lower adit to open up the lode at a deeper level.

Crossan and Gray.—This party found a reef on the face of the range above Bald Hill Flat by sluicing away the surface gravel. There was a water-race brought on to this ground by Mr. Kemp, the proprietor of the hotel and store at Bald Hill Flat, and he gave the prospectors the use of the water to carry a cut into the ground to prospect it. In taking in this cut, two small leaders with gold-bearing stone were exposed to view. After taking down a cut on these leaders about 15ft. deep and a chain in length, the sides came in, and the cut had to be abandoned. A shaft was then sunk, and a lode about 4ft. in thickness struck, at about 6ft. below the bottom of the cut previously taken in. They went down to a depth of 25ft. on the lode and commenced blocking out, and up to the end of March last it was reported to me that they had crushed 315 tons of quartz, which yielded 766oz. of gold.

Macetown.

There were only two quartz-mining companies working mines in this locality last year—namely, the Premier Consolidated and the Sunrise. The latter company did very little work last year, as the previous crushing from their mine showed the stone of too low grade to pay for working, and they have sold their claim and plant to the Premier Consolidated Company, who have been carrying on continuous operations in and about their mine for the year. A low-level adit has been constructed for a distance of 1,410ft., and about 60ft. under the old workings. This is the lowest adit that can be taken in. At the time of my visit they had twenty men employed in and about the mine, and three men and two boys attending to the crushing-battery. A tramway has been constructed from the adit mouth for ten chains down the gorge, where a large stone paddock for holding quartz is erected. This paddock is capable of holding about 400 tons of quartz; and from the paddock to the crushing-battery, a distance of about seven chains, it was proposed to lay down a tramway and tip the quartz into a chute, so as to land it on the floor of the crushing battery in front of the stamp mortars. The lode which they are working varies in width from 1ft. to 2ft. 6in., but it is well defined and in a better looking country than it was on the upper levels, and, from the appearance of the lode, the quartz should contain more gold than it did on the upper levels. The mine is now well opened up, and the workings ought to be much more economically carried on than in former years.

The old overshot water-wheel for driving their crushing-battery has been substituted by a Pelton, and they find they can now do much more work. The crushing-battery consists of ten heads of stamps, and the one recently purchased from the Sunrise Company has also ten heads, so that they have now two batteries of ten heads each. They use an 8in. drop, and make seventy blows per minute; the stamps in the old battery being 600lb. each when new. There is a fair percentage of pyrites in the stone carrying gold; but, beyond what is collected on the blanket-tables,

the pyrites is not saved. They tried to find what the pyrites was worth by grinding a tubful in a berdan, and were astounded to get 10dwt. of gold; and this would not be more than 50 per cent of the gold in the pyrites if it were treated in a proper manner. When gold is in pyrites it is in a very finely divided-state, and in combination with sulphur, and only a small percentage of the gold can be got by amalgamation unless the pyrites is roasted and desulphurised. During last year 957 tons of stone was crushed, which yielded 945oz. of gold.

Tipperary Company.—This company's operations have been suspended for several years; but during last year the company was re-formed in London, with a capital it is said of £35,000, of which £10,000 is available. Mr. L. O. Beal, of Dunedin, has been appointed consulting engineer for both the Tipperary and Premier Companies; and Mr. John Eliott, the present manager of the Premier Company, is to have the management of both companies. The New Zealand shareholders, or really the vendors, are to receive £1,000 cash, and £9,000 in shares, for their interest. At the time of my visit Mr. Beal was making surveys of both mines, and he informed me that it was contemplated to construct a low-level adit into the Tipperary Mine, which would be about 1,800ft. in length, and be when completed 13ft. under the lowest level previously worked. There has been a large quantity of gold obtained from this mine, and there is a large lode still continuing to go down at the lowest level in the mine; but the expense of working the lode in the manner in which the old company was carrying on their operations previously to closing the mine was too great for the quantity of gold obtained. When the low-level adit is completed, this lode can be taken out at a far less cost.

Shotover.

Gallant Tipperary Company.—This company has stoped out the greater portion of the lode where the shot of gold occurs, to near the surface, and it will take a considerable amount to open out a lower adit-level. There is another block of stone above the present level, but they will require to drive from 450ft. to 500ft. to reach it. The present block they are working is from 4ft. to 6ft. in width, the quartz averaging about 7dwt. per ton. They had an average of six men in the mine and four men at the crushing-battery. During last year there was 1,170 tons of quartz crushed, which yielded 363oz. gold, representing a value of £1,397 9s.

Skippers.

The only company carrying on quartz-mining operations in this locality is the Phœnix. This has recently been re-formed in London with, it is said, a capital of £100,000, of which £50,000, either in cash or shares, is to go to the vendors. The new company were to take possession on the 31st March last. During last year they crushed 5,457 tons of stone, which yielded 1,920oz. gold; and at the time of my visit they had twenty men taking out quartz, ten men at dead-work, twelve men opening out levels, and six men prospecting. The total number, including battery hands, was fifty-eight. The lode they are working on varies considerably in width—in some places it is 5ft. wide, and at other places it is very narrow. The workings are all in the ground purchased from the Phœnix Extended Company. At the time the gold was first struck in this ground it was anticipated that there would be a very large amount of quartz of a payable character for working got from this new discovery; but the shot of gold only went about 40ft. on one side of the cross-cut, and 60ft. on the other, making the shot of gold 100ft. in length along the lode. There is no connection yet made with the old workings at the low level, and the manager is not certain as to which of the lodes in the old mine will correspond with the one he has recently been working.

The present electrical plant employed to drive the crushing-battery is proposed to be used for driving the air compressor, and two new dynamos are to be erected, and four motors to drive the battery; there is to be a motor to each ten heads of stamps. It is also proposed to erect the electrical plant at the junction of the right and left branches of Skipper's Creek, where considerably more power will be obtained to drive the dynamos. Mr. F. Evans, the former manager of this Company, is now in England, and it is said he has purchased a new electrical plant, and shipped it to the colony. The present crushing-battery is of thirty heads of stamps, twenty heads of which have a weight of about 600lbs. each when new, and ten heads about 750lbs. each, having a drop of from 7½in. to 8in., and making eighty blows per minute. There are no steps taken to stack the tailings as the manager stated they are valueless; but this assertion is open to question. Hardly any experienced mill-man can save a large percentage of the gold from blanket-tables alone, and it will probably be found yet that a very large percentage of the gold in the ore crushed has been washed down the creek.

In concluding my remarks on the quartz mines in the Otago District, it can be said that very little has been done in the way of prospecting quartz-lodes, attention being more directed to hydraulic-sluicing. The recent discoveries of Messrs. Crossan and Gray in the Old Man Range show that very rich lodes exist, and the large percentage of quartz-gravel in the alluvial drifts tends to prove that a great deal of the gold, if not all, came originally from auriferous lodes, leaders, and veins in the schistoze rock; and my impression is that Otago abounds in auriferous lodes, which will yet be discovered, and many of them will prove highly remunerative for working.

WEST COAST SOUNDS.

Wilson's River.

The south-western portion of the Middle Island is beginning to attract attention; not only has there been rich patches of auriferous wash-drift in the creek-beds, but the recent discoveries of auriferous lodes have shown that there is a large extent of country where gold is likely to be found. Some rich finds have been got in Coal Island, which is on the same belt of country that crosses Wilsons's River, the Coldburn, Goldburn, Big River, and on to Price's Inlet; but the country in this locality being destitute of any tracks, and there being no way until recently of obtaining

a supply of provisions, has prevented it from being prospected. There are now four stores, two of which are at Preservation Inlet and two at Gates Bay, the latter place being about four miles to the eastward of Wilson's River; and there are other buildings being erected at Kisbee, which is now known as the Township of Cromarty. The latter place is seven miles up Preservation Inlet, and the nearest and best landing for persons working at the reefs.

The alluvial workings up to the time of my visit in January last were confined to the bed of Wilson's River and banks of that stream; and also Sealer's Creek No. 1, and terraces. In all localities on the mainland where gold has been got in the alluvial drifts it appears to have come from a quartz-reef. Not only does this apply to the gold found in the bed of Wilson's River, but also to Sealer's Creek and the adjoining terraces. The wash-drift contains a great deal of quartz stones, some of which are rich in gold. No quartz lode has yet been discovered in the vicinity of Sealer's Creek; but the character of the country, having dense scrub and undergrowth, and covered with soft peat, makes prospecting for lodes a difficult undertaking. Indeed, it may be said it is only by mere chance that lodes can be discovered. There are several places where large lodes are cropping out in different localities, but unless they show gold on the outcrop they have hitherto been passed over.

Prospectors' Claim.—The recent discovery of a rich auriferous lode crossing the bed of Wilson's River has given an impetus to prospecting for lodes. A large lode was seen in the bottom of the river, but the parties working in the bed had no idea it contained gold, although large blocks of quartz containing gold was found in the river-bed below the line of reef, and all the gold got in the wash-drift and crevices of the rock was greatly honeycombed, with quartz attached to it, and showed by the sharp edges that it had not travelled far. It was only when one of the men, James Smith, was felling a tree on the north bank of the river, when it struck another tree growing on the slope on the south side, tearing it up by the roots and displaying a large lode in the face of the bank, that attention was directed to it. This lode is from 8ft. to 10ft. in width, and the solid quartz near the surface shows a considerable amount of gold through the stone. The exposed face of the lode at the time of my visit was about 16ft. high and about from 7ft. to 8ft. in width of quartz, with a horse of mullock about 2ft. thick near the hanging-wall side of the lode; the quartz on the upper side of the face for 4ft. below the outcrop was all of good stone, but below this the gold seemed to be confined to the foot-wall side; which showed that, though the rich gold-bearing stone will be found in ledges, a large portion of the lower face is of low grade ore.

On the north side of the river there is a considerable quantity of loose material, which has at some previous period been brought there by a slip from the side of the range. A drive was put up for some 7ft. or 8ft. in this stuff, and the lode found in the bottom of the drive, and also rising in the face. On the hanging-wall side of this lode there is a band of stone about 2ft. in width, which contains a great deal of gold. A dishful of quartz was broken out from the bottom of this drive, and pounded up in a mortar during my visit: the quartz previous to crushing was 12lb. in weight, and from this small quantity 4dwt. 4gr. of gold was obtained, which is equal to 36oz. 16dwt. of gold to the ton. It must not, however, be inferred from this that the lode is all of this character, as the other portion showed to be of very low grade ore; but even if the band referred to only runs a fair distance into the range, the yield of gold will be considerable. It must, however, be borne in mind that the shots of rich auriferous quartz do not, as a rule, run for a long distance—sometimes a shot will only be 60ft. or 70ft., while in other cases they run to 400ft. in length; but the latter is very rare in the quartz-lodes in this colony. Considering the width of the river-bed, which is here from 60ft. to 70ft., and that it has cut through a rich shot of gold, it becomes a question how far the lode will continue into the range, and also whether the rich quartz near the surface on the south side of the river is not the same ledge as that found in the bottom of the drive on the north side. If so, the strike of the lode will be northerly, and the best portion of the lode found in that direction.

The direction of the lode is North 20 degrees West, or South 20 degrees East, and it is dipping at an angle of about 60 degrees to the eastward. The foot-wall where exposed on the south side is very smooth and well defined, but the hanging-wall is not so clearly shown. There appears to be a small vein of mullock and quartz-grit next to the hanging wall, and a horse of mullock about 2ft. wide between that and the quartz-lode. On the north side of the river, with the lode being in the bottom of the drive, the walls could not be seen, neither could the width be determined, the quartz extending on both sides of the drive. Notwithstanding the rich stone discovered, it would have been more satisfactory to have driven for some distance on both sides of the river, and proved the reef more, before thinking of erecting crushing-machinery; but the prospectors having given a fourth part of their claim to get crushing machinery erected, they have everything to gain by its being erected quickly.

The formation where this lode occurs is slate, of the Lower Carboniferous or Upper Devonian age, and, although very rich stone is sometimes got in this formation, it cuts out remarkably fast. The same formation exists in the Longwood Range, where exceedingly rich stone was found, but on sinking on it the gold cut out. The prospectors must therefore be prepared for disappointment if a similar thing occurs at Wilson's River. The rich shot of stone may continue for a considerable distance, or it may be only a small patch. The prospects are certainly tempting, especially to those who have not had much experience in quartz workings, but it would be more prudent on the part of the prospectors to open up and prospect their claim well before commencing to erect machinery. It may be said that they have no place to put their rich stone; but, if needs be, a building could be erected, and the rich stone stacked in the building. There is a possibility of the gold being found in the lode in ledges, and this should be proved to some extent before incurring the expense of erecting crushing-machinery on the ground. Should the gold continue in the lode the same as it shows on the north side for 200ft. or 300ft. it will prove a very rich property.

The sides of the range rises very abruptly from the river, and there will be a difficulty in getting a good site for a crushing-battery. The only site in the locality is directly on the upper side of the

lode, close to the edge of the river; but as this is on an old slip there will be a considerable amount of excavation to get a solid foundation. There is a considerable body of water in the river in ordinary weather, which can be utilised to drive crushing-machinery, but to lift it and bring it along the steep face of the range will necessitate the water being brought in a flume to the machine-site.

About 500ft. above the bed of the river on the north side there is an outcrop of the lode in a small-creek bed in the face of the range. The lode at this place is only about 2ft. in width, and no gold is visible in the stone. The quartz is also different from what it is at the creek level, and on crushing a piece of it in a mortar no gold was found. On the south side of the river the lode runs for some distance parallel with the river-bed, and close alongside it. There is a large body of quartz along the bank of the river for some distance, but whether this is the lode or a slip from the lode is not easily determined without cutting through it, which has not been done. Indeed, far more prospecting should be done to determine this, and more especially at this particular place there is a wide lode of quartz crosses the bed of the river, and the lode may take a slightly different direction than that anticipated by the holders of the claims to the southward of the prospectors. The prospectors have, to all appearance, a good chance of having a rich claim; but no one can see underground, and it is possible that they may find that it would be more advantageous to test the lode more before erecting machinery. There were originally eleven shareholders in the prospecting claim, and they have given four shares to other gentlemen, who have agreed to erect crushing-machinery.

There are four licensed holdings applied for to the north of the Prospectors, but the lode is not visible in any of these holdings. The No. 1 North holding is taken up by eleven men, and six were employed in sinking a shaft near the line of reef at the time of my visit; this shaft was down 35ft. For the first 32ft. from the surface it went through a fine glacial consolidated silt, and then into a cemented quartz gravel; but they had not reached the rock. They intend sinking some distance in the rock and then driving for the lode.

The No. 2 North is held by two parties of five men in each, but no work had been done at the time of my visit. No. 3 and No. 4 North: the holdings applied for are 30 acres each; but it is not expected that much work will be done on any of these holdings until the lode is traced further than at present.

On the south end from the Prospectors' there were three licensed holdings applied for of 30 acres each, but there is no lode visible on the surface on any of the ground comprised in these applications of a payable character. Indeed, the holdings both to the north and south of the Prospectors' are simply marked off by taking the direction of the lode visible in the Prospectors' Claim. Whether the lode will continue unbroken in a straight line for a long distance remains to be proved; but even should this prove to be the case, there will be large portions of the lode that will not carry sufficient gold to pay for working.

Another quartz-lode has been found near Cuttle Cove, on the opposite side of Preservation Inlet, and an application made for a licensed holding; but as there was no work being carried on here it was not considered important to inspect it. The value of the quartz-lodes in this district will take a considerable time before they can be proved, as it can only be ascertained by crushing a quantity of stone; and taking into consideration the topographical character of the country, and the boggy nature of the ground between Kisbee Bay where the new Township of Cromarty is surveyed and the Prospectors' Claim, it will take at least twelve months before machinery can be erected and ready for commencing to crush the stone. During this time all the work on the reefs must necessarily be only of a preliminary character; and, unless by those who can afford to hang on for a long time without getting any returns, there will be very little work done in any of the claims.

The following statement shows the battery returns forwarded from the Otago District:—

Name of Company.	Stone crushed.	Yield.
	Tons.	Ozs.
Crœsus Battery, Nenthorn	426	403
Achilles Goldfield Company	..	...
Sunrise Gold-mining Company*	...	...
W. Walter's Battery, Barewood	1,970	659
Premier Consolidated Gold Company...	957	945
Phœnix Mine	5,457	1,920
Crossan and Gray	315	766
Gallant Tipperary	1,170	363
Syme Brothers	130	119
Sheppard and Todd	137	16
Harrison and party	38	8·8
Mathew Begg	37	13·5
	10,637	5,263·3

*Sold to Premier Consolidated Gold Company (Limited).

The following tables give a list of the mining companies who have complied with the provisions of "The Mining Companies Amendment Act, 1890," in publishing a statement of their affairs:—

STATEMENT of AFFAIRS of MINING COMPANIES as published in accordance with "The Mining Companies Act, 1886," and Amendment Act, 1890.

Name of Company.	Date of Registration.	Number of Shares.	Number of Shares allotted.	Nominal Capital.	Subscribed Capital.	Value of Scrip given to Shareholders.	Amount of Capital actually paid up.	Amount paid up per Share	Number of Shares forfeited.	Arrears of Calls.	Amount of Dividends paid.
AUCKLAND DISTRICT.											
				£	£ s. d.	£ s. d.	£ s. d.	£ s. d.		£ s. d.	£ s. d.
Komata	23 April, 1892	20,000	15,056	20,000	20,000 0 0	..	..	..	..	..	..
Woodstock United	17 Feb., 1890	55,000	52,568	27,500	26,284 0 0	10,513 12 0	..	0 4 0	..	..	..
New Alburnia	10 Sept., 1885	50,000	50,000	25,000	25,000 0 0	2,500 0 0	3,625 0 0	0 1 9	..	..	500 0 0
Silverton	4 Feb., 1886	40,000	40,000	20,000	20,000 0 0	..	3,000 0 0	0 1 6	10	..	600 0 0
Norfolk	24 April, 1889	50,000	49,995	25,000	24,997 10 0	12,500 0 0	3,338 6 8	0 6 6	50	52 8 9	..
Saxon	2 Dec., 1884	50,000	50,000	25,000	25,000 0 0	750 0 0	8,123 15 4	0 3 2	1,080	180 4 10	15,416 13 4
Lone Hand	22 Mar., 1889	30,000	30,000	15,000	14,500 0 0	500 0 0	705 6 8	0 1 0	..	19 13 4	..
Puhipuhi Prospectors'	18 July, 1890	53,360	52,025	26,680	26,014 0 0	10,005 0 0	7,038 8 0	0 7 2	150	1,231 8 4	..
May Queen	4 Mar., 1889	50,000	50,000	25,000	25,000 0 0	625 0 0	2,259 19 4	0 0 11	..	34 16 3	..
Vizard's	8 Sept., 1890	40,000	40,000	10,000	10,000 0 0	..	101 1 3	0 0 1	..	65 12 1	..
Red Mercury	22 April, 1890	30,000	30,000	7,500	7,500 0 0	937 10 0	2,437 10 0	0 2 3	160	..	..
Pride of Karaka	21 Oct., 1890	50,000	50,000	12,500	12,500 0 0	3,800 0 0	1,082 9 8	0 2 1	16,010	18 5 0	..
Mariposa	28 Feb., 1890	50,000	50,000	12,500	12,500 0 0	..	2,708 6 8	0 1 1	12,712	..	..
Occidental	2 Oct., 1890	100,000	100,000	100,000	25,000 0 0	..	..	..	..	..	..
New Manukau	10 Feb., 1883	30,000	30,000	30,000	30,000 0 0	..	2,232 3 9	0 1 6	..	..	..
Hazelbank	13 Sept., 1890	42,000	42,000	10,500	10,500 0 0	2,100 0 0	2,625 0 0	0 2 3	..	..	1,050 0 0
Magnolia	16 Feb., 1883	50,000	41,250	50,000	45,000 0 0	2,625 0 0	1,848 17 9	0 3 1	3,750	240 4 2	..
Victoria	2 Sept., 1890	120,000	117,183	24,000	23,436 12 0	15,994 16 6	6,617 16 9	0 1 7	..	..	..
Consols	16 Sept., 1890	50,000	50,000	50,000	25,000 0 0	750 0 0	3,033 13 11	0 1 6	..	716 6 1	..
Cambria	4 Jan., 1884	44,700	44,700	44,700	44,700 0 0	12,851 0 0	1,181 5 0	0 2 0	..	..	80,475 0 0
Waiotahi	1 Aug., 1871	6,000	6,000	18,000	18,000 0 0	..	15,000 0 0	2 10 0	..	..	27,750 0 0
Kuaotunu	— Oct., 1890	50,000	50,000	12,500	12,500 0 0	..	..	..	11,862	74 3 1	..
City of Dunedin	6 May, 1890	50,000	46,550	25,000	23,275 0 0	11,637 10 0	824 13 9	0 5 4½	..	51 17 6	..
Hauraki	17 Oct., 1890	45,000	37,450	11,250	11,250 0 0	..	300 8 4	0 0 3	755	211 17 6	..
Silvia	16 June, 1890	100,000	100,000	100,000	100,000 0 0	82,500 0 0	14,587 10 0	0 16 9	69,750	871 17 6	..
Kapai	17 Sept., 1890	50,000	50,000	12,500	12,500 0 0	..	1,186 18 3	0 0 6	2,768	29 6 10	..
Calliope	8 Sept., 1890	50,000	50,000	12,500	12,500 0 0	..	625 0 0	0 0 3	50	..	..
Carbine	21 May, 1890	50,400	50,400	25,200	25,200 0 0	..	660 0 0	0 0 4	..	70 17 8	..
Waitemata	27 May, 1891	50,000	38,100	12,500	12,500 0 0	..	449 8 2	0 0 3	11,900	19 5 2	..
Waihi	7 Dec., 1887	150,000	150,000	150,000	150,000 0 0	53,333 0 0	96,667 0 0	1 0 0	..	10 0 0	..
Emminence	13 Aug., 1891	50,000	49,000	10,000	9,975 0 0	1,225 0 0	442 15 5	0 0 9	40,735	..	..
Otama	25 Mar., 1890	40,000	39,912	20,000	20,000 0 0	..	515 13 0	0 0 3	14,843	..	..
Junction	21 June, 1890	30,000	30,000	7,500	7,500 0 0	..	1,250 0 0	0 0 5	200	144 15 10	..
Orlando	2 April, 1890	40,000	40,000	10,000	10,000 0 0	..	1,457 17 6	0 0 9	..	1 13 4	..
Owera	8 Sept., 1890	50,000	50,000	12,500	12,500 0 0	7,500 0 0	4,354 7 6	0 4 9	750	20 12 6	..
North Star	21 Feb., 1891	50,000	45,000	10,000	9,000 0 0	4,307 15 3	1,170 5 3	0 1 6	3,750	31 5 0	..
Try Fluke	3 Dec., 1889	50,000	50,000	12,500	12,500 0 0	..	1,250 0 0	0 0 6	..	..	7,486 7 6
Coromandel Mint	18 Aug., 1891	50,000	22,390	6,250	3,486 5 0	600 0 0	1,863 1 8	0 1 3	4,700	194 5 3	..
New Moanataiari	16 Nov., 1888	50,000	49,910	25,000	24,955 0 0	2,670 0 0	9,905 2 0	0 5 0	..	..	..
Kapanga	4 Mar., 1872	250,000	250,000	250,000	246,750 0 0	..	31,000 0 0	3/- & 1/-	..	337 11 3	4,625 0 0
New Fearnought	22 July, 1886	50,000	50,000	25,000	25,000 0 0	2,291 13 4	1,746 18 5	0 0 11	..	9 5 0	..
Phœnix	28 Sept., 1892	50,000	50,000	25,000	25,000 0 0	416 13 4	549 13 4	0 0 2	14,600	128 2 6	..
Mountain Flower	10 Sept., 1890	60,000	57,000	15,000	14,250 0 0	..	335 16 8	0 0 1½	9,800	68 7 4	..

STATEMENT of AFFAIRS of MINING COMPANIES as published in accordance with "The Mining Companies Act, 1886," and Amendment Act, 1890—*continued.*

Name of Company.	Date of Registration.	Number of Shares.	Number of Shares allotted.	Nominal Capital.	Subscribed Capital.	Value of Scrip given to Shareholders.	Amount of Capital actually paid up.	Amount paid up per Share.	Number of Shares forfeited.	Arrears of Calls.	Amount of Dividends paid.
AUCKLAND DISTRICT—*continued.*											
				£	£ s. d.	£ s. d.	£ s. d.	£ s. d.		£ s. d.	£ s. d.
Maori Pah	17 Sept., 1890	42,000	42,000	10,500	10,500 0 0	..	..	..	..	..	..
Nemesis	25 Mar., 1890	40,000	40,000	20,000	20,000 0 0	..	145 18 9	0 0 1½	7,900	52 15 3	..
Ophir Silver Mining Company	23 June, 1891	50,000	34,000	5,000	3,400 0 0	1,700 0 0	138 16 11	0 1 1¾	..	109 1 5	..
Irene	— Mar., 1891	50,000	36,000	12,500	9,000 0 0	..	350 0 0	0 0 2½	..	95 16 8	..
Flying Cloud	8 Sept., 1890	50,000	50,000	12,500	12,500 0 0	..	729 3 4	0 0 3½	..	111 7 6	..
Golden Age	10 Sept., 1890	25,000	24,200	6,250	6,050 0 0	..	151 5 0	0 0 1½	..	..	..
Freedom	18 Mar., 1890	24,800	24,800	6,000	6,000 0 0	..	900 0 0	0 0 9	..	88 3 6	..
Souvenir	11 Sept., 1890	50,000	40,000	12,500	10,000 0 0	..	416 13 4	0 0 2	15,383	2 0 0	..
New Zealand Crown Mines	31 May, 1891	65,000	63,341	65,500	45,673 0 0	11,468 0 0	45,673 0 0	1 0 0	..	82 7 0	..
Totals	..	2,823,260	2,001,830	1,519,830	1,374,696 7 0	256,101 10 5	313,606 7 4	..	243,668	5,375 13 5	137,903 0 10
NELSON DISTRICT (including West Coast).											
A1	12 May, 1891	24,000	24,000	6,000	6,000 0 0	..	300 0 0	0 0 3½	..	50 0 0	..
Keep-it-Dark	2 Mar., 1874	20,000	20,000	20,000	20,000 0 0	10,000 0 0	2,977 7 6	0 3 1½	..	147 12 6	105,106 13 4
Globe	8 Aug., 1882	36,000	36,000	18,000	18,000 0 0	..	14,775 0 0	0 8 2½	5,450	..	40,050 0 0
Keep-it-Dark South, No. 2	13 June, 1887	24,000	24,000	12,000	12,000 0 0	..	4,600 0 0	0 3 10	..	..	8,600 0 0
Golden Treasure Extended	14 Dec., 1888	24,000	24,000	12,000	12,000 0 0	..	4,163 1 8	0 4 4	8,365	582 10 6	900 0 0
Scotia	10 Feb., 1888	24,000	24,000	12,000	12,000 0 0	..	4,291 10 3	0 3 8	7,950	45 2 1	3,000 0 0
Golden Hill	30 Oct., 1891	24,000	24,000	12,000	12,000 0 0	..	700 0 0	0 0 7	12,200	100 14 2	..
Kapai	30 July, 1891	24,000	24,000	12,000	12,000 0 0	..	541 5 1	0 0 7	8,117	50 11 1	..
St. George	30 Oct., 1891	24,000	24,000	24,000	24,000 0 0	..	400 0 2	0 0 5	1,500	81 4 10	..
Durham	11 July, 1891	24,000	24,000	12,000	12,000 0 0	..	739 5 5	0 0 8	4,775	22 3 9	..
Cumberland	10 July, 1890	24,000	24,000	24,000	24,000 0 0	..	2,400 0 0	0 2 0	..	779 9 0	8,400 0 0
United Italy	24 Mar., 1882	24,000	20,000	24,000	24,000 0 0	12,000 0 0	4,150 0 0	0 13 5½	4,270	..	..
Inglewood Extended	25 Aug., 1882	24,000	24,000	12,000	12,000 0 0	..	8,200 0 0	0 6 11	935	..	..
Merrijigs	10 Mar., 1888	24,000	24,000	12,000	12,000 0 0	..	2,000 0 0	0 1 8	..	..	..
Lyell Creek Extended	2 Aug., 1881	48,000	48,000	24,000	12,000 0 0	12,000 0 0	8,491 1 0	0 13 11	8,378	6 14 0	..
Alexander	15 Oct., 1890	24,000	24,000	9,000	5,250 0 0	3,750 0 0	3,070 2 9	0 7 6	..	23 13 9	..
Dillon	12 Oct., 1891	24,000	24,000	12,000	12,000 0 0	..	305 10 10	0 0 3½	2,653	44 9 2	..
Specimen Hill United	14 June, 1884	20,000	20,000	20,000	10,000 0 0	10,000 0 0	9,929 12 1	0 19 6	2,011	29 3 5	..
Hercules	22 Nov., 1889	24,000	24,000	24,000	24,000 0 0	..	3,341 6 1	0 2 9	1,523	258 13 11	300 0 0
Sir Charles Russell	16 Oct., 1890	24,000	24,000	12,000	12,000 0 0	..	2,332 10 0	0 2 0	450	67 10 0	..
Progress	26 Nov., 1886	24,000	24,000	12,000	9,600 0 0	2,400 0 0	4,500 0 0	0 5 9	..	..	8,400 0 0
Lord Edward	13 Nov., 1883	24,000	24,000	24,000	12,000 0 0	12,000 0 0	2,250 0 0	0 11 10	500	..	..
Big River	11 April, 1891	24,000	24,000	12,000	12,000 0 0	..	600 0 0	0 0 6	..	..	12,000 0 0
Sir Francis Drake	10 June, 1887	24,000	24,000	12,000	12,000 0 0	..	11,250 0 0	0 9 4	950	175 1 3	..
Golden Lead	30 Oct., 1890	24,000	24,000	12,000	12,000 0 0	..	4,200 0 0	0 3 6	..	14 10 0	..
Venus Extended	21 Aug., 1885	24,000	24,000	24,000	24,000 0 0	12,000 0 0	3,870 0 0	0 13 2	350	530 0 0	2,700 0 0
Gallant	7 Feb., 1888	24,000	24,000	12,000	12,000 0 0	..	3,873 17 6	0 3 3	13,500	26 2 6	..
United Alpine	31 Oct., 1874	32,000	..	48,000	40,933 6 8	16,000 0 0	24,933 6 8	0 15 7	..	..	54,666 13 4
Southern Cross	22 Mar., 1889	14,000	14,000	14,000	14,000 0 0	1,400 0 0	3,150 0 0	0 2 4	2,484	..	..
Hibernian Extended	15 May, 1889	48	48	1,200	1,200 0 0	1,200 0 0	1,125 0 0	25 0 0	..	..	1,824 0 0
Johnston's United	27 June, 1881	20,000	20,000	20,000	18,584 11 6	1,668 0 0	12,409 5 11	0 15 11½	8,209	..	1,916 0 9
Pandora	2 Oct., 1891	36,000	36,000	18,000	18,000 0 0	..	950 0 0	0 0 8	18,241	..	..
Paparoa	18 Sept., 1892	40,000	40,000	20,000	20,000 0 0	10,000 0 0	104 13 9	0 10 2	..	228 12 11	..
Wealth of Nations	21 Aug., 1889	32,500	32,087	32,500	21,125 0 0	..	20,322 17 8	0 13 0	1,372	509 10 0	..

STATEMENT of AFFAIRS of MINING COMPANIES as published in accordance with "The Mining Companies Act, 1886," and Amendment Act, 1890—*continued.*

Name of Company.	Date of Registration.	Number of Shares.	Number of Shares allotted.	Nominal Capital.	Subscribed Capital.	Value of Scrip given to Shareholders.	Amount of Capital actually paid up.	Amount paid up per Share.	Number of Shares forfeited.	Arrears of Calls.	Amount of Dividends paid.
NELSON DISTRICT—*continued.*											
				£	£ s. d.	£ s. d.	£ s. d.	£ s. d.		£ s. d.	£ s. d.
Royal	2 June, 1888	24,000	24,000	24,000	13,850 0 0	12,000 0 0	1,837 10 0	0 11 6	2,750	..	..
Fiery Cross	27 Sept., 1879	32,250	32,250	32,250	30,906 5 0	19,081 5 0	11,776 11 6	0 19 2	1,937	48 8 6	24,168 15 0
Golden Bar	30 Oct., 1891	24,000	24,000	12,000	12,000 0 0	..	230 0 0	0 0 3	13,675	..	..
Success	13 July, 1891	24,000	24,000	12,000	12,000 0 0	..	177 3 9	0 0 3	..	122 16 3	..
Exchange Quartz-mining Company ..	23 May, 1890	24,000	24,000	6,000	2,100 0 0	..	1,800 4 4	0 1 9	2,550	246 17 11	..
Davis and Carr Terrace Sluicing Company	13 Mar., 1890	2,000	1,385	2,000	864 15 0	864 15 0	242 0 0	0 17 0	460	46 0 0	..
Mont D'Or	25 July, 1882	12,000	12,000	12,000	12,000 0 0	..	10,800 0 0	0 18 0	..	..	18,600 0 0
Wakamarina Golden Bar	22 Jan., 1889	7,000	6,138	7,000	1,675 8 4	5,132 0 0	1,675 8 4	0 7 0	2,957	109 9 6	..
South Pacific Extended	26 Oct., 1882	36,000	36,000	36,000	36,000 0 0	..	2,032 0 11	0 1 7	29,146	..	..
Humphrey's Gully	— May, 1883	150,000	150,000	150,000	67,000 0 0	77,000 0 0	62,984 0 0	0 19 0	4,016	..	..
Ross United	— May, 1883	150,000	150,000	150,000	46,500 0 0	103,500 0 0	45,450 12 6	0 19 6	701	..	..
Totals	..	1,335,798	1,297,908	1,017,950	739,589 6 6	321,996 0 0	310,282 5 10	..	172,375	3,888 0 10	390,632 2 5
OTAGO DISTRICT.											
Rees Valley	30 Aug., 1890	14,060	14,000	14,000	14,000 0 0	13,650 0 0	1,050 0 0	0 19 6	..	..	..
Bluespur and Gabriel's Gully	1 Feb., 1888	130,000	90,000	130,000	90,000 0 0	30,000 0 0	30,000 0 0	1 0 0	..	..	..
Longwood Sluicing	15 Oct., 1888	300	290⅗	3,000	2,574 10 0	2,574 10 0	2,454 10 0	£2/10–£10	..	175 10 0	..
Rise and Shine	22 July, 1890	10,000	10,000	3,000	3,000 0 0	1,500 0 0	1,440 15 0	0 6 0	340	596 5 0	..
Amalgamated Waipori Deep Lead ..	20 Dec., 1889	12,500	12,050	12,500	12,050 0 0	6,150 0 0	5,823 1 0	1 0 0	..	76 10 0	..
Roxburgh Amalgamated Sluicing ..	2 Mar., 1889	30,000	29,565	30,000	29,565 0 0	15,000 0 0	13,101 2 4	1 0 0	825	6 14 4	..
Sew Hoy, Big Beach	9 Dec., 1889	54,000	54,000	108,000	108,000 0 0	72,000 0 0	8,757 15 0	1 10 0	225	17 5 0	6,727 10 0
Jutland Flat (Waipori)	2 July, 1890	15,000	15,000	15,000	15,000 0 0	3,750 0 0	4,000 0 0	0 8 0	..	..	..
Sandhills	2 Aug., 1889	25,000	25,000	12,500	12,500 0 0	4,000 0 0	7,142 4 0	0 10 0	200	80 0 0	849 18 10
Cromwell	14 Nov., 1889	110,000	108,021	110,000	108,021 0 0	97,218 18 0	8,499 1 0	0 19 7½	3,417	592 7 0	..
Dunedin No. 2	29 Aug., 1887	3,000	2,992	3,000	2,992 0 0	..	2,655 8 0	0 17 9	..	..	..
Bonanza	16 July, 1890	12,000	12,000	1,200	336 0 0	9,000 0 0	336 0 0	0 0 6⅗	..	..	2,732 8 0
United Hercules	13 Aug., 1888	12,000	12,000	12,000	12,000 0 0	4,125 0 0	4,125 0 0	0 15 0	..	..	7,800 0 0
Undaunted	— Mar., 1878	120	120	9,600	9,600 0 0	..	9,600 0 0	1 0 0	..	..	..
Totals	..	427,920	385,038⅗	463,800	419,638 10 0	258,968 8 0	98,984 16 4	..	2,007	1,544 11 4	17,259 18 0
DREDGING COMPANIES.											
Roxburgh Gold	20 Aug., 1891	5,000	5,000	5,000	2,500 0 0	2,500 0 0	1,856 5 0	0 16 0	..	144 0 0	..
Golden Run	29 June, 1891	5,000	5,000	5,000	3,000 0 0	2,000 0 0	2,165 10 0	0 19 0	1,085	52 15 0	..
Ettrick Gold	29 Aug., 1890	4,500	4,500	4,500	2,500 0 0	2,000 0 0	1,871 15 0	0 15 0	..	3 5 0	..
Dunedin	1 Sept., 1881	8,700	8,700	8,700	8,700 0 0	..	7,540 0 0	0 17 4	..	..	10,920 0 0
Waipapa	23 Dec., 1890	5,000	4,765	2,500	2,382 10 0	500 0 0	1,870 4 6	0 10 0	288	12 5 6	..
Matakitaki	7 July, 1892	2,000	1,455	2,000	1,455 0 0	..	474 10 0	0 8 0	..	107 10 0	..
Six-mile Beach	19 Oct., 1889	12,000	12,000	12,000	12,000 0 0	2,250 0 0	7,449 0 0	0 17 6	..	51 0 0	..
Upper Waitaki Alluvial	3 Sept., 1889	24,000	24,000	12,000	12,000 0 0	5,000 0 0	5,950 0 0	0 8 6	..	..	1,200 0 0
Enterprise	24 Aug., 1891	1,200	1,200	1,200	1,200 0 0	..	1,140 0 0	0 19 0	..	..	..
Phœnix Water-race	12 Oct., 1867	1,000	1,000	1,500	1,500 0 0	1,500 0 0	1,500 0 0	1 10 0	..	..	5,425 10 0
Greenstone Sluicing	8 Dec., 1888	7,000	7,000	7,000	7,000 0 0	2,300 0 0	2,702 10 0	0 11 6	..	..	1,050 0 0
Totals	..	75,400	74,620	61,400	54,237 10 0	17,550 0 0	34,519 14 6	..	1,373	370 15 6	18,595 10 0

GEOLOGICAL FORMATION OF KUAOTUNU.

The following notes on the geological formation of the Kuaotunu Mining District are by James Park, Esq., F.G.S., Director of the Thames School of Mines :—

"It has often been asserted that the Hauraki Peninsula is a goldfield from one end to the other, and the numerous discoveries of the last few years would certainly seem to justify this conclusion. The wide gaps which at one time existed between the older-established goldfields are being gradually filled up, while the boundaries of all the fields are being continually extended.

"Perhaps the most important find of late years was the discovery of payable gold at Kuaotunu, a little over three years ago. Since that date a large amount of money has been expended in the preliminary work of prospecting and opening the mines, erection of batteries, and other necessary works; and, as a result, this field has now taken its place as a steady gold producer.

"Kuaotunu is situated on the east-coast side of the peninsula, on the neck of the short peninsula lying between Mercury Bay and Whangapoua Harbour. It is connected with Coromandel by a bridle-track, and there is regular communication with Auckland by a steamer-service twice a week. The port suffers the disadvantage of being an open roadstead, and this a difficulty which it will be very costly to remedy. The waterway has, nevertheless, been an inestimable boon to the place, and it is doubtful if without this it would have been able to survive the troubles which beset the early stages of its existence.

"*General Geological Features.*—The geological features of this field differ but little from those of the other goldfields scattered throughout the peninsula. Excluding the recent deposits, the rocks are found to belong to two distinct geological formations, both of which are gold-bearing, although differing greatly in age and physical characters. The younger formation consists of highly decomposed andesitic tuffs, which extend northwards from Mercury Bay till within a mile of the sea at Kuaotunu roadstead.

"Within the drainage-area of the Kuaotunu River and its branches, these tuffs form a high ridge, which seems to stand in an ancient valley in the older Palæozoic rocks. This tuff ridge ends abruptly at the place locally called 'The Junction.' It is bounded on both sides by ridges composed of Palæozoic sandstones and greywackes. The western ridge lies on the west side of the river, and forms low descending scrub- and fern-covered spurs, which reach the sea at the rocky point at the end of the sandhills. The eastern ridge is rugged and forest-clad. It reaches a height of 800ft. in some places, and descends to the sea on the eastern and northern sides of the peninsula, of which it occupies the greater portion. On the coast-line it forms high, precipitous, and inaccessible cliffs.

"*Classification of Formations.*—The general formations may be classified as follows:—1. *Recent:* Sand-dunes, alluvial flats and swamps; 2. *Lower Tertiary:* Andesite tuffs; 3. *Palæozoic:* Sandstones, slaty shales, and breccias.

"*Recent.*—The sand-dunes extend along the coast from Maori Point to the mouth of the Kuaotunu River, a distance of about half a mile. On their inland side they are bounded by a wide extent of low-lying flat and swamp land, which follows the course of the river for over a mile and a quarter, and in places possesses a width of over 25 chains.

"*Lower Tertiary Tuffs.*—These are first seen in ascending the valley, near the junction of the Kuaotunu and its right-hand branch, where they rise as a conspicuous, bare, abruptly-ending spur or ridge, on the lower slopes of which are built the new school-house and schoolmaster's residence. This ridge extends southwards to the head-waters of the Kuaotunu and its branches, where it spreads out into a number of long spurs which descend in the direction of Mercury Bay.

"These tuffs are highly decomposed at every point where I examined them, but in composition and general physical characters they are undoubtedly closely related to the gold-bearing tuffs at Coromandel and the Thames. Their finely-stratified appearance in places would tend to the belief that they were of pyroclastic origin, the materials of which they are composed having probably been derived from great submarine or maritime volcanic eruptions.

"This district affords no evidence as to their age. They rest unconformably on a highly-denuded surface of the Palæozoic sandstones, while no clastic rocks of younger date are found overlying them.

"The scarcity of evidence relating to the age of these tuffs is a noticeable feature of the geology of the Hauraki Peninsula, and this circumstance is solely due to the almost entire absence of members of the numerous fossiliferous formations, which, in other parts of New Zealand render the geological structure so varied, and very frequently so involved and complicated.

"The only evidence bearing directly on the age of these rocks, so far as known at present, is found at Waitete, situate on the coast-line a few miles south of Cabbage Bay. Two years ago, when making a reconnaissance geological survey of that part of the coast, I discovered a small patch of the New Zealand brown coal-measures, occupying an area not many square chains in extent. They consisted of the following strata, reading the section downwards :—

1. Hard shelly limestone;
2. Calcareous and marly sandstones;
3. Ferruginous conglomerates.

"The conglomerates were about 200ft. thick, and rested directly on the basement rocks, which at this point consisted of blue and red-banded slaty shales. The shelly limestone, which was the highest and closing member of the series, dipped away to the north-east, and a few chains back from the beach disappeared below a great accumulation of volcanic tuffs, breccias, and solid lava-flows of an andesitic character. These rocks, so far as could be judged from physical characters and general appearance, were in every respect similar to the gold-bearing tuffs and associated rocks in other parts of the peninsula.

"On a subsequent occasion I traced these tuffs and breccias, without a break, as far as Paparoa and Paul's Creek, and thence southward to the Tokatea Range, near Coromandel. Another circumstance which tends to prove their identity with the tuffs of the Thames and Coromandel is the discovery in them of gold-bearing veins of quartz in the neighourhood of the limestone deposit.

"The Palæozoic rocks on which the coal-measures rest are, in several places in the vicinity of Waitete, intruded by massive dykes of igneous rock. It is a noteworthy fact that I was unable to find, after a most careful examination, a single fragment of igneous rock included among the materials composing the conglomerates. This negative evidence is of great value, as tending to prove that these igneous intrusions took place after the deposition of the Cretaceo-tertiary coal-beds. The whole of the stratigraphical evidence obtainable at Waitete points to the Post-eocene age of these Kuaotunu tuffs, which can be traced almost continuously to Coromandel on the west and Tapu on the south.

"In connection with their economic importance, it is interesting to note that they are the youngest gold-bearing rocks in the Southern Hemisphere, being younger than the gold-bearing rocks of Otago, Reefton, and the different goldfields of Australia by the whole of the secondary epoch and the upper part of the vast Palæozoic. Even in composition and origin they stand unique, and their homologues are found only in two countries in the Northern Hemishphere — namely, Transylvania, in Hungary, and the Pacific States of America; and in these countries the similarity extends also to their gold and silver contents, which are frequently as refractory and difficult to treat as ours, while their free-milling bullion is alloyed with silver to the extent of about 30 per cent., as it is throughout the Hauraki Peninsula.

"*Palæozoic Rocks.*—These form the basement or floor of this district, and, indeed, of the whole peninsula. They consist principally of hard siliceous, greenish, and grey-coloured sandstones, interbedded with slaty breccias, and occasionally slaty shales. The siliceous sandstones or greywackes are the prevailing rock here. They are everywhere much shattered and jointed, and often streaked with thread-like veins of quartz or hæmatite. On the spurs behind the township, and in most places near the point of contact with the overlying tuffs, they are decomposed into reddish-coloured clays to a great depth, as if they had been subjected at some period to the long-continued action of thermal waters.

"The gold-bearing reefs of this formation are found in the more decomposed portions of these sandstones, and the quartz is often of a brecciated, flinty, or chalcedonic character, which is an evidence of hydrothermal origin.

"These rocks have yielded no fossil remains, and their exact age is therefore still undetermined; but in the Waikato they have been found underlying rocks which contain *Halobia*, *Monotis*, and other Triassic forms, and hence have been placed in the Palæozoic period.

"*Gold-bearing Reefs.*—I have already pointed out that there are two distinct reef-systems at Kuaotunu—one belonging to the tuff formation, and the other to the Palæozoic formation. The major lode of the field is the Try Fluke Reef, found in the former. It possesses well-defined walls, and varies in width from 2ft. to 20ft. Its average width is probably about 6ft. Its course is N.N.E., S.S.W., and its dip easterly, at angles seldom under 60 degrees, more often over 65 degrees. It has been traced through the leases of the Kapai, Try Fluke, Carbine, Red Mercury, Great Mercury, and Irene. It has been proved to continue downwards in the deepest workings so far undertaken upon it. All the workings on this reef have, so far, been confined to the brown oxidized tuffs above water-level.

"The nature of the quartz varies in different parts of the lode. In places it is hard, cavernous, and stained black with manganese oxides; in others it is mullocky, and more friable or crumbling, and is stained rusty-brown with peroxide of iron.

"The gold is alloyed with about 30 per cent. of silver, and it exists principally in an extremely finely divided state. The patches of rich stone, which are so characteristic of the Thames reefs, are not known in this reef, or, indeed, in any other reef in this field.

"The reefs in the Palæozoic sandstones have received a large amount of attention, and most encouraging results have been obtained from the 'Black Jack' and many others.

"There are no known laws regulating the distribution of gold, although some geological conditions are known from experience to favour the occurrence of gold more than others. It is, therefore, impossible for anyone to predict with any degree of certainty where gold may or may not be found in paying quantities. At Tapu and Coromandel it is found that when the reefs descend from the tuffs to the Palæozoic rocks they run out or become non-gold-bearing. At these places the old rocks consist of black jointed slaty shales. At Kuaotunu they consist of siliceous sandstones, and the prospects of the permanency of the reefs in them are altogether more favourable. At the same time it would be wrong to neglect the experience of other places; and in the case of Kuaotunu it would, I think, be prudent to thoroughly prospect the reefs before undertaking the erection of batteries and other expensive works.

"Up to the present time the Try Fluke Reef has proved the chief gold-producer on this field, and, so far as can be judged from the existing conditions, it seems likely to hold this position for a number of years to come; but, to effect this, low levels will have to be driven in most of the mines on its course.

"With the advent of a cheaper motive-power, many reefs that at present would not pay to develop could be worked with profitable results, and there would then exist a fresh incentive to undertake systematic prospecting in new directions, which would no doubt result in other discoveries of a valuable nature."

ALLUVIAL MINING.

MIDDLE ISLAND.

The principal portion of the gold continues to be obtained from the alluvial drifts, and this is to be attributed to the magnificent water-supply that is to be obtained on every goldfield. Were it not for this water-supply, the alluvial workings would now be of very limited extent. The most of the ground where hydraulic-sluicing operations are carried on would not pay to work from shafts and tunnels. Instead of getting several pennyweights of gold to a load, it is considered good ground that will yield a few grains of gold to the cubic yard. In some of the claims in Otago, where there are not a large number of stones to contend with, 1½ grains of gold to the yard will pay all expenses in connection with working; this, however, does not refer to hydraulic-sluicing operations in the ordinary manner, where there is plenty of fall for tailings, one grain of gold would be sufficient to pay all expenses; but some of the claims worked by hydraulic elevators and dredges can be made to give a return to the shareholders with the former quantity of gold. It is, therefore, of the utmost importance to the miner of to-day to have a fair supply of water, and although almost every stream on the goldfields is utilised, there is plenty of room for improving the water-supply by building large reservoirs and dams wherever suitable sites can be procured, and conserving the water in wet weather. The difficulty in doing this at the present time is the number of water-rights held by different persons from the several creeks and streams. Those who have the first and second rights from large creeks are insured a fair supply; and those having inferior rights, were any of them to go to the expense of conserving the water in wet weather, those having prior rights would compel them to let down the number of sluice-heads mentioned in their certificates, notwithstanding had the reservoir not been constructed there would not have been sufficient water in the creek for the prior rights to be supplied. It is, therefore, only by a combination of the whole of those who have water-rights from any stream that a system of conservation of water could be effected. There are thousands of acres of auriferous drifts on every goldfield in the Middle Island that could be profitably worked if water was available, and no doubt the time will come when the conservation of water will become a question that will be more looked into in the future than it has been in the past.

Marlborough District.

Mahakipawa.

The ground on the upper portion of the Mahakipawa Creek is all worked out down to below the Prospectors' Claim; but owing to the manner in which the lower claims have been worked without leaving a solid block of ground on the upper boundary, as was ordered by the Warden to be left, the slightest fresh in the creek floods out all the lower claims. The whole of these were flooded out at the beginning of January, 1892, and the water was not again pumped out until about the beginning of November of the same year, having been flooded out for a period of ten months. The whole of the pumping plants constructed on the field are far too small for the work they have to do, and even if the miners manage to sink a shaft in the flat with them in dry weather, they cannot expect to work in a wet season. Neither will the present pumps keep the water down when the ground gets opened out. The gold has been traced to a certain extent from the end of the gorge in the creek in Nelson and Johnston's claim, into the Hibernian Company's ground, and thence into the King Solomon's Mine; but how far it will be traced down the flat remains yet to be solved. From the present workings in the King Solomon's Mine, the lead appears to go under the street between the Public Hall and the hotel, and runs nearly under the road going down the flat. It may be said that the whole of the creek-claims down to the Hibernian Company's Claim have been worked, and the best portions of the ground taken out; still, as the claims are abandoned, other people take up the ground—in some instances purchasing it for a small sum—and seem to be able to make small wages in spite of the repeated occurrence of floods.

Hibernian Company.—This company had only got their claim pumped out about seven days prior to my visit. Their shaft is 50ft. in depth, and the wash-drift about 6ft. to 8ft. in height, and the width of the river is about 40ft. The whole of the worked-out ground is very carefully stowed up with stones, having good walls built alongside the main drive. There was very little weight on the timbers at the time of my visit; this was owing, however, to the ground being full of water for such a length of time; but there is little doubt that the ground will settle after a little, and the timbering will require to be carefully watched. This company are on good ground, but they do not know the day when they may come up against the reef. The claim above them shows the bed of the creek to be in a very narrow gorge, about 8ft. to 10ft. in width, and has a great fall. The bottom of the gorge being worn smooth, by the action of the water and gravel rushing through it, scarcely any gold was got in this narrow gorge. It appears to have been swept through it on to the ground now worked by this company. There appears, from the depth of the ground, and the gradient on the bottom in working up the creek-bed, that there must be a fall between them and the adjoining claim, and that below this fall the creek-bed widened out with less fall. Therefore, although they have yet over 300ft. to work before they get to the boundary, they may come up against the mouth of the gorge at any time, and this will, doubtless, cut off the gold. There were nine men employed in this claim at the time of my visit.

King Solomon's Mine.—There are two shafts in this claim side by side, one of which is 47ft. in depth, and the other is 75ft. The object of this is to have two pumps at work, one lifting the water from the bottom for a certain distance, and the other lifting it to the surface; a pump being attached to a crank on each end of the axle of an overshot water-wheel. The most of the water comes through the ground at a depth of 40ft. below the surface, and it was intended to try and dam back the water in the shaft above this depth, where there is a tolerably firm and compact stratum to commence the foundation of the dam from. These pumping appliances consist of two

pumps each 9in. in diameter, worked by an overshot water-wheel 22ft. in diameter, having a 4ft.-breast, and these pumps were at the time of my visit working at the rate of eleven strokes per minute, with a stroke of 8ft. 6in., which is too high a speed to work at economically. The workings up the creek-bed are carried on for a distance of 207ft. from the bottom of the shaft; the width of the lead being about 18ft. They have still several hundred feet to go before getting to their upper boundary, and about 80ft. on the lower side of the shaft to their other boundary. At the time of my visit there were nine men employed in the claim. Since my visit, the ground has been paying very well; but this claim, like all others on the field, is subject to be flooded out after heavy rain. If there is heavy rain, the company find it is of no benefit to keep the pumps at work; but as soon as the flood goes down in the creek they start pumping again, when it takes from eight to fourteen days to get the water out.

Golden Gate Company.—This company's shaft is 118ft. in depth. It is constructed 10ft. by 10ft. for a distance of 29ft., and then taken in to 6ft. by 7ft., the object being to puddle back the water in the top layers of drift. They have driven from the bottom of their shaft for a distance of 35ft., apparently in the deep ground or old bed of the creek, but the bottom rises here very rapidly, and is very smooth, as though it had been worn with sharp gravel and sand passing over it. This bed is about 40ft. in width, but they had not up to the time of my visit got much gold. It is however questionable if another old channel will not yet be found further into the side next the range to the south of their shaft, or it may be that the portion of the creek-bed they have worked, having so great a fall, has formed a sluice where the gold has been swept through. The company has 900ft. of the creek-bed to their upper boundary from their shaft, and 60ft. to their lower boundary. This company uses a small portable engine for pumping and winding, the pump being 10in. in diameter. There were eleven men employed in the claim at the time of my visit, but since then they have suspended operations for want of funds.

Alice Fell Company.—This company has from first to last done a large amount of work. They have been prospecting the flat ever since the field was opened, and have sunk shaft after shaft in trying to get into the deep ground. When this party first commenced to sink it was anticipated by the miners at that time that the deep ground would be found near the present creek-bed. But this has proved a fallacy; and when the formation of the place is studied, the reason of this is apparent. The water coming through the gorge struck a band of hard rock, which now forms a sort of promontory at the mouth, and was the means of turning the water more to the southwards. A large slip from the range on the south side of the creek subsequently took place, and blocked up the creek, causing the water to flow against the foot of the range on the northern side where the creek now flows. This slip is clearly visible, and portions of the Township of Cullensville are now built on it. The last shaft this company sunk is 120ft. in depth, and after driving a short distance it was found that the ground was still dipping southwards; and on sinking down in the drive with the aid of a small California pump, 6oz. of gold were obtained. They had not got into proper working order on the lead at the time of my visit. There were seven men employed in the claim. Information was subsequently supplied me that this company have got on to the lead, and doing fairly well when they can work; but after every heavy shower of rain their claim is flooded out, their pumping plant not being large enough to contend with any extra water.

Davis and Carr's Claim.—This is a terrace claim on the opposite side of the creek from the Township of Cullensville. It has been worked ever since the commencement of the field, and has paid steady wages, and likely to do so for some time to come. There appears to be a great deal of ground here that would pay for working by hydraulic-sluicing if there were a good supply of water brought on to the ground, and this can be got out of the Mahakipawa Creek as soon as the claims in the creek-bed are worked out. There is a considerable number of overshot water-wheels used for pumping these claims at the present time, so that the whole of the water could not be diverted for sluicing the terraces until the claims in the creek-bed are worked out.

Wakamarina.

There are still a few miners working in this locality, but there is not much gold being obtained. Recently a rich patch of gold-bearing drift has been discovered at Dome Creek, by Flanigan and party, who are said to have obtained 260oz. of gold.

The Gorge Claim, on which a large amount of capital has been expended, is again taken up by a Melbourne syndicate; but the old story is again repeated. A flood came down the river and filled up all their workings before they were able to get to the bottom. Their prospects do not look bright. A gentleman from the Thames, who was employed by the syndicate to report upon this ground, informed me that he considers there is a prospect of gold yet being got in this gorge. It is, however, very doubtful if ever there will be a sufficient quantity obtained to pay for the outlay in getting it; and, if ever it is worked, more energy will have to be displayed in getting the drift excavated than has hitherto been done.

Nelson District.

Collingwood.

There has been very little done in this district beyond prospecting. The company mentioned in my last report which was formed to work the ground taken up by Messrs. Adams and Gilmer, and Mr. Travers' freehold, have done a good deal of prospecting, but there has been no legitimate sluicing done to prove whether there is any large area that will pay for working or not. The prospects obtained from different parts of the ground last year did not give so encouraging results as were anticipated; still the manager of the company, in a report to the shareholders, showed that the ground was not a duffer, although not nearly so rich as represented. This company purchased the water-rights, water-race, and all the buildings and property of the Red Hill Company last year for about £600—a property which was floated in England for £150,000, and of this about £98,000

GEOLOGICAL MAP
OF
KUAOTUNU
GOLDFIELD

To illustrate Report by James Park **F.G.S.**

Scale of Chains.

10 0 10 20 30

PACIFIC OCEAN

Township

BLACK JACK

701

SAND DUNES

ALLUVIAL FLATS AND SWAMPS

KUAOTUNU RIVER

RED MERCURY BATTERY

IRENE

GREAT MERCURY

RED MERCURY

LINE OF TRY FLUKE REEF

CARBINE

TRY FLUKE

KAPAI

A

B

C

D

II

I

II

II

II

— REFERENCE —

I. ANDESITE-TUFFS - LOWER TERTIARY

II. SANDSTONES, SLATY SHALES &c.
PALAEOZOIC

KUAOTUNU RIVER

SEA-LEVEL

— SECTION ON A-B. —

KUAOTUNU RIVER

TRY FLUKE REEF

RIGHT BRANCH

II

I

II

SEA-LEVEL

— SECTION ON C-D —

in paid-up shares was given to the promoters, and £2,000 in cash. About £20,000 was spent on the works, and debentures were issued for £4,565; and all that was got for this expenditure was the £600 —the price given by the present company for the property. It is to be deplored that English capitalists who embark money in mining ventures in the colony are led astray by men making representations which cannot be borne out. Even the gentleman this Red Hill Company sent out from England, who was represented to be a Fellow of the Chemical Society, and at one time an Instructor in the Royal School of Mines, London, reported to the company that they had a mine of undoubted value. This shows clearly that, notwithstanding this gentleman's high scientific attainments, he lacked the practical knowledge of the value of mining property.

The present company hold the whole of the water-rights from the Parapara River, and therefore will always have a good supply of water to carry on hydraulic-sluicing operations. It is only with a good supply of water that this ground can be made to pay. Although there are some runs or leads of gold going through their ground, they have found that a great deal of barren ground will also require to be washed away. At present prospecting work is suspended, owing to the shareholders who are finding the working capital being dissatisfied with the arrangements they entered into with the vendors; however, this has now been satisfactorily adjusted, and water will be brought on to the ground.

WEST COAST.

Westport District.

Charleston.

In the early days of this field a number of machines were used to crush the auriferous cement found in the different leads of gold-bearing sand in this locality. Some of the proprietors of these crushing-machines did extremely well; but for many years this system of working the ground has been abandoned for hydraulic-sluicing. A large portion of the field has been worked by the latter system, but the known auriferous leads that can be profitably worked on the sluicing system are becoming daily less, and the miners have again turned their attention to the working of the auriferous cement. In some places this cement is very hard and compact, and in other places it is merely found in blocks amongst the sand; but in no place on this field is there a large number of stones mixed with the cement. The whole of the auriferous leads in the vicinity of Charleston, and, it may be said, along the coast-line for a long distance each way, has been caused by the action of the sea. They are merely ancient ocean beaches, the land having gradually risen, and different leads were from time to time formed by the action of the waves on the beach, the light sand and material being carried away with the waves, and the heavier and denser material being left behind by a system of natural concentration on a gigantic scale. The large quantities of iron-sand concentrated by this action are so closely connected together that in some places it stands up like a hard sandstone-rock, in thin seams or bands, having a horizontal bedding. In other places the cement is soft and very easily broken up, but of too hard a nature for the particles of sand of which it is composed to be thoroughly disintegrated by the action of water from a hydraulic nozzle. The result of this has been that there are a number of men who get their livelihood by simply putting wide tables in the bed of the river covered with blankets or cocoanut matting, and as the muddy water passes over some of the fine gold adheres to the blankets or matting. The particles of cement sent down the tail-races of the miners lies on the beaches of the river in places, and becomes disintegrated by the action of the atmosphere, and thereby liberates the particles of gold encased in the cement.

About two years ago the proprietors of the Dublin City Claim erected a crushing-machine to treat the cement, and, this having proved a success, there are now five other machines erected by other parties. The Dublin City proprietors have a battery of eight heads of stamps, which, they informed me, was capable of crushing about thirty loads of cement in the twenty-four hours. The stamp-mortars have a back and front delivery, and are fitted with gratings having about 190 holes to the square inch. The pulverised material is carried away in chutes from the gratings, and distributed over wide tables, the head of which is covered with copper-plates 4ft. long, and below this, the tables are 12ft. long, covered with blankets. This, together with a small rotary amalgamating barrel, completes the plant. The stamps are very light, not more than from 3cwt. to 4cwt. each. These are driven by an overshot water-wheel, 30ft. in diameter, using about half a sluice-head of water. All the plants on the field are similar in construction, and driven by overshot water-wheels. The following are the claims which have cement-crushing machines:—

Dublin City Claim	...	...	...	8	heads of stamps,		4	men	in	claim.
Hero	...	...	...	4	"	"	3	"	"	
Try Again ...	...	...	...	5	"	"	2	"	"	
Higgins and party	...	...	...	5	"	"	3	"	"	
Birch and Sons ...	...	...	...	4	"	"	3	"	"	
Fox's Claim ...	...	...	...	4	"	"	1	"	"	
Connelly and Dwyer	...	...	...	4	"	"	3	"	"	

With the exception of the Dublin City, the rest of the claims have only commenced operations, so that at the time of my visit very little was known as to the results of working the cement. There is no doubt if the cement is found to be payable for working, a large number of cement-crushing machines will be used, as the auriferous cement deposits cover large areas. There is also a very large deposit of this cement at Brown's Terrace, on the opposite side of the Nile River from the Back Lead, and this is said to be very rich; and it is stated that a company has been formed in Christchurch to work a portion of the ground on this terrace.

Weir Brothers, who erected a hydraulic elevating-plant to work the tailings in Ballarat Creek several years ago, are still carrying on their operations and getting well paid for their labours; and

Gregory and Horner, who own a large number of valuable water-rights in this place, are said to be doing extremely well. Indeed, it may be said that the mining population in this district, on the whole, are doing fairly well. Some of the beach-claims yielded a good deal of gold last year. The character of the gold is extremely fine and difficult to save, requiring a great width of tables to treat the material. If the proprietors of dredging-machines were to adopt similar tables, and good separating appliances, these machines would prove more profitable investments.

Addison's Flat.

There are still a large number of miners employed in claims in Addison's Flat who appear to be doing fairly well. A company has taken up the ground on what is known as the Shamrock Lead, and are constructing a head-race from the Totara River, where they expect to get a good supply of water for the most part of the year. The head-race was nearly completed at the time of my visit, about the beginning of the present year, and will give about 300ft of hydraulic head at the point where they intend to commence operations. This company purchased the hydraulic elevating-plant and appliances formerly belonging to the Fairmaid and Gladstone Company, and were employed at the time of my visit in removing this plant on to their claim. At the place where it is intended to open out, the ground is said to be from 35ft. to 40ft. in depth, which they contemplate working in one lift; but, as they are not certain as to the actual depth the ground is, it may be possible that double elevators will have to be used. The ground, as far as it could be worked for water in the early days, proved exceedingly rich, but the quantity of water there was to contend with proved to be too great to lift by manual labour, and the miners combined and constructed an underground tail-race to drain the ground. This tail-race is said to be about three miles in length, but when it got up to the ground it was found to be too shallow to be of any use, and there was some difficulty encountered in keeping the tail-race open. Several breaks took place, and the whole undertaking was abandoned; and for many years no one could see a way of working the ground advantageously unless a very large expenditure was made. The amount of work that was done by the miners in the early days, who knew the value of the ground worked, is a certain guarantee that gold is there in sufficient quantity to pay for working by the present method of hydraulic elevating.

The owners of the claim close to the Township of Addison's had, at the time of my visit, been engaged for several months in shifting their plant forward to enable them to work the ground more advantageously. They had these alterations nearly completed, and would be ready to commence sluicing operations in the beginning of the year. The large area of virgin ground on Addison's Flat which has never been prospected leads one to believe that other leads of gold will yet be discovered in this locality. Indeed, at the rate the ground is being worked and fresh discoveries made, one hundred years will not see the auriferous portion of the flat worked. It is true the ground may become poorer; but, with the approved methods of working which are yearly being brought into use, there may be very little diminution in the profits of working.

At the lower end of Addison's Flat, at what is known as Bradshaw's Terrace, a new lead of gold was discovered last year, and there are several claims which are said to give payable returns for working—namely, Rodgers and party, of six men, who up to the time of my visit got gold to the value of about £800; this party has the nearest claim to Cape Foulwind, and, coming on from them is Cullen and party, of four men, who were opening out and getting payable returns. Adjoining them is Sangwell and another two men, and McIntyre and party of five men. All these parties are well satisfied with the prospects they are obtaining, and more new claims are likely to be taken up if water was available. The whole of these claims are close to the edge of a steep terrace, and there is plenty of fall for sluicing the ground in the ordinary manner.

Between Bradshaw's Terrace and Wilson's Lead, Minogue and party are working another lead of auriferous drift, which is said to give very good returns. Indeed, judging from the number of leads containing gold-bearing gravel, which have been formed at some period in the past by the action of the waves on the ocean beach, and the great distance there is between the leads already discovered, it is very probable that several others will yet be found to prove remunerative for working.

Apart from the auriferous drift and sand, there are large areas covered with auriferous cemented sand which cannot be worked by sluicing. This sand contains a large percentage of iron, which is greatly oxidized, and forms, as it were, blocks of soft sandstone, which cannot be disintegrated unless by crushing it. A company, composed of gentlemen in Westport, took up some ground containing this character of cement, and have erected an overshot water-wheel 35ft. in diameter, and twelve heads of light stampers, erected in batteries of four stamps in each. The mortars discharge back and front, and the stamps being driven at the rate of sixty-five blows per minute, with an 8in. drop, they are able to put through about twenty-four cubic yards per day. The crushed material passes from the mortars into a distributing chute, and thence on to tables having an aggregate width of 30ft., where the gold is recovered. This cemented material is in places mixed greatly with rounded stones, to which the cement firmly adheres, and consequently they are coated with fine gold, which cannot be got off except by either crushing them or rolling them one against another by some mechanical appliance. If a good pressure of water could be obtained on the ground to turn them over against one another by a jet of water from a nozzle, there is no doubt that this would be the most economical method of washing them; but as a sufficient head of water is not obtainable, the company are putting the smallest of them through the stamp mortars, and the largest are being stacked on the ground. The manager, Mr. Wilson, informed me that on washing a small truck-load of these stones in a berdan, he got gold to the value of 12s. The returns from this company—which is termed the Venture Gold-mining Company—was up to the time of my visit highly satisfactory, and, as there are large areas covered with this class of material on the flat, no doubt other parties will take up ground and work it in a similar manner.

The following is the return of the quantity of cement crushed, and the yield of gold obtained, for the quarter ending 31st March last:—

Name of Party.	Cement Crushed.	Amalgam.	Retorted Gold.
	Tons.	Ozs.	Oz. dwt. gr.
W. Fox, Charleston	12	...	0 10 0
J. Birch	200	2	10 0 0
Dublin City	1,020	255	66 0 0
Woodheady and party	540	126	37 0 0
Bird and party	100	55	15 0 0
Dwyer and party	160	61	19 0 0
Venture Company, Addison's Flat	233	...	115 0 0

The latter return shows that the cement worked at Addison's Flat has averaged 10dwt. per ton.

The following is the amount crushed for the year ending 31st December, 1892:—

Name of Party.	Cement Crushed.	Amalgam.	Retorted Gold.
	Tons.	Oz.	Oz.
R. Higgins, Charleston	2,500	240	60
William Fox "	2,880	185	46
James Birch "	500	164	43
P. O'Connor "	2,080	520	134
Woodhead and party "	50	41	11
Dwyer and party "	200	...	23
Homan and party "	400	90	23
Bird and party "	2,000	437	195
Garvin and party, Addison's	2,090	968	272

Grey Valley District.

There are a large number of miners employed at the different places along the Grey Valley, and some of them are doing fairly well. At Nelson Creek, J. Law and party have completed a tail-race which has taken them three years to construct, and now they are reaping the reward of their labours; their claim is said to be a very good one. The Nelson Creek Company are engaged in constructing a head-race and extending their tail-race, which is said will cost about £4,000. Craig and party, who have been working the bed of Gow's Creek, near Welshman's, by means of a hydraulic elevator, have not met with the success they deserve; but it is said that the ground, as they go up the creek-bed, is getting better. M. Roche was the first person to introduce this mode of working on the West Coast, and he deserves credit for the energy and perseverance he displayed in combating with the difficulties he encountered, and persistently adhering to this system of working for the last twelve or thirteen years, though getting but very little return for the outlay. This plant is now leased to Craig and party, who are steadily carrying on elevating operations, except when the floods in the creek will not permit them to work.

The ground belonging to the Nelson Creek Company could be advantageously worked by means of hydraulic elevators, but the miners in this part of the colony are very chary of using any new appliance with which they are not thoroughly conversant, preferring to stick to the older methods of working, even should they be more expensive. The Nelson Creek Water-race passes close to this company's ground and at an elevation of some 400ft. above it, where a constant supply of water could have been got for the last four years, that is, since this ground was first opened. Indeed, the whole of the ground could have been nearly worked out by this time had they adopted the hydraulic elevating principle at first. There is a large area of auriferous ground in the bed of Nelson Creek between Hatter's Terrace and Messrs Drennan Brothers' farm, which will take a number of years to work; but the auriferous drifts of the terraces, which are only shallow in depth, are rapidly being washed away.

At Blackball some of the miners are doing very well. The ground in this locality contains a fair amount of gold, but it is full of very large stones, and the supply of water being, as a rule, very limited, it takes good ground to give fair returns for working. The Minerva Company, who have a water-race from the Roaring Meg Creek, having a carrying capacity of thirty sluice-heads of water, and is at its terminating point some 600ft. above the level of their workings, have now completed their tail-race at the lower level, and are ready to commence sluicing. This company have good ground if they can get clear of the large boulders, but to work their ground economically they will require cranes or derricks to lift the stones. The face of the wash-drift is from 50ft. to 70ft. in depth, and said to contain a little gold all through it, although the richest layers are near the bottom. The workings in this locality are all carried on by hydraulic sluicing; but the iron pipes that are generally used here are from 7in. to 9in. in diameter, and the quantity of water used by each party is too little to work the ground advantageously.

At Moonlight and adjacent gullies there are about seventy-five miners at work, some of whom are making fair wages. This is a locality where some large nuggets of gold have been found, and where it is anticipated there will be a rich quartz-lode found some day, as the gold is all impregnated with quartz. The wash-drift is all full of large boulders, and some of the ground is worked by hydraulic

sluicing; while in other cases it is driven out from tunnels or adits, constructed in the face of the terrace.

At Waipuna some of the miners are doing extremely well. It is said that there are seven claims on a terrace between Half-ounce Creek and Barry's Gully, which give a return of about £8 a week for each man employed in them. This ground is worked from tunnels, constructed in from the face of the terrace.

Taking the alluvial workings in the Grey Valley generally, there are about one thousand two hundred miners at work, some of whom no doubt earn but small wages, while others are doing fairly well. Fresh ground is being almost daily opened up, and, although not rich, it is made to pay small wages by working it systematically. There is really very little ground yet worked in the Grey Valley in comparison to the area that is auriferous; but this is owing to the limited supply of water that is brought on to the ground. It is only rich ground that will pay for working from shafts and tunnels, while the general quality of the auriferous drifts can only be made remunerative with a plentiful supply of water. As soon as one claim is worked out the water is taken on to another; and hydraulic-sluicing will be made remunerative employment in this valley when the present generation will have all disappeared.

Kumara District.

During the last year there were seven of the original claims on the field worked out—namely, Turnbull, Arthur, Rodgers, Gibbons, Bain, one of Harris's, and Seaton's. These claims used generally about 57½ sluice-heads of water, and there are three claims in which very little sluicing has been done, namely, those belonging to Morris, McIlveney, and Trickey and party. The latter claim was close up against the Kapitea Hill, and the ground proved too poor to pay for working. There are three fresh claims being opened up—namely, Shrives and party, at the place known as the Break, alongside the Dillmanstown Road; also Connor and party, at the Shallow Lead; and Barrett and party. Shrives and party have constructed the widest sluice of any private party on the field, namely, 30in. wide, with splayed sides, set on a gradient of 12in. to the 12ft. box, and they intend using about sixteen sluice-heads of water. Their sluicing-water is brought on to the ground in two rows of pipes 18in. in diameter. Connor and party, who are opening out in the Shallow Lead, have recently constructed a new tail-race, 1,550ft. in length, having a jump-up of 80ft., from which they intend to commence sluicing, when they will use ten sluice-heads of water. The other party, Barrett, is opening out a claim alongside Fifth Street, Kumara, but the ground up to the time of my visit had not proved remunerative. This party uses ten sluice-heads.

Some prospecting-shafts have been sunk on the north-western Town-belt, and the Mining Reserve adjoining. To all appearance gold will be got, and the ground worked on this belt; and there is little doubt but that payable ground exists under a portion of the Town of Kumara. There is still a considerable area of unworked ground between Larrikin's Road and the Kapitea Hill, and also very little ground has been worked between the Larrikin's Road and the Hokitika–Greenstone Road.

The ground also on the northern side of Seddon Street, comprising Nardoo Flat, will all be worked yet. There are four claims being worked in this locality which are said to pay very well, and there is a large area of ground in the flat, which, although not so rich possibly as the ground that is being at present worked, will yet be made to pay with a plentiful supply of water. Hitherto the demand for water has been so great that large quantities could not be supplied to any one party, but now that some of the claims are getting worked out more water will be available. Many of those who have been working claims on this field freely acknowledge the reason why some of the claims have not paid them so well for working as they should have done. In the early days of the field there were too many men in each claim; they could not all be advantageously employed in carrying on hydraulic-sluicing operations. Had the ground been worked in the ordinary manner by paddocking, it would never have paid for working, but even supposing that there had been sufficient gold to work it in this manner every man could be fully employed.

The future success of the field will depend on working the ground in the most economical manner, doing away with as much manual labour as possible, and utilising the water for doing the work. There is no getting away from the fact that unless some new ground is opened in the locality there will not be the same quantity of men actually engaged in mining; though the field will support a large population for many years to come. The nature of the drift-wash on this field is more stony than on almost any other field, and the shifting of these stones is a great item in the cost of working. In most of the claims water is only used for sluicing for three hours a day, and a few of the claims for four and a half and six hours a day, the rest of the time being all occupied in shifting the stones, and many of the large stones have to be blasted before they can be shifted. In America, derrick-cranes worked with Pelton water-wheels, for shifting and stacking the stones are employed, but in general the stones on the Kumara field are all shifted by manual labour. If derrick-cranes and flat scoops were used, these stones could be removed at far less cost than they are at present, and, no doubt, the day is not far distant when far more labour-saving appliances will be used on this field. The water-supply here is all that can be desired, and, although some people are still advocating a larger supply being brought in, there is nothing to warrant this being done at the present time.

The complaint that some of the miners have here is that they are bound to employ one man for every acre they hold, and as the most of the claims are held here as extended claims, and from five to six acres in extent, they have actually to have more men to hold the ground than can be advantageously employed in carrying on their mining operations by hydraulic sluicing; but there is nothing to prevent them holding the ground as a licensed holding, and then only one man to every two acres is required. Where the ground is poor, a moderate area has to be granted in one claim to make it worth while to place a good hydraulic-plant on the ground and construct tail-races. The tail-races on this field in the future will be costly to construct in order to work the back-ground, and far less fall will have to be used in their construction than is given in the tail-races working the

ground in front of the terrace. All these things tend to greatly increase the capital required in opening out a claim, and also the cost of carrying on sluicing operations. To give sufficient encouragement for poor ground to be worked, and which cannot be made to pay by any other method than by hydraulic sluicing, one man will have to be allowed to represent a larger area than given him under the head of extended claims; and, in order to insure actual sluicing operations to be carried on, it would possibly be the best way to allow a certain number of sluice-heads of water actually used in working to represent one man's ground; say, for every five sluice-heads of water used daily in working a claim by hydraulic sluicing, it shall represent one man's ground. This would not only insure the continuous working of the ground, but it would give a high incentive to parties to use large quantities of water, and thereby enable them to make ground pay for working that is now considered too poor.

It is a hard matter to introduce any new method of carrying on mining operations on any field. Men will adhere to the methods they have been accustomed to, until, by sheer necessity, they are compelled to adopt other means. On this field, for instance, a few years ago, from 11in. to 13in. was considered ample diameter for pipes to convey water, to convey any number of sluice-heads; and it was only after ample trial was made with these that the miners were convinced that by trying to force large quantities of water through them they lost a large percentage of the head. Far larger quantities of water are now used on this field than in former years, and also wider sluices, and it will be found that larger quantities of water will still have to be used to make plenty of the ground that will be taken up as sluicing claims pay moderate wages for working. Therefore every encouragement should be given to get the miners to adopt this. The future of the field will depend to a great extent on whether the large area that is covered with the more recent auriferous drifts above the false bottom can be made to pay for working, and also whether there are other gold-bearing layers underneath the present false-bottom; and if the latter proves to be the case, they will be likely to belong to an older formation, and the leads of gold-bearing drift will probably extend for greater distances than those near the surface.

The following is a list of the different parties working ground at Kumara; with the fall in their tail-races, the number of men employed, and the quantity of water used in working their ground:—

Name of Party.	Number of Men employed in the Claim.	Fall to 12ft. in Tail-race.	Number of Sluice-heads of Water used.	Name of Party.	Number of Men employed in the Claim.	Fall to 12ft. in Tail-race.	Number of Sluice-heads of Water used.
No. 2 Channel — Water from Kumara Race—				*Private Tail-races—Water from Kumara Race—*			
Holst and party ...	4	6	12	Turnbull and party ...	5	12	10
Watson and party ...	5	9	9	Cullen and party ...	6	6	10
Hughes and party ...	3	6	11	Henderson and party ...	6	7	10
Palmer and party ...	6	9	10	Lee and party ...	7	7	11
Fahey and party ...	3	6	10	Anderson and party ...	6	10	10
Ireland and party ...	4	5	12	Americh and party ...	2	12	10
Pascoe and party ...	6	8	10	Shrives and party ...	5	13	12
Bauke and party ...	3	5	10	Barrett and party ...	4	10	10
Millson and party ...	3	7	10				
				Private Tail-races—Water from Holmes's Race—			
No. 3 Channel — Water from Kumara Race—				Moran and party ...	4	10	10
				Reid and party ...	5	7	10
O'Sullivan and party...	5	8	8	Payne and party ...	5	8	10
Harris and party ...	6	7	9	Dinan and party ...	6	7	10
Dennett and party ...	5	5	10	Evenden and party ...	4	10	10
Rizzie and party ...	4	8	8	Burke and party ...	5	10	10
Williams and party ...	3	8	8	Bowden and party ...	6	10	10
Carew and party ...	4	8	8	Johnson and party ...	3	12	10
Light and party ...	5	6	10	Ames and party ...	5	9	10
Thomas and party ...	5	8	10				
O'Connell and party ...	5	8	8	*Water from Private Water-races—*			
Moynihan and party ...	4	8	8				
Rochford and party ...	4	8	8	Pearn's lease ...	6	10	15 to 20
				Long Tunnel G. M. Co.	6	7	10 to 15

At Cape Terrace, on the opposite side of the Teremakau River from Kumara, there are three parties carrying on sluicing operations, and two parties working the ground by tunnels. Taking the tailings coming from the claims on this terrace, and from the Kumara field, it has altered the bed of the Teremakau River considerably from what it was a few years ago. The river-bed a little below the bridge on the Hokitika–Greenstone Road is now fully half a mile in width, and must be at least 8ft. or 9ft. above the level it was at the time the bridge on this road was constructed.

Prospecting Shaft.—The prospecting shaft referred to in my last report has been sunk below the bottom where gold was originally obtained to a depth of about 100ft. There was no gold in the material until getting near the blue reef, when an auriferous layer of drift was found, but not sufficiently rich to pay for working by driving the ground out. The shaft, however, bottomed on a reef, which appeared to be dipping in all directions. Sinking was continued for some distance in the

blue reef, and a drive put into the apparent deep ground to cut the wash-drift, but so far the Prospecting Association has not been successful in finding gold. The ground, however, is by no means proved yet. The deep ground where the bed of the river has originally been has not yet been touched. Gold was obtained on the northern side of the flat on the blue reef; but where this was found the reef was dipping in towards the Kapitea Hill, and the place where the gold has recently been got in this shaft on the blue reef is on the southern side of the flat, and the reef here is said to be dipping towards the river. The shaft should therefore be sunk to a greater depth, and a drive constructed from the bottom across the flat. If no lead of gold-bearing wash-drift be then found, it may fairly be presumed that it does not exist on the blue bottom.

Hokitika District.

Waimea.

There are still about the same number of claims at work as there was last year, but the unworked ground is yearly getting further back into the range, and the fall for carrying on sluicing operations is gradually becoming less, and the ground is also getting poorer. The only party that is carrying on sluicing operations on a large scale are the proprietors of the Wheel of Fortune Claim. This party have erected elevators, and have commenced sluicing material into a well, and lifting it about 40ft. with elevators worked by a water-wheel. The elevated material is dumped into a hopper, and thence passed into a regular set of sluice-boxes. The sluicing-water from the well passes out through the drainage-tunnel. The quantity of material lifted by this means is about sixty loads an hour. This is a similar elevator to that used by the Ross United Company, at Ross and Donoghue's, only the elevators at the Wheel and Fortune Claim are set in a more upright position. The elevators are worked by an overshot water-wheel 25ft. in diameter, using about three sluice-heads of water, which is again used for sluicing the elevated material. A sluicing-nozzle 3in. in diameter is used in the paddock, under a head of 60ft., for breaking down the dirt, and an additional quantity of water comes over the face of the bank, to carry the material into the well. Mr. Batchelor finds his wheel not powerful enough for the quantity of material he has to lift: as the width of the breast is only 2ft. 4in., with 7in. in depth of bucket, he cannot use a larger quantity of water on the wheel to advantage. The buckets of the elevator hold about one and a half cubic feet of gravel in each, and it is lifted to a height of 30ft., when it is dumped into sluice-boxes, and washed a second time; but the most of the gold is got in the short line of boxes in the bottom of the paddock. The water used for washing in the paddock flows away in an underground tail-race. The depth of the ground they were working at the time of my visit was about 18ft., with hard cemented bands through it. Some years ago this claim was opened out and worked, but without payable results. The present proprietor is, however, very well satisfied with the amount of gold he has obtained since commencing to work it. He had spent a considerable amount on this plant, and deserves credit for the manner in which it is constructed.

The different parties of miners who are carrying on sluicing operations in the Waimea District have all dams of their own, and are therefore able to store the water which they get from the Government water-race at night, but none of them take it direct from the water-race to their claims. All the dams are at a considerably less elevation than the water-race, and even then they do not take it direct in pipes from their dams, but lead the water down in open races, having a considerable fall. Some of the parties only take a portion of their water in pipes, and let the remainder come over the face. The general method is to drive tunnels along the face, with pillars here and there, in order to break down the ground, which could easily be done if the full head of water were taken from the Government water-race. It will therefore be seen that the ground has to contain a considerable amount of gold to pay for this method of working. The parties working in this locality complain about the ground being poor, but, if worked in more approved manner, there is every likelihood of it giving good results. The general fall in the sluices is about 5in. to every 12ft. A greater gradient cannot be obtained, owing to the bed of the Waimea Creek being filled up to a great depth with tailings.

There is a considerable area of ground in the valley of the middle branch of the Waimea Creek, which is proved to be auriferous, still unworked. Some shafts have been sunk, but there is a good deal of water in the ground, which will require a tail-race or tunnel to drain it before it can be properly prospected. The ground is from 20ft. to 30ft. in depth, and if a tail-race were constructed it could all be worked by hydraulic-sluicing, as the water from the recent extension of the water-race towards Callaghan's commands the whole of this ground. The President of the Waimea Miners' Association waited on me when in this district to inquire whether the Government would subsidise the construction of an underground tail-race, which he stated would have to be about 2,000ft. in length, and which he estimated would cost about 5s. per foot to construct. If it could be done for this amount—namely, £500, it would be likely to open up a large area of ground. It is, however, very doubtful if there is sufficient fall for a tail-race to carry tailings, and, even if this proved to be the case, the cost of construction would be far more than the estimate given by the President of the Miners' Association, as it would require to be boxed and blocked throughout; but probably a drainage tail-race could be constructed for the amount named.

Arahura.

The principal gold-workings in this district are situate at Humphrey's Gulley, but there are other mining ventures in the locality which are deserving of mention. Amongst these is the tunnel constructed by Mr. Boys, of the Blue Spur, from the Arahura Valley to the valley of the Hauhau Creek. This tunnel has been in course of construction for the last seven years, and at the time of my visit to this locality, in December last, was constructed for a distance of 4,861ft. Several years ago a prospecting-shaft was sunk in a flat terrace above the valley of the Hauhau Creek, and struck gold, but could not work it owing to the large influx of water. Rich gold-bearing wash-drift was

traced into this flat in the early days, but the quantity of water to contend with when the ground got deep prevented it from being worked. About seven years ago Mr. Boys took up a claim on this terrace, and commenced to construct a drainage-tunnel from the Arahura River, on the expectation that possibly he would find some auriferous layers of wash-drift long before he reached this terrace where the prospecting-shaft was sunk. The tunnel is about 6ft. high and 4ft. wide, and was carried in through gravel-drift for a distance of 4,508ft. when it came up to the blue reef, and, at the time of my visit, was into this reef 353ft. Mr. Boys expected to have another 200ft. to drive to get underneath the prospecting-shaft, where he intends to construct an uprise shaft should he carry the blue reef for the whole of the distance. Judging from barometer levels taken at the top of the air-shaft that was sunk at 4,158ft. in from the mouth of the tunnel, and the level of the top of the prospecting-shaft, this tunnel will drain the ground to a depth of between 60ft. and 70ft. below the surface, whereas the depth of the prospecting-shaft is only said to be 45ft.

Mr. Boys deserves great credit for the untiring energy he has displayed in carrying on this work. It was only on the eve of its completion—after he struck the blue reef—that he asked for any assistance from the Government to enable him to complete it. He deserves to be well rewarded for his labours. If he is fortunate in finding rich auriferous drift, when this tunnel is completed, it may be the means of a considerable area of ground being worked outside Mr. Boy's claim.

Mr. Olderog has been for several years working on the beaches of the Arahura River, and getting a little gold. He has recently commenced to cut-up a tail-race into a flat alongside the river, and found a very good sample of gold in the wash-drift in the face of his tail-race. This flat is situate about two miles above the Humphrey's Gully Company's workings on the opposite side of the river, and is about from 12ft. to 15ft. above the ordinary water-level of the river. It is from two to three miles in length, and from twenty to forty chains in width, so that if a lead of gold be struck here it may prove to be of considerable importance.

Humphrey's Gully Company.—This company has washed away a large quantity of material, but, owing to the height of the face, they have not gone over a very large area of ground yet. The ground is about 200ft. deep, containing a little fine gold through it in layers, but the principal gold is found in the bottom wash, which lies on the top of a glacial silt mud. There is a considerable thickness of this glacial silt, and the action of the water and atmosphere together causes it to swell and spue out underneath the great depth of superincumbent gravel which has covered it since it was deposited. This action causes a great depth of the silt to be broken up and washed away in order to recover the gold in the wash-drift overlaying it. Judging from the manner in which this silt is lying, it must have been in a consolidated state previous to the deposition of the gravels.

At the time of my visit in December last, the tributers estimated that they were using thirty-six sluice-heads of water; the main supply-pipes were 22in. in diameter, and have a head of about 150ft. on the nozzles. They were using two nozzles, one 6in. and the other 7in. in diameter; but even this quantity of water makes very little impression on the height of the face. The sluice-boxes are too narrow for the quantity of material they have to convey. When there is a fair supply of water they are always full, and the gold has not a chance of settling on the bottom. The tributers state that in ordinary moist weather they can carry on sluicing-operations with three shifts continuously, but in dry weather they can only work for a few shifts in a week.

This company has a large area of ground, containing a great depth of auriferous wash-drift, which will pay for working if they could depend on a steady supply of water, but they can never do this unless the race is constructed to the Arahura River. The ground is far from being rich, and requires to be worked on a continuous system, with a large supply of water, before the company can ever expect to be recouped for their outlay or receive any interest on the capital expended.

During the last year sluicing has been carried on as energetically as the limited supply of water would permit. According to the directors' report for the year ending 10th February last, sluicing operations were carried on for 471 shifts, with the result that 720oz. 6dwt. 14gr. of gold have been obtained, and it is estimated that there is still 200oz. of gold in the sluices. The value of the gold actually obtained last year was £2,809 5s., as against £1,351 2s. 6d. for the preceding year. The expenditure, according to the balance-sheet, was £1,180 7s. 7d., placed under the head of "Claim Working Account," which seems to include the money paid to the tributers and salary of mining superintendent; and £402 5s. 5d., including water-race maintenance, rent and taxes, &c.; making the total expenditure in connection with the actual working of the ground £1,583 13s. The expenses in connection with the legal management, directors' fees, &c., was £302 16s. 4d., being about 19 per cent. on the actual expenditure in connection with carrying-on sluicing operations, thus making a total of £1,886 9s. 4d. In addition to this, £389 11s. was paid for additional plant, which was necessitated by their head-race breaking away in the preceding year. This amount is charged to the capital account, and therefore the net profit on working last year may be said to be £922 15s. 8d. The ground appears to be getting better as it goes back into the range, or else the supply of water was greater last year than the previous one, which would also account for the increased yield of gold. It is a pity to see a mining property like this sacrificed in the manner this is by not having an adequate water-supply, although plenty is available with comparatively little expenditure in proportion to the results that would be obtained. The expenses of management would be no more if there were six times the number of men employed, and getting twenty times the present yield of gold.

Rimu.

There are still a considerable number of miners working at Back Creek, Seddon's Terrace, and Rimu. During last year gold was discovered on the sloping terrace rising out of Rimu Flat, and several claims were taken up and shafts sunk. It was thought the lost lead at Rimu might prove to go in this direction. The prospects obtained at the time of my visit were said to be sufficient to pay for working, but, in general, the character of the auriferous layer of wash-drift was very poor. At Seddon's Terrace several of the claim-holders have constructed adit-levels from the front of the

terrace facing the Hokitika River, and are working the ground from these, instead of hauling the wash-drift up shafts. The ground here is not rich. None of the miners are making more than small wages. The sluicing-claims at the front of the terrace are good property, but even the returns from these could be greatly increased if a large supply of water was available.

There is little doubt but there is a large extent of ground in this neighbourhood that would give remumerative employment to a considerable population if there was a large supply of water brought on to the field, but the expense of bringing in a sufficient supply to work the ground would be a very big undertaking. When in this district, a deputation of the Miners' Association at Rimu met me, and wished me to represent to the Government the advisability of having a survey made to see if water could not be brought on to this field, and at what cost. Several sources are mentioned from which it can be got—namely, the Hokitika River or some of its tributaries, the Kanieri Lake, and the Arahura River. The distance it would have to be taken from either of those sources would be very great, and the quantity of water required to maintain a large population on this field, taking into consideration the great depth of the gravel deposits, would have to be at least eighty sluice-heads; and no matter what source the water was taken from, it would have to be conveyed at least three miles in iron piping.

The elevation of the terrace at Belcher and party's shaft on the top of the terrace at Back Creek is 346ft. above high-water mark, and some of the claims are at an elevation of 390ft.; the water therefore would have to be at least 450ft. above sea-level at the terminating point of the supply. The elevation where the water was lifted would need to be at least 700 feet above sea-level, to provide for fall for the ditching, fluming, and iron pipes. The cost of three miles of iron pipes alone, to convey eighty sluice-heads of water, allowing 15ft. to the mile of fall, would be over £35,000.

The Miners' Association at Rimu have been doing good work last year in trying to find fresh discoveries with the small amount of money they had at their disposal. The following is an extract from a report forwarded me by A. Clifton, the President, on the subject: "We have not been able to do as much work as in the previous year owing to the scarcity of funds, and also as some of our work was more expensive than usual. We have sunk four shafts of an aggregate depth of 233ft., at a cost of £51 6s. 8d., and have constructed 370ft. of prospecting drives at a cost of £27 15s. We have also put down a line of bore-holes from Mahinapua Creek to the ocean beach, a distance of about 60 chains, at about half a chain apart. The total number of bores put down was one hundred and fifteen, having depths varying from 15ft. to 25ft., making the aggregate distance bored 2,300ft., the cost of this work being £51. Owing to the peculiar nature of the boring we had to pay men 30s. each per week instead of the schedule rates, which made a considerable difference in our funds. The ground along the line of bore-holes is all of a sandy beach formation and black sand, and a little gold was found in five or six of the bore-holes; but nothing was found to be anything like payable for working. Out of all the work done last year we only obtained gold payable for working out of our shaft, which was the means of six parties of miners setting in and getting gold. This was to the south-west of Rimu. We have made another effort to raise subscriptions, with the result that we have between £70 and £80 promised for the next six months. This, with the Government subsidy, will enable us to do a considerable amount of work the next spring."

This shows that there is a considerable interest taken amongst the miners of this portion of the Westland district in prospecting for new ground, and shows that the miner of to-day has not lost the vitality and determination of seeking to open up fresh fields and pastures new. The bore-holes referred to in Mr. Clifton's report were put down to try and find the continuation of the Black Sand Lead along the old ocean beach line, and the shaft they discovered gold in is the one mentioned by me previously as being on the rise of the terrace above Rimu Flat.

Craig's Freehold.—This is between Rimu and the Mahinapua Creek, from which a considerable quantity of gold has been obtained. This land has been worked now for several years on tribute, the tributers paying 33½ per cent. of the gross yield of gold. Recently fresh arrangements have been entered into with reference to the working of this land, and there are now three parties of tributers at work.

Ross District.

This field still continues to support a fair mining population, but the quantity of gold obtained comes far short of the returns of the earlier days of the field. There is no goldfield in the colony where the alluvial drifts are at so great a depth as they are on Ross Flat, neither is there a field where there are so many gold-bearing layers directly above one another. The character of the formation of these layers on the upper levels are entirely different to those below, and these lower auriferous gravels are now 200ft. below sea-level, and no bed-rock has ever yet been reached in Ross Flat. This portion of the colony has been elevated and depressed at different periods, as marine shells can be seen at high elevations above the level of the sea, while the auriferous gravels referred to—now 200ft. below sea-level, and it is not known how much more—have been brought there by the action of flowing water. This was referred to in my last year's report, and a theory set up that the older gravels found in the lower auriferous layers came from a different direction to that of the present mountain chain, while the upper or newer gravel deposits came from the present mountains or high land.

Mr. A. McKay, F.G.S., the Mining Geologist, has devoted a good deal of consideration to this subject, and, after exploring this part of Westland, between the Grey and Mikonui Rivers, arrives at the conclusion that at one time there was high land to the westward of Hokitika, and the auriferous gravels referred to at the lower levels are likely to have come from the westward, and not from the present chain of mountains. This would account for the great richness of the sea-beaches all along the West Coast, but, whether this theory is correct or not, one thing is certain, that there is none of the same character of material to be found on the present mountain chain.

There is still a considerable quantity of gold in Ross Flat, but the great difficulty is the large quantity of water there is to contend with at the deep levels; and it really becomes a matter of pounds, shillings and pence whether the gold on these levels is worth more than the money expended in obtaining it. It is now about twenty years ago since the original workings on these levels were suspended, and, with the exception of a few months' work by the Ross United Company, no mining operations have been carried on.

Ross United Company.—This company was formed with the express intention of working the deep ground in Ross Flat, but found, after they had got all their machinery erected, their pumping-engines and plant were not sufficiently powerful to contend with the water, and after a few months' work they had to abandon ground which was giving good returns. The failure of this company in not carrying out its original intention is due in a great measure to the manner in which their operations were conducted. At the time they sank their shaft the whole of the old original workings were full of water, and no regular surveys of the old workings had been ever made or at least kept by each company who were then working the ground. It was also known to those who were acquainted with the character of the ground on this flat that it was liable to run if the greatest care was not taken in timbering the ground. After the present company got down their shaft, they commenced to block out ground adjacent to the old workings, and very soon the water broke in from the roof of the drive and swamped them out. Indeed, taking the state of the flat at the present time, no company can work the ground systematically unless they are prepared to pump the water out of the original workings, and divert the course of Jones's Creek down the back of the Cemetery Hill, to prevent floods from overflowing the channel, which sends the water into the worked-out grounds, and would be always liable to swamp the low levels with any pumping machinery that could be erected.

During last year the company has been carrying on operations on the upper levels on Ross Flat, from which the drainage can be carried away in a tail-race to the ocean beach. According to the mining-manager's report to the directors of the 7th February last, the elevators on Ross Flat have been kept continually working with two shifts of men throughout the year on tribute; and up to the end of December last, being about eleven months' work, 73,825 cubic yards of wash-drift were treated, which yielded 804oz. 15dwt. 5gr. gold, representing a value of £3,138 11s. Of this amount, £1,098 9s. 6d. was paid to the company in tribute, being 35 per cent. on the gross yield of gold. From January up to 7th February about 5,000 cubic yards of material was washed, but the gold from this was not taken out of the boxes.

In addition to the claim on Ross Flat, this company have another at Donahues, where another set of elevators are worked on tribute. The yield of gold from these for the year was 368oz. 14dwt. 6gr., having a value of £1,442 19s., of which amount the tribute paid the company was £419 18s. 6d., being about 29 per cent. of the gross proceeds. Altogether, including their ground on Ross Flat, there has been during the past year forty men employed on tribute. Although the tribute paid to the company may appear to those not acquainted with all particulars to be very high, the company has last year expended in maintenance and other expenses in connection with these two elevator claims, inclusive of the salary of mining-manager, £1,112, less £76 9s. 6d. for sales of water to other parties, thus leaving the net expenditure by the company to be £1,035 11s. 6d. The total tribute paid by those working the two claims referred to was £1,518 8s. Deducting from this the expenditure by the company, the tribute paid last year was about 10½ per cent. of the gross yield of gold. In addition to the tribute paid by those working in the elevator claim, the company received in tributes from other parties £101 13s. 6d., who were working in other portions of their ground. The sales of water to these were as previously stated, £76 9s. 6d., thus making the company's total revenue for the past year £1,696 11s. Their expenditure in connection with the claims and management at Ross was £1,115 10s. 8d., and the expenses in connection with the management in Hokitika £336 2s. 10d., making the total expenditure for the year £1,451 13s., which leaves a net profit on last year's transactions of £244 18s.

Mont d'Or Company.—This is the only other company of any note carrying on extensive operations, and it may be termed the most prosperous one that has been engaged in mining in the Ross District for the last twenty years. They are working the ground by hydraulic-sluicing, and although they wash away a large amount of material yearly, they make very little alteration in the face of the hill, owing to the great depth of drift-gravel. This company have all the water-rights at present that commands the ground at the elevation they are working, and it will take many years to work out their present claim. During last year they obtained 1,823oz. 8dwt. 14gr. of gold, representing a value of £7,112 4s.

Rangitoto.

A considerable amount of prospecting has been done on Messrs. Pollock and Bevan's property at Rangitoto, and it is represented that they have obtained both gold and silver of a payable character for working a granitic conglomerate, which crumbles away on exposure to the atmosphere. The following is an extract from a letter forwarded by these gentlemen recently to the Hon. the Minister of Mines, which shows that, notwithstanding the failure of the original company to find gold or silver in payable quantities, Messrs. Pollock and Bevan have been for several years expending money in prospecting operations, and their letter shows that they are likely to be rewarded for their energy and perseverance:—

"You may perhaps be aware that for a very long time past we have been prospecting a huge belt of conglomerate, or a sort of bastard granite, which crumbles away on exposure, and that we have found it to be auriferous. We have had many trials from the outcrop, taken indiscriminately from an extensive surface. One trial of a ton by chlorination in Melbourne gave us 6dwt. 12gr. of gold; another by the Cassel process yielded 6dwt. 14gr. Our own fire-assays from the face of the formation have yielded a variety of results; some poor, some exceedingly good, but encouraging from a prospector's point of view, owing to the fact that we seldom or ever failed to get gold, although

nothing is visible to the naked eye. On another occasion we sent five small lumps to Reefton, and Mr. Fenton found gold in every one of them, and recommended us to further prospect the discovery.

"In February last a tunnel was driven right into the formation. The tunnel was 4ft. 6in. by 6ft. 6in.; at every 3ft. of driving 12lb. of stone was taken and tried. The tunnel was driven for a distance of 40ft. and nine of these trials of 12lb. each were made, and in every case gold was obtained. In order to get a good all-round average the results of the nine trials were cupelled and run into one button of gold, with the gratifying result that it yielded 4dwt. 4gr. of gold; whilst the tailings contained another 2½dwt., or equal to 6dwt. 16gr. per ton. The process adopted was by quicksilver amalgamation of the ordinary character, with but very primitive appliances at command. This mode of dealing with the stone proves that the gold is free, and does not require either the Cassel process or chlorination to extract it; hence the probabilities of making such a huge mass pay well, for it must be borne in mind that there are simply millions of tons of stuff to operate on, which could be broken down for a mere nominal cost, probably less than one shilling per ton. The gold is very fine, and will require careful treatment; but recent amalgamation-pans and intelligent battery management ought to be sufficiently understood to make the undertaking a success."

Otago District.

The Otago District may be said to contain the largest area of auriferous drifts of any district in the colony, but the high elevation at which a large portion of this area is situate precludes its being worked. Not only is it covered with snow from about four to six months of the year, but there is very little water available at high elevations to carry on hydraulic-sluicing operations; and it is only by working the ground by this method that it can be made remunerative. Even in the low grounds in the Manuherikia Valley, Maniototo, and Shotover, and even in the Clutha Valley, there is generally about from one to two months of the year that sluicing operations cannot be carried on for frost; but those who have claims in Campbell's and Potter's Gully—near the top of the Old Man Range—the Nevis, Mount Criffel, and Mount Burster, have a long period during the winter months when they cannot do any work. It may be fairly stated that the whole of the gold in Otago is got, on an average, during ten months of the year. The rainfall in this district, especially on the goldfields, is much less than in any other goldfield in the colony; and while there may be a plentiful supply of water to carry on sluicing operations on the West Coast, the supply in Otago is very limited. The miners, therefore, in this district have two elements which enter into the question of their earnings—namely, the frost and snow in winter, and the severity of rain in summer.

Maerewhenua.

There are considerable areas of auriferous drifts in this locality, but the present quantity of water on the field is very limited, and can only be used by a small population. None of the ground here is sufficiently rich to pay for working from shafts or tunnels. It is only by washing it away in a wholesale manner that the miners can make fair wages. It may be termed good sluicing-ground, where any one can make good wages with a plentiful supply of water. The Mountain-hut Race Company have had about twelve men employed in constructing a water-race from one of the branches of the Maerewhenua River for the last fifteen or sixteen months, and have about seven miles of it completed. Its total length is said to be about fifteen miles, which leaves eight miles yet to construct; and in this distance the north branch of the Maerewhenua River has to be crossed by either a flume or iron-piping. The elevation at which this race is being constructed will command the whole, or nearly so, of the auriferous ground on the west side of the Maerewhenua River; but it is doubtful if a large supply can be got except in wet weather. The only chance of bringing in a fair supply of water for this field at a reasonable cost is from the Kakanui River, but it would require a good amount of capital to do this. The Maerewhenua River is a very small stream, even below the diggings, in dry weather; and when the water is lifted from any of its branches, at—say ten miles above the diggings, and leakage and evaporation are considered, there can be but very little in dry seasons that the Mountain-hut Race Company can get to work their ground. This is a field that will last for many years; and it is one where the miners can always employ their spare time in cultivating small patches of ground, and the large area of a mining reserve affords an opportunity for each miner to have some cows.

Waipori.

There are only a few miners employed in this locality outside those employed in claims held by companies. The most of the shallow ground has been worked that was found to be payable, and it now requires a fair amount of capital to enter into mining ventures to bring them to a successful issue; hence large areas of the flat have been taken up, and are being made remunerative for working by using dredges.

Waipori Amalgamated Deep Lead Company.—This company was formed about two years ago, and purchased the ground held at that time by Messrs. O'Brien Brothers on the Deep Lead, which is a deep gut of ground between the Lammerlaw Creek and the Waipori Flat, and at one time has been the bed of the Lammerlaw Creek; but through some change that has taken place, either by a slip from the side of the gorge through which the water flowed, damming up the creek, or by some other cause, the gut got completely filled up and caused the creek to go down in its present channel. The gut referred to is about 80ft. deep in places, and about from 25ft. to 30ft. wide in the bottom, having the schist rock shelving up on each side on a batter of from ¾ to 1 to 1 to 1. The whole of the gut is filled up with drift-wash, but the richest portion of the auriferous drift is near the bottom. It was formerly worked by O'Brien Brothers for many years, who made very good wages by hauling the wash-drift upon an incline tramway and washing it. The present company were so satisfied with the prospects they got, that they purchased some water-races in the locality, and worked this ground by a hydraulic elevator. The whole of the ground in this gut is now worked

out, and the lead has been traced into the flat; but instead of going straight into the river, the ancient bed of the creek was found to turn round nearly at right angles to the line of the gut previously referred to, and, from the present appearance of the run of the deep ground, will cross the bed of the river and go underneath the old township, or it may be when it is traced into the river that it may follow the course the river has now taken; but, be that as it may, the ground on the flat is about 60ft. in depth, consisting of a fine quartz drift-wash, but the upper portion of the wash-drift contains very little gold. There was a paddock excavated in the flat at the time of my visit, which was estimated by the manager, Mr. Charles Hilgendorf, to contain 60,000 cubic yards of excavation, and the quantity of gold obtained from the quantity of material was 220oz., being an average of 1·76gr. of gold per cubic yard, but as there was scarcely any of the bottom-wash taken out of the paddock, the manager anticipates getting a much better washing next time.

There seems to be a difficulty in working this ground, owing to the soft nature of the reef or bottom on which the quartz wash-drift is lying. As soon as the bottom gets exposed to the water and the atmosphere it becomes soft, and spues up, causing the upper portion of the ground to come in; hence the large quantity of the upper portion of the material that had to be taken away before getting the bottom portion lifted. The lead appears to get much wider as it goes out into the flat, and until the bottom of the paddock is taken up and washed it will not be ascertained whether the rich auriferous layer of drift found in the bottom of the gut will continue into the flat. The company have gone to a considerable expense in providing a good plant, and in opening out the ground, and their capital being too small to meet all the expenditure, they had to borrow a considerable sum of money to complete their undertaking; and the interest on the borrowed money, in addition to the ground being poor, it is a difficult matter to make ends meet.

This company has three water-races, two of which lead the water into a reservoir which is constructed in the bed of the Nardoo Creek, and one from this reservoir to the penstock, where the water is conveyed in pipes to their claim. One of the water-races leading into the reservoir is twenty-two miles in length, and the other twelve miles, and these take their supply of water from the several creeks they cross, but the principal supply is from Nardoo Creek, where the dam is constructed. The main supply-race from this dam is 5ft. wide and 2ft. deep, constructed on a gradient of 1 in 60 or 8ft. to a mile. The cost of the construction of this race is said to be £100 per mile. From the penstock to the ground that is now being worked the distance is about 100 chains, or 6,600ft. Of this distance, about 2,000ft. of the upper end is constructed of wrought-iron pipes, No. 14 B.W.G., which are 18½in. in diameter, and the remaining portion consists of pipes 15in. in diameter, No. 12 B.W.G., double-rivetted in the longitudinal seams. The total hydraulic head is said to be 400ft. The manager stated that he had lifted material as high as 80ft., but at the time of my visit they were only lifting the material about 52ft., using a jet 2¾in. in diameter, having the sluicing-nozzle 1½in. in diameter. Taking the velocity of water due the discharge of water from a jet 2¾in. and one 1½in., it equals 7·7 cubic feet per second, which is equal to a velocity in a pipe 15in. in diameter of 6·27ft. per second, and, omitting the loss of head altogether in the portion of the pipe 18½in. in diameter, which is equal to 46ft., the hydrostatic head would not exceed 350ft.; and, as the quantity of water discharged by a jet 2¾in. in diameter under a hydrostatic head of 350ft. is 5·94 cubic feet per second, then $\frac{350 \times 5{\cdot}94}{7{\cdot}7 \times 52} = 4{\cdot}97$, the ratio of the power used for lifting the material; but the manager also stated that he sometimes used a sluicing-nozzle 2in. in diameter, and in that case the ratio of power used would be 4·02. There is a large extent of unworked ground, but the problem to be solved yet is whether it will pay to work. The quantity of gold obtained by the company during the year ending the 31st March last is said to be 354oz., which represents a value of £1,372. This amount does not leave any margin of profit.

Tuapeka District.

This is beginning to look a deserted goldfield; the different gullies and flats where gold was found in the early days have been turned over again and again, and, even yet, some of the Chinese seem to make a livelihood, but the number of these is gradually getting less every year. The only workings of any magnitude that are being carried on are those at the Blue Spur, Gabriel's Gully. Where, in the sixties, there was a large population earning good wages by extracting the gold from the drift in the most primitive manner, there is now one mass of tailings from side to side of the gully; none of the original surface is left to work. At the place where at one time over a thousand men were at work, only about six Europeans and three Chinese are now to be found. At Weatherstone's the same deserted appearance is seen; but, instead of the ground being covered with tailings, there is a network of holes and mounds of excavated material, marking the remains of the active operations that were carried on in the early days. There is still ground here that would pay for working if water was available, but all the principal water-races are now held by the Blue Spur Company, and utilised by them at the Blue Spur.

Blue Spur Company.—This company, previous to last year, was working the tailings in the bed of Gabriel's Gully and cutting an opening into the cement. This paid handsomely for working; but it has been always considered questionable whether the cement which goes through the range between Munro's and Gabriel's Gully could be worked by this company at a profit. During the last year their workings have been entirely confined to the cement, and the results of working it has proved very satisfactory. The quantity of cement operated on for ten months ending the 31st December last was 137,000 cubic yards, and the quantity of gold obtained from this was 1,589oz., representing a value of £6,109, showing the value of the material to be 10·7d. per cubic yard, or each cubic yard contained 5·56gr. of gold. The total quantity of gold obtained from the 1st January, 1892, to the 28th January, 1893, was 2,130oz., representing a value of £8,193, while the working expenses average about £490 per month when in full working order; but there is some time during the winter months that the work is suspended on account of frost and other causes. The cement, therefore, may be considered payable for working, with a considerable margin of profit. To take

but a liberal deduction for lost time during the last winter it leaves £2,000 as profit on the workings.

A great many contrivances have been adopted to crush up this cement, but all of them have hitherto proved failures. Mr Jackson, the engineer and superintendent of the company, states that he finds it most advantageous to blast it into small blocks, so that it can be broken up with hammers and picks by manual labour, small enough for the water from the nozzle to pulverise it before sending it down to the elevator.

There are three elevators at work in this claim. No. 1 is lifting 66ft., the jet being 3¼in. in diameter, and the hydraulic head 445ft. The water is supplied from a pipe 15in. in diameter and 1,740ft. in length. No. 2 is lifting 62ft. 5in., having a jet of 3¼in. in diameter under a hydraulic head of 400·5ft., the supply-pipe being 15in. in diameter and 1,580ft. in length. No. 3 is lifting 42ft., having a jet of 2⅝in. in diameter under a hydraulic head of 354ft., the supply-pipe being 15in. in diameter and 1,333ft. in length. The sluicing nozzle for these elevators is 4in. in diameter, under a hydraulic head of 400·5ft., and the water is supplied from a pipe 11in. in diameter and 1,580ft. in length. As the whole of these measurements have been accurately made by the superintendent, the ratio of power to carry on hydraulic operations can be fairly ascertained. There is, however, one element which enters largely into the calculation which is not supplied: that is, the diameter of the throat-piece; but if it is assumed that the throat-piece is in proportion to the head and jet, the following will show the ratio of each elevator:—

No. 1 Elevator: Jet 3¼in., supply-pipe 15in. and 1,740 feet in length, head 445ft. The discharge from a 3¼in. jet under a 445ft. head = about 9·35 cubic feet per second, which is equal to a velocity of 7·6ft. per second in the supply-pipe. The loss in head due to this velocity and length of pipe is equal to 24ft.—namely, $H = \frac{P l c v^2}{a\ 2\ g}$ where P = perimeter of the pipe, l = the length, c = a co-efficient given by Mr. J. T. Fanning, v = the velocity, a = the area, and g = the acceleration of gravity—all in feet. Therefore, the hydrostatic head = 445 − 24 = 421ft., and a 3¼in. nozzle under this head will discharge equal to 9·1 cubic feet per second.

The sluicing nozzle being 4in. in diameter under a hydraulic head of 445ft., and the supply-pipe being 11 inches in diameter and 1,580ft. in length, the loss in head due to the velocity of the water, the diameter and length of pipe, would be on same basis as formerly = 218ft. Therefore, the hydrostatic head = 400·5 − 218 = 182·5ft., and the discharge from a 4in. nozzle under this head is equal to 9·07 cubic feet of water per second. We have therefore, in No. 1 Elevator, 9·1 cubic feet, under a hydrostatic head of 421ft., working the elevator, where there is 18·17 cubic feet of water to lift, exclusive of any material, 66ft. high. The ratio of the power, therefore, required to work this elevator = $\frac{9{\cdot}1 \times 42}{18{\cdot}17 \times 66} = 3{\cdot}18$.

As this sluicing-nozzle is common to all the elevators, the ratio of the No. 2 elevator would be as follows: Jet, 3¼in.,; head, 400·5ft.; pipe 15in. in diameter; and length, 1,580ft.

The discharge from the jet under a head of 400·5ft. = 8·88 cubic feet per second, which is equal to a velocity in the pipe of 7·23ft. per second. The loss of head in the supply-pipe due to this velocity = 20·8ft., therefore the hydrostatic head = 400·5 − 20·8 = 379·7ft., and the discharge from the jet under this head = 8·64 cubic feet per second; therefore the ratio of the power required = $\frac{8{\cdot}64 \times 379{\cdot}7}{17{\cdot}71 \times 62{\cdot}41} = 3{\cdot}02$.

No. 3 elevator: Jet, 2⅝in.; supply-pipe, 15in.; length, 1,333ft.; head, 354ft. The discharge from the jet under a head of 354ft. = 5·43 cubic feet per second, which causes a velocity in the pipe 4·43ft. per second, and this velocity in the length of the pipe is equal to a loss of 7ft. of the head. Therefore the hydrostatic head = 354 − 7 = 347ft., and the discharge from the jet under this head = 5·38 cubic feet per second. The ratio of power used is equal to $\frac{5{\cdot}38 \times 347}{14{\cdot}45 \times 42} = 3{\cdot}14$. The respective ratios are therefore as follows:—

No. 1 elevator	3·18	mean, 3·11.
No. 2 "	3·02	
No. 3 "	3·14	

This means that the mean of the ratio of power used to work effectively these elevators is 3·11 times the actual power required to lift the water, exclusive of the weight of material. However, the weight of the material lifted forms only a small factor in the weight in proportion to the water. Suppose, for example, that the quantity of water lifted by the No. 3 elevator be taken—namely, 14·45 cubic feet per second, this is equal to 933lb.; whereas the weight of the material lifted in the same period of time would not be more than 60lb. The friction of the shingle and stones going up the elevating-pipe would, however, be considerable, the velocity being about 12ft. per second. In comparing these elevators with those at work elsewhere, they will bear a favourable comparison.

In blasting the cement, Mr. Jackson found that roburite is the most economical explosive, it being considerably cheaper than dynamite and nearly the same strength. This explosive is said to consist of chlorinated dinitro-benzol mixed with ammonia-nitrate in certain proportions, and it is claimed that it has a flameless detonation. It, however, requires a much stronger detonator to explode it than dynamite.

Where this auriferous cement came from is still a question not easily solved. The bed-rock on the one side is laid completely bare, and is quite hard and smooth, and shows that the depression through the range between Gabriel's and Monro's Gully is more due to a slide, that has at a very recent period taken place, than exclusive glacial action; at all events, the rude stratifications of the cement itself shows that it has an inclination towards the north-east or face of the slide. The face of the slide itself is a highly indurated sub-schistoze rock, produced, no doubt, by the frictional heat when the movement took place; and the face of it presents a highly-polished slickenside, on which the blue cement abuts, having a thin film of glassy silica on the surface. If the depression

had been a cup-shaped hollow, as represented by Prof. F. W. Hutton in his "Geology of Otago," published in 1875, there would be reason to suppose that it was excavated by glacial action; but the straight, smooth face of the slide having a uniform inclination, goes to show that a large movement has at an early period taken place, and that the depression caused by the faulting has been filled by material conveyed there by glacial action, and apparently this glacier came from the direction of Waikaia and the southern end of the Old Man Range. The cement itself appears to be composed of a quartzose schist rock, the schist being crushed and ground into a pulpy condition by the glacier, having quartz pebbles and sub-angular pieces of rock, some of which are of a jasperoid slate, thoroughly disseminated through the mass. When this material got consolidated it became a compact mass of breccia with partially angular pieces of rock through it.

Geological Formation of the Blue Spur, Tuapeka.

Mr. T. A. Rickard, an American mining engineer, after his visit to this locality, read a paper before the American Institute of Mining Engineers at Plattsburgh, in June, 1892, on "The Goldfields of Otago and the Geological Formation of the Blue Spur," in which there is a great deal of interesting matter. The following is an extract from the paper referred to:—

"The Blue Spur is, perhaps, the best-known and most interesting alluvial deposit in New Zealand. It is situated near the head of Gabriel's Gully, about two miles east of the Town of Lawrence. The name is derived from the colour of the alluvium, which was first discovered in the gully at the foot of the spur, into which it was afterwards traced. The blue, or, more accurately, greenish blue, tint is probably due to the silicate of the protoxide of iron. The deposit consists of a mass of cement and conglomerate, occupying a cup-shaped hollow in a ridge or spur which divides two nearly parallel gullies. Figures 1, 2, and 3 illustrate it, figure 1 being a cross section. The contour line of the ridge, as here shown, is obtained from an old photograph taken in 1865. The working of of the deposit has entirely altered the lines. The longer axis is nearly at right angles to the present level of the Blue Spur ridge, the depression which the deposit fills having been cut out of the Wanaka schists, the characteristic rocks of Otago. Figure 3 gives the longitudinal section. The gully on either side is filled with tailings.

"The plan, figure 2, shows the deposit to have a roughly oval shape, the longer axis having a strike N. 60° W., and a length of about 34 chains. The shorter, or N.E. and S.W. axis is 22 chains in length. For the sake of brevity the two longer sides of the deposit, facing respectively N.E. and S.W., will be mentioned as the "Lawrence" and the further side. On ascending the ridge on the further side, about 400ft. above the present level of Gabriel's Gully, the country presents the appearance roughly indicated in figure 2. The accumulation of tailings will in part explain the increased width of the gullies at a point opposite the deposit; but there is no doubt that this is also due in a large measure to the erosion of the conglomerate which formerly extended across. In both instances the gullies narrow rapidly above their intersection with the larger axis of the deposit, and at a short distance become merely rock ravines. It is also noteworthy that there are marked lateral gullies which correspond to the line of the deposit.

"The gold first discovered in Otago, the discovery of which inaugurated the rush to the New Zealand goldfields, was derived from this mass of wash. Neither Gabriel's nor Munro's Gully proved rich above their intersection with the deposit, while both were particularly rich at and immediately below that intersection.

"The mass of the cemented conglomerate has been variously estimated at from eight to ten million cubic yards; but the present manager, whose opinion is of the most value, puts it at from eleven to twelve millions. The area covered is 45 acres.

"A nearer view of the deposit presents the following features. On the Lawrence side, the rock forming the rim of the cup-shaped hollow presents a very uneven surface, and the folia of the schist are much distorted and fractured. The pebbles of the conglomerate are imbedded in the soft crushed country, there being no distinct boundary or line of demarcation between the deposit and the surrounding country-rock. There are longitudinal furrows in the schist, parallel to the strike of the country and the longer axis of the deposit. These furrows are not regular either in shape or direction. Looking down from the ridge on this side, the enormous masses of wash present, by reason of their unequal erosion, the appearance of a miniature cordillera. Reddish layers of oxidized material form marked lines through the general faint blue tinge of the cement, and indicate the dip of the deposit, which is seen to be at a low angle towards Gabriel's Gully, or south-eastward.

"Descending among the masses of conglomerate, one can observe the structure of the material. Fractures cut through the included fragments of the more fissile schist, but they do not pass through the harder pebbles. These last are of varying size up to boulders 2ft. in diameter. The wash shows a large proportion of schist fragments, held together by a light greenish-blue fine-grained cement. Of the remaining portions of the material, large jasperoid boulders are most prominent.

"Going to the further side of the deposit, it is seen at once that the rim-rock has an altogether different appearance from that noted on the Lawrence side. The bounding wall is perfectly straight and even, with a dip of 25° 30′ to the south-west. It shows incrustations of alum. The schist of the country, which dips with the face of the rim-rock, shows no signs of having been crushed or dislocated. When first uncovered, the face of this wall is said to have been (and its present appearance suggests it) wonderfully straight and smooth. Exposure to the weather has induced the slow shaling off of its surface, which is now littered with the thin sherd-like fragments broken off by frost and rain. Originally the rim-rock was covered with a thin layer of clay, which protected it; but this clay first hardened and then cracked, to be subsequently removed by the rain; and the underlying country-rock is being rapidly eroded. Fig. 4 gives a view of its present appearance. *C D* is the face of the rim-rock; *E E* are the fragments which have scaled off its sur-

face. Along *A B* a section has been taken, which is indicated on a larger scale in Fig. 5. In this, *F* is the quartzose schist of the country; *E* is a chocolate-brown indurated clay covering the rim-rock itself; *D* consists of a ¼in. layer of hard cement; *C* is a 2½in. layer of soft brown mud; *B* is 2½ft. feet of reddish small gravel; *A* is the main body of cement and wash.

"Fig. 6 shows the arrangement of the material in a block of the conglomerate. *A* is a layer of large pieces of the quartzose schist, but slightly rounded; *B* contains smaller brown schistose fragments; *C* is schist rock, containing but little quartz; *D* is a band of bluish cement; *E* is a highly quartzose schist bed; *F* contains quartz pebbles, not rounded; *G* is mixed material, quartz fragments and schist, irregularly distributed through a cement matrix.

"Coming toward Gabriel's Gully, a pink layer containing lignite is seen. Near the gully, mining operations have partially uncovered the bed-rock, which here presents the features shown in Fig. 7. This is a section taken along a line N. 36° W., making an angle of 14° with the longer axis of the deposit. At the present time the edge of the rim-rock is laid bare, but the bed-rock of the gutter itself is under water. It is seen that the gutter comes abruptly against a ridge over 60ft. high; from the foot of this it rises gently towards Munro's Gully, but soon meets with another interruption in the form of a wall of rock over 20ft. high, beyond which it slopes away again before taking its regular rise. Numerous irregular crevices, found in the bed-rock of the gutter, generally contained a great deal of gold. Above this, the cement was very variable in its gold-contents, which were usually arranged along certain red bands. Some of the material was absolutely non-auriferous; while other portions would form a pudding-stone of golden wash, the gold of which, as distinguished from the fine flakey character which it usually had, was of the size of beans.

"While the rim-rock arising from the gutter on the north-east side was, as we have seen, smooth and regular, that of the Lawrence side was rendered remarkable by "crab holes," as they were called by the miners. These were irregular corrugations, not parallel or straight, but narrowing and opening out at intervals. The cavities were as much as 15ft. deep; they were covered with a casing of cement as regular as plaster; and the material which filled them was a different-looking cement from that of the main body, the line of division between the two being so marked as to be of assistance in blasting.

"The north-east wall continues underneath the Lawrence rim-rock. In working along the smooth face of the north-east rim, a party of miners followed it and were working their way underneath the south-western "reef" before they discovered their mistake by hearing the blasting of those above them.

"The Genesis of the Blue Spur Deposit.

"The above concludes the general description of a deposit the origin of which is a subject of much interest. To recapitulate its main features; it consists of a mass of cement and conglomerate, lying in a depression formed in the quartzose mica-schists of the Wanaka series and transverse to the present watershed of the district. The country has a dip of 15° to 20° south-west, the inclination increasing near this deposit. The rock on the north-east side conforms in dip to the bounding-wall of the deposit on that side. On the Lawrence side there is no conformity; the schist is disordered; and the boundary between the conglomerate and the country-rock is almost obliterated. On the north-east side the bounding-wall, when first uncovered, had a smooth, polished surface. On the Lawrence side corrugations and irregular holes were common in the rim-rock. The north-east wall continues underneath the face of the opposite side. The gutter itself is in places very irregular; it has one particular break of 20ft. in height; it is separated from Gabriel's Gully by a rocky ridge, and has a general rise towards Munro's Gully.

"The deposit has a roughly-bedded structure, indicating a gentle dip south-eastward, or towards Gabriel's Gully. The wash at the north-west or Munro's Gully end is the coarsest. Along its shorter axis the dip is scarcely noticeable, save near the edges. It is more flat on the Lawrence side.

"Beds of lignite occur, confined to an upper horizon of the deposit. The dip of the gutter would bring the conglomerate above the present surface as we go north-west. It is, therefore, not surprising that no traces of it are found in that direction, beyond Munro's Gully, for erosion has removed it. Going south-eastward, however, it has been uncovered and worked in the next parallel gully, Weatherstone's. It was found again in Waitahuna Gully. Along the same line, other smaller patches have been found at intervals; and, finally, at Kaitangata, according to Sir James Hector, it underlies the coal.

"The Blue Lead in Sierra and Nevada Counties, California, an old river of Miocene age, was to the Yuba and its tributaries what the Blue Spur was to the Tuapeka. In both cases, the bulk of the gold found in the river-gravel came from an old deposit, the course of which lay at right angles to that of the present drainage-system.

"With regard to the age of the Blue Spur deposit, it was obviously formed at a period preceding that of the erosion which produced the gullies the direction of which it crosses. These gullies are the sources of streams which feed the Clutha, whose course also lies across the line of the Blue Spur Lead. The Clutha received the drainage of glaciers belonging to the Pliocene period. The Blue Spur is therefore older yet. This is confirmed by its occurrence under the coal measures of the Oamaru formation, which is of Eocene or Cretaceo-Eocene age. It is thus perhaps the oldest gold alluvium which is worked of which there is record.

"Its origin is more difficult to determine. The glaciers were in Eocene times, as they are to-day, the great natural sculptors of the face of Otago. All investigation into the surface geology of this portion of New Zealand points to this agency as having cut out the lake-basins which form so prominent a feature of the country. It is glacial action which is generally mentioned as explaining the origin of the Blue Spur. That it is no ordinary ancient river-deposit is proved by the contour of the bed-rock; for the conglomerate lies in a pot-hole rather than in a regular channel. While the general slope is gently south-eastward, the lower end at Gabriel's Gully is found to be bounded

by a rocky ridge fully 75ft. in height; and midway between the two gullies another rapid rise of 20ft. is encountered. Such a configuration is best explained by considering it as a pot-hole or hollow scooped out by ice-action. Though there are no striæ or markings produced by glacial movements now to be seen, yet this is in no way remarkable; for the bed-rock is of too soft a character to have preserved any such evidence. The presence of the large jasperiod boulders is confirmatory. They do not belong to the locality, since no similar rock is found nearer than the Blue Mountains or Tapanui, twenty-five miles north-westward. They were carried down by the ice. The character of a large portion of the material forming the deposit similarly indicates that it was not brought down in or by a stream of water, but as the rocky freight of a glacier. A large part of the wash consists of angular fragments of quartz, as well as of pieces of the quartzose schist-rock, which are not rounded. The agency which eroded the depression in which the auriferous material lies was assisted by the structure of the rock at this particular point. I have no doubt that the north-east bounding-wall of the deposit forms the line of a fault, and that the reason of the formation of the rocky basin at this particular spot is to be found in the fact that the schist had been crushed by the movements accompanying faulting. Of this, the north-east wall, its smooth face, and its continuation under the opposite rim-rock, together with the crushed condition of the south-west country, are ample evidence. The line of fault is not parallel to the course of the lead; the two meet between Munro's and Gabriel's Gully, and so explain the enlargement at that point of the receptacle of the ore-deposit.

"This explains the natural selection of this particular place as the *locus* of the deposit. To proceed further, the glacier in its slow downward progress to the sea is temporarily arrested by the softer rock, which it here encounters much in the same way as a runner is retarded in crossing a ploughed field. This arrest allowed the accumulation of a terminal moraine, which, protecting the rock on which it lay, assisted the tendency of the ice to erode the softer schist; where the terminal moraine at one time lay, we now find the rocky bar shown in Fig. 2. A hollow was scooped out. This was in early Eocene days. A little later, that subsidence took place which preceded the deposition of the Oamaru series. This caused the retirement of the glacier; or, more accurately, the melting away of its lower portion. The rocky basin which had been scooped out by the ice now became a fresh-water lake, with its upper end still guarded by the glacier. The ice which broke away from the foot of the glacier bore with it the large boulders of jasperoid which had been brought down from Tapanui. This and other material was borne across the lake, to fall eventually upon its bottom as the ice-floes melted. In the meantime, up above, the glacier continued to plough through the soft quartzose schists, and sent down a golden tribute, derived from the lode-formations which it cut through. The fine flakes of gold were accompanied with micaceous mud and angular bits of quartz, all to be deposited in the capacious hollow of the lake. Thus the rocky basin became gradually filled up with confused layers of big jasperoid boulders, quartz-gravel, and bluish mud, the gold sifting its way to the lower portions. The subsidence continuing, and with it the slow retirement of the glacier, and the lake being nearly full of *detritus*, it became a morass. Vegetation took root, and flourished for a brief period. A time of flood, due to excessive thaw, brought down a volume of water, bearing the sand and gravel which covered the vegetation. Being thus protected from the air, the reeds of the morass became the lignite of to-day.

"A river linking a series of small lakes, of which the Blue Spur was one, now flowed along the course of the present alluvial lead. Additional material was deposited in some places, while material was removed in others. In the middle of the Eocene period, the elevation of the land culminated and changed the drainage system of the district. In Miocene times, the Clutha and its tributaries began to flow across the line of the Blue Spur Lead. That erosion then commenced which, in the cutting out of Munro's, Gabriel's, and Weatherstone's Gullies, left the gravel-deposit as a part of a dividing ridge.

"Reference has been made by Hutton to the fact that certain of the Eocene beds contained gold, in order to explain its occurrence in the Blue Spur deposit. This is not needed. The examination of the material composing the conglomerate shows that the larger part is derived from the degradation of the primary schists. The grinding by the ice of these rocks formed the mud, which is now "cement." It was from the quartzose *folia* that was derived the coarse gravel, and, finally, it was the gold which elsewhere to-day is found in the lodes, and even in the rocks of the Wanaka series, which made the Blue Spur not only a geological study, but also a valuable gold mine."

Local Industry Company.—This is a company which has a claim in the bed of Gabriel's Gully, about half-way between the Blue Spur and Lawrence. The shares are all held by people residing in the immediate locality. They have leased the Pioneer Company's water-race for the sum of £150 per annum, which gives about 300ft. of head of water in the bottom of the gully. The ground, which is chiefly tailings in the bed of the creek, along with what headings had been thrown away in the early days, is about from 25ft. to 30ft. in depth, and is worked on the hydraulic-elevating system. Their main supply-pipe is 15in. in diameter, and they are lifting the material about 35ft. The capital of the company is £1,500, in 1,500 shares of £1 each, of which 14s. per share, or £1,050, is paid up. They commenced sluicing operations in April last year, and up to the beginning of December last the value of the gold obtained was £1,179, and dividends up to that date of 2s. per share had been paid. Since then, it is said that this company are paying regular dividends monthly. There are six men employed. A small company like this has every chance of being a profitable investment. There are no idle men to pay. Every one has to work in the claim, and the interest of the small outlay being very small, the shareholders ought very soon to have the capital returned to them in dividends. The total yield of gold for the year ending 31st March last is said to be 422oz., and this was obtained from the treatment of 70,000 cubic yards of tailings, which would be about 2·9gr. of gold per cubic yard.

Clutha Valley.

The Clutha Valley may be said to contain the largest area of rich auriferous alluvial deposits there is in any valley in the colony. The whole of the watersheds of the Clutha River and its tributaries, from the source to below the junction of the Pomahaka and Waitahuna Rivers, contain highly auriferous drifts, and large quantities of gold have from time to time been ground up by attrition of boulders, shingle, and sharp sand, being carried forward by the volume and velocity of these streams; and, although there are still rich deposits of the precious metal in the beds of these rivers, streams, and valleys, there are considerable quantities carried down by the action of the Clutha River to the ocean which will never be recovered. The erosion of the valleys of these streams and rivers to their present depth has been a work of thousands of years. The rivers have shifted their courses from time to time, carrying on the work of concentrating the material by separating the lighter particles from the denser, and leaving rich auriferous layers here and there amongst the drift. The whole of the dredges working in the bed of the river are payable ventures, and some of these work the auriferous gravels in the river-beds and low-lying flats very successfully, and give good returns to their owners.

There are several large flats in the valley of the Clutha which are now being worked by hydraulic-elevators, where the fall is not sufficient to carry on sluicing by the ordinary method, and wherever a good supply of water can be got the ground can be worked very economically on this principle. In the Clutha Valley, where there is not a large percentage of boulders to contend with, two grains of gold to the cubic yard of material leaves a fair margin of profit on the workings. All the available streams are utilised to carry on hydraulic operations, either with elevators or sluicing in the ordinary manner, and if there were three times the present quantity of water to be got the whole of it would be utilised. The quantity of men employed, therefore, in working the alluvial drifts, especially in Otago, is simply limited to the quantity of available water. There are a number of claims being worked along the Clutha Valley, from the Horseshoe Bend, where Eddie and Kirkpatrick are working a claim by sluicing in the ordinary manner, and said to be giving them very good returns. It will only be necessary to refer to the principal claims in this valley, where the workings are carried on extensively.

Island Block Company.—This company has done a considerable amount of work, and have expended over £21,000 on the plant and claim. The place where they carry on their operations has been known for many years as the Island Block, on account of a rocky ridge running alongside the river on the western side for a distance of about three miles and a half; and on the western side of this ridge is a wide low valley between it and the main range. This ridge is termed the island: hence the name of the Island Block. Judging from the topographical features of the country, there seems no doubt but that the Clutha River at some time flowed at the western side of this island, as a distinct channel can be traced out of the present river-bed where the low ground on the southern end of the island or rocky ridge joins the low valley previously referred to and the river. After the company commenced operations, near the side of the river on the southern end of the island, they got into a deep gorge full of rough rounded river-wash in the bottom; and on the southern side of this deep gut, on the shelving reef, very rich auriferous drift was found. But there was very little gold found in the bottom of the deep gut, the best layers being higher up amongst the drift.

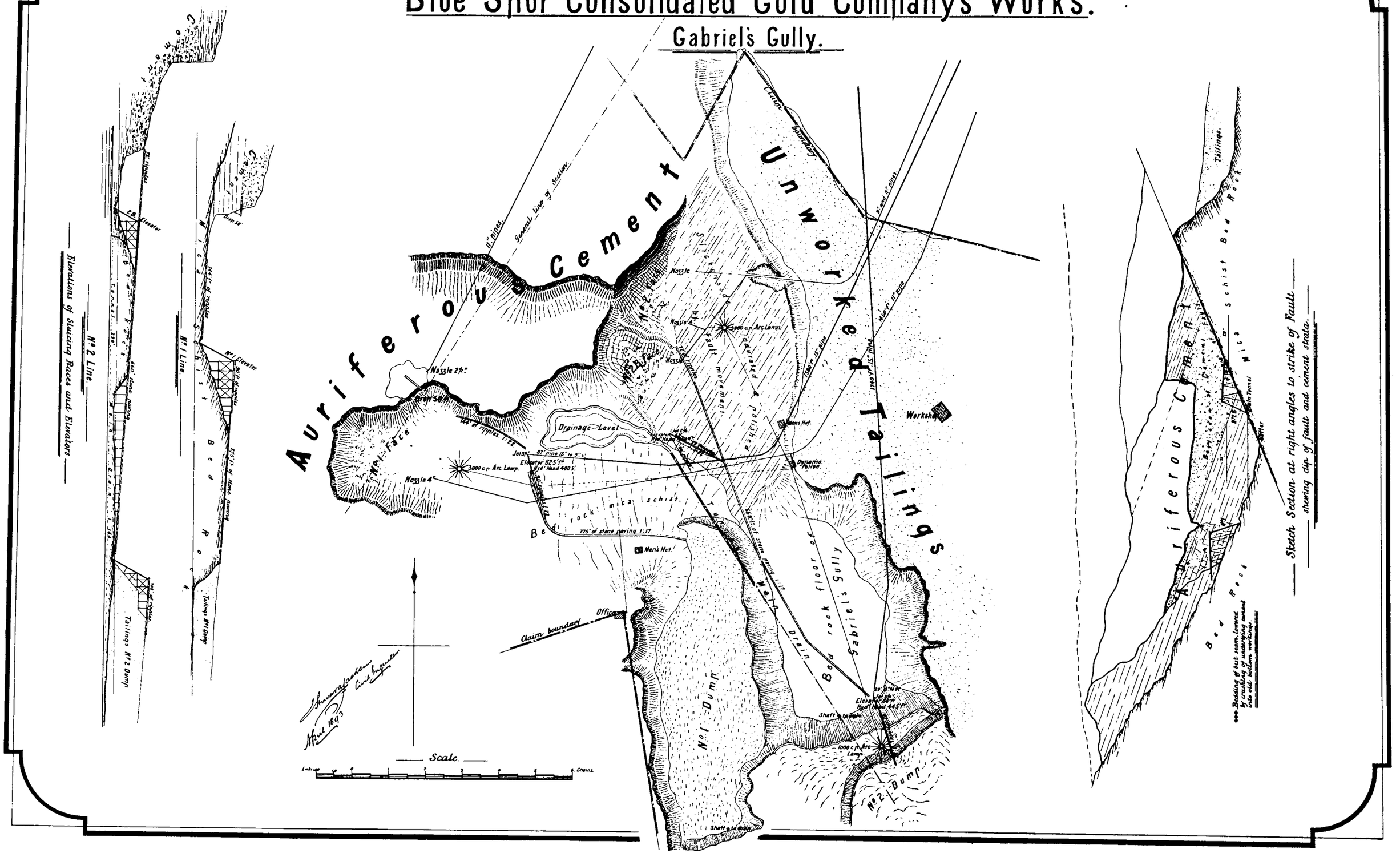
On taking a cut up from the river towards the main range they got off the run of the gold, and, after working over twelve months sinking paddocks here and there, they came on rich auriferous drift in the low valley on the western side of the island at the southern end; but it is really very questionable if they have got the original river-bed yet. The valley is from 20 chains to 35 chains in width, and it takes some time to get a cut put across this. Judging by the curve in the main range on the western side of the island, the river has at one time flowed close in to the foot of the range, and wherever a gentle curve inwards is found in the course of a stream, the water follows that curve. Hence, it seems to me, that probably the deep ground will yet be found between the present workings and the main range; although there is little doubt but that the river must have had different channels from time to time along the valley, and that the present workings are in one of these. The ground is about 40ft. in depth. At the time of my visit, in the centre of the paddock there was a deep gut, having the rock rising slightly towards the main range, but there was very little gold in the deep gut. The rich layers were a considerable distance above the bottom, from which very good prospects were obtained by washing a little of the drift on a shovel.

There is from 6ft. to 8ft. deep of rich alluvium on the surface of the ground, very compact, and forms a clayey substance which is difficult to get away, as it is not easily broken up, but rolls down the box or sluice in lumps to the elevator. This necessitates the layer of surface material being washed off by itself, as it would collect fine particles of gold were it to mix in the sluice with the auriferous gravels. The gold would adhere to the sticky substance, and be carried away with it down the sluice. The manager, Mr. C. E. Rawlins, informed me that he had got 720oz. of gold out of the paddock they were working in, and its dimensions were about 180ft. by 270ft., and an average of 39ft in depth. This is equal to 60 × 90 × 13 = 70,200 cubic yards, and $\frac{720}{70200}$ = ·0102564oz., or 4·92gr. of gold to the cubic yard of material worked, which is considered very rich ground to work on the elevating system.

To work this ground the hydraulic head of water is 750ft. It is conveyed for a mile and three-quarters in two lines of pipes, each 15in. in diameter. Thence these join on to one pipe 22in. in diameter, for a distance of 30 chains, and then in pipes 11in. and 9in. in diameter for a distance of 15 chains, to the paddock where they are working; but, although the hydraulic head is 750ft., the actual hydrostatic head, when working with one elevator, having the jet $2\frac{5}{8}$in. in diameter, and the sluicing nozzle 2in. in diameter, the pressure shown by gauge was 230lb., which is equal to a head of 530ft. Therefore, the loss of head in this instance is 220ft.—that is, presuming that the pressure-gauge was registering correctly. The elevator was lifting material about 67ft. The discharge from a jet of

Blue Spur Consolidated Gold Company's Works.

Gabriel's Gully.



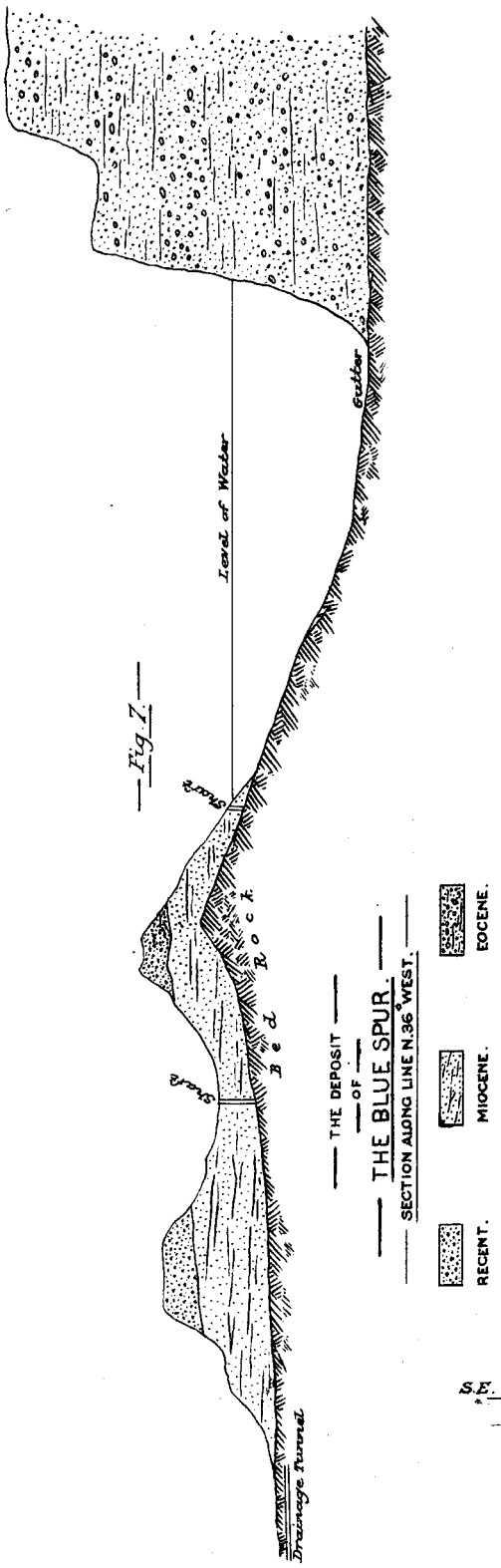


Fig. 1.
Level of Water
Gutter
Shaft
Rock
Bed
Shaft
Drainage Tunnel
THE DEPOSIT
OF
THE BLUE SPUR.
SECTION ALONG LINE N.36° WEST.
RECENT.
MIOCENE.
EOCENE.

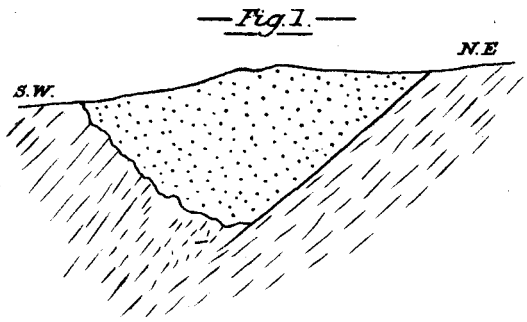


Fig. 1.
S.W.
N.E

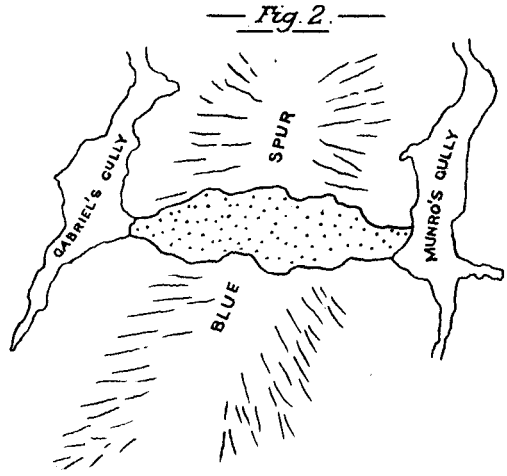


Fig. 2.
GABRIEL'S GULLY
SPUR
MUNRO'S GULLY
BLUE

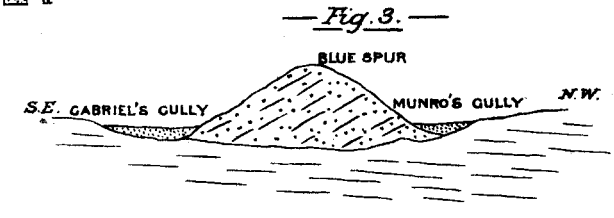
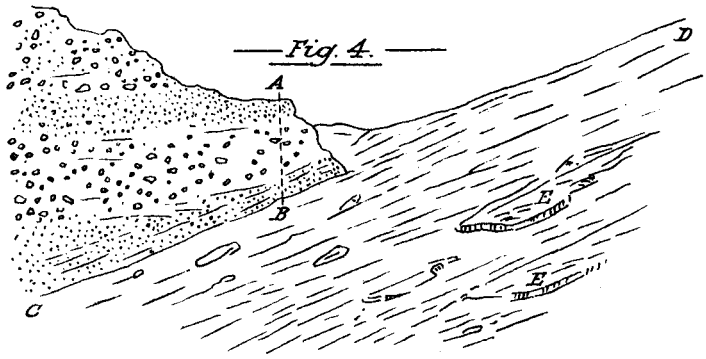


Fig. 3.
BLUE SPUR
S.E.
GABRIEL'S GULLY
MUNRO'S GULLY
N.W.

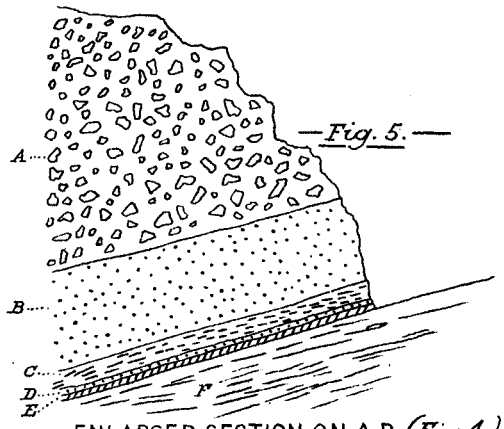
C.H.P. del.

Fig. 4.



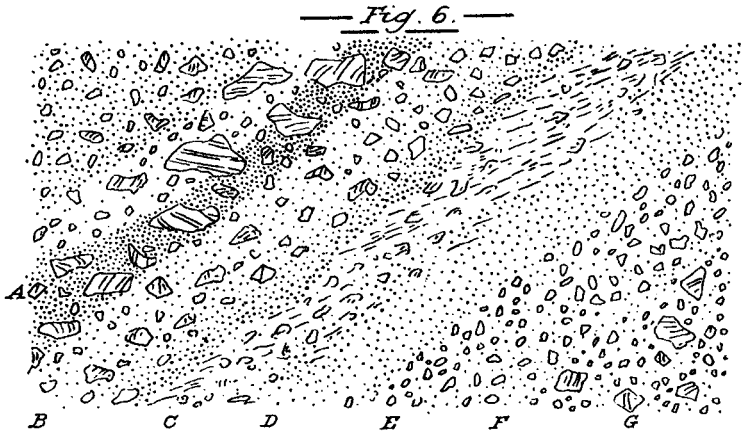
BLUE SPUR DEPOSIT.

Fig. 5.



ENLARGED SECTION ON A.B. (Fig. 4.)

Fig. 6.



ARRANGEMENT OF MATERIALS IN
BLUE SPUR CONGLOMERATE.

C.H.P. del.

2⅝in. in diameter under a hydrostatic head of 530ft. is about 6·65 cubic feet of water per second, and from a nozzle 2in. in diameter under same head is 3·87 cubic feet per second. Therefore, the quantity discharged in both jets is about 10·52 cubic feet per second; but in addition to this quantity of water to be lifted there is about half a sluice-head comes from drainage in the ground; therefore, 6·65 sluice-heads has to actually lift eleven sluice-heads along with the drift gravel to a height of 67ft. The ratio of power employed to do the work, irrespective of the quantity of ground lifted, is $\frac{6{\cdot}65 \times 530}{11 \times 67} = 4{\cdot}78$. The ratio of power employed, however, depends to some extent on the condition of the throat-piece. If this is greatly worn, the elevator is not so effective as when it is in exact proportion to the quantity of water used and the diameter of the elevating-pipe.

There is an ingenious appliance used by this company, designed by Mr. Adams, the former working manager. This is a slide which is worked by means of a lever, and goes over above the top of the jet. This sends the water out at the intake of the elevator, and clears away any rubbish or material that may have collected to stop the regular inflow of the water and gravel; but it is of no service in clearing the throat, and that is the place where the greatest danger is of stones getting in and jamming in the throat-piece. The following description of this is taken from the *Tuapeka Times*:—

"Mr. W. Adams, manager of the Island Block Extended Gold-mining Company, has applied for a patent for use in hydraulic sluicing, where stones or other large substances may frequently choke an elevator. This causes great trouble in many places, and serious delays arise, and many queer means are resorted to by ingenious persons to free a choked elevator. The patent consists of a solid bar so arranged in the side of an elevator seat that by a lever, or other suitable means, it can be projected over the jet, not so as to stop the flow, but rather to turn it downwards, when the weight of the water and the material above at once relieves the elevator, and on withdrawing the bar the elevating is continued without even losing the material and water in the elevator, as on many occasions during the trials only a foot or two was lost when the work was re-started, the stoppage being but a few seconds in all. Several of these have been made, and tested in the presence of persons interested; and the work done has been so satisfactory that elevator seats on this principle have been ordered by several of those who were present at the experiments, which were recently conducted at the Island Block."

This company have the best hydraulic-pipes there are in use in the colony, being lap-welded steel, all manufactured in England. All the joints are faced in the lathe, a collar being shrunk on each end of the pipe, having a loose flange slipped on previous to the rings being shrunk on both ends. These joints act very well where the pipes are laid in a straight line, but where there are bends in the line they are not so good. The cost of these pipes in England were as follows:—Pipes 15in. diameter, ¼in. thick, 8s. per lineal foot; pipes 15in. diameter, $\frac{3}{16}$in. thick, 6s. 10d. per lineal foot; pipes 11in. diameter, $\frac{3}{16}$in. thick, 4s. 9d. per lineal foot. Their plant is in every respect a good one; and there is a prospect, when they have got on to the run of auriferous drift in the valley where the river formerly flowed, that it will continue payable for working for a considerable distance before another break takes place.

Island Block Extended Company.—This company has carried on operations successfully last year, and though they have not yet been able to declare dividends, they have reduced their liabilities considerably, the net profit on the working last year being £1,387 14s. 11d. About two years ago this company was on the verge of liquidation; but the shareholders had confidence that by holding on the venture could be brought to a successful issue, and the operations last year justified the opinion thus formed. They have a good hydraulic plant, and they have the water at the highest elevation above their ground of any company in the Clutha Valley. The supply of water last year was very limited; but the company intend, as soon as their liabilities are paid off, to increase the supply, so as to insure the carrying on of hydraulic operations continuously. Their present supply is taken from the Menzion Burn, but the quantity of water in this stream in dry weather is very small; and, although in some parts of the colony there was an unusual amount of wet weather, it has been a very dry season in Otago, the miners in every goldfield complaining of the scarcity of water. The quantity of gold obtained by this company last year was 1,155oz. 4dwt. 9gr., which would represent a value of about £4,620.

Hercules No. 1 Company.—This company is working back into the flat, but the ground is not so good as it was close to the edge of the river. It is a question whether they will find another channel between their workings and the terrace; judging from the appearance of the bottom, there seems a probability that another channel will be found. As far as they have worked back the whole of the material is river-wash; but there are a very large percentage of boulders among the drift, which make the ground more expensive to work than the claims lower down the valley. They were, at the time of my visit, elevating the material about 46ft., having a jet of 3¼in. in diameter, under a head of 450ft., the water being supplied from a main 19in. in diameter, and about 4,000ft. in length. The sluicing jet varies from 2in. to 2½in. in diameter. If the sluicing nozzle be taken at 2½in., then the quantity of water discharged by the two nozzles—that is, the jet and sluicing nozzles—would be about 13·83 sluice-heads—that is, 8·71 discharged by the jet, and 5·12 by the sluicing nozzle. This would produce a velocity in the main pipe of 6·9ft. per second, which is equal to 40ft. loss of head; but as there is a small quantity used for pumping, the loss would be a little more, or, say, the hydrostatic head would be somewhere about 400ft.; then $\frac{8{\cdot}71 \times 400}{13{\cdot}83 \times 46} = 4{\cdot}69$ as the ratio of power used to work the elevator.

The bottom they were working on at the time of my visit was very uneven, being full of holes, so that one could hardly tell in what direction the bottom was dipping. The manager stated that the ground was paying expenses for working it, but he was rather reticent as to its value. However, he stated that they got 37oz. of gold for fourteen days' work; but it appeared to me doubtful at

the time whether this referred to the place where he was working, or when he was taking out the paddock nearer the river. There were nineteen men employed by this company.

Hercules No. 2 Company.—This company went into liquidation, and the claim and plant was purchased about the end of last year by Messrs. Ewing and McConnechie for £1,800. They purchased it merely for the plant, but, having bought it, they proposed to give the claim another trial before removing it to their claim at Tinker's, where they require a similar plant to work their special claim on the flat. At the time of my visit they were elevating the material to a height of 50ft., the elevating jet being 3in. in diameter, and the sluicing-nozzle 2⅝in. in diameter, under a hydraulic head of 500ft., the main pipe being a mile in length. The quantity of water that would be discharged by the jet would be 6·78 cubic feet, and by the sluicing-nozzle 6 cubic feet per second therefore; and the discharge being 12·78 cubic feet, the velocity of the water in the pipe would be about 6·6ft. per second, which would be equal to about 52ft. loss of head. The hydrostatic head would therefore be 448ft. and $\frac{6\cdot78\times448}{12\cdot78\times50} = 4\cdot65$ the ratio of power used.

The ground here is of the same description as that in the No. 1 Hercules Claim, full of large boulders and stones, which are all shifted by manual labour. The same remarks apply to the workings in both claims. There does not seem to be a proper system of working adopted in either of the claims to get these stones shifted. The men have to do the work of removing the stones in the face amongst the water, and where the sluicing-nozzle is playing close beside them they have to keep a look-out that they do not come in the way. The men, therefore, cannot do so much work as though the water was turned off the face where they are working. It appeared to me that if two elevators were so placed in the paddock that the water could be easily turned from one to the other, the fine material could be sluiced away, and then, when there were stones to be shifted, the water could be turned into the second elevator and the loose material sent away with it from another portion of the face; and by the time that was done the stones would be removed from the first face, and sluicing could commence there again, and so on, always having the face dry and free from water when stones had to be shifted.

In California, where there are a large quantity of stones, derricks are used. In Bowie's "Practical Treatise on Hydraulic Mining," he states: "Strong derricks are used in hydraulic mines to facilitate the movement of large boulders and rocks, which are of frequent occurrence. The present style of bed-rock derricks has a mast 100ft. high, and a boom 92ft. long, which is set in a cast-iron box placed on sills. The mast is held in position by six guys of galvanised-iron-wire rope, 1in. in diameter. A whip-block with ¾in. diameter steel wire-rope is used for the hoisting tackle. A 12ft. hurdy-gurdy wheel is attached, and using 30in. of water under 275ft. head, it lifts stones weighing 11 tons. The guys are held by double capstans. This derrick can be readily moved 100ft. in 10 hours without being taken down." Some similar appliance could be used in hydraulic-sluicing claims where there is so large a quantity of stones; it would cheapen the cost of their removal considerably, and make ground payable for working that is now abandoned.

The ground had been worked by Messrs. Ewing and McConnechie for a few weeks prior to my visit, and they were engaged in cleaning up, but the result was not payable however. The ground seems to dip back towards the range, and it is anticipated another run of rich gold-bearing drift will be found further back. The place where the operations are being carried on is at the lower end of the flat, where the two Hercules Claims are situate, and at the end of this flat the rocks rise up and go close to the river. It is therefore anticipated that the river has at one time flowed nearer the main range, and swept round against these rocks into the present channel.

Roxburgh Amalgamated Company.—This company has done a considerable amount of work since my previous visit. They have four elevators in position in their ground, two of which are constantly kept going when there is a supply of water, and they are lifting the material about 50ft. on the average, using a 3-inch jet in the elevators and 3-inch sluicing nozzle under a head of 700ft., the water being supplied from a main 22in. in diameter for a distance of 38 chains, 18in. in diameter for 12 chains, and 15in. for the last 16 chains. The manager informed me that his pressure-gauges, when water stood in pipes, registered correctly—namely, 300lb. per square inch; and that when two elevators were at work the gauge showed a pressure of 250lb. per square inch, which is equal to a head of 567ft.; and when four jets were at work the pressure went down below 200lb. per square inch. Therefore, assuming that a 3-inch jet and sluicing-nozzle is under a hydrostatic head of 576ft., these are each capable of discharging 8·8 cubic feet of water per second; therefore, $\frac{8\cdot8\times576}{17\cdot6\times50} = 5\cdot63$ as the ratio of power used in these elevators. If the diameter of the jet and sluicing-nozzle given me are correct, then this is a very fair test of the ratio of the power, as the hydrostatic head is accurately determined by the gauge, which evidently registers correctly by what it shows when the pipes are full, and water cut off from the elevaters. It is evident, however, that some of the measurements given me are inaccurate, as the water for two sets of elevators, with 3-inch jets and sluicing-nozzles, under 250lb. pressure to the square inch, could not be supplied and that pressure maintained, out of a main, supposing it to be 22in. in diameter for the whole distance of 66 chains, or 4,356ft. It is, therefore, doubtful if this ratio, which seems very high, is of any real value in arriving at a formula for calculating the power required for working these elevators.

This company strips as much of the ground as possible by the ordinary method of sluicing as far as the fall will permit before commencing to use the elevators. They have worked a considerable distance back into the flat. A cut was put in on the end next the Teviot River, and the ground was found to dip in towards the range, but they could not carry this cut further back at the time. On the upper end of the ground there is a considerable area of the surface stripped ready for the elevator being used, which is said to be very good ground. The manager here seems to be thoroughly acquainted with this method of working, and keeps several elevators always in position, so that if any accident takes place to one he can turn the water on to another without any loss of time or water, the latter being the great desideratum. Some of the ground is very rich. The

manager informed me that, out of a paddock 99ft. by 66ft. and 30ft. deep, he got 101oz. of gold, which is equal to nearly 6·7gr. of gold per cubic yard. The total quantity of gold obtained by this company for the year ending the 31st December last was, in round numbers, 1,555oz., representing a value of £5,995. There are twenty-four men employed by this company, and the average monthly expenses of working the ground, including all wages and other expenses of the claim, is about £320, or £3,840. This, therefore, leaves £2,055 of clear profit on last year's working. The nominal capital of the company is £30,000, of which £12,783 is paid up, and £15,000 given in paid-up shares to the promoters, making the paid-up capital and that given to the promoters amount to £27,783. Taking the profit on the working last year, it gives nearly 17 per cent. on the paid-up capital, or nearly 8 per cent. including the promoters' shares. The company have been working at a considerable disadvantage last year, as they had to strip a large area of the surface in which there is little or no gold, and the next year ought to give a very good return to the shareholders. According to the balance-sheet submitted at the annual meeting of shareholders recently held, the value of the gold obtained for the year ending the 30th April last was £4,530 6s. 7d., and the expenditure in connection with carrying on hydraulic operations, and expenses in connection with conducting the affairs of the company, was £3,495 4s. 5d.; and £1,036 19s. 8d. was paid in dividends. The nominal capital of the company is £30,000, of which amount £15,000 was paid to the promoters in paid-up shares; 435 shares are unallotted, and 412 shares have been forfeited. The amount of capital actually paid-up is £12,737 5s., exclusive of the paid-up shares given to the promoters. The following is an abstract of the report of the Board of Directors:—

"During the twelve months ending 30th April last, No. 1 elevator was working 181 days 5 hours; and No. 2, 163 days 18 hours.

"The time lost by alterations, removals, &c., has averaged about 22 per cent. for each elevator. Finding that by the equipment of a third elevator this loss of time could be saved, by admitting of two elevators being constantly worked during the continuance of the water-supply, the directors have provided an extra elevator and piping at a cost of about £450, the advantage of which will be demonstrated during the current twelve months. It will be observed that a considerable time had been employed in stripping the ground overlaying the gold-bearing wash. On the completion of the stripping, the water fell off, so that the revenue account for the past twelve months has not benefited by this work. The manager reports that there is sufficient wash-dirt laid bare to employ two elevators constantly for the next two years, and that now that he has the spare elevator in position, he will be able to keep two elevators going during the continuance of the water-supply. He speaks very encouragingly of the prospects of the claim, and predicts good returns for the current year.

"The directors regret that the arrangement with the other companies interested in the water-supply for increasing the storage capacity of the dam, referred to in last year's report, has not been given effect to, owing to one of the companies having gone into liquidation, and the purchaser of the claim not having yet determined whether he will take that company's place under the agreement. The Board had taken no active steps to raise the dam, having some hope that an arrangement satisfactory to the company will be come to, whereby the storage capacity of the dam will be increased so as to secure a constant supply of water for the future, and they will endeavour to make such an arrangement.

"During the twelve months the sum of £462 5s. 7d. has been expended on new plant; £1,094 paid in dividends; and the preliminary expenses reduced by £200, leaving the profit and loss account in credit £572 8s. 11d., out of which the Board recommend that the sum of £200 be applied in further reduction of preliminary expenses, and the balance carried forward."

The quantity of gold obtained during the past year was considerably less than that for the previous one, the difference in the value being about £2,734, which is accounted for by the shortness of water, and the amount of dead-work done is stripping the ground. The latter can scarcely be termed dead-work, since the ground has been worked to the best advantage by sluicing off the top material in the ordinary manner before commencing to elevate the auriferous portion of the ground near the bottom. For the plea as to shortness of water the company has only itself to blame. They have one of the best water-supplies in Otago if they would only take steps to conserve it. The supply is taken from the Teviot River, where a large reservoir could be constructed at comparatively a small outlay. This company have constructed a concrete dam across the bed of the river to a height of 8ft., but it could be raised to a height of 50ft. with a very moderate outlay; this would give a reservoir of over a mile square, having an average depth of about 38ft. after deducting, say, 40 per cent. for evaporation and leakage. This reservoir would supply sixty sluice-heads of water for 122 days without a drop of water coming into it. Where water can be conserved the same as can be done at this place, companies are standing in their own light not to make provision to insure their always having a sufficient supply.

Bald Hill Flat.

A few years ago the workings here were almost deserted, there being not sufficient fall for sluicing the ground in the ordinary manner. Simmonds and party, who commenced to work this flat on the hydraulic-sluicing principle, found the supply of water too little to be able to carry on hydraulic-mining operations successfully. They purchased the water-race and water-rights from the Commissioner's Flat Company, when it was in liquidation, for £600, and during last year they have been constructing a water-race from Shingle Creek, where the purchased rights were from, to take the water in to command the ground in Bald Hill Flat. The length of this new race, which has just been completed, is about seventeen miles, and it has a carrying capacity of about fifteen sluice-heads. When water is available, this, in addition to their former supply, will enable them to carry on operations with two elevators. Every drop of available water is brought on to the ground in this locality, and all those having claims with a fair supply of water are making good wages.

It may be observed that this flat is at the foot of the Old Man Range, directly under the place where White's Reef and the reef now being worked by Crossan and Gray is situated. The whole of the face of the Old Man Range in this locality would pay for sluicing with a fair supply of water. Some very rich patches of gold was obtained by Mr. White in the alluvial drift before he discovered the reef, and the same can be said in regard to Crossan and Gray's discovery. The flat at the foot of this range has been prospected very carefully, and it is said that there is at least 70 acres of it that will pay handsomely for working with a fair supply of water and good appliances. The different gullies coming out of the Old Man Range in this vicinity were very rich in gold in the early days, as for instance Butchers' Gully; and all the flats at the foot of this range from Butchers' Gully to the lower end of Bald Hill Flat will yet prove to be payable for working with a good supply of water. Unfortunately some portions of these flats are freeholds; but some of these are now being worked, the miners having made arrangements with the proprietors. The most of those having claims on the flat have been doing a large amount of dead-work last year in constructing head-races and tail-races, but there should be a good deal of gold obtained from this locality during the ensuing year.

Mount Buster.

There are two claims being worked at Mount Buster, or what was known in the early days as "Clarke's Diggings," namely, that belonging to Messrs. Guffie and Inder, and a party known by the name of the Cornish and Scotch Company. Both of these parties have done a large amount of work and got a good deal of gold. The gold workings here are at an elevation of about 4,200ft. above sea-level, so that actual mining operations can only be carried on for about six, or at most seven, months of the year. Gold was first discovered here in 1863 in a small creek-bed known as Clarke's Creek, which runs into Deep Creek, forming a tributary of the Waitaki River. The ground was very shallow and easily worked, and in some parts of this creek-bed the auriferous wash-drift was found to be very rich. As soon as the shallow ground got exhausted, attention was directed to the higher ground on the east side of this creek, where a deep run of fine quartz-drift gravel was found, similar to that at St. Bathan's basin, having a little gold through it in layers of concentrated material, showing that at one time this drift had been brought down by the action of a large river or stream, and that the work of concentration had been carried on from time to time, leaving the material of greater density in thin layers or bands before another deposit was brought down to undergo a similar process—namely, by washing away the lighter sands and material, while particles of greater density remained behind.

This run of quartz-drift is one of the most interesting auriferous leads of wash-drift there is in the colony, inasmuch as it can be traced for a distance of seventy miles almost in a continuous line, and all the material shows that it has been brought for a long distance, as it is ground up into small particles, and the gold found in it presents the same characteristics; but the question yet remains to be solved as to where this material came from. Nothing similar has been found in the mountain-range from which it has evidently at one time been denuded; nor is it certain what direction the river flowed at the time this deposit was made. The same run of quartz-drift can be traced in a northerly direction to the foot of Mount Domett; but that mountain-range appears to cut it completely off, the same as if that range had subsequently been raised up through this ancient river-bed, and altered the features entirely of the surrounding country.

It was, however, very interesting to find, on my recent visit to Donald's Creek, in the Waimate County, that traces of the same character of quartz-drift appears here and there, and possibly may yet be traced into the mountain-ranges in a northward direction. At the southern end of the lead, near Clyde, the Clutha River seems to cut off all trace of it for a long distance; but the same character of drift is again found on the other side of the Old Man Range at Waikaia. Wherever this deposit came from, it has evidently been carried a long distance by the action of water, to be ground-up in the state in which it is found; also, that in all likelihood thousands of years have passed away since this deposit was formed—the topographical features of the country at that time being entirely different from what they are at the present day. It is evident, from the apparent magnitude of the ancient river-bed referred to, that there was more water in the streams than at the present time; and the inference by that is, that the mountains were at one time at a much greater elevation. Wherever this class of drift is found, there is almost invariably a little gold in some layer through it, although in many places there is not sufficient gold to pay for working it. At the same time, where such rich deposits are found, as at Mount Burster, St. Bathan's, and Tinker's, the inference is that there are other parts of this land quite as rich, and probably even richer, than any portion of it that has been yet tested.

Guffie and Inder's Claim.—This claim is situate on the top of the saddle of the range dividing the watersheds of the Waitaki and Taieri Rivers. The ground is worked by hydraulic sluicing, and the tailings and tail-water can be sent down either into Clarke's Creek or the Kyeburn. These gentlemen have almost the whole of the available water that can be got at an elevation sufficiently high to command the ground so as to work it to advantage; but the whole of the water available is not sufficient for a good supply to carry on extensive sluicing operations during dry weather in summer. The supply of water depends entirely on the quantity of snow that falls during the winter months. If there is a heavy fall of snow, there will be a plentiful supply of water for the ensuing season; and, with a light fall of snow on the mountains, *vice versâ*. One of the proprietors of this claim, who accompanied me to Mount Buster, stated that the returns from their claim is from 400oz. to 800oz. of gold for the season; but that for the season before last the return was not so good. At the time of my visit there was only one man employed at this claim, but I was informed that the supply of water was almost done for the summer months, at least they were depending on showers of rain. The depth of the quartz-drift in Messrs. Guffie and Inder's claim is from 30ft. to 70ft., but the best of the gold is found near the bed-rock.

Scotch and Cornish Company.—There was no work being carried on by this company during the time of my visit on account of the supply of water being exhausted. The face where they have been at work presents the same appearance as that of the adjoining claim, but I was informed that it was not so rich. This company have only a limited supply of water, and possibly cannot operate on so large a quantity of material as Messrs. Guffie and Inder, which would, in itself, account for less gold being got. It was, however, stated that this company holds some ground which can be worked into the fall of the Kyeburn Creek, which is likely to turn out very well.

This run of quartz drift has a break on the top of the saddle on the southern end of the workings on Mount Buster, but on going down the range into the flat large blocks of quartz and quartzite are seen following the line in which the lead ought to take. These can be traced here and there all along the foot of the Mount Ida Range, crossing the Manuherikia River to Muddy Creek and St. Bathans, and no doubt some rich finds will yet be made in this lead or run of drift; but it will require a good supply of water to work, as a large quantity of material has to be washed away which contains very little gold.

Kyeburn.

There are a few miners working in this locality, all said to be making fair wages. The most of them have water-races of their own, and, having acquired comfortable homes by a lengthened residence in the place, it will only be when the ground becomes too poor for them to make small wages that they will leave. There seems to be an auriferous belt of country from Naseby to Kyeburn, a little further into the flat than the place where the deep lead of quartz drift passes through, and probably some of the gold from this deep lead has been washed down into the lower-lying lands since the time the disturbance took place which altered the features of the country, and was finally covered up by more recent denudations from the present mountains. There seems, however, to be a belt of auriferous ground on the lower side of this deep lead, which the miners in the district consider would pay for working by hydraulic sluicing if a plentiful supply of water was available at a moderate elevation.

Mount Ida.

This field was first opened in 1863, and it still continues to supply its quota of gold from the alluvial drifts. There are still a few mining claims in the bed of the Hogburn (which is the creek where the gold was first discovered), and these are said to give the owners fair wages for working. One of these claims is known by the name of the "Deep-level," and is worked by a hydraulic elevator, the ground being from 12ft. to 20ft. in depth. To take the gold-workings in the immediate vicinity of Naseby—that is, alongside the Hogburn—the ground is getting pretty well worked out. A large portion of it on the south side of the Hogburn Creek was very shallow, being only from 1ft. to 3ft. in depth, the gold-bearing wash-drift being confined to the surface lying on older drift-gravel known as the Maori or Old Man bottom. In some places where this bottom has been sluiced away a little gold was found, but not sufficient to pay for working. This false bottom joins on to the schist rock about 20 chains up the Hogburn Creek from the township. The prospecting shaft sunk some five or six years ago went through this Maori bottom at a depth of about 200ft., and came into the old quartz-drift wash which is found on top of Mount Buster and St. Bathan's, which contained a little gold. This shaft was small, and, in consequence of the influx of water in the drift, sinking had to be abandoned, as the horse-whim used for baling the water could not keep it down. It is to be regretted that the quartz-drift formation in this locality has not been tested, as in all likelihood it would be found to contain sufficient gold to pay for working in places. The great depth of Maori bottom overlying this material makes it expensive to prospect the ground thoroughly.

With the exception of the gullies adjacent to Naseby, there has been very little prospecting done, the reason being chiefly that the supply of water on the field is limited. As a general rule the ground is shallow, containing a little gold which can only be made remunerative for working by adopting the most approved methods, and this really means a plentiful supply of water. The present gold-workings are confined chiefly to the vicinity of Robertson, Enterprise, Coal-pit, Wet, Roche's, Home, and Spec Gullies, and the Hogburn, all of which are within a radius of three miles of Naseby. The ground being at an elevation of about 2,000ft. above sea-level, and the gold-workings within a couple of miles from the foot of the mountain-range, there is very little water to be had in dry weather, so that miners who have not water-races of their own are entirely dependent on a supply from the Mount Ida Water-race, and, although this race commands a large extent of auriferous country, it is not at a sufficient elevation to command the whole of it.

The largest extent of auriferous ground yet unworked in the immediate vicinity of Naseby is at Spec Gully. There is scarcely any of the ground worked in the low valley of Spec Gully, and from what Donnelly and party informed me when I was last in this locality there is a large extent of it which would pay to work by hydraulic-elevating. This party has opened out a paddock by using an elevator, and they assured me the ground would pay good wages for working on this principle. They are lifting the material about 25ft., the hydraulic head of water used to do this work being 200ft., the diameter of supply-pipe used being 11in., 10in., and 9in. diameter, and the elevating-pipe 15in. in diameter. This party are also working a claim on the face of the terrace on the side of Spec Gully next to Naseby. There are claims being worked on the other side of Spec Gully, on the face of the terraces between this and the Kyeburn, which are said to give fair returns for working when water is available; and apparently the same run of ground extends to the Kyeburn.

In Roche's Gully Messrs. Guffie and Inder are still working the old ground on the hydraulic-elevating principle, taking the whole of it in a face before them, and it is said to give very good returns for working, which shows that the ground here must have been very good in the early days, and that the former system of working was very defective. The whole of the ground appears to have been previously turned over, and one would hardly expect to be able to work old ground

which after paying wages leaves a profit on the working of from £50 to £100 a month, which this ground is said to return. It certainly shows that with improved methods of working ground can be made remunerative for working which a few years ago was considered valueless.

Taking the Mount Ida Goldfield as a whole, there is a large extent of country covered with auriferous drifts which are apparently very shallow, and, although these drifts may contain a fair amount of gold distributed among them, the character of the country, which has a gradual slope from the foot of the mountain to the Taieri River, with low, undulating terraces, makes the ground far more expensive to work than deep faces of auriferous ground with high terraces, where water-races can be brought on to the top, and a sufficient hydraulic head of water obtained with short length of pipes. The ground about Mount Ida, although shallow, requires a considerable head of water on the hydraulic nozzle to be able to break it up, as the surface portion of it, for a depth in some places of 8ft., is of a very compact loamy clay, requiring a good force to pulverise it sufficiently to run it away in the sluice or tail-race. The water would in many cases have to be brought for a long distance in pipes before a sufficient head can be got, as the sloping nature of the ground prevents a ditch being constructed so as to attain the desired object; also, the ground being shallow, there is always a considerable expense in shifting plant.

The system generally adopted for working ground in this locality is greatly inferior to that used in many other places. The long lengths of canvas hose one sees when going round the workings, and the miners using a pick for breaking down the face of the ground before water has any effect upon it, seems strange to those who have been accustomed to see the more improved systems of working; but the intermittent supply of water has a great deal to do with this. The ground not being rich, and a constant supply of water not always to be got, the miners are only able to make small wages, and cannot afford the outlay to get a proper plant on their claims. It is not to be inferred from this that the ground is poorer than at any other place, because it has to be considerably richer before men can make a livelihood when all the conditions of working it are taken into consideration. There are many places where there are deep faces of drift which do not contain the same quantity of gold per cubic yard as the ground about Mount Ida, still with a good supply of water they can be made to give better returns and made more remunerative for working. It has to be said that the miners at Mount Ida are gradually substituting iron piping for the antiquated canvas hose, but the pipes in general use here are far too small to utilize the water with the best effect.

Blackstone Hill.

There are only about twelve minesrs working about Blackstone Hill. The supply of water to work ground in this locality is limited to that which can be got from the water-races recently purchased by the Government from the Official Assignee of the estate of R. Johnstone. Only one of these water-races commands the whole of the ground, and this race only comes to near the saddle where the main road crosses from Hill's Creek to the Manuherikia River. Some very rich patches of ground were worked on the saddle of the range where the old quartz drift appears, but as this drift gets further into the ranges, it is covered over with a more recent deposit, or it may be said that since the quartz drift was deposited here the rocks have been tilted up, and are now positively overlying the quartz drift deposit. Underneath the quartz drift there is a bluish-black puggy bottom, or at least when exposed to the action of water and the atmosphere it gets soft and swells up, so that the superincumbent weight of material above the auriferous layers in the quartz drift has the effect of causing the bottom to bulge up, and very little of the auriferous layers can be now got at. The drift has been worked along the foot of the hill for a considerable distance, but it has not so far proved remunerative; but Mr. R. Johnstone is still continuing a cut-up through the ground with the hope that it will improve.

The opinion of all the miners in this locality is that there is a large extent of ground that would pay remuneratively for working if the water-race were extended across the main road and carried along the range to the fall into the Poolburn. This would command both sides of Blackstone Hill. To all appearance, and from a cursory view of the country, this could be done at a comparative small cost. The greatest expense would be a siphon across the saddle. The Government now possess the only water-right which can command this ground, and not only is it valuable in this respect, but, in the event of the Mount Ida diggings being exhausted or worked out to such an extent that the water could not be advantageously disposed of, the whole of the water from the Mount Ida Race, from Hill's Creek upwards, could be brought on to this range, and be made to command the largest area of known auriferous ground in the colony, including the whole of the ranges between the Ida and Manuherikia Valleys and the northern slopes of the watershed of the Clutha River below its junction with the Manuherikia; and in this respect the Government now hold one of the most valuable water-rights in the colony either for mining or irrigation purposes.

There are considerable areas of apparently auriferous drifts between Naseby and Blackstone Hill, and also on a terrace on the upper side of Pearce's Gorge, where very little prospecting has ever been done; and breaks in the Mount Ida Water-race washing away portions of the drift-gravel in the vicinity of the latter place have disclosed the fact that it is auriferous. A few years ago claims were worked at the Little Idaburn, and close adjoining this the deep run of quartz-drift comes through; but nothing has been done to prospect this deposit in any place between Mount Buster and Blackstone Hill.

Foggarty and party are constructing a water-race from the Manuherikia River to work ground between Blackstone Hill and St. Bathan's, with the ultimate view of extending it along the face of the range to Black's; but even were this water-race extended to Black's it would only command a limited quantity of ground, as it would not be at a sufficient elevation. The race at the time of my visit was constructed for a distance of about two miles and a half, it being 4ft. 6in. in width in the bottom, 2ft. deep, and 5ft. 6in. wide on the top, having a fall of 10ft. to the mile. If this water-race be taken at an average depth of 21in., and the fall to be uniform, its carrying capacity would be about

seventeen sluice-heads. They brought the ditch down on the opposite side of the river for 50 chains, and have taken the water across in a pipe 20in. in diameter on a suspension-bridge having 160ft. span, the cables having a deflection, it is said, of 16ft. Two steel-wire ropes 3in. and two ropes 2¼in., in circumference are used for cables, which will be found to be rather weak, on account of the heavy strain stretching the cables and causing the joints to leak. The ropes, also, being of different diameters, it will be a difficult matter to get them to act in unison as regards taking the proportion of the strain due to their strength. The weight of these cables, the bridge, and pipe when filled with water, is about 12 tons, and the strain that this weight will exert at each of the piers will be about 16·15 tons, namely, $\frac{(W)}{\frac{2d}{\sqrt{2d^2 \times S^2}}}$ when W = half the weight of the bridge and load in tons, d=the deflection of the cables in the centre in feet, and S=half the length of the span. Taking the working strength of the steel-wire ropes, two of 3in. and two of 2¼in. in circumference, as given by Molesworth, they are good for 12·66 tons; but that is not sufficient for the strain they are subjected to.

This party have discovered the ground they now intend to work since they commenced to construct their race, and they estimate by extending it from time to time they will command auriferous ground all the way down to Black's which will pay for working.

Black's.

There is very little mining being carried on here. A few parties are merely fossicking in the old ground. Portions of the flat between Ophir and the old station-buildings have been worked since the extension of the tail-race, but the ground is said to have been very poor. But it is possible that if water were brought on to the range above Black's at a sufficient elevation a great deal of this flat would pay for working on the hydraulic-elevating principle. Wherever there is gravel drift on the face of the range, and water procurable, it seems to be worked, which would indicate that the whole of the range where any gravel drift occurs would be worked if water was available.

St. Bathan's.

Although this goldfield has been worked for the last twenty years, there is still a large quantity of gold being got from the old quartz drift, or what is known locally as the granite wash. Indeed, the run of wash-drift is very extensive, and it has only been prospected in a very few places. It can be traced nearly in a continuous line from the foot of Mount Domett on the western side, passing along the foot of the ranges, to Clyde, a distance of about eighty miles. In some places this drift is denuded, or it appears as though the schist rocks had been lifted up in places through this drift, as there is a gravel wash drift in many places now overlying the schist rock of a more recent date than the quartz-drift deposit, showing that the quartz drift could never have been overlying the more recent gravel. This quartz drift also is lying at a high inclination on the side of the schist rock, sometimes dipping in entirely different directions. The layers or bedding of this deposit show a varied stratification; in some instances, as at St. Bathan's, the layers are parallel, and again at Vinegar Hill they are greatly contorted in places.

There is a layer composing a bed of leaves amongst the quartz drift at St. Bathan's, about 5ft. in thickness, and this layer lies at about the same inclination as the face of the schist rock against which the quartz-drift is lying. This shows conclusively that the leaves at the time they were deposited had a horizontal bed, and that there could not have been a rapid current near the place where such deposition took place. The manner in which the layers have been tilted up shows that an upheaval took place and altered the topographical features of the country, causing the rivers to flow in different directions from that in which they flowed at the time the quartz-drift was deposited. There is no district in the colony that deserves more attention as to its geological formation than that from Mount Domett to Clyde. There is a great probability of very rich deposits of auriferous drifts being discovered at different places along this run of quartz drift, and it would be interesting to know from what direction it came. There appears to be little doubt but that the mountains were at a greater height than they are at the present day; but it seems questionable whether this drift is the denudation of the present mountains.

There is only a very small area of gold-workings in the vicinity of St. Bathan's, but a very large quantity of gold has been obtained. Over 100,000oz. have been purchased by one of the banks there, and the quantity of gold in the quartz drift does not appear to diminish as it gets down. The deepest workings yield about as much as those near the surface, and the way that it is being traced has the appearance of continuing along the foot of the range between Vinegar Hill and the main range.

John Ewing's Claim.—This claim is now being worked with two elevators, one under the other, to a depth of 75ft. The bottom elevator lifts the material 30ft., and the upper one 45ft. The lower elevator has a jet of 1¾in. in diameter under a head of about 300ft., the water being supplied from a main pipe 11in. in diameter and 2,000ft. in length. The jet of the upper elevator is 2½in. in diameter, and is supplied with water from an 18in. main 2,000ft. in length, having a head of about 440ft. The sluicing nozzle is 2in. in diameter, and it may be said that the drainage in the bottom of the paddock is about half of a sluicehead. The ratio of power, therefore, required to work these elevators would be as follows:—Taking the bottom elevator first: Taking the hydrostatic head on the lower jet and nozzle at 250ft., then—

1¾in. jet discharges under 250ft. head	1·98	cubic ft. per second
2in. nozzle discharges under 250ft. head	2·59	" "
Drainage	0·50	" "
Total	5·07	" "

Then, $\frac{1{\cdot}98 \times 250}{5{\cdot}07 \times 30} = 3{\cdot}25$, which is the ratio of power required to do the work effectively. And the top elevator: The discharge from a 2½in. jet under a hydrostatic head of, say, 400ft. would be 5·12, and this added to the former is 10·19 cubic feet of water per second that has to be lifted 45ft. by 1·98 cubic feet of water under a head of 400ft. Therefore, $\frac{5{\cdot}12 \times 400}{10{\cdot}19 \times 45} = 4{\cdot}46$, the ratio of power used in the top elevator.

From experiments made with the working of the top elevator Mr. Ewing finds that a throat of 6in. in diameter produces the best result. More material can be lifted with a throat of this dimensions than one of 5in. in diameter, or with one larger than 6in. Hitherto there has been no definite formula by which the lifting-power of hydraulic elevators can be calculated. The difficulties which stand in the way are that the conditions under which each elevator is placed seems different; as, for instance, if there are no large stones amongst the washdrift the throat may be made to the corresponding ratio with the quantity and velocity of the water used from the jet; but when there are large quantities of stones in the ground, such as are found at the Hercules Nos. 1 and 2, near Roxburgh, the throat requires to be larger, in order to take stones of a medium size. There are so many elements to take into consideration that the co-efficient of ratio of power required would alter in almost every case.

Mr. Ewing gave me a note of the work he was doing with an elevator some years ago when he was only lifting the material 13ft., with a jet 2in. in diameter under a hydrostatic head of 200ft., and he was using six sluice-heads for sluicing. The result would therefore be as follows:—

Jet 2in. in diameter under 200ft. head discharges	2·3	cubic feet per second
Sluicing-nozzle	6·0	" "
Total quantity of water lifted 13ft. ...	8·3	" "

Therefore $\frac{2{\cdot}3 \times 200}{8{\cdot}3 \times 13} = 4{\cdot}26$, the ratio of power that was employed. Also at Vinegar Hill the elevator used there is lifting the material 25ft. The quantity of water used on the jet under a hydrostatic head of 246ft. is 3 cubic feet per second, and 5 cubic feet is discharged through the sluicing-nozzle, therefore $\frac{3 \times 246}{8 \times 25} = 3{\cdot}69$, the ratio of power used in this instance. It will therefore be seen that the ratio of power, or a co-efficient that would have to be used even in the calculation of elevators used by Mr. Ewing, working the same description of ground, varies from 3·25 to 4·46. In regard to the character of the auriferous deposit found in St. Bathan's basin, Mr. Ewing's claim seems to be on the richest portion of it that has yet been tested, and there seems to be no diminution of the gold in the drift as it goes down, but if anything it may be said to increase. The season before last he got 1,500oz. of gold, and he had only on an average five men employed; and for the last season 800oz. of gold was obtained. He expects to be able to elevate to a height of 100ft. with his two elevators.

Eagle and Gray's Claim.—This claim adjoins Mr. Ewing's, with apparently the same run of quartz drift; but they have only a poor supply of water. They have a water-race from Wheeler's Gully, which is one of the tributaries of the Dunstan Creek; but, except in wet weather, they have not sufficient water to work their ground advantageously. They are merely sluicing off the upper portion of the ground to such a depth as the tail-race will admit.

M. & E. Company's Claim.—This claim is next to Eagle and Gray's, and they are working it in a similar manner—only working it down to such a depth as the tailings can be carried away by the tail-race. They have a water-race from Dunstan Creek, and have had a very fair supply of water for the last season; but, the piping they use for conveying the water to the sluicing-nozzle being only about 7in. in diameter, they lose a large percentage of the available head of water by friction. There are five men employed in this claim, and they got 200oz. of gold for last season's work.

P. Tiernan's Claim.—This is the adjoining claim to the M. & E. Company's ground, being similar in character, and also worked in a similar manner. It is stated that this ground pays the owner very well for working. He has had a very good supply of water for the last season from the same race that the M. & E. Company uses, he being one of the proprietors along with the company referred to.

St. Bathan's Sludge-channel Company.—This company was formed amongst those holding claims in St. Bathan's basin, each shareholder in these claims paying in proportion to the interest he held. The channel was carried up to the place where it crosses the road from St. Bathan's to Clyde, and then the company commenced to work the surrounding ground. They have now been employed in working this ground for the last four years, and have obtained a considerable quantity of gold. The previous year they got 450oz., and the return for this season is expected to be about 500oz. The character of the ground they were working last season is quite different from that in the claims in St. Bathan's basin, and to a great extent resembles the consolidated clay found in Mr. Ewing's claim at Vinegar Hill. Overlying this clay there is from 6ft. to 8ft. of loamy material, which has a little gold in it; but the principal washdrift that they get the best of the gold in is lying directly on the top of the clay referred to. This clay is full of the vertebræ of small fishes and shell fossils similar to that found at Vinegar Hill. This material seems to abut on to the old quartz-drift wash, which is seen higher up on the face of the terrace, and gives one the impression that there is a deep run of this drift between the place where they are working and the terrace; and very likely a great portion of the ground that has been stripped by this company will be worked again to a greater depth when the tail-race or channel is constructed to the proper level. There have been five men employed on an average by this company during the last year. This company has a wide spread of tables, having a distributing-box set at right angles to the main sluice and directly under the grizzly or perforated plate. The mining manager informed me that the proportion of the gold obtained on these tables was about 80oz. out of 450oz., which is over a sixth portion of the total yield. Previous

to these tables being constructed this gold was run down a tail-race and was considered lost. Probably some of the gold in the tail-race will yet be got, but certainly not the whole of it. They were proposing to wash up at the time of my visit, and were constructing a flushing-race to enable them to cut up the channel to allow the claims to be worked to a greater depth.

Vinegar Hill.

John Ewing's Claim.—The character of the ground worked the last season is similar to that mentioned in my last report, the depth of the face being from 50ft. to 70ft. The uniform layer of wash is only from 1ft. to 2ft. thick, consisting of a quartz gravel lying on the top of the schist rock. The sedimentary deposit overlying this wash has the appearance of a highly-consolidated glacial mud. It is formed in bands, having only a slight inclination from horizontal. Last season he had taken a cut-in towards the range, and found a fault in the sedimentary deposits, which shows that the side next the range has been lifted up about 12ft. since the material was consolidated, every band being distinctly seen corresponding with those at the 12ft. deeper level.

The most interesting discovery made in this claim is on the end of the cut next the mountain range. The old quartz drift is found to join on to the schist rock, dipping away into the range at a high inclination. This shows that the deep run of quartz drift is between these workings and the range, and this deposit has never been tested in this locality. There is a little gold through the drift, as far as it has been tested, below the level of the schist rock, and in all probability a rich run of this ground will be found between the present cut and the range. Taking the run of this deposit at St. Bathan's, and the similarity of the ground worked by the St. Bathan's Channel Company, there is little doubt but that the channel of the ancient water-course goes through this claim. Whether there is sufficient gold in the drift to pay for working remains to be proved, but there is a great probability of Mr. Ewing being well recompensed for the outlay he has been at and for the enterprising manner in which he has conducted this mining-venture. He employs on an average five men. He was busy washing up a large paddock the result of over a year's work. From this he has obtained 200oz., from a box 100 yards down race. No gold has been taken out of race or paddock. From these he expects about 700oz. more. He started, and has a large paddock (about 4 acres) stripped, on some new and shallower ground, from which he expects good results. He also worked during the year, when water was short, 2 acres of shallow ground 4ft. to 20ft. deep for 200oz.—a result hardly payable.

Hughes and Morgan's Claim.—This claim is closely adjoining Mr. Ewing's, and on the side of hill facing Vinegar Flat. The quartz drift here is formed in bands, highly contorted, and lying at a steep inclination. The party have worked a considerable area of ground, which is said to have paid them fairly well. Recently they sold a portion of the worked-out ground to another party, who is working by tunnelling and paddocking, taking up more of the bottom and side of the reef than Morgan and Hughes had done; and this is said to pay very good wages to the men working the ground in this manner. The depth of face where Morgan and Hughes are working is about 90ft.

Vinegar Flat.

Watson and Party's Claim.—This party has worked a considerably larger area of ground last year than formerly, but it has not been so rich. Still it has paid good wages for the three men employed, the yield of gold being about 250oz. The reason assigned for the ground being poorer this season is that they have been working farther into the flat than they had done formerly. But, the party adjoining them having worked out their claim, it will allow them to work to more advantage, and they expect to do better next season.

Thomas Morgan and party have a claim lower down the flat than Watson and party, but the ground is poorer. Still, by being able to work continuously, they make fair wages. The ground in this flat is a coarse gravel wash, having none of the quartz drift that is found higher up near the foot of the range.

Davis and party, referred to in my previous reports, have abandoned their claim in this flat, as it was too poor to work at a profit, and they are now working ground south of Cambrians which is commanded by their water-race.

Cambrians.

There are a few individual miners fossicking here in the old ground, some of whom are said to be doing better than they have for the last twenty-five years, by driving out pillars and ground on the Saddle between Cambrian's and Soldier's Gully, where the gold is in a layer of quartz-drift wash. There are two parties of Europeans and one party of Chinese working ground by sluicing, who are said to be making wages. There are also several parties of Chinese who have taken up ground south of Cambrian's, which is reputed to be good. One man obtained gold worth £70 from this place for seven weeks' work.

A party of Chinese in lower end of the gully are doing well, although working in a very primitive manner. Mr. J. Ewing has taken up a terrace just above them and opposite the township, which he intends to work with his lower race—the first right from Dunstan Creek—and expects good results. He will use a large body of water and elevate the material.

Fordham, Guy, and party are making good wages higher up the gully, alongside the old workings; but their supply of water has not been good. Several small parties at Cambrian's and on Station Hill are making wages, in some cases sinking and driving, and in others sluicing.

Excell and Coulson, at Vinegar Hill, are making very good wages, driving and paddocking in ground left behind by Morgan and Hughes, and have many years' work ahead of them.

Muddy Creek.

There are four parties working ground which is sluiced into the Muddy Creek Channel, but none of them, with the exception of the Scandinavian Company, are not doing much; it is only by the economical method they have of working that makes the latter company's ground payable.

They make the water do all the work, with only one man to attend to it regularly, and another occasionally when required. This company have been enlarging their head race from the Manuherikia River, so as to have a carrying capacity of twelve sluiceheads. Previously it would only carry eight heads. They sell portion of their water, and have from three to four men employed on their race. They have worked a considerable area of ground, but do not intend to wash up until next spring.

The M. and E. Company's ground in this locality has been very poor recently. They only got 165oz. of gold for three years' work. They were at the time of my visit, in conjunction with the Scandinavian Company, washing up a portion of Muddy Creek Channel, which is held jointly by the two companies, who term themselves the Channel Company. They have washed about fifty chains of the channel, beginning one and a half miles from the head. This piece was washed up as an experiment, to see what gold was being saved in it, and to see whether it would be likely to pay to put tables in the channel, to do which the channel would have to be blocked and a drop formed. This would raise the level of the channel for 50 chains up from the drop—hence the place chosen for the experiment. The value of the gold obtained was £504, and the total expense of getting it was slightly under £200. This proves conclusively that much gold is being lost from the claim, as probably in such a rush of water (twenty-five to thirty-five Government heads) in a channel about 8ft. wide, and with such fine gold, twice or three times what was got went past. This portion of the channel was washed up seven years ago, with almost similar results. As soon as they have some more of it cleaned up they intend constructing a double set of tables in the channel, which will be covered with cocoanut matting. These will be 24ft. wide on each side of the main sluice, divided into 3ft. partitions, which will be 12ft. in length, divided into two tables, each 6ft., having a drop-well at the foot of each. The miners in the St. Bathan's district are just beginning to see the advantage of having a great width of tables to save the gold, which is of a very finely-divided character, resembling the gold on the ocean-beaches on the west coast of this Island. It has only been by the practical demonstration of the St. Bathan's Channel Company that others have been induced to construct tables to save the gold from their claims. Indeed so conservative was the opinion of the late manager of the M. and E. Company, that it was only after he found that these tables had saved 80oz. of gold during the previous season that he could be induced to go and see them, although he was living within half a mile of where they are placed. There are a number of similar instances amongst the old miners. They tell one plainly that they are not going to adopt any new-fangled idea, and it is only dire necessity which compels many of them to try any new improvement.

The other parties at work in this locality are the St. Bathan's Water-race Company and Garty and Gallagher. The latter get water from the Scandinavian Company to work their ground. The latter party are working at the Lagoon Surface Hill, and have done very well last season. They are troubled at times in working the ground, the stripping being a sticky clay, which sometimes slips away in large quantities when least expected, and carries the gold along with it. During the last season they got about 250oz. of gold.

Matakanui and Tinker's.

At Matakanui there are only a few people at work—that is, the Welshman party, and also Jack and party, and W. Wilson and another; all are said to be making fair wages.

Matakanui Company.—This company's mining operations have been confined to Tinker's. Last year they sluiced off the top of their ground in the ordinary way into their tail-race, and then elevated about 14ft. in depth of the bottom portion. They have eight men employed in their claim. The ground is very stony, which entails a considerable labour in stacking the stones on the worked out ground. During the last year they have increased the carrying capacity of their head-race by six sluice-heads, having pipes about 13in. diameter, and have got a new hydraulic plant, which they intend to use at Matakanui to test the quartz-drift wash under the old workings. During the last season they obtained about 639oz. gold.

Undoubted Company.—This company is still obtaining a large quantity of gold. Previous to my visit they washed up, and got 700oz., and they expect to get a similar quantity by the end of the season. They are working ground which was worked many years ago and has been by many of the miners in this locality considered valueless, the top portion having been sluiced off and abandoned. They are working it deeper, and elevating the wash-drift 26ft., having eight men employed. During the last year they have been constructing a new head-race to carry the water which had previously been conveyed in Ewing and McConnechie's high-level race. This new race will give them about 380ft. of head at their workings, and is expected to cost about £2,000. This company a little over three years ago paid £6,400 for a water-right, and has since spent £2,500 in the purchase of other water-rights, construction of water-races, &c—about £9,000 in all—and has done this entirely out of profits, without calling up or creating a farthing of additional capital. It has done so, too, out of ground that a few years ago was regarded by the knowing ones of the neighbourhood as not payable.

Reid and Party.—This party has been working the last season in the Deep Lead Company's ground, they having amalgamated with that company. This ground was covered with stones stacked from previous workings, and they have erected a water-balance to work a truck to remove them on to another portion of their claim, and intend placing a hydraulic-elevating plant on their claim to work the deep ground. There are five men employed, but the result of last season's work has not proved a success.

Mountain Race Company.—This company is working in the run of the quartz drift down to such a level as the tail-race will admit. They have put in gold-saving tables similar to those constructed by Mr. Ewing in Ewing and McConnechie's claim, and in the St. Bathan's Channel Company's tail-race. They have sluiced away a considerable quantity of ground last season with the limited supply of water at their command, but they do not intend to wash up this season. Their ground

looks well; the extensive slips which threatened to carry away the water-race above their ground have given them no trouble last year.

Ewing and McConnechie's Claim.—The workings in this claim was carried on to May last in the quartz-drift wash which is dipping under the side of the range; but the large amount of stones and *débris* that is overhanging the quartz-drift deposit entailed considerable labour to get away, and the top material, being of a loose nature—apparently it has been a slip from the range—requires a great slope before it will stand. Also it was found that the quartz-drift wash contains less gold as it gets back underneath this top material. After working for four months, they found it impossible to get further back, and they washed up the tail-race, when gold worth only £100 was obtained, for an expenditure of about £400. A considerable quantity of gold had to be left on the bottom of the paddock, owing to it being covered with the top material slipping from the side of the range, which would not pay them to remove, as it contains a large quantity of rock. Previous to Mr. Ewing putting in the cut into the side of the range, it was considered by all those who have claims on this run of ground that the gold got better as it got nearer the range; but this has been proved a fallacy. However, Mr. Ewing is confident, that the front seam of the quartz-drift run and the younger gravel-drift on his special claim of 60 acres will pay them remuneratively for working, and give them a good percentage for the capital they have invested, and thinks it probable that the more recent alluvial deposits will pay better than the quartz-drift they are now working. But, before these younger gravel-drifts can be worked, an additional hydraulic plant will be required. There are seven men employed in this claim, and they have been working very fair ground for some months past; but the water-supply has been limited, and their paddock is not in such a shape as to justify washing up before next spring or summer. They are now laying another half-mile of pipes to bring their water on to better ground in the lower end of their claim, and will be in a position to start operations on this place in the spring.

Morgan and Sims.—This party is now working about half a mile south of their old workings, in the front seam of the quartz-drift run, which is said to pay good wages. In the place they were working previously they put in cuts at intervals through the drift into the side of the range, and left solid blocks between, which act as abutments, and have prevented large slips from taking place. The place they are now working is about 40ft. in depth, and they have four men employed in the claim; but the quantity of gold obtained for last season's work has not been made public.

Clyde.

The only workings here are on the bank of the Clutha River, but the ground is getting very poor as it gets back into the flat. Every party has a water-supply of their own, and they are contented with a little gold, as they can employ portion of their time in cultivating land, which most of the old miners have taken up either as a freehold, or on occupation license, or residence sites. There are a few miners working during the summer months at the head of the Fraser River, where occasionally good patches of gold are obtained. A local syndicate or company took up a licensed holding of 30 acres in a small flat above the first gorge in the Fraser River, about five miles up from Messrs. Fraser and Laidlaw's homestead. They constructed two water-races, one from Rough Creek, about five miles in length, and one from the main river for about the same distance. The terminating points of these races are about 260ft. above the ground they intend to work. They also constructed a dam about a mile from the terminating point of the race from Rough Creek, which is capable of storing six sluice-heads of water for about sixteen hours. The men who constructed the water-race from Rough Creek got four shares in the company for their labour, and twelve other parties joined, and put on a hydraulic plant and elevator on the ground, at a cost of about £782. After constructing the race from Rough Creek and putting the hydraulic plant on the ground, they commenced hydraulic-elevating operations, and got gold to the value of about £110. They found, however, that the supply of water was insufficient to carry on their workings to advantage, and they constructed another race from the Fraser River, at a cost of £310, and afterwards got gold to the value of £170; but their expenditure in connection with getting the gold was £714. It would therefore appear on the face of this that the venture was not a remunerative one; but Messrs. Horne and McKersey, who are two of the principal shareholders, assured me that, after deducting the expenditure in repairing breaks, &c., during the time they were working, it left them £17 to the good. A flood occurred in the river and carried a large quantity of shingle and boulders down through the gorge on to Messrs. Fraser and Laidlaw's land, who threatened to take action against this company if they continued operations. Hence all work has been suspended since.

There are nine water-races taken out of the Fraser River below the mouth of the gorge, having an aggregate carrying capacity of forty sluice-heads. The heads of some of these races were also filled up with shingle, which came down the river when it was in flood; but a great portion of this shingle had come from the sides of the river-bank, which washes away to a certain extent every flood, and was not wholly attributable to the company's operations above the gorge.

Bannockburn.

The principal sluicing-claims in this locality are in the vicinity of Pipeclay Gully, where a tailings-channel was constructed about ten years ago by a company of local gentlemen. This channel has been the means of a large area of ground being worked which otherwise could not have been, as there was no fall for tailings. There are several good claims being worked by the aid of this channel, and a few years will see the whole of the ground now held washed away; but most likely new ground will be taken up ahead of the old workings. The shareholders of the Pipeclay Channel have as yet got very little of their money back that it cost to construct. They depend on the quantity of gold saved in the channel to recoup them for the outlay. About two years ago some 200oz. of gold is said to have been taken out of about 40 chains of the upper end of the channel. The miners pay the company for the right to use it 10 per cent. on the value of water used; and,

as the price of a sluice-head in this locality is 30s. per week, it requires a steady supply of 30 sluice-heads flowing continuously to get sufficient revenue to pay the wages of the man who looks after it. The following is a list of the claims which are worked by the aid of the Pipeclay Channel: Parks and party, three men's ground; Menzie and Horn, four men's ground; Aitken and Menzie, three men's ground; Renshaw and Tocher, two men's ground; Tippet and Croll, three men's ground; Halliday and Sim, two men's ground; Geikie and George, two men's ground.

Renshaw and Croll's and Tippet and Croll's claims are said to be the best in this locality, but Aitken and Menzie's is also a very good claim.

There is another tailings-channel constructed a little higher up the valley of the Kawarau River, belonging to Messrs. Patterson, Bull, and Rooney. It is about 40 chains in length, and constructed on a gradient of 1 in 20. Another party besides the proprietors work ground with the aid of this channel. To take the whole of the miners about Bannockburn, the most of them make fair wages when they have a plentiful supply of water; but there is no getting away from the fact that the best of the ground, as far as yet known, is getting gradually worked out, and that some of the old miners, who have been for years in this locality, are shifting their belongings to other places where they expect to get better returns for their labour.

Cardrona and Criffel.

There is very little to record about either of these places. Notwithstanding that the gold-workings have been steadily carried on at Cardrona for about thirty-one years, there are still a comparatively large number of miners on this field. When it is taken into consideration the time that has elapsed since the creek was first rushed, some are making very fair wages on the field, and small patches of fresh ground are being continually opened up. There is a probability of a lead of gold yet being found on the side of the range leading towards Mount Criffel. At the same time the gold at the Cardrona is of a different quality to that obtained at Mount Criffel; but the latter corresponds with that found in the branch creek coming out of the opposite range. There are a large extent of terraces and country in the Cardrona Valley that have never yet been prospected, and which have every appearance of being auriferous. It is, however, a question whether they contain sufficient gold to pay for working. This can only be proved by making a practical test. There is little doubt but that a considerable number of miners will find employment in this valley for many years yet to come, and the number will entirely depend on the quantity of water brought on to the ground. There are about eighty miners employed in claims in the Cardrona Valley; and the yield of gold last year was something like 1,600oz.

The hydraulic-elevating claim that was commenced about two years and a half ago proved to be a failure, as was anticipated, owing to the small temporary plant that was used. The company finally let the claim on tribute to the late manager, Mr. Piazzoli, at 30 per cent. tribute, which was a large rent for any one to pay for the privilege of working ground with a plant which can only be termed a prospecting one. After working for some time, Mr. Piazzoli found that he could not carry on, and got the percentage reduced to from 15 per cent. to 22½ per cent. of the gross yields according to the returns. The ground has not so far proved to be very rich. It is said 64oz. of gold was obtained from an area of bottom 100ft. by 40ft., the ground being about 40ft. in depth, which means that from 5,926 cubic yards of material, 64oz. of gold was obtained, being 5·18 grains per cubic yard. This ground, with a properly-constructed hydraulic plant, should be made to give very good returns.

At Criffel the miners have had a fair season, but there are only a few that can work. They are wholly dependent on Halliday and party's water-supply, who hold all the principal water-rights on the field. About 350oz. of gold was obtained during the last season, while fifteen miners were employed on the field.

Arrowtown.

In my last report reference was made to a rush setting in on the Crown Terrace, on land held as an agricultural lease by William Baker. A fair amount of gold was got for a few months, but now there are only about six or eight men employed in this locality. The area of the gold-bearing wash did not prove so large as was at first anticipated.

The largest mining venture in the alluvial drifts in this locality is that of the Arrow Tunnel Sluicing Company, hitherto mentioned in my previous report as Davis and Moody's Claim. This is one of the mining ventures that Sir Matthew Davis, of Melbourne, was interested in; and through the failure of the Mercantile Bank in Victoria all operations have been suspended in this claim for nearly twelve months. The tunnel is constructed for 950ft. through rock; it is 10ft. wide and 7ft. high, and paved with stones in the bottom—12in. pitching. Two shafts have been sunk at the upper end of the tunnel, and strongly timbered and made thoroughly secure, each shaft being provided with a gate so as to regulate the quantity of water going through the tunnel. Cranes and derricks are erected to lift these gates, and everything ready to commence working the bed of the Arrow River. At the time of my visit the creditors or mortgagees were taking steps to sell the property. This sale has recently taken place, Mr. J. Miller being the purchaser for about £1,510. It is expected that there is a large quantity of gold in the bed of the Arrow River above the head of this tunnel, as a slip has come down, and filled up the gorge with rocks of such dimensions that the water could not move them, and this caused for a time a dam in the bed of the river, which is now all filled up with shingle; and the rocks in the gorge from the slip referred to causes the place to be known by the name of the "Falls." In the early days, several parties tried to sink shafts through the accumulations of shingle, but were always driven out with water. It is therefore thought that, as the wash-drift in the bed of the river was very rich both below and above the Falls, there is every prospect of a good deal of gold being got when the accumulation of shingle is sluiced away that is now lying on the top on the original river-bed wash-drift. The present proprietor is a brother of the former manager for the company who commenced this work, and he has the utmost confidence in the venture that it will be brought to a successful issue.

There are several terraces on the range between the Arrow and Shotover Rivers, which are covered with auriferous drifts, some of which are partially worked when water is available, but in general their high elevation precludes sluicing operations from being carried on to any extent, as there are no streams of any dimensions where water can be taken from, unless by going to far more expense than individual miners could afford. Some three years ago, Davis, Moody and Company contemplated constructing a water-race from the Arrow River to work portions of the terraces referred to, but the magnitude of the undertaking and state of their finances made them abandon the project.

Shotover.

It can fairly be said that more gold has been taken out of the bed of the Shotover River than from any other river-bed in the colony, and there are still several very good claims along its banks and on the terraces. The river has now worn itself into a deep rocky gorge; but at one time the water was flowing at far higher levels, and has left a succession of terraces to mark its course. The auriferous gravel in some of these terraces is very rich, but in places there is a great depth of superincumbent drift to be removed before the rich auriferous layers are met with.

Davis Brothers' Claim.—This claim continues to give fair returns; but the great depth of drift there is to shift with little or no gold through it necessitates a good continuous supply of water to make the working remunerative. During last season, for about four months' work, it is said that 470oz. of gold was obtained. This may be considered a fair claim; but there is no doubt the claim is not so rich as many represent it to be, as one of the brothers has left it and taken a situation as manager of a company. This step would hardly be expected if the claim were very rich. A large amount of capital has been expended in construction of water-races and plant, and the proprietors deserve to be well recompensed for their outlay.

R. Johnston's Claim.—This claim continues to give its owner good returns for working; but he has a very inferior plant, and were it not that the ground is exceptionally good it would be a hard matter to make ends meet. He has not washed up his tail-race for the last two years, and does not intend doing so until until he has sluiced away all the ground that can be run away from the present channel. He is however satisfied, by what he gets about the head of the channel, that the ground is highly payable for working. He has a fair supply of water, and his claim will take him a lifetime to work out.

Londonderry Terrace Sluicing Company.—This is one of Messrs Davis and Moody's mining ventures, and to all appearances it will be a highly profitable one; but, unfortunately, the financial depression in Melbourne involved them to such an extent that they could not pay their creditors, and this property, as well as the one they held in the Arrow River, being mortgaged to persons residing in New Zealand, the mortgagee foreclosed, and both properties have recently been sold for a little over £3,000, one-half of which being for each claim—the purchaser being Mr. J. Miller, a brother of the former manager for Messrs. Davis and Moody. Both ventures are now in full working order, and have cost, up to the present time, over £16,000. Mr. Miller has, therefore, got a valuable property for less than one-fifth of the money expended in water-races, tail-races, and hydraulic plant. During last year, a large area of ground was worked on Burke's Terrace, but although there was a rich auriferous layer near the bottom, there was a great depth of top material that had no gold through it, consequently the ground only paid working expenses. They shifted the plant, and commenced working on Londonderry Terrace; but the result of the washing from this terrace was not made known. The present tail-race deposits the tailings in the bed of the Shotover River, directly below the bridge crossing to Skipper's Point, and in dry weather will be likely to fill up the bed of the Shotover River to a level with this bridge, which may probably be the means of its being carried away.

Aspinall's Claim.—This claim has been one of the richest in this locality. Some years ago the late Mr. Aspinall informed me that he had taken about 30,000oz. of gold out of it during the last thirty years, and it is estimated that it will yet take five years to work the ground out. This claim is now being worked by two sons of the late Mr. Aspinall; but they have very little water. In medium wet weather they get a small damful a day, which allows them to sluice for about an hour and a-half. During last season for six weeks' water they got about 73oz. of gold.

There are several parties working up the Shotover River above Skipper's Point. Some of them have been working in the same ground for many years, and are contented with their earnings. There are very few terraces where there is any gravel-drift that will not pay for working with water; but all the small streams in this locality are taken up. The ranges alongside the river, being very steep, the water quickly drains away, and there are no large watersheds to any of the creeks coming into the Shotover above Skipper's Creek; so that a good permanent supply of water is not to be got unless taken from the main river or its branches. But to lift the water from this source, and bring a supply at a high elevation, would involve a very large outlay such as no local party could afford to do. It seems astonishing to find the small quantity of ground that has been worked year after year on visiting some of the claims; yet the owners seem well satisfied with the returns. To take, for instance, the claims of A. Smith, and Monk and Gemmell's, at the Sandhills; there is very little difference in the appearance of the ground in the latter claim during the last eight years. The Upper Shotover is a place where a small mining population will find employment for many years, and be able to earn small wages.

Southland District.

Round Hill.

This is a locality from which a large quantity of gold has been taken. Some of the ground has been extremely rich; had it not been so it could not have supported the large mining population that have been there for the last twelve years. It is a field where there has been for the last ten years from thirty to fifty European miners employed besides a large number of Chinese. There

are, at the present time, about one hundred and seventy Chinese, and about four years ago there were about four hundred. There is a large area of auriferous ground yet to work in this locality; but the great difficulty is the scarcity of water on the field, which necessitates the claims being worked with a small supply. Indeed, there are few localities on the goldfields at the present time where claims could be made payable for working with the quantity of water used at Round Hill. With the exception of four small water-races, having a carrying capacity of six sluice-heads when water is available, the Round Hill Syndicate Company hold almost the whole of the water-rights and require the greater portion of the water to work their own claim. Indeed, it may be said, to work their ground advantageously, they require far more water than is at the present time brought on to the field.

With having a very limited supply of water, the number of Chinese miners have decreased considerably last year, some having left for other fields and some of them returned to their native land. From information supplied me by one of themselves, there are yet claims on this field that are paying £5 per man per week for working; but these only form a small proportion of the claims that are being worked. Many of the Chinese are working here for 25s. per man a week; and the ground must be good to even pay this amount, with the small quantity of water they have to work it and the intermittent supply. In many places there are two layers containing payable auriferous drift. The top layer was considered the only one for a long time; and some Europeans, after they thought that they had taken out the best of the ground, sold their claims to the Chinese, who brought up tail-races at a deeper level and got a far richer layer of auriferous gravel from 10ft. to 15ft. in depth below the bottom previously worked. Some of these claims, the Chinese acknowledged to me, were paying them a few years ago as high as £10 a man per week. However, this is now a thing of the past, and the time is not far distant when the whole of the available water will be absorbed by one company, which will no doubt use it in working their ground, if they find it more profitable to utilise the water in this way rather than sell it to the miners.

Round Hill Syndicate Company.—This company has worked a considerable area of ground since my last visit. They have shifted their plant recently a few chains higher up the flat, and commenced to open out a paddock with one elevator. In the place they were working in previously, the quantity of gold got less as they went into the terrace, owing, principally, to the extra depth of material above the wash-drift which had to be sent away. The manager of the company, Mr. Evans, states that the best ground is in the bed of the creek, which he proposes to work as soon as he gets his sludge-channel constructed for, say, a mile up the Ourawera Creek, to carry away some of the top sludge and sediment there is in the bed.

The place where the company are opening their present paddock has been all driven out in the early days of the field. The timber is all standing in position, and as sound as the day that it was put in, ten and twelve years ago. The timbering shows that the ground has been all carefully worked on the bottom layer of wash-drift, and since these workings have been abandoned the ground has been full of water, which accounts for the preservation of the timber. Even white-pine slabs are perfectly sound. Mr. Evans had only got down the elevator on the bottom and commenced to use the nozzle for bringing down the drift at the time of my visit; but he intends to erect another elevator with sluice-boxes and tables, as soon as the opening is sufficiently large. But the insufficient supply of water the company have will not allow their sluicing operations to be conducted on a larger scale; but even with the supply of available water, the manager informed me that he had obtained gold since he commenced operations to the value of about £5,000, and that the expense of working the ground and keeping the water-races in repair, did not amount to much more than £3,000, thus leaving about £2,000 profit; but this profit was absorbed in the construction of works which were chargeable to capital—such as the construction of the sludge-channel from the ocean beach, which is completed for a distance of 9 chains, and consists of two flumes made of timber, each 6ft. wide in the bottom, and laid side by side on one length of bottom-beams. These flumes are constructed on different gradients, the greatest being nearest the ocean beach, which is said to be 10 to 12 inches to the chain, and the least gradient at the upper end is 4 inches to the chain, which they propose to continue the channel on, provided this gradient will permit of the channel being constructed under the present railway bridge across the Ourawera Creek. This channel is not being constructed, as was originally intended, to sluice away the sludge and tailings in the bed of the creek, but it is more with the view of carrying the water, and preventing the bed of the creek from rising by the continual deposits of tailings and sludge, so that the bed of the creek can be worked with their hydraulic-elevating plant. The manager informed me that the bed of the creek, even in the early days of the field, could never be worked on account of the water there was to contend with; and he stated that the nearer the bed of the original creek they get, the gold increases in quantity. This seems a reasonable hypothesis, as there is little doubt if the original bed of the creek has never been worked, a large extent of valuable ground still remains untouched.

There are twelve different water-races on the field, which convey an average supply of about seventeen sluice-heads of water. Of this quantity, the Syndicate's water-races carry on an average about from twelve to thirteen sluice-heads; but in very dry weather this supply is considerably less. The result is, that there is only a very small supply for working two elevators, and, were it not for the fine material, a large quantity of which goes away in suspension with the water, they could not work more than one elevator. Surveys are completed for a water-race to bring in the water from the Pourakina and other creeks, which will be fifteen miles in length; and it is estimated to cost £8,000, which it is said will bring into another twenty sluice-heads. There is a water-race at present constructed, twelve miles in length, which the Syndicate purchased from Charles Port. They intend to widen this race and extend it for fifteen miles; but if it were extended for eight miles, the manager states it would tap creeks which would give them an additional ten sluice-heads of water. If this quantity of water can be depended on, and the estimate of the cost of construction correct, no time should be lost in getting this new water-race constructed, for it can never be expected by even the most sanguine shareholders, that the capacity of the present plant will enable the ground to be

worked to pay interest on the capital invested, which, up to the present time, is £13,000, including £7,000 in promoters' shares. The value of the promoters' interest was originally £19,800; but the original company was put in liquidation, and a new company formed, which took possession of the property from July, 1892, when the value of the promoters' shares was reduced to about the amount stated. But this syndicate is managed on the same lines as other English mining companies; that is, there is an annual expense of about £2,000 for directors' fees and office expenses, and which is in itself 10 per cent. on the actual money spent, including the value of promoters' shares, so that nothing short of extensive operations would ever give the other shareholders any interest on their capital. Taking the small area of ground already worked, and the quantity of gold obtained therefrom, with a good water-supply this company has a valuable property.

At the present time the elevator is supplied with water from a main pipe 13in. in diameter, and about one mile in length, having a head of 280ft. They use for the elevator a nozzle of 2¾in. in diameter, and a breaking-down nozzle of 1¾in. in diameter, which discharges about 6¾ sluice-heads of water; this means that the velocity of water in the main pipes exceeds 7ft. per second, and with this velocity the friction in the pipe is equal to at least 1·30ft. of head for every 100ft. in length of pipe. Taking it on this basis, the loss of the hydrostatic head equals about 69ft. of head that is absorbed in friction; therefore, taking the total head at 280—69, it leaves an actual hydrostatic head of only 211ft. If the syndicate work two elevators from one main they ought to have a pipe of at least 24in. in diameter. If it were conveying double the quantity of the present water used, namely 13·5 sluice-heads, the velocity would be about 4·3ft. per second, and the head absorbed by friction would be about 32ft., or 37ft. more than at the present time; this would be equal to an additional head of water on each elevator, as will be seen in analyzing the result. Taking 6¾ heads with a hydrostatic head of 211ft., it gives a force of 5,340,937 foot pounds per minute, and the same quantity, with a head of 248ft., gives a force of 6,277,500 foot pounds, being a difference of 936,563 foot pounds; and as one sluice-head of water with a hydrostatic head of 248ft. gives a force of 925,040 pounds per minute, it is clear that the saving by using the larger pipe would be equal to a little over an additional sluice-head of water. The larger the main supply-pipe the better results will be obtained, but, as a general rule, the velocity in the supply-pipe should not exceed about 4ft. per second. Where the main supply-pipes are a considerable length the first cost is a great item, but this will soon be recouped by the extra amount of work that can be done by having pipes of a sufficient diameter in the first instance. The Round Hill Syndicate Company are not the only ones in the colony who have laid down too small pipes at first. The generality of miners are apt to do the same thing, on account of the expense; but after using the pipes the mistake is soon acknowledged, and endeavours made to get larger ones, having a sufficient carrying capacity.

In wet weather, or when the syndicate cannot use their water, they sell it to the miners at the rate of 15s. per week for a quantity that will pass over a notch 8in. long by 1in. deep. With such a supply as this, it must be extremely good sluicing-ground for men to be able to pay for their food and clothes, without their being able to earn wages. Almost each party of miners have a small dam where they store the water, which allows them to carry on sluicing operations on a very small scale for two or three hours per day.

Wilson's River.

The alluvial workings opened up in this locality have been as yet confined to the bed of Wilson's River, Sealers' Creek No. 2, and the terraces alongside Sealers' Creek. At the time of my visit it was estimated that there were altogether about 200 miners on the mainland and on Coal Island, the greater portion of these being at work in the bed of Wilson's River. The gold in this river-bed is found principally in the joints and crevices of the rock, having very little gold in the gravel-wash laying on the bottom. The tide comes up this river for about a mile and a half, and the bed has been worked as far down the river as the tide would admit, and for about four miles up the stream. The whole of the gold obtained from the alluvial workings here is extremely porous, and intermixed with particles of quartz, the edges in many instances being sharp, thus showing that it had not been carried any great distance by the stream. The character of the gold is coarse, and in some instances 2oz. nuggets have been found.

There has been gold found in the river-bed as far up as it has been worked; but that found above the place the prospectors' reef crosses the river is far more rounded and flattened than that found below; at the same time there are particles of quartz adhering to it. This shows that the particles of gold came down the river from another source than the reef referred to. The country is of such a broken character, that the great difficulty in getting a supply of provisions for inland is necessarily a great drawback to prospecting in this part of the colony. Had it not been for the surveyed line of road, which induced miners to prospect inland, nothing would probably have yet been known about the auriferous character of the country in this direction.

At Sealers' Creek the gold is similar in character to that found in Wilson's River, being all extremely porous, having particles of quartz attached. The gold found in this locality appears to have come from no great distance, and in all probability a rich lode will be found in this vicinity. Several very rich quartz specimens have been found amongst the wash-drift.

At Coal Island there are about twelve miners, all of whom are working in the beds of the small creeks and streams, and said to be doing fairly well. But to take the district altogether, the miners are not making wages, owing to the wet climate, and the floods in the creeks and streams where they are working, which in many cases only admits of work being carried on for a few days in the month. Even the best claim on Wilson's River is said not to have paid more than £3 10s. per week for the whole of the time it has been held; and there are many claims which have not given the owners £1 10s. per week. When it is taken into consideration that the cost of packing provisions from Preservation Inlet is £1 per hundredweight, and that it is very seldom that fresh beef and mutton can be got, and that the climate is extremely moist, men require to be making a good livelihood to stay.

There is now a pack-track constructed from the Lighthouse Store landing at Preservation Inlet to Wilson's River, a distance of seven miles; but this road is of very little use to those living in the vicinity of the quartz-reefs. The store where the miners get their provisions from is about four miles up from the mouth of the inlet, and they have to carry them on their backs over a very steep and muddy track for a distance of about four miles, or else pay some one else to bring them to their tents and huts. A visit to this field reminds a person of the early days of the goldfields. At the time of my visit there were two publicans' licenses issued, but there was no accommodation to be had but a shakedown on the floor; but no doubt this will soon be remedied, as builldings were being erected at the new surveyed Township of Cromarty, which is about four miles further up the inlet than the place where the store is at present.

DREDGING.

There are now a large number of dredges at work in connection with gold-mining, and, although they have not yet proved so remunerative as was at first anticipated, they must be acknowledged as successful machines for working ground of a comparatively shallow depth, where there is a large quantity of water to contend with, or for working the beds of rivers. As far as lifting the material is concerned, they are all that can be desired; but the same cannot be said in regard to gold-saving appliances in connection with them. But it is only a question of time when dredging machines will be perfected to such an extent that they will not only lift larger quantities of material, but the appliances in connection with them will be capable of extracting a fair percentage of the gold. It was considered by many, when the dredges were first introduced on the West Coast beaches, that they would open up a new era in gold-mining; but, unfortunately, the whole of the dredges which were erected on the ocean beaches of the West Coast have all proved failures. These failures are due entirely to the class of machines that were erected, and by those in charge of them not being sufficiently acquainted with the mode of working. The whole of the ocean beaches on the West Coast are less or more auriferous, and large quantities of gold have been obtained from them, and they still continue to afford remunerative employment to a considerable number of miners in collecting the golden sand and washing it in the ordinary way. The time will come when dredges will be again placed on many of these beaches, and made remunerative ventures. It seems strange tha men can strip the ground by manual labour, washing the auriferous layers of sand, and make wages, when dredges which can shift in an hour about as much as eight men could do in a day, cannot be made remunerative for working. And yet the whole of the expense in connection with working them does not exceed £50 per week when they are working continuously day and night; and this is only wages for about seventeen men. The secret of this, however, is well understood by those acquainted with the method of beach-combing. The machines are made to lift the sand at the bow and deposit it at the stern, without extracting scarcely any of the gold. This was amply shown at the Saltwater Beach, where a Welman dredge was at work in a lagoon, where after working for some time, they could not get sufficient gold to pay working expenses, and therefore suspended operations. After a while this lagoon broke out and left the dredge high and dry, and some miners went out to the place where it was working and obtained a considerable quantity of gold.

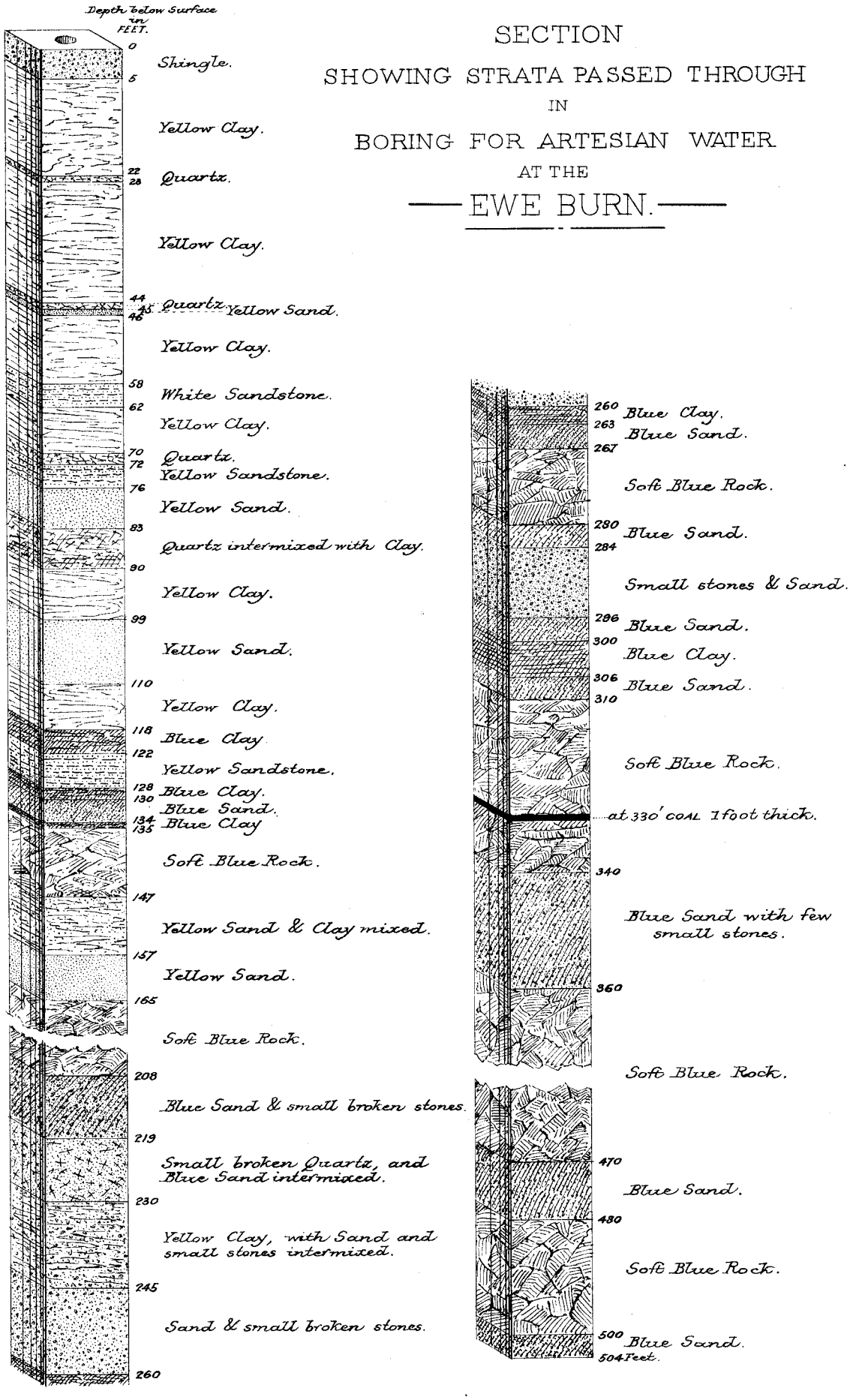
It may truly be said that the dredges that have been erected on the whole of the Southern beaches have been on ground that should be made to give good returns if the washing appliances were constructed in a proper manner to deal with the quantity of material that the dredges are capable of lifting. Both Gillespie's and the Five-mile Beach are two of the richest beaches on the West Coast, and ought to be made to yield excellent returns by working them with these machines. It is found that the working expenses of the dredges for the quantity of material lifted is not more than the expense of working ground with a hydraulic elevator. They should, therefore, be made much more remunerative ventures than they hitherto have been.

West Coast.

Taylor Dredging Company.—The ground where this company is working is situate about three miles north of Greymouth, on an old beach lead that was partially worked in the early days of the West Coast. Mr. Joseph Taylor commenced first to work a Priestman elevator, and he afterwards had a dredge with a cataract pump erected; but this proved a failure, and the Priestman grab was again resorted to. About two years ago this venture was floated into a registered company, who have been carrying on the working with the Priestman dredge, and using the cataract pump to drain the ground. It has not transpired what amount of gold is being obtained from this claim, but the inference is that it is payable for working.

Alexandra Dredge.—This dredge is working on the Buller River at Fern Flat. The pontoon which carries the dredging appliances is 80ft. long, with a beam of 20ft., but the weight of the steam-boiler and machinery has sunk the pontoon that it has only about a foot of free-board on the front end. When there is a slight fresh in the river and heavy current, the water washes over the front portion. The after-portion of the hull, where the engines and boiler are, is raised on the sides about 4ft. higher than the front or bow end. It is an ordinary centre-bucket dredger, having a ladder capable of dredging about 15ft. below water-level, and the tumbler-shaft is about 15ft. above water-level. The dredged material is dumped from the buckets on to a chute lined with iron rails, and from this hopper-chute there is another leading over the stern of the dredge, which is 2ft. 4in. wide in the bottom, and set on an inclination of about 4in. to 1 foot. This chute is fitted with cast-iron ripples placed crosswise in the chute. At 10ft. from the head, the bottom is covered with perforated iron plate, which allows the fine material to pass through into a box placed underneath the chute at right-angles. This leads the fine material on to four small tables, which are covered with cocoanut matting. There is likewise a grizzly, placed in the main chute near the bottom end, and the fine

SECTION
SHOWING STRATA PASSED THROUGH
IN
BORING FOR ARTESIAN WATER
AT THE
EWE BURN.



C.H. Pierard. del.

material led on to six small tables, about 20in. wide and 2ft. long, which are also covered with cocoanut matting. The whole of the table surface for saving the gold on this dredge is about 45 square feet.

The dredging engine is of compound type, having the high-pressure cylinder 9in. in diameter, and the low-pressure one 15in., the stroke of the piston being 20in. The engine for working the centrifugal pump, which has a disc of about 3ft. 6in., has cylinders of 7in. and 11in. respectively, with a piston-stroke of 16in., and travelling at the rate of 440ft. per minute, and the engineer informed me that it required a pressure of 90lbs. per square inch in the boiler to work the engines at this speed, with the steam cut off at five-eighths of the stroke, which shows that this large centrifugal pump, in order to raise about three sluice-heads of water 16ft. high, requires about eighty theoretical horse-power to work it. The engines are supplied with steam from a multitubular boiler, 15ft. long, and 5ft. in diameter, set in brickwork inside the hull of the pontoon, and fired below.

The washing appliances on this dredge are certainly the worst that has come under my notice, and yet with all this they can get about 36oz. of gold per week. The gold here is said to be scaly, with a good deal of it in fine particles; at the same time there is a good deal of heavy gold, some pieces of 6dwt. having been obtained. Were it not that there is a good deal of heavy gold, this company could not carry on dredging operations with the present washing appliances. There is a large quantity of big stones in the wash-drift, and these are raked down the sluice from the hopper and pass over the stern. Some of these boulders are so large that they stick firm in the ladder, and cause the friction-wheel on the vertical shaft to slip, until the stone is removed. One thing is certain, if there is much fine gold in the wash-drift, the most of it will be again deposited in the river at the stern of the dredge.

Taking the hull of this dredge, there has been so many alterations made since this dredge was first constructed, and additional weight placed on the punt carrying the dredging appliances, that the present depth of the punt does not leave sufficient margin of safety for men to be on this dredge during a heavy flood in the river.

Matakitaki Dredge.—This dredge is placed in the Matakitaki River, about five miles above its junction with the Buller. At the time of my visit to this locality this dredge was being strengthened, the framing and ladder being too light for dredging the bed of the Matakitaki River, where there is a large quantity of stones and boulders. It is said the wash-drift contains a fair amount of gold, and, if the dredge is made strong enough to work the ground, it ought to be made a profitable speculation for those interested in it. Information has subsequently reached me to the effect that the dredge is now working satisfactorily, and that fair returns are being obtained.

Otago District.

Waipori.

There are three dredges at work on Waipori Flat—namely, two belonging to the Waipori Gold Dredging Company, and one belonging to the Jutland Company. One of the dredges belonging to the Waipori Company was purchased from the Golden Bar Company, at the junction of the Shotover and Kawarau Rivers. The manager of the company states that this dredge is too small to work the ground on Waipori Flat economically. The hull is 75ft. long, with 18ft. of beam, and can dredge to a depth of about 22ft. The dredging-buckets have a capacity of 2¼ cubic feet each, and, when they are working at full speed, they dredge at the rate of fourteen buckets per minute. At the time of my visit they were dredging on a lignite bottom, the wash-drift being quartz gravel, with very few large stones.

The dredged material is lifted to a height of 16ft. above the deck, and dumped into a hopper which leads into a revolving screen having longitudinal bars 2in. wide and ⅝in. between. The coarse material passes through the centre of the revolving screen into a sluice which is 32ft. in length and 3ft. in width, fitted with iron riffles; the fine stuff passing through the slots into a box, which distributes the material on to tables set at right angles to the revolving-screen, and covered with cocoanut matting. There are five tables at each side, each 2ft. 6in. wide and 10ft. long. These tables empty into another longitudinal sluice, fitted with iron riffles, the sluice being 36ft. long and 3ft. in width. The centre sluice has a fall of 15in. to 12ft. and the side sluices have a fall of 12in. to 12ft. The washing appliances, although far from perfect, are much improved since dredging was first used as a means of obtaining gold from alluvial drifts. The separation of the stones and shingle from the sand is fairly well carried out, and the fine material coming through the revolving screen is very well distributed over the tables; but the quantity of material passing over these tables is far too great for their capacity as gold-collectors. When a large quantity of material has to be sent over the tables it requires the volume of water to be in proportion, and fine flaked gold has not much chance of being caught on the cocoanut matting. For these tables to act as good gold-savers the material must pass over them in a very thin film, and with as little water as possible, in order to keep them clear. Taking the capacity of each bucket to be 2¼ cubic feet, and that they come up two-thirds full, and fourteen buckets per minute, the average quantity of material lifted would be 46 cubic yards per hour, and the surface-area of the tables to save the gold from this quantity of material is 250 square feet. This may seem a tolerably large surface-area of tables, but the length of tables has not nearly so much to do with saving gold as their width, as, for instance, a table 6ft. wide and 42ft. long would have a surface-area of 252 square feet; but as the whole of the material would have to be confined to a width of 6ft., the material would have to pass over in seven times as thick a film as it would do were the tables 42ft. wide and 6ft. long, and therefore far more gold would be got by the tables being wider. The revolving screen used on this dredge is about 12ft. in length, and 3ft. or 3ft. 6in. in diameter, having ⅝in. perforated holes for allowing the fine material to get through, and it revolves at the rate of eight revolutions per minute. In order to distribute the material evenly on the tables there is a longitudinal box placed underneath the revolving-screen, and to get all the material from the screen

to fall in the centre of this box, there is a plate of sheet-iron bent into the segment of a circle and placed on the side of the screen against its revolving motion. As most of the material comes out of the screen on this side, the segment of iron plate shoots it down to the centre of the distributing-box, and by this means it is evenly distributed over the tables on both sides of the screen.

The dredging appliances are worked by a compound steam-engine having cylinders of 8½in. and 16in. in diameter respectively, with a stroke of 17in., making 104 revolutions per minute, the steam being cut off at half the stroke; and the minimum pressure of steam in boiler that is capable of driving the engine to its proper speed is said by the company's engineer to be 50lb. per square inch. This means that the average pressure of steam on the piston of the high-pressure engine is 42lb. per square inch, and, taking the low-pressure cylinder to be equal in power to the high-pressure one, then the engines are developing 42½-horse power theoretically. The actual horse-power required to lift 45 cubic yards of gravel per hour, from a depth of 22ft. under water to a height of 18ft. above water-level, and disregarding the difference in weight of shingle under water-level, is equal to only a little over 4-horse power theoretically; so that it will be seen that there is a very large amount of power absorbed by friction in dredging.

This company has also another dredge at work a little further down the flat, the hull of which is 93ft. long, having a beam of 18ft. The dredging-buckets have a capacity of 3½ cubic feet each, and dredge to a depth of 22ft., and when going full speed lift fourteen buckets per minute. There is no revolving-screen on this dredge. The material, after being dumped into the hopper, passes into a centre sluice, in which there is a grizzly placed, having bars 6ft. in length and placed ¼in. apart. Underneath this grizzly is a distributing-box, from which the fine material passes on to tables 12ft. wide and 9ft. long, covered with cocoanut matting, and from these tables the material passes into side sluices. The centre sluice is 4ft. 2in. in width and 64ft. in length, and the side sluices are 3ft. wide and 54ft. long. This dredge cost £3,370, while the upper one only cost £2,472; but, being of a larger capacity, it pays the company much better than the smaller dredge. The average quantity of material dredged per week by the larger dredge is 8,000 cubic yards, and the average quantity of gold obtained is 24oz., being at the rate of 1·44gr. of gold per cubic yard. The average quantity lifted by the smaller dredge is 5,000 cubic yards per week, giving an average of 15oz. 7dwt. of gold, which is equal to 1·47gr. of gold per cubic yard; there being six men and three boys employed on each of those dredges. The expense of working is nearly the same, but the extra quantity of material operated on by the larger dredge gives 8oz. 13dwt. more of gold per week, and consequently proves more remunerative for working. The company at the time of my visit were thinking of suspending operations with the small dredge. During the year ending the 31st March last, it is said that this company obtained about 1,495oz. of gold, which would represent a value of £5,793.

Jutland Flat Company.—This company has one of the most complete dredges there is at work in the colony, as far as lifting the material and machinery is concerned; but in regard to gold-saving, the appliances are equally as defective as in any of the others. Every manager of a dredge seems to be under the impression that he is saving the gold, and that all he is losing is harmless. On one of my visits to Sew Hoy Company's dredges on the Big Beach, on the Shotover River, the manager was confident that he was saving a very large percentage of the gold, and yet the same dredge actually worked the same ground twice and three times over, and got equally as large returns of gold for working it on each operation. The loss of gold in some of the dredging operations is simply appalling. The auriferous material is lifted, and rushed through the sluices, and again deposited at the stern of the dredge, and in all probability will be worked over again at a profit.

The hull of this dredge is 80ft. long, with a beam of 20ft., having the dredging-buckets with a capacity of 3½ cubic feet each. They dredge to a depth of 18ft. under water, and lift about 23ft. above the water-level, and travel at the rate of eleven buckets per minute. The dredged material is dumped into a hopper and passes into a sluice-box 4ft. in width, having a division in the centre, forming as it were two sluices each 2ft. wide and 58ft. in length. At the stern of the dredge there is a grizzly in the sluice 10ft. in length, with the bars of spring-steel, placed crosswise in the box, and ⅜in. apart. The fine material coming through the grizzly falls into a distributing-box, and thence passes over return tables 5ft. wide and 12ft. long. The water for washing purposes is supplied by a centrifugal pump having a runner or disc of 18in. in diameter, which is driven at a speed of 660 revolutions per minute, and is estimated to be lifting 2,000 gallons of water—5⅓ sluice-heads—to a height of 17ft. 6in. The winches for working the ropes and anchor-chains are very compact, and still have plenty of room to effect any repairs. The engines and the whole of the machinery are kept in excellent order, which reflects the highest credit on those in charge. There is a large area of ground already dredged, and looks on the surface as though a large amount of trenching had been done. The company have constructed a dam in the centre of the river to prevent the tailings from being washed down by the stream; in fact, every care seems to be taken to work the ground without damaging those below them. This company's dredge is working ground about thirty chains up the river-flat from the township, while the Waipori Company are working about half a mile below the township. The total quantity of gold obtained by this company last year is said to be 1,281oz., representing a value of £4,964.

Clutha Valley.

Most of the dredges on the Clutha River have done fairly well last year. The current-wheel dredges will shortly be a thing of the past, as they are being supplanted by steam-dredges. One would think that the current-wheel dredge would be more economical to work than a dredge worked by steam; but this would only apply when the dredge is placed and working in the centre of the stream. Indeed, current wheel-dredges are only suitable for working in places where the current of the river is strong. They are not adapted for working near the beaches and in eddies, and it is generally in these places where the best of the auriferous gravel-drift is found. The early-

constructed dredges were not built to dredge at a great depth, nor were they required to do so when they were first placed upon the river. But the bed of the river is getting gradually filled up with gravel, which is continually travelling down with the current; so that, the depth of drift at the present time to lift before getting at the best portion of the auriferous wash is fully 9ft. more than it was when dredging first commenced on the river.

Between the bridge crossing the Clutha River near the Beaumont and Coal Creek, at the head of the flat above Roxburgh, there are ten dredges worked by steam and one worked by a current-wheel, representing a value of about £25,000. Five of these dredges are owned by private individuals, and six of them by companies, and there are about sixty-five men continually employed on them. The following is a tabulated statement which gives some idea of the dredging results in this locality for the last year:—

Name of Company or Owner.	Locality at Work.	Quantity of Gold obtained Last Year.	Remarks.
		Oz.	...
Golden Run	Island Block ...	999	...
Miller's Creek	Miller's Flat ...	698	...
Ettrick...	...	490	
J. Dewar and party ...	...	Not known.	Small wages. 5oz. to 6oz. of gold a week.
Roxburgh	Roxburgh... ...	555	
Dunedin	Coal Creek ...	922	
Pringle and party ...	Between Island Block and head of Miller's Flat	Not known.	Gives fair wages to the shareholders.
Bennett and party ...		"	Paying very well.
Brazil and party		"	Gives an average of £5 per week to each of the shareholders.
Aitken and party... ...		"	Paying small wages.

The Golden Run Company paid the shareholders, from the proceeds of five months' operations, dividends to the extent of 8s. per share, besides clearing off the whole of their liabilities. The Roxburgh Company have cleared off their liabilities, and paid a dividend of 1s per share.

Some of the dredges higher up the river have given good returns. Mr. Garde got something like 30oz. of gold per week from his steam- and current-wheel dredges, which leaves him a handsome profit for the capital he has invested. The pneumatic dredge which was erected below Alexandra, in the gorge of the Clutha, by a syndicate of Melbourne gentlemen, proved a failure, and they let it to a party of tributers, who shifted it higher up the river and succeeded in getting very good returns. It was thought that this dredge could be made to work amongst the boulders in the gorge where bucket-dredges could not be placed.

Spencer and party have purchased the steam-dredge formerly belonging to the Kawarau Big Beach Company, and removed it to their special river claim below Clyde, at a cost, it is said, of about £2,000. This is about one-half its original cost, and they are now commencing to work it.

Hyde and party purchased the dredge belonging to the Frankton Beach Company for £400, and removed it, at a cost of £200 for carriage, to the Clutha River at Clyde, where they were erecting it at the time of my visit, and expected to have it completed at a total cost of about £2,000. This party lowered the framing supporting the dredging tumbler, so as to have less top leverage, but they have destroyed to a great extent the space for gold-saving appliances; but this is held by a great many persons connected with dredges to be of only secondary importance. It seems to be a question of lifting the material and to rush it through, taking chance whether a large percentage of the gold is saved or not; and wherever this is done the auriferous gravel is lifted at the bow of the dredge and deposited again at the stern, with only a small percentage of the gold extracted from it. It is simply an impossibility to rush a great body of auriferous gravel through a narrow sluice with a large quantity of water, and save a fair percentage of the gold it contains; and this applies with greater force to the auriferous drifts found in river-beds, where the gravel and particles of gold have been rolled and knocked about together until the gold is in minute particles and in very thin flakes. It is the mistake that is made on all the dredges, that there is not sufficient washing-surface where the gold is in fine, minute particles. The material requires to go over the surface of the gold-saving appliances in a very thin film, having all the stones and shingle separated from the sand before the material is allowed to pass over the gold-saving tables.

Both Spencer and party and Hyde and party have got their dredges very cheaply, but it remains to be seen whether they will in future be worked with success. The failure of these dredges heretofore has been in their gold-saving appliances. They could lift large quantities of material, but only to deposit it again at the stern of the dredge with very little of the gold extracted. It is reported that Hyde and party, since commencing to work, have got about 20oz. of gold per week, which should give the shareholders good returns for the capital they have invested.

A great many are now turning their attention to dredging the beds of rivers, and the results of the dredging operations every year go to prove that this principle of working auriferous drifts will be used greatly in the future. Many of the defects of the early dredges have been remedied, and further improvements are being made every year; and, although the appliances are yet far from being perfect, dredging, as applied to gold-mining, is further advanced in New Zealand than in any other country in the world, and it is to be hoped that it will continue to maintain this prestige.

Shotover.

The principal dredging operations in this locality is carried on by the Sew Hoy Company, at the Big Beach and at Arthur's Point. This company has had three steam-dredges continuously at work last year, with very good results. When these dredges were first constructed it was found necessary to make a great many alterations in the washing appliances before they were got to work satisfactorily. In my last report it was mentioned that Mr. Gore, of Dunedin, one of the directors, was constructing a shaking-table, to separate the stones and shingle from the sand. The shaking-table was said to work very well, and attain the end for which it was constructed; but the wear-and-tear on it was considerable, and its use was discontinued. This company have been getting fairly good returns during last year, and have paid several dividends to the shareholders.

Sandhills Company.—This is the only dredge in the colony which is worked by electricity. It has now been at work for about two years, but the result of the dredging operations has not, so far, been encouraging. When they commenced dredging operations first the dredge was down the river about a mile and a half from the house where the electric generators were placed, and the current was carried from the generators to the dredge by a small copper wire suspended on poles; but on my recent visit the dredge had worked a channel up the bed of the river to above the place where the generators are placed. Some of the old miners in the district attribute the failure of this company to their persistently following up the centre of the stream, and not working the shallow beaches on the sides. The river-bed is a considerable width where this dredge is placed, and it is said that very rich gold was got on and near the beaches, but that on these beaches, although only having a comparatively small depth of drift gravel, the ground was so porous that the water came in so fast when trying to work the ground by paddocking that the gold could not be obtained. A spoon-dredge was afterwards worked on these beaches with success. The place where the dredge is now working is likely to prove remunerative, and, if so, there is a large extent of river-bed ahead of it where there has been very little working done since the early days. The working-expenses in connection with this dredge, including wear-and-tear, is said not to exceed £35 per week, which is equal to the value of about 9oz. of gold. The high elevation of the bed of the Shotover at this place, and having their water-supply for driving the generators at a further elevation of about 550ft., there is always a few months in the year that dredging operations cannot be carried on, owing to the severe frost, which cuts off the water-supply entirely.

ARTESIAN WELL BORING, MANIOTOTO PLAINS.

Although the boring at Eweburn has not been successful in striking an artesian water-supply, it is interesting to know the different strata gone through. A diagram showing this is annexed hereto, which shows the different strata to a depth of 504ft. Recently, however, on my examination of this bore, which is now down 575ft., small rounded quartz-pebbles were being forced up the bore by the pressure of water from the force-pump used; and on washing a prospect on a shovel, the material from the bore-hole at the depth mentioned, a comparatively large speck of gold was obtained, thus showing that there is auriferous drift at a depth of 575ft. below the surface, and that probably it belongs to the same description of drift as that found in St. Bathan's basin and at Matakanui and Tinkers'. So long as the bore is on alluvial-drift there is still a probability of a porous stratum being found, where water may yet be got. The contractor had on the 16th of June last, which was the date of my visit, still 75ft. to bore to complete his contract. The probabilities of getting a flowing well are, however, now very remote.

GEOLOGICAL EXPLORATIONS OF THE NORTHERN PART OF WESTLAND.

By Alexander McKay, F.G.S., Mining Geologist.

Last year, in conjunction with Messrs. Gordon and Gow, I visited the northern part of the Westland District of the South Island, with the object of determining the site of a prospecting-shaft intended to prove the deeper ground of Larrikin's Flat, near Kumara. At the same time, in company of Mr. Gordon, I had an opportunity of examining some parts of the Greenstone Valley, and saw several of the more extensive gold-workings that are being or have been carried on in that part of the district. We also together visited Ross and its neighbourhood, and examined the Cedar Creek reefs, on the eastern slope of Mount Greenland. With Mr. Gow, I examined the Teremakau Valley as far as Jackson's; and I had also the opportunity of seeing various places of interest in the nearer vicinity of Kumara. Subsequently I reported on the main subject, and principal object of my visit to Westland. This report was in due course published; but in the course of the different examinations and investigations it was deemed necessary to make in connection with the correct placing of the prospecting-shaft, much general geology had to be discussed between Mr. Gordon and myself, which to many might appear to have no very direct connection with the end and object of our deliberations. In my report I therefore but barely touched on the subject of the general geology of the northern part of the Westland District; but afterwards, in a further report addressed to the Director of the New Zealand Geological Survey, this subject was dealt with at some length. At the time of writing this, my actual knowledge of the geology of the district dealt with was somewhat circumscribed, and the results were those common to an imperfect knowledge of the subject dealt with. I had previously, in 1875–76, accompanied Mr. Cox, late Assistant-Geologist, on a geological expedition from the northern to the southern limits of the County of Westland, and the information thus acquired, together with what I drew from the writings of Hochstetter, Haast, Hector, and Hutton, the "Handbook of New Zealand Mines," and other sources, enabled me to draw up a general account of the geology of the northern part of Westland. This was printed in the volume of reports published by the Geological Department for the year 1891–92, but in the meantime I had again been directed to make a more extended examination, especially towards the east, in the more mountainous parts of the district. This work has been effected as

far as a very unfavourable season for exploring the rougher and back parts of the country would admit of, with the result that, while the previous report may be said to be generally fairly correct in certain particulars, statements purporting to be based upon facts require to be corrected, and speculations based upon these require to be modified. The work of the present season being much impeded by unseasonable weather about the end of January, I abandoned the mountainous parts of the district altogether, and for the remainder of the season confined my examinations to the low grounds between the borders of the mountain country and the sea coast. I had thus the opportunity of examining at many places the drifts that have been or are being worked for gold, and at the same time of securing a large number of photographic views, illustrating the methods of gold-mining now being pursued on this part of the West Coast, and at the same time I obtained a large series illustrating matters of pure geology, the scenery, and physical peculiarities of the district. These, it is hoped, will be made available for the purposes of this report, as very many of them have been taken with this special object in view; but it is questionable whether press of work in the photo-lithographic department will admit of the number being reproduced which it was intended should illustrate this report.

On the 2nd November I received the following instructions:—

"Colonial Museum of New Zealand, Wellington, 1st November, 1892.

"Mr. McKay, Assistant Geologist.

"The Hon. Minister of Mines desires me to instruct you to proceed as soon as possible to explore the country about the Upper Arahura and Hokitika Rivers, with the view of discovering any auriferous or any other metalliferous deposits that occur there.

"Special instructions and maps will be provided for your guidance.

"James Hector, Director."

"*Memorandum of Instructions for Mr. McKay.*—With reference to my letter of yesterday, I now furnish the following special instructions for your guidance: You will proceed by way of Arthur's Pass, in order that you may have an opportunity of revising the section which displays the general structure of that part of the Southern Alps, as the stratigraphical position of the auriferous rocks on the west slope has yet to be decided.

"The late Sir Julius von Haast adopted the view that there is a distinct Westland formation, but did not define its relations to the older metamorphic rocks of the same district. But in the Reefton District the facts observed indicate that there has been a mineral, and particularly an auriferous impregnation of the argillite sandstones that are younger than the fossiliferous Devonian strata in the district.

From this it is probable that synclinal inclusions of upper Palæozoic formations may occur along the western flanks of Alps which have been subjected to chemical, mechanical, and metamorphic action, and which, having originally included "tufaceous" deposits of igneous matter, have now developed masses of the same hydrated magnesian rocks that characterize the mineral belt of Nelson District.

"This view is, of course, opposed to that which supposes the outcrop of a formation along the western flanks of the Alps older than the Te Anau series, and younger than the metamorphic rocks represented by the granites and mica-schists of the same district.

"It is therefore desirable that you should commence with a thorough examination of the Mount Torlesse formation in its typical locality, and especially by a careful scrutiny and collection from the strata which carry the obscure fossil plants and annelid casts which are usually quoted as characteristic of this formation, and which have also been found on the western flanks of the Alps. In passing, your attention should be given to the verification of the theory that the inclusion of the Trelissick Cretaceo-tertiary basin has been due to faulting, and probably some new and important information bearing on this point may be obtainable from the sections on the New Zealand Midland Railway line along the valley of the Waimakariri below the Cass.

"The section in the upper part of the Waimakariri, above the Bealey Ford, should also be examined, and compared with that occurring at Arthur's Pass, so that the section can be continued westward; not only to the auriferous rocks at Taipo, but also directly towards the headwaters of the Arahura and Hokitika Rivers, where your special exploration is to be made.

"After reaching the West Coast, your best course will be to explore the up-rivers into the heart of the range in a deliberate manner, establishing camps at convenient distances to enable you to make a thorough examination of the structure of the country, and above all things to avoid being cut off from communication.

"You will also, as hitherto, keep full notes of your observations in the form of a daily journal, and collect, as largely as circumstances will permit, specimens of rocks and minerals, and fossils for future reference and study.

"If the weather is suitable, it would be advisable to re-cross the Alps by Whitcombe's Pass.

"James Hector,
"Director of New Zealand Geological Survey."

On receipt of these instructions I made preparations for the trip, and on the 9th November I went to Christchurch, and thence to Springfield and Castle Hill stations, from which places I made the necessary examinations of the Mount Torlesse Range and the Trelissic Basin.

After having examined the coal seams in the lower valley of the Broken River, I went by coach to the Bealey, where I remained for two days, examining the strata in various directions; and the following coach-day I crossed Arthur's Pass to the foot of Otira Gorge, where I waited the arrival of the next coach from Springfield, meantime making such examinations as might further my work in other parts of the district to be examined.

On the 23rd November I arrived at Kumara, and, after a few days spent in necessary preparation, the exploration of the Arahura Valley was begun, and continued till the 12th December without any important discovery being made. This was owing to the prevalence of wet weather, which, especially amongst the mountains, proved exceedingly stormy and unseasonable.

Between the 14th and the 24th December, work was confined to the low grounds, in the hope that after the new year the weather in the mountain region would improve. January and February are usually regarded as fine months for the purpose I had on hand; therefore, early in January a start was again made for the Upper or second Gorge of the Arahura River, but the weather proved no better than during the earlier part of the season, and much time was lost on this account. Up till 6th February, out of thirty-four days spent amongst the mountains, only four could be said to be other than wet days. The magnesian rocks and mineral belt which crosses the Arahura Valley about the middle of the second gorge is better explored on the north than on the south side of the river; as on the north side, if the river was at all high, there would be no escape by way of the mountains; and thus only once, and then at considerable risk, was this part examined. The chief explorations were on the south side of the valley as far as the Styx Saddle, leading from the Upper Arahura into the valley of the Browning River, along the western base of Mount Sale.

Subsequent to the 8th February I made examinations of the country north of the lower part of the Arahura Valley, including the valley of the Waimea River, and in the opposite direction the middle part of the Three-mile Creek; and from Kanieri Township, the Kanieri Valley to Kanieri Lake. The Kokatahi Plain, Hokitika Gorge, Rimu, Back Creek, and Ross were also visited. Also during the latter part of the season, examinations, mainly in connection with the classification of the various auriferous drifts, were made in the vicinity of Kumara, in the Greenstone Valley, and along the southern shore of Lake Brunner, and more to the north as far as New River and Marsden. I was thus occupied till the 12th March. In the meantime, my guide and assistant, Richard A. Harcourt, made another attempt to reach the mineral belt on the north side of the second gorge of the Arahura, and this time by crossing the mountains forming the Mica-schist Range east of Turiwhate and Island Hill. In this work he was accompanied by John Olderog, who also was with me during the early part of the season. The attempt failed, owing to the exceedingly rough and precipitous character of the mountains that had to be passed before reaching the line of the mineral belt. Finally, they were driven back by bad weather, but not before it was evidently impossible to reach the mineral belt by this route.

It was now quite evident that the season throughout was likely to prove unfavourable for prospecting the higher mountains towards the main water divide, and I determined to make no further attempt in that direction. It was necessary, however, that I should have some knowledge of the upper valley of the Teremakau, and between the 16th and 20th March this work was accomplished. On the 22nd I left the Kumara District, and, sailing from Greymouth on the 23rd, arrived at Wellington on the 25th March.

Physical Aspect and General Geological Structure of the District Examined.

District East of the Main Range.—The Provincial District of Canterbury, not including Westland, consists of the eastern slopes of the Southern Alps, and the lower grounds of the Canterbury Plain. Between the Rakaia and Waimakariri Valleys, rocks of Cretaceous age form the lower slopes of the Malvern Hills, and to the eastward disappear below the gravels of the alluvial plain. The lesser mountains of the Malvern Hills are formed of strata of Middle and Older Secondary date, while the Big Ben and Mount Torlesse Ranges, forming the outer portion of the truly mountainous district, are at least of Palæozoic age. The Mount Torlesse Range rises abruptly from the low grounds of the Waimakariri Valley to a height of 6,000ft. above sea-level. On its western side lies the Trelissic Basin, an oblong depression amongst the mountains, about nine miles in length, north and south, and about four miles in width, in an east and west direction. This has an average elevation of about 2,300ft. above the sea, and is filled with Tertiary and Young Secondary or Cretaceo-tertiary deposits and gravel accumulations of Post-tertiary date. It is drained by the Broken River, a tributary of the Waimakariri, and is surrounded on all sides by mountains, the higher parts of which are snow-clad during the greater part of the year. Between the Trelissick Basin and the Bealey Township, on the right bank of the Waimakariri, the road follows the lower grounds along the southern side of the valley; but in the direct line between Castle Hill and the Bealey high ranges intervene, drained by the Cass River and Bruce's Creek, tributaries of the Waimakariri. Very little is known of the geology of this particular part of the district. In the mountains north-west of the Trelissick Basin, and in the Craigieburn Range, the rocks are mostly grey sandstones and dark-coloured slaty shales, which, towards the east dip to the west, and west of the Cass River dip to the eastward. Green and red rocks, similar to those of the Selwyn Gorge and Flag-pole Hill, in the Malvern Hills, are met with at the Cass Crossing, and it is probable that both Mesozoic and Palæozoic strata are present in the mountains surrounding the sources of the Cass River. Along the Bealey River, by the valley of which Arthur's Pass is approached, the strata again dips to the westward, and are probably of the Old Secondary or Permian ages. From Springfield to the top of Arthur's Pass there are thus three great synclines, and two corresponding anticlines, the first and most easterly syncline being shown in the structural arrangement of the Mount Torlesse Range. On Porter's Pass the rocks are much crushed and disturbed, probably owing to the presence of the great Clarence Fault, which crosses the pass at the very saddle, and thence is continued to the southern end of Lake Lyndon. The evidences by displacement of the surface along the line of fault is so very clear that it cannot be but that the peculiar features formed by this action must have been noticed by the different geologists who previously examined the district; yet there is no reference in previous writings to these or their cause. In tracing the probable continuation of the great Clarence Fault in the line southward beyond the Marlborough District, the evidences of faulting on Porter's Pass were not known to me, and the connecting links more to the south-west indicated the theoretical line as passing along the north-western base of Mount Torlesse. As a matter of fact, a line of fault does run along the north-west base of Mount Torlesse, and roughly forms the boundary between the older rocks of Mount Torlesse and the younger Cretaceo-tertiary deposits of the Trelissick Basin; but this has not the general direction of the great Clarence Fault. From the lower valley of the Broken River it is traceable along the foot of the mountain range to the Porter River, where that is crossed

by the West Coast Road, and thence the line of fault follows along the valley of Coleridge Creek to the mountain pass leading into the Rakaia watershed. Between Coleridge Creek and the Broken River, along the western boundary of the low grounds and younger deposits of the Trelissick Basin, there is no very distinct indication of a fault-line, though such may be present; but from the Broken River to the Craigieburn Saddle there are distinct evidences of faulting on this, the north-western side of the basin. Between Blackball Creek and Craigeburn Saddle, this line is well marked on the mountain sides; and from the saddle along Coal Creek to Craigieburn Station, the coal-measures are seen to be deeply faulted and much crushed along the southern side of the fracture. In fact the small area here present could not have been preserved but for the measures being involved in the manner they have been by the action of faulting.

In the lower valley of the Broken River there is a second and smaller area of Cretaceo-tertiary coal-bearing rocks, which are separated from those of the Trelissick Basin by a narrow belt of old rocks connecting Mount Torlesse with Constitution Hill, on the northern side of the gorge of Broken River.

The older rocks underlying the younger series of the Trelissick Basin may be regarded as forming the axis of an anticlinal arrangement, the general dip in Mount Torlesse being to the south-east, and in the mountains on the north-west side of the basin in the opposite direction. Between the Cass and the Bealey the dip is generally to the eastward, while along the Bealey Valley the dip is again to the westward. The Upper Waimakariri, therefore, runs along a denuded anticlinal ridge, and the third great synclinal lies between this and the crest of the Southern Alps. As directed, I examined the western side of the second great syncline along the course of Bruce's Creek for fossils, in proof of the supposed age of the rocks there exposed, but only fragments of a fibrous shell and some very obscure plant remains were obtained. On Arthur's Pass the dip changes again to the eastward, and thence to the granite mountains flanking to the westward the lower slopes of the main chain, through a variety of rocks and different formations; the dip of the strata south of the Teremakau Valley is steadily to the eastward.

In the Malvern Hills, and on the north-eastern spur of Mount Torlesse, at the Cass, and again in the Upper Teremakau Valley, within three miles of the Hurunui Saddle, there are cherts, diorite sandstones, and diabase ash-beds, often highly calcareous and frequently associated with red jasperoid slates, which, in their different places, may be regarded as belonging to the same period of deposition, and as being unconformable and younger than the Maitai series, or Mount Torlesse formation, with which they are generally in contact. Red and green slates are also met with in the deposits belonging to the Maitai series, but the diabase ash-beds and more intensely ferruginous rocks are usually absent from this formation in the South Island. At the Cass these rocks are evidently unconformable to the bulk of those forming the Cragieburn Range, and the mountains between the Cass and the Bealey. And, in this relationship to the other rocks of the district, they appear to extend along the valley of the Hawkdon and across Mount Whyte to the Upper Teremakau. When, in 1888, I had occasion to examine the Waiau-ua and the Hope Valleys, in connection with tracing the effects of the earthquake of September in that year, I was readily satisfied that the rocks along the Hope Valley to the junction of Kiwi Creek were of Triassic age, but there was great difficulty in determining the western boundary of that formation. The rocks of the Upper Hurunui, above Lake Sumner, have always been considered as of Palæozoic age, and not younger than the Maitai series; yet in the Upper Hope I passed considerably to the westward of Lake Sumner without convincing myself that I had reached on to Palæozoic formations. From the evidence collected during the present season, it would appear that in order to do so the main water-parting must be passed.

Northern Part of Westland.—The rocks of the higher part of the Southern Alps, from Arthur's Pass to the southern sources of the Hokitika River, are sandstones and slaty shales, scarcely differing from the rocks that, belonging to the older series, have already been described. On the top of Arthur's Pass grey or greenish gritty sandstones form a very compact rock, as the highest beds on the western side of the syncline, where this can be distinctly observed. Lower in the section are heavy beds of black mudstone or slaty shale, while farther down the Otira Gorge the same beds are repeated in thick or thinner alternations, the sandstones, however, usually predominating. Following the Otira north to its junction with the Teremakau, although continually passing from higher to lower rocks, the same alternations of sandstones and slaty shales continue to the junction with the Teremakau. But turning up Kelly's Creek, which runs more directly across the strike of the strata, dark splintery or flaggy slates are met with more abundantly than the interbedded sandstones, and it is evident that here a distinction can be made between two formations, or between the higher and lower parts of the same formation. So far as ascertained there is no stratigraphical unconformity; but a few obscure fossils collected by me in 1875, point to the conclusion that the Trias or Permian rocks of the upper part of the syncline have been passed, and that we have entered on a series that are the equivalents of the Mount Torlesse formation in Eastern Canterbury. These rocks continue into the Taipo Valley, and along Kelly's River and Taipo Range, till in their lower beds they begin to show evident signs of metamorphic influence. Their western boundary to the northward crosses the Teremakau River a little below the Otira Junction, and to the south-west it crosses the Taipo above the Seven-mile Creek, and the Arahura above the second gorge, and, passing along the western flanks of Mount Sale, is continued in the same general direction across the intervening mountains and the Hokitika Valley above the gorge, to the southern sources of that river.

Following the Teremakau Valley westward, the rocks of the Maitai series gradually pass into a series of sub-metamorphic strata, and these in turn into true mica-schists. The semi-metamorphic rocks may be considered as being of Upper Devonian age. They lithologically compare with the rocks of the Kurow Range in north-eastern Otago, and with the Walter and Cecil Peak series on the western side of Lake Wakatipu. A little before reaching Rocky Point, opposite the break in the mountains leading from the Teremakau Valley to Lake Brunner, the change to highly metamorphic rocks is complete; and thence to the valley of the Big Wainihinihini, draining the eastern slopes of Turiwhate and the western slopes of the Mica-schist Range, with the exception of a band of magnesian rocks of variable thickness, different varieties of schist alone are met with. The mica-schist

rocks form a triple series, the lower of which is composed mainly of a dark wavy or contorted mica-schist, abounding in garnets. The facility with which this rock breaks up, and its easy transport along the water-channels of the district, or its yielding character when subjected to the grinding action of glacier-ice, has resulted in the production of a low valley between the mica schists generally and the next formation, of a gneissic and granitic character, to the westward.

The remarkable erosion of the lower schists from Bell Hill to Lake Kanieri is one of the most striking physical features of the northern part of Westland. The mica-schist rocks, forming a belt of rugged mountain country between the gneissic schists and granites to the west and the sandstone country to the east, extend throughout the length of the district. Separated from the other rocks of the district in the manner above described, the gneissic and granitic rocks form a line of isolated blocks of mountains along the western border of the mountain region, being cut through and thus isolated by the valleys of the greater rivers of the district. Firstly, in the north, between Lake Brunner and Bell Hill, by an ancient course of the Teremakau River; secondly, by the present course and valley of the Teremakau River, between the Greenstone Mountains and Turiwhate; thirdly, by the Kawhaka Saddle and a former course of the Arahura River between Turiwhate and Island Hill; and, fourthly, by the present valley of the Arahura, between Island Hill and the granite mountains surrounding Kanieri Lake. South-west of the Hokitika River the schists have not been cut down in the manner described, so as to form a transverse valley leading from the Hokitika Valley into that of the Upper Mikonui.

If not in the Upper Teremakau Valley, near the saddle leading into the Hurunui watershed, there are no rocks of Old Secondary age within the Westland District; on Arthur's Pass and along the crest of the Southern Alps the younger rocks being referred to the Permian period; while the mountains south of the Grey River opposite Brunnerton, and in the southern part of the district, forming Constitution Hill and Mount Greenland, are of Carboniferous date and belong to the Maitai series of the Geological Survey classification.

The young Secondary, Cretaceo-tertiary, or coal-bearing series, are chiefly developed in the northern part of the district immediately south of the Grey River. Small areas of the same rocks exist further south: near Lake Kanieri, at Camel-back Hill on the southern side of the Kokatahi Plain, and on the south side of the Hokitika Valley, and thence extend through the mountains into or almost into the Totara watershed. At Lake Kanieri these rocks are deeply involved; along the western boundary of the granite area, and in the Hokitika Valley, they form the tops of the ranges, the middle and lower parts of which are of granite.

Tertiary deposits, of Miocene date, form over the greater part of the low grounds of Westland the substrata over which have been accumulated the different auriferous drifts. In the northern part of the district they rest towards the west on the coal-bearing series, while towards the east they abut against the abrupt termination of the granite rocks. Along the course of the Kanieri and its tributaries they again rest on Cretaceo-tertiary rocks, or on rocks supposed to represent the Maitai series. On the western slopes of Constitution Hill, and thence to the south boundary of the district, the Miocene rocks rest on those of the Maitai series, forming Mount Greenland.

Although these Tertiary deposits are thus widely distributed as rocks appearing at the surface, their area is comparatively limited, glacier morainic material covers them for the most part on the inland side of their development, while marine terrace gravels of younger Pliocene and recent date obscures them north of the Hokitika River along the coast-line. The strictly marine part of the formation, known on the coast as "blue bottom," is exposed chiefly in the cliffs and banks of the deeply excavated river-channels, while the higher part of what is probably the same sequence though perhaps of Pliocene date, known as "terrace" or "Old Man bottom," forms ridges of hills and low ranges in different parts of the district, and in the southern part attains to a considerable elevation above the sea.

Glacier morainic deposits in their original condition, or re-assorted by the action of rivers, covers a large part of the total area of the low grounds, more especially between the lower Hokitika and Totara Rivers. More towards the coast-line marine terraces with leads of auriferous black-sand cover a moderate area between the Lower Hokitika Valley and the mouth of the Teremakau River, and a narrow strip of country along the coast north of the Teremakau. Lastly, at yet lower levels, there are the black-sand beaches of the present coast-line, and the alluvial flats and lower terraces along the valleys of the larger rivers.

Physical Characteristics of the Northern part of Westland.—The northern boundary of Westland is the Grey River, from the sea to the junction of the Arnold, draining from Lake Brunner; and from the outlet of Lake Brunner a direct line to the Hurunui Pass at the source of the Teremakau.

The eastern boundary is the crest of the Southern Alps, and the southern boundary of the part under description is the Mikonui River, and the southern side of the Hokitika watershed in its upper part. The sea limits the district to the west.

The mountain region occupies from one-half to two-thirds of the distance from the crest of the main range to the sea; and within this the only flat lands, excepting the narrow valleys of the present rivers, is Bruce's Paddock, between the Teremakau River and Lake Brunner, and the valley of the south branch of Crooked River, which is connected with the larger area east of Lake Brunner, and the Old Lake Basin between Turiwhate and Island Hill to the north-west, and the Mount Tuhua Range, on the south side of the Arahura Valley.

The out-running spur-ranges from the main chain of mountains have no very definite order of arrangement, but generally have a nearly north direction. The mica-schist ranges, on the other hand, trend nearly parallel with the summit ridge of the main chain. This is due to the direction of the strike and the varying hardness of the different bands of rock in the mica-schist series. The general trend of the gneissic and granitic rock, and the physical features which they form, is conformable to those of the mica-schist country.

Grey River System, Valley of the Arnold River.—From the mouth of the Grey to the junction of the Arnold there are no important streams draining from the southern or Westland side of the watershed, Omotumotu Creek and the Waimea or Stillwater being streams of small volume,

the first draining a basin-like area, between the limestone range at the back of Greymouth and the outcrop of the coal-bearing series on the south side of the Grey. The Waimea drains the northern slopes of the range of older rocks, extending from Brunnerton South to the water shed of the New River.

The Arnold has no tributaries of any consequence joining it from the south, nor, indeed, from the northern side of its water shed. It acts merely as a drain to carry off the surplus waters of Lake Brunner. The main stream of the Crooked River to the crossing of the track from the Teremakau to Bell Hill, and the southern branch throughout, traverse low alluvial grounds similar in character to and probably originating in the same manner as the larger alluvial tract of Bruce's Paddock. The sources of the Crooked River, in Mount Alexander, are mountain-torrents, the beds of which are bounded by vertical cliffs of schist rock, or clad with bush to the limit of forest growth. Mount Alexander, on this side, is more precipitous than on the southern face overlooking the Teremakau Valley.

The Orangipuku and the Big Hohonu Rivers are the principal streams draining from the south into Lake Brunner. The first of these has, like the Crooked River, its main course along the low alluvial grounds, formerly occupied by glacier-ice, and latterly traversed from side to side by the waters of the Teremakau River. At the present time its chief tributary creeks bring to the Orangipuka the drainage of the northern slopes of the Hohonu Peak Range, Mount Bruce, and the granite mountains between that and the Teremakau, opposite Rocky Point.

The Big Hohonu is a mountain torrent of considerable volume, which drains from the centre of the granite mountains, having Hohonu Peak to the north, and Mount French and Mount Smart on its western and southern borders. Before escaping from the mountains around its source the stream is confined within a deep gorge, along which, during floods, it carries a vast amount of detritus in the shape of huge angular blocks of granite, to the lower grounds. Below the bridge, on the road from the Greenstone to Lake Brunner, the stream cuts its way through glacier-deposits and lake-terraces considerably above the present level of the lake.

Lake Brunner itself is a fine sheet of water, extending five miles and a half in an east and west direction by about four miles in the opposite north and south direction. From its outlet into the Arnold River to where it receives the Crooked River the northern shore is low and far from picturesque; but between the entrance of the Crooked River and the lower end of Bruce's paddock, Tekinga or Paddock Hill, sends down steep spurs to the water's edge, and this, opposed to the Hohonu Peak range on the southern side, gives to the eastern end a totally different aspect to what obtains at the western end. The southern shore towards the west is formed by a series of shallow or deeper embayments, with bold projecting points between, formed by the descending spurs of the irregular hilly country and terrace-land to the south. The lake is said to be very deep, but I could get no reliable information on this point. The surface of the lake is 281ft. above the sea. It is reported to be in places 100 fathoms deep; hence part of its bed must be below sea-level.

New River Valley.—This has been eroded out of a sloping table-land declining westward from the water-parting between the New River watershed and those of Maori Gully and the Arnold River, &c. The drainage system has been established, and the whole valley of the New Rive excavated, since the disappearance of the glacier-ice from the low grounds west of the Granite Mountains. Undisturbed morainic deposits are still to be met with on the Hohonu–Greymouth Road immediately east of Fuchsia Creek, and from the glacier and river deposits spread over this area, and perhaps even more from the cutting down and removal of much material from gravels of older date—"Old Man bottom"—have resulted the valley gravels of recent date. These re-assorted gravels have proved rich in alluvial gold, the New River area being of great importance in this respect.

The main stream and its numerous tributaries have effected the erosion of their beds to the present level with great rapidity, owing to the fact that the rocks underlying the gravels are soft sands and sandy marly clays, which were easily cut into and undermined by the denuding agents, which applied to them were eminently effective for that purpose. Cock-eye or Caraboo Creek is a special instance of the manner in which the former sloping table-land has been cut into by the action of running water.

Teremakau Valley.—The Teremakau in the volume of its waters is less than either the Hokitika or the Grey River, but nevertheless it is a river system ranking with either of them in importance. By way of its upper valley the West Coast was first approached from the Canterbury side of the main range, and even now, by way of one its tributary valleys, is the only land communication being maintained between the settled districts of Canterbury and the northern part—and indeed the whole of Westland. Within the Teremakau watershed were made the first gold discoveries that rendered famous the West Coast of the South Island of New Zealand; and, scarcely had the richness of Maori Point and Greenstone Creek begun to decline, when another and more important gold-bearing area was discovered at Kumara, which since 1875 has maintained the largest mining population brought together on one field on the West Coast since that date. But in quite other respects the Teremakau Valley merits a special description. Its physical peculiarities are not to be passed unnoticed, and the majestic scenery of the mountain region in the middle and upper parts of the valley are of world-wide fame. Who has not heard of the glories of the Otira Gorge. And these are not alone, since the Teremakau Valley, from the Otira Junction to where the river leaves the mountains between Mount Smart and Turiwhate may be rivalled but not excelled in the grandeur and beauty of its scenery by any of the other river valleys of the West Coast or throughout New Zealand. Its lower course from Kumara to the sea is between moderately high banks, exposing the blue Tertiary clays that underlie the superficial deposits of the coastward region. On the northern bank the country soon becomes hilly, but on the southern side a broad terrace-plain, thickly timbered, extends to the Kapitea Creek and the northern foot of the Waimea Hills. In its upper part, towards Kumara, this plain has been formed by the action of the river alone; but, more to the westward, its lower levels are due to the united action of the river and the sea.

The Greenstone Creek, or Little Hohonu River (I prefer the better-known name, Greenstone Creek), is the only tributary of consequence falling into the Teremakau west of the Granite Mountains. The Greenstone is famous on account of the rich deposits of gold that have been worked along its immediate banks and higher terrace-lands. This stream takes its rise in the Granite Mountains—the southern branch from between Mount French and Mount Smart, while the northern branch, of lesser consequence, drains the western slopes of Mount French, and draws its waters from the southern side of the water-parting between its various lesser streams and the valley of the Big Hohonu. The Three-mile and Blackwater Creeks are the principal tributaries of the Greenstone; the first making junction on the left bank of the main stream, the last coming from the north, and draining a part of the sloping table-land which has already been described as extending west of the Granite Mountains and Lake Brunner, and south of the Arnold River, out of part of which the New River Valley has been excavated. The southern and more important source-branch of the Greenstone, the Greenstone proper, as a rapid mountain stream, has at first a westerly course to the point where it leaves the mountains a little above Harrison's Terrace, at Maori Point. Here it turns to the north, and its course is now deeply cut into the glacier drift of the Teremakau glacier which here rests on the brown sandy beds that, underlying the "Old Man bottom," constitute the highest beds of the marine Tertiary series. It is here, in the neighbourhood of Harrison's Terrace, where the stream cuts through the old drifts of the Teremakau, that the gravels of the Greenstone first become auriferous. Higher than this no gold has been worked, and the stream has been thoroughly prospected to its source. This matter will again be referred to in a further section of this report.

At Harrison's Terrace, the channel of the stream is cut into the brown sands of the marine series, and, while the bed of the creek is mainly covered with granite *débris* from the adjoining mountains, the material of the higher terraces, coming from a different source, is less granitic, and of a darker tint. The higher auriferous terraces here, and at Maori Point, attain to about 200ft. above the present level of the creek-bed. At Maori Point, the terraces on the east side of the creek are fully 200ft. above the bed of the stream, and the gravels are of a very coarse description, evidently re-constructed glacier material, mixed with granite blocks, from the source of the creek. On the opposite western side of the valley the cutting down of the creek channel has been by a succession of narrow terraces, all of which have been worked for gold. Three old workings are being rapidly overspread by a vigorous growth of scrub vegetation, which in due time will be followed by timber-trees and heavy forest growth.

Below Maori Point, the stream turns to the west-north-west, and so continues till after being joined by the northern branch at the Greenstone Township (Pounamu), whence its course is nearly west to its junction with the Teremakau. At the Greenstone Township the old terrace-workings are on both banks of the creek, but those on the southern side are at a lower level than the gold-workings on the northern terrace. These higher deposits are not due to the action of the Greenstone Creek, but to a stream of far greater volume, which, from another direction, had part of its course over the area where these gravels are now present. On the southern bank, the old gold-workings form a succession of feebly-marked terraces, the surface material of which, above the township, has been almost completely overturned in the search for gold. These terraces are due to the action of the creek when running at higher levels, and are in origin quite different to the high-level terrace on the northern bank. The old gold-workings on the southern bank are being rapidly overgrown by scrubby vegetation.

From the junction of the right-hand branch to that of the Blackwater, at the crossing of the Hohonu–Greymouth Road, the northern bank of the Greenstone is formed by the stream encroaching upon the sloping table-land, which has been described as occupying the area to the north and north-west. Below the Blackwater Junction, the stream in the same manner trends to the northern side of its valley, running close under the hills on that side, to within one mile of its junction with the Teremakau.

Immediately west of Maori Point there rises an isolated hill of rounded outlines, formed in its lower part of brown sands, and capped by the well rounded gravels of the "Old Man bottom." Flanking this on the west side, and extending about a mile down the left bank of the stream, there is a high table-topped terrace formed of morainic matter, in which blocks of schistose rocks predominate. On its western side this sinks abruptly to a lower level, that of the table-land between the Greenstone Township and the special settlement near Piranui Creek, on the northern bank of the Teremakau River. This lower table-land has evidently been formed by the action of the Teremakau before it had cut down the barrier at Dillsmanstown to the present level of the stream. This ancient course of the Teremakau River can still be traced across the Greenstone Valley at the township, and for some distance beyond the right bank of the Greenstone, over the area held by the Greenstone Sluicing Company on the Duke of Edinburgh Terrace. Here, making a sharp curve to the left, the stream turned to the west, and at a higher level followed approximately the present course of the Greenstone Creek to its junction with the Teremakau, opposite Kumara. On the left bank of this ancient watercourse rises a rounded hill of Tertiary rock, between which and the lower part of Greenstone Creek lie the high-level alluvial terraces that were formed by the Teremakau under the conditions described. On the west side of this hill of Tertiary rock begins a line of lower hills, formed by the morainic material of the Taipo–Teremakau glacier, which, on the northern side of the river, terminates in Haye's Terrace, and crossing the Teremakau at and above the Greenstone Bridge, the same accumulations form the ridge of hills that lie between Kumara and Dillmanstown. These hills, on this the southern side of the river, limit to the eastward the lower terrace plain extending from Kumara to the sea, and which has already been described. In former times the Teremakau has broken through these hills at several places before establishing itself in its present channel. The first discovery of gold at Kumara was made in the more northerly and most recent of these old channels of the Teremakau, and the higher and first

formed can still be traced at the upper end of Dillsmanstown, where it forms the saddle by which the road leads into the upper part of Larrikin's Flat. The right bank, in the lower part of the saddle, is destroyed, but the left bank of the ancient stream is clearly traceable a little further to the south-east.

These morainic hills, and the coarse river-gravels that have been derived from or underlie them, are the chief repositories of gold worked on the Kumara goldfield. This is principally effected by the operation of hydraulic sluicing, and by this process the morainic hills are being gradually washed away: it is merely a matter of time and they will have wholly disappeared, and with them the key to one of the most interesting problems which the physical geography of the Teremakau Valley presents. The Township of Dillmanstown is built, much of it, in an old channel of the Teremakau which runs along the east side of these morainic hills.

From the Greenstone Bridge to the tailings-site of the many sludge-channels, passing under the morainic hills of Dillmanstown to drain the claims on their western side, the channel of the Teremakau is comparatively narrow, and lies between high banks on each side.

Opposite Dillmanstown the accumulation of tailings has so encroached on the channel of the river that the stream is now directed against the northern bank, and the channel is contracted to an inconsiderable width, causing speculations as to the effect of this obstruction on the low lands along the banks of the river higher up the stream. There is, I think, no need for anxiety as to this matter, since the scour of the river, especially in times of flood, is or should be sufficient to keep its channel clear, and there thus can be from this cause no danger to the flat lands of the river valley that lie a quarter of a mile above the threatened obstruction. From Dillmanstown, and the head of Larrikin's Flat, a long line of morainic hills limits and extends east along the south side of the valley at a distance of from a mile to a mile and a half from the river-channel. This line of morainic hills reaches to the western base of Turiwhate, the massive granite mountain that, opposed to Mount Smart on the northern side of the valley, forms the entrance to the second or middle part of the Teremakau Valley. The northern sides of these morainic hills are composed of materials brought down the valley by the Taipo-Teremakau glacier, and deposited as a lateral moraine; the southern slopes in the same ridge of hills being of like manner formed by the northern lateral moraine of the combined Kawhaka-Arahura glacier. Near the junction of the Loop-line Road with the Christchurch–Hokitika Road, the medial line between the two lateral moraines is easy to be distinguished. This is at a height of from 650ft. to 700ft. above the sea.

From the point where the Christchurch–Hokitika Road begins to ascend this morainic ridge, east to Rocky Point, four miles above the Taipo Junction, the low grounds of the Teremakau Valley are of much the same extent and character to what they are between the point mentioned and Dillmanstown, but the character of the surroundings are very different. The river traverses a wide bed in many streams, both its banks beyond ordinary flood-mark being clothed with heavy forest-timber; but now on the northern side rises the granite mountains of which Mount Smart forms the western peak. These, though very abrupt on the slopes facing the river-valley, are, nevertheless, clothed with heavy bush to the level of the winter snow-line. The total area of this granite region, including Mount Smart, Mount French, Hohonu Peak, and a number of nameless heights between the Teremakau Valley and Lake Brunner, is about forty-five square miles. Opposite the Taipo Junction and from Rocky Point, viewed from the river-valley, they present many scenes of unrivalled beauty and grandeur, and contribute not a little to the charm of the journey from Christchurch to the West Coast. Opposed to these northern mountains, on the south side of the valley, rises the granite mass of Turiwhate, which, as a single mountain, attaining an elevation of 4,482ft., rests on an area of fully twelve square miles. Viewed from all points, Turiwhate is an exceedingly grand mountain; its higher part exposing bare crags of granite rock; its middle slopes thickly timbered, as are its equally precipitous lower slopes, that, on the Teremakau side, spring from the level grounds of the alluvial plain. The Waimea Stream drains the western slopes of Turiwhate, and part of the eastern end of the morainic ridge already described. It makes junction with the Teremakau a little below where it is crossed by the Christchurch Road. Its mountain waters are augmented by streams of spring-water filtering from the Teremakau through the shingle-bed of the alluvial plain above its junction. In its lower course the stream and its banks present a number of charming views characteristic of West Coast scenery.

The Big Wainihinihini is the first tributary of the Teremakau that takes its rise amongst the mountains to the east of the granite belt. The more direct source of this stream lies on the saddle between Turiwhate and the Mica-schist Range. This saddle is very low, and viewed from higher up the river valley in the neighbourhood of the Taipo, it seems as though it were a mere matter of election whether the Teremakau might take this course in its journey, or that which it does actually follow to the sea by way of Dillmanstown and Kumara. Many tributaries from the ranges on each side of its valley join the Big Wainihinihini before it enters on the low grounds of the Teremakau Valley. Where crossed by the Christchurch–Hokitika Road, its volume is not great in fine weather, but during wet weather it is far otherwise, and then it frequently is, for a time, uncrossable.

The Mica-schist Range—so-called for lack of a better name—stretches along the southern side of the Teremakau Valley from the source of the Big Wainihinihini to the gorge of the Taipo River. The only other stream of any consequence draining from this part of the Mica Schist Range is the Little or Smooth Wainihinihini. Smooth and gentle under ordinary circumstances it may be, where it enters the Teremakau, or where it was formerly crossed by the road to the West Coast. Where it is now so crossed it has no longer a claim to the qualifying epithet. A short distance above the road-crossing, this stream emerges from a gorge so narrow and profound that, from a little distance off, it appears as though no stream of consequence could escape from the mountains in this part, the thick forest growth adding to the difficulty of tracing the course of the stream. In fact, the map of this part of the County of Westland, which did service with

me in the field, although it shows the sources of this stream apparently correctly enough, yet makes it a branch of the Big Wainihinihini; the Smooth Wainihinihini, as a distinct river, having no existence at all on the map.

The Taipo is the principal tributary of the Teremakau, being less in volume than the combined Upper Teremakau and Otira, but considerably greater than either of these taken singly. It collects the waters of the main range, from Mount Rolleston on the south-west side of Arthur's Pass to Mount Harman, immediately north of Browning's Pass, and, its upper waters being snow-fed, it is a stream of considerable volume almost to its source. Being also confined to a narrow channel amongst high mountains, at any part of its course it is a difficult and dangerous river to ford, and but recently life has been lost in making the attempt. Kelly's Ridge and Taipo Range supply the tributary streams of the Seven-mile Creek, and some others, that make junction from the north-east and east; while larger mountain streams flowing from the Tera Tama Range make junction from the south-west. Kelly's Ridge and Taipo Range rise above the line of forest growth, but in no part are they permanently covered with snow. The summits of these ranges are comparatively flat, and no jutting craggy peaks rise above the general level of the bare or grass-covered mountain-tops. The higher parts can therefore, once reached, be traversed with ease, but their precipitous and bush-clad sides are difficult to explore. The inner faces of these ranges, their southern slopes overlooking the Taipo Valley above the Seven-mile Creek, are not bush-clad, and they, with the mountains on the opposite side, give to the whole of the Upper Taipo Valley a wild and savage aspect, which is not lessened by the greater magnificence of the towering snow-clad peaks that limit the watershed towards the east and south. The Upper Taipo is difficult of access, but to the adventurous tourist the extra difficulties might add a zest as compared with the ease with which the scenic wonders of the Otira Gorge can be surveyed. Below the junction of the Seven-mile Creek the Taipo runs close under the steep slope of the southern face of the Taipo Range, and after passing through the gorge formed by the extreme spur of this range and a spur range of the Tera Tama Mountains, on the south side, its cold blue waters appear from between high terraces of gravel and coarser drift, and finally enters on the low grounds of the Teremakau Valley. Thus the Taipo traverses the main river-bed and joins the Teremakau close under the granite mountains on the northern side of its valley.

The Teremakau receives no stream of any consequence from the granite area on the north side of its valley; the Greenstone Creek, the Big Hohonu, and Orangipuku draining the greater part of these mountains.

Above Rocky Point to the left, looking up the valley, there is the broad and level opening that leads from the Teremakau by way of Bruce's Paddock to Lake Brunner. This is divided by Tekinga and Paddock Hill into a greater and a lesser part. Tekinga is a mass of granite, which, to the east of Lake Brunner, overlooks the southern part of it, and has between it and the western spurs of Mount Alexander the lesser area of the low alluvial tract that has just been mentioned. This contains Lake Poerua, and along it to the north flows the southern branch of the Crooked River. Beyond the junction of this with the main branch of the Crooked River, the depression is continued to the north beyond the boundary of the district, in the direction of Bell Hill. This area is not now strictly to be regarded as forming part of the Teremakau watershed, but it has been so within a comparatively recent date, and no explanation of the peculiarities of the middle part of the valley of the Teremakau would be complete without taking this into consideration. Looking up the Teremakau Valley, from between the Big Wainihinihini and the Taipo, or even nearer to Rocky Point; it seems to be that the river must come from the direction of Bell Hill, and flow along the depression between the granite and schistose mountains; and it is only when Rocky Point is fully reached that the course of the river and the trend of its valley is seen to be more to the eastward. The Teremakau River and its valley, for a distance of ten miles, or from the eastern spurs of Turiwhate to midway between Rocky Point and Jackson's, runs along the remarkable depression that lies between the granite mountains to the west, and the schistose ranges to the eastward of this depression. And this continued, irrespective of the course of the river, leads to the confusion that arises with respect to the probable course of the river above Rocky Point. This of course is only appreciated in travelling up the valley from the West Coast. It has already been remarked that a similar doubt may be entertained as to its probable course passing Turiwhate, and whether or not it may at one time have flowed along the valley of the Big Wainihinihini, and so reached into what is now the watershed of the Arahura River.

Above Jackson's to the junction of the Otira the Teremakau receives no important tributary, either from the north or the south side of its valley. At Jackson's, the river-bed is narrowed by the opposition of two great shingle-fans: that on the northern side being built by detrital matter from the western spurs of Mount Alexander; while that on the southern side has been supplied by the material of denudation from Taipo Range. Above this point the river-bed never assumes a width equal to what it shows below Jackson's. The character of the Teremakau River-bed, from the Otira junction to Dillmanstown, resembles closely that of the larger shingle-carrying rivers of Canterbury. Excessive floods result in the formation of a broad shingle-bed, along which, under ordinary circumstances, the river finds its way in one or many streams. Frequently the main stream changes its course, and the full force of the current sets against the low flats covered with grass or bush, that for long periods have had immunity from such attacks. When such changes take place, it is usually against an improved piece of ground that the full force of the river is directed.

The Otira brings to its junction with the Upper Teremakau a volume of water quite equal to that which it is joined to from the Teremakau below the junction. Neither the Otira nor the Teremakau, above their junction, are large streams, and it is surprising that the union of the two should form such a considerable river as appears opposite McDonald's, two miles below the junction. I made inquiries as to the probable cause of this, assuming that a considerable body of water might come in from Mount Alexander, on the north side of the valley, but no important tributary comes

from that quarter; and it is the opinion of the residents in the valley that much water, percolating below the surface of the shingle-beds of the Lower Otira and Upper Teremakau, makes its appearance below the junction of the two. The Otira Valley, from its junction with that of the Teremakau to the foot of the celebrated Otira Gorge, differs but little from the ordinary character of a mountain valley excavated in similar rocks, and having a moist and comparatively mild climate like that of the west coast of the South Island. The low ground, where the river has not recently converted it into a shingle-bed, is bush-clad, as are the mountain sides to an elevation determined by the average temperature of the particular district. Higher than this are the scrubby or grass-covered slopes of the sub-alpine region, above which, according to the nature of the rocks present, we have broad fields of angular debris, or jutting rocky projections, crags, and precipices, to the highest peaks of the mountain range. All this can be seen along the right bank of the Lower Otira. The character of the ranges on the western, or left bank, has already been given when treating of the watershed of the Taipo Valley.

Kelly's Creek, making junction from the west, is the principal tributary of the Otira in the lower part of its course. This is a mountain torrent, better known on account of its dangerous ford when in flood, where it is crossedby the Christchurch–Hokitika Road. Its valley is thickly bush-clad in the lower part, but towards its source it drains the bare or grassy uplands of Kelly's Ridge, and discharges its waters to the lower part through a deep gorge, the walls of which are formed of dark slatey rock, which enhances the gloomy character of the surrounding scenery. At the foot of the Otira Gorge, the Otira is joined by Rolleston Creek, which drains from the northern slopes of Mount Rolleston and the opposite heights lying towards the Taipo watershed. The valley of Rolleston Creek is out of the line of tourist travel, but, on account of its magnificent scenery, it would well repay a halt at the Otira Hotel, in order to explore its upper part. As seen from the coach-road, the whole surroundings of Rolleston Creek form a characteristic view of the mountain scenery of the West Coast. The Otira Gorge, being traversed by the coach-road from Christchurch to the West Coast, has long been celebrated for the grandeur of the scenery in the gorge itself, or amongst the mountains surrounding it and Arthur's Pass, by which the main range of mountains are crossed. With respect to the beauty and grandeur of its scenery, it has no peculiar claim to be the first, most magnificent of the mountain gorges of Westland. It simply chances to be the better known of many that are no mean rivals to it, and of some that yield to it in no respect. The Gorge is divisible into three sections, each having its peculiar characteristics, and some parts of each combine in the general view to be obtained from the valley of the Otira below the gorge. The first section or division extends from the foot of the Gorge to the second bridge, from which part, looking north, many fine views can be obtained, to which Kelly's Ridge, or the more distant Mount Alexander, afford a suitable back-ground. The views which may be had in the opposite direction may be so arranged as to show only the gorge itself, and the steep declivities on either side of the foaming torrent that hurries along its rocky bed; or they may include the lower peaks of the Mount Rolleston Range, or a distant view of the upper gorge, as a back-ground; or the road, a bridge, the stream, and some lower bush-clad spur of the mountain ridges on each side of the gorge combine generally with marked pictorial effect.

The second division includes the deeper part of the gorge, from the second bridge to the roadman's hut on the zigzag descent from the great shingle-fan at its upper end, which may be sketched or photographed subject to the same variety of conditions that have already been indicated for the first part. The upper part of the gorge is sub-alpine. It is distinct and separate from the middle and lower parts. The zigzag overlooks, at its nearest approaches to it, a deep, narrow, rock-walled gorge, unexplored and impassable under ordinary circumstances At its upper end this opens out so as to form a funnel-shaped basin, one side of which is formed by the great fan of angular detritus, the waste of the mountains to the east, over which, by a steep gradient, the coach-road ascends, to again descend its northern side by the zigzag leading down into the middle of the gorge.

Above the gorge, for a distance of a mile, the stream traverses a mountain valley, and then divides into two branches. That to the east comes from a gorge between two mountain spurs of a high range, retaining considerable areas of snow throughout the great portion of the year. That to the west, the main stream and true course of the Otira, drains the permanent snow-fields of Mount Rolleston, in which direction the scenery is truly alpine. The two main sources of the Otira, draining from the east and west, meet in the middle of the depression leading to Arthur's Pass, which has a north and south direction. From the actual height of land on the coach-road to this junction there is no creek of any consequence, the little drainage there is collecting in a lagoon or mountain tarn, formed by an ancient moraine of a glacier from the west being piled across the valley at this point. The drainage from this tarn is by soakage through the moraine into the Otira.

Arthur's Pass itself is an upland valley, 3,000ft. above sea-level, between two opposing mountain ranges, whose spurs are, on the average, fully half a mile apart. This valley depression leads forward to the descent into the Bealey Gorge, and, in the stricter sense of the word, there is no saddle, and the phrase is correct: "from Canterbury the main range is crossed by Arthur's Pass."

The Upper Teremakau, from the Otira Junction, in fine weather has but a small volume of water, but the wide stony river-bed and numerous dry channels abandoned by the river, or only filled during times of flood, give ample evidence of the state of things during wet weather and sudden storms of unusual severity. This portion of the valley, sixteen miles in length, is bounded on both sides by mountains, which, though not reaching above the line of perpetual snow, are high ranges, retaining much snow during the winter season, which does not disappear until the summer is far advanced. Unlike Mount Alexander, and Taipo Range further down the valley, the main summits of these mountains do not immediately overlook and yield directly the bulk of their waters to the main stream, but they are drained by numerous creeks of lesser volume, which have cut deep gorges or wide valleys amongst the mountains, and these drain frequently from the south-

east or north-west faces of the higher peaks standing back from the river. The main river-valley has nearly a straight course from the Otira junction to where it takes its rise on the saddle between this and the Hurunui watershed.

Kapitea Creek.—This stream has its main source a little to the west of the Christchurch–Hokitika Road, near the junction of the Loop-line Road. The stream flows west-north-west, and reaches the sea four miles to the south of the mouth of the Teremakau River. In the upper part of its course it drains the south-western side of the eastern part of the line of hills formed by the lateral moraines of the Taupo-Teremakau and Kawhaka-Arahura glaciers. Part of its course lies along the bed of an ancient ice-stream belonging to the latter-mentioned system of glacier-ice, which, finding its way into the low grounds from between Turiwhate and Island Hill, tended towards the main body of ice occupying the low grounds to the south-west; but this, unaffected by the lesser mass, and itself tending to the northward, the Kawhaka-Arahura branch was forced to the north, and a line of medial moraines was formed, less in bulk, but similar in character to those that extend from Dillmanstown to the Christchurch Road, and the source of Waimea Creek at the western base of Turiwhate. This ice-stream had its terminal face at the head of Larrikin's Flat, near Kumara, but the present Kapitea Creek does not follow the depression of its bed thus far. Below the crossing of the Loop-line Road and the Big Dam of the Kumara Water-race, it breaks through the line of morainic hills to the west, and holds the course described to its junction with Little Kapitea Creek. Entering the area occupied by the ice of the main body of the Arahura glacier, towards the northern limits of this it is joined by the Little Kapitea, draining the country to the south and west covered with morainic deposits, or the silt deposits of pre-existing lakes. Such tributaries to the main stream as Italian, Callaghan's, and Maori Gully Creeks, drain the northern and eastern slopes of the Waimea Hills north of the Waimea River, while Duffer's and Greek's Creeks drain the northern slopes of the east part of the Waimea Hills south of the Waimea Valley. Though but a small stream, draining but a limited area, the watershed of the Kapitea is of great geological interest and of no little consequence in connection with the development of mining in the surrounding district.

Waimea Creek.—The Waimea of the present day is confined to the block of hilly country that lies between the Kapitea watershed and the lower valley of the Arahura River. Three streams, the middle, right, and left-hand branches, unite at Goldsborough, to form the main stream of the Waimea, which thence pursues a nearly west course to the sea. The right and left-hand branches have their sources in the hilly country to the north and south of the middle branch. The middle branch, however, passes right through the block of Tertiary hills, and takes its rise from the lower lands that lie to the east of the Greenstone–Hokitika Road. Three miles below Goldsborough, the most important branch from the south, Liverpool Bill's Creek, makes junction opposite the Township of Stafford. The drainage of German Gully and Sandy Creek, though uniting with the Waimea before it enters the sea, scarcely belongs to that of the Waimea Valley, since not very long ago each constituted an independent watershed, and the slightest depression of the coast-line would again bring them to the same condition. The Waimea has been celebrated on account of the extent and richness of its gold deposits. In dealing with the origin of these deposits in the case of the principal stream, and the middle branch, to its source, it will have to be shown that the auriferous gravels are not only foreign to the watershed, but that under no circumstances could they have been produced and arranged as they are by the action of such a small stream as that of the Waimea at the present day.

Arahura Valley.—The Arahura River takes its rise from Browning's Pass, between Mount Harman and Twin Peak, situated on the main water-divide between Canterbury and the West Coast. The immediate source of the river is Lake Browning, a small sheet of water on the summit of the saddle leading into the Rakaia watershed. The outlet from the lake is to the north; but the river immediately assumes a westerly course, and within the first three miles it receives several considerable tributaries, fed by the snows of Twin Peak. Below the junction of Harman's Creek the river turns to the north-west, and again to the west, before reaching opposite the saddle leading into the valley of the Browning River, forming part of the Hokitika watershed. Below this its course is along a narrow valley, with grassy flats on each side of the river; and to the west and east this valley is confined between high mountains, devoid of forest vegetation. About ten miles from its source the river receives a large tributary from the north-east. This drains the high bare country of the dividing range between this watershed and that of the Taipo River. The Arahura is now a considerable stream, and its banks and the adjoining mountain slopes in their lower part begin to be clothed with stunted forest growth. It has now passed from the sandstone country of the main range and crossed the belt of semi-metamorphic rocks introductory to the triple series of the mica-schist belt; and, with this, a sudden change in the aspect of the Arahura Valley takes place. The river plunges into a deep gorge, the walls of which, whether rock or gravel, are such that it is barely possible to leave this part of the river-bed, except by following the stream upwards or downwards, and thus escape from the close confinement of the Crowbar Gorge. This forms the upper end of the second or Upper Gorge of the Arahura. About the middle of the Crowbar Gorge, the course of the stream alters from north-west to south-west agreeably to the direction of the mountain ranges between which it flows. It continues its course in this direction, when at the foot of the second gorge it again alters to a north-westerly course, and enters on the low grounds of the Old Lake Basin that, surrounded by mountains, lies between the first and second gorges of the river. The middle part of the second gorge is more accessible than the upper part; and on the high terraces of the south side there are some small areas of comparatively flat land, where some attempts have been made to reclaim the wilderness. How far this has been successful may be judged by the condition of the homestead. From the sloping table-land, on which this is built, the terrace on its northern side descends sheer to the river-bed, causing the waters to be deflected against the opposite mountain, and at a level of 250ft. below the track. Throughout

the gorge the river tends to run close under the mountains on its northern side. These rise with exceeding abruptness to a height of 4,000ft.; higher than which the culminating peaks are at places clad with alpine grasses, and forms of scrubby vegetation, but, as a rule, are rocky crags separated by impassable gulches. Along the southern bank of the river, and at one place on the northern bank, are vast accumulations of glacial matter, brought down from the upper part of the valley, or of shingle, fan, and slope deposits from the neighbouring ranges. These have apparently at one time filled the valley to a depth of from 700 to 800ft., and, in spite of the carrying capacity of the furious mountain torrent that passes through the gorge, the removal of this detrital matter is little better than begun. At the western end of the gorge there are some narrow flats near the level of the river; but even here the southern side of the gorge is buried beneath gravel cliffs and shingle deposit, several hundreds of feet in thickness. Throughout the middle and lower parts of the gorge, wherever it can find footing, heavy or more scrubby forest growth prevails. The river-channel has a fall of 60ft. to the mile in the lower and middle parts, and the fall is somewhat greater in the upper part. In a confined space this would cause a heavy rush of waters, especially should the stream be at all swollen; but, in addition, the narrow river-bed is choked by huge boulders of sandstone, schist, and olivine rock, between which the waters chafe and roar as they find their way through the gorge. This state of things renders the river uncrossable even when low, and thus it was, the track being confined to the south side, that the northern side of the gorge could not be examined or prospected. Such is the noisy violence of the stream, that towards the foot of the Crowbar Gorge, although the track is nearly 300ft. above the water, conversation is not easily carried on.

Mount Brown Creek, on which is the head-lift of the Humphrey's Gully Water-race, has exposed in its bed the junction between the lower division of the mica schists and the gneissic schists that underlie. Here the second gorge terminates. Immediately west of the junction of Mount Brown Creek from the Mount Tuhua Range, a line of lower hills, composed of granitoid gneiss stretches north-east to the southern bank of the river, below which the Arahura enters and traverses an old lake basin now drained by the cutting down of the morainic hills between the southern slopes of Island Hill and the Rocky Pyramid, apart from the western spur of Mount Tuhua, on the south side of the valley. Between the first and second gorges the east and west extension of the bed of this drained lake is between three and four miles; in the opposite direction the width of the lake was less at the extremities, but a long arm extended north along the valley of the Arahura–Wainihinihini, and its extreme limits in this may not have been less than in the opposite direction. The Arahura–Wainihinihini joins the main river about the middle of the Old Lake Basin. Its course is north-east and south-west, parallel to the general trend of the Mica-schist Range which confines its valley on the eastern side. On the opposite western side the valley is bounded by the peaks of Conical Hill, and Turiwhate, with the Kawhaka Saddle between. Its middle source is on the saddle between Turiwhate and the Mica-schist Range, the same as that which holds the source of the Big Wainihinihini falling into the Teremakau River. The western branch drains from the Kawhaka Saddle, and drains its waters partly from Island Hill and partly from Turiwhate. The eastern branch is more important, and has its source in the Mica-schist Range. From this it escapes along a narrow, deep, and utterly impassable gorge, the lower part of which is bounded by walls of gneissic rock. The united branches constitute a moderately-sized stream, having its course along a well-timbered valley to its junction with the Arahura. A mile below the junction, on the left bank of the Arahura, there is a stockman's hut, which served as headquarters while examinations were being made to a convenient distance from it. This position may be regarded as the middle part of the Old Lake Basin. The elevation above the sea is, at this place, 440ft; at the foot of the second gorge it is between 550ft. and 600ft. At the bark hut, in the upper third of the second gorge, the height is 1,100ft. From the stockman's hut a general view of the upper gorge can be obtained in clear weather; but, unfortunately, while here, the weather was far from being fine. From the same point an excellent general view of the valley of the Arahura-Wainihinihini and the Mica-schist Range can be obtained, as well as of the granite mountains to the north-west and south-east.

The depression between the granite and schist ranges to the north-east of this part of the Arahura, on the southern side of its valley, is continued through to Kanieri Lake, between the western spur of Mount Tuhua, and the isolated hill stands apart from it to the north-west. This, however, is not in the direct line of the depression from Bell Hill to the northern bank of the Arahura, which should be continued along the valley of Mount Brown Creek to the upper end of Kanieri Lake. As looked at from the low grounds, in the direction of Mount Brown Creek, the continuation of the depression is less evident; while at the same time it must be said that if the causes of this remarkable feature are what I have considered them to be, then it is by way of Mount Brown Creek the depression should be continued to the south-west, and the gap leading from this part of the Arahura Valley to the lower end of Lake Kanieri must be referred to the operation of another cause.

From the southern slopes of Island Hill, to the rocky hill isolated from Mount Tuhua on the opposite side of the valley, there stretches across the Arahura Valley a glacier moraine of great size. Its surface is uneven, but how far this has been modified by denudation since its original deposition is uncertain. It now forms heights from 800ft. to 900ft. above sea-level. It is crescent-shaped, and from the outlet of the Old Lake extends down the river valley a distance of fully two miles, and through it, by a tortuous, narrow channel, the river has cut its way to a depth of 500ft., so as to effectually drain the former lake, the waters of which were retained by the morainic barrier. On the down-river side the stream has not yet exposed the base of the deposit, and it is uncertain on what rocks it may here rest. Towards the upper end of the gorge the river has cut through the superficial deposits, and exposed massive strata of gneissic schist, striking across the valley from Island Hill. Near the upper end of the gorge, strata of sand and gravel and beds of black sand, oxidized to a brown colour, are seen along the track. Below the gorge, morainic matter forms high cliffs on the north bank of the river, but a moderate breadth of low river-flats are found on the southern side. At higher levels it is probable that glacier-matter is continued along the

slopes of Humphrey's Gully Range. This, for a mile or so below the foot of the gorge, has not been ascertained, but it is highly probable that such is the case. The presence of morainic-matter on the same range from the junction of the Caledonian Creek with the Arahura to Olderog's Bluff, a mile above Humphrey's Gully, may be taken as a verification of the assumed fact. On the opposite side of the valley the ridge of morainic hills has a depression between it and the lower slopes of Island Hill, indicating that either the river or a body of ice flowed to the west while the great morainic barrier was being accumulated. At the upper end of this depression a high morainic terrace rests against and for some distance flanks the lower slopes of Island Hill, forming part of the crescent-shaped barrier already described. The low depression spoken of is very noticeable, as seen from Fox's Hill, or Whiskey Creek on the Kawhaka, west of its line of extension. As seen from the latter place the depression appears to have been the course of an ice-stream, which expanded to fill the whole of the extensive pakihi that lies between the upper Kawhaka, Island Hill, and the morainic ridge extending from the Kawhaka at Whiskey Creek to the lower end of the first gorge of the Arahura. The Arahura escapes by the first gorge into a comparatively narrow valley, between the Humphrey's Gully Range on the south side and the morainic ridge spoken of on the north side of the river. At Olderog's Bluff, about a mile above Humphrey's Gully, morainic deposits form a high cliff on the left bank of the river; but this is not immediately opposed by a similar bluff on the northern bank, otherwise here had been the first gorge of the Arahura. Lower down the valley, nearly opposite the tailings-site of the Humphrey's Gully Company's Claim, cliffs of morainic matter have their bases washed by the stream. Here it would appear that a moraine stretched obliquely across the valley, the hilly heaps of which subsequently received additions to form the whole series that lies on the northern side of the Arahura, between it and the depression described above. Below Humphrey's Gully the valley widens, and alluvial flats stretch along the south side of the valley, the Humphrey's Gully Range still continuing to opposite the junction of the Kawhaka.

The Kawhaka, the chief tributary of the Lower Arahura, takes its rise from between Island Hill and Mount Turiwhate. Flowing nearly due west, it drains the eastern part of the area covered by the Old Lake Basin of the lower grounds, outside the line of granite mountains. Fox's Creek runs nearly parallel to the lower course of the Kawhaka, and drains the eastern slopes of the southern Waimea Hills. It falls into the Arahura one and a half miles below the junction of the Kawhaka. Below the junction of Fox's Creek the Arahura tends more in the direction of the north side of the valley, and near its mouth on this side it is encroaching on the higher marine terraces that lie between the Waimea Hills and the coast-line. It thus leaves a considerable area of a flat, low terrace, or swampy land on its southern side, which gradually, as it approaches the sea, increases in width till it blends with the littoral deposits of the coast-line. Parallel to the coast, and but a little elevated above the sea, there are two lines of low sandhills, the inner of which is nearly obliterated. Where the Arahura breaks through these, the part of the river below the lower bridge forms a small tidal basin between the road-line and the actual bar.

Houhou Creek.—Midway between the lower course of the Arahura and Hokitika Rivers, the Houhou Creek drains from the southern end of the Humphrey's Gulley and Mount Misery Ranges. It is a small stream, and in any ordinary description of the country might with propriety be overlooked. But not so in this case. It has been excavated out of formations of great geological interest amongst the gold-bearing deposits of Westland, and its alluvial lands in the middle and upper parts have been the site of notable gold-diggings. It is joined by several small tributaries coming from the south-east, also gold-bearing, and after a course of five miles it falls into the sea three miles north of Hokitika.

*Hokitika Valley.**—The Hokitika is considerably the largest river of the northern part of Westland. With its numerous tributaries it drains fully twenty miles of the main chain, which carry snow-fields of considerably greater extent than are met with more to the north-east. Its main sources, the Upper Hokitika and the Pass Rivers, unite into one stream at the northern base of Mount Browne, and thence the course of the river is through a deep gorge, overlooked by high snow-clad mountains, to the upper end of the Kokatahi Plain. In the upper part of the gorge the river flows to the north-west, in the lower part its direction is towards the north. On entering on the Kokatahi Plain, for eight miles the river runs to the north-west along the southern side of the plain; thence for four miles it has a northerly course to where it is joined by the Kokatahi branch.

The Kokatahi has a volume of water about equal to that of the Hokitika above the junction, and for about the same distance that the Hokitika traverses the southern side of the plain, the Kokatahi makes it way along the northern side.

The Kokatahi Plain is the most extensive area of flat land to be met with in the district. It extends from the junction of the Kanieri with the Hokitika, south-east, to the foot of the Hokitika Gorge, a distance of thirteen miles. In the opposite direction, south-west and north-east, its width is about ten miles. This extensive area of flat land is almost wholly covered by river alluvia of recent date. To the west and north-west it is bounded by hilly or terrace lands, consisting chiefly of material brought down the Hokitika Valley by the agency of glacier ice. On the southern side the plain is bounded by hilly country, separating the Hokitika from the Totara watershed. On the east side, the outer-spurs of the mountains flanking the Southern Alps limit the level lands, while to the north the plain is bounded by the granite mountains on the south side of the Kanieri Lake. The Kokatahi River as one stream traverses the level lands of the plain, but at the eastern corner it divides into three source branches: the Browning, the Kokatahi, and the Toaroha Rivers. Of these, the most northerly is the Browning, which rising on the Styx Saddle

* This description has already exceeded the bounds intended to limit it, and it will be impossible to deal with the Hokitika Valley in the manner I have treated of the Teremakau and Aharua Valley, partly for the reason just given, and partly because I have no intimate acquaintance with the inner mountain region of this watershed. It is, however, generally the same in its general character, and specially resembles that of the Arahura Valley, but is yet of a more pronounced type as regards its special manifestations of glacier action, the different phenomena connected with which are in active operation on a greater scale than elsewhere in the northern part of Westland.

leading from its valley into that of the Upper Arahura, flows west-south-west in a straight narrow valley between high mountains to where it is joined by the Upper Kokatahi. Between Browning's Pass and Mount Park, limiting this part of the watershed, the water-divide of the main range is very irregular, and does not seem to conform to the synclinal axis of the geological structure of the mountain range. The sources of the Arahura, Wilberforce (a branch of the Rakaia), and of the Kokatahi, over-lap each other considerably, and the erosion of the valley of a large tributary of the Wilberforce, draining from beween Mount Julius and Mount Sale, has so far passed to the west of the main axis, that the water-parting lies between this and the middle part of the valley of the Browning River; while at the central source of the Kokatahi it is fully five miles to the south of this point. Thus, in almost the same line, the distance from the crest of the main range to the sea is less than twenty-two miles or more than twenty-six miles as the case may be. As a consequence, though taking its rise six or seven miles north-west of the source of the Arahura, and in the course of a few miles having the Kokatahi interposed between it and the main range, it nevertheless for a short distance drains the main water-parting. The Upper Kokatahi and the Toaroha drain from the sandstone mountains of the main ranges; and both, to reach the low grounds to the westward, break through the Mica-schist Range by cutting very deep gorges along this part of their course. They enter on the Kokatahi Plain before reaching the granite belt. Both these rivers, like the Arahura, remarkably alter their courses from north to west at points close to the junction of the unaltered sedimentary rocks with those of the metamorphic series. That the Browning Valley does not show this is because its source is just on or close to the line connecting these remarkable bends in the courses of the other streams.

The Kanieri River is the only other considerable tributary of the Hokitika. The main branch of this is the outlet of Kanieri Lake. The lake is six miles in length, with an average breadth of not more than a mile. In the direction of its length, it trends nearly north and south, and its waters are held between Mount Tuhua Range on its eastern side, and Conical Hill and Mount Graham to the south-west and south. Formerly the Browning Glacier, principally supplied from Mount Sale, passed along the bed of Lake Kanieri.

The stream supplied by the surplus waters of the lake flows west-north-west through a series of morainic hills, and morainic material re-assorted by the action of running water, or of the lake at higher levels. After a course of five miles it receives the north and south branches, below the junction of which it breaks through the morainic barrier on the northern side of the lower Kokatahi Plains, and finally joins the Hokitika River a little above Kanieri Township.

Mahinapua Lake and Mahinapua Creek.—Mahinapua Lake receives the drainage of a large part of the morainic hills between Rimu and Ross. On the seaward side its waters are confined by low sand-hills, and the most recently elevated line of black-sand beaches. Its eastern shores are of a bolder character, being backed by the morainic hills already mentioned. The outlet from the Lake, Mahinapua Creek, flows to the northward, with but a low sandy spit between it and the sea, and enters the tidal part of the Hokitika River just inside the bar.

Totara Valley.—This encircles Mount Greenland on its eastern and northern sides, and Donnelly's Creek, the principal tributary of the Totara, drains the west slopes of that mountain; the drainage of the south-west and southern slopes falling into the Mikonui River. From the junction of Smythe's and Cedar Creeks a low saddle leads from the Totara Valley into that of the Upper Mikonui. The Upper Totara has numerous small tributaries draining from Fraser Park and Bald Hill Range, and the out-running spurs of these to the north-west; and several streams of lesser size from the opposite direction drain the eastern slopes of Mount Greenland.

Donnelly's Creek has many branches—the right and left-hand branches, Jones's Creek, Quartz Creek, &c.; the importance which these small streams have acquired being due to the fact that they flow along beds that have proved highly auriferous. The Township of Ross is situated on the southern bank of Donnelly's Creek, a mile above where that stream makes junction with the Totara.

Mikonui River.—Three miles from the sea, the level lands west of the lower spurs of Mount Greenland give place to hilly country, above which point the Mikonui is confined to a deep valley between Mount Greenland and Mount Rangitoto Ranges, and between the eastern continuation of Mount Rangitoto Range and Fraser Peak. The sources of the river lie on Mount Beaumont, and neither the Totara nor the Mikonui spring from the mountains of the main range.

Both the Totara and the Mikonui are small rivers. The latter forms the southern boundary of the district with which this report is concerned.

Historical Notes on the Discovery of Gold in the Northern Part of Westland.

The County of Westland, formerly the West Coast of the Province of Canterbury, includes the western slopes of the Southern Alps, and the lower grounds between the mountains and the sea from the Grey River to the northern boundary of the Otago Provincial District. Though typically the same throughout, Westland is yet in different parts characterized by a variety of scenery climate, and soil. As one vast wilderness it lay unexplored and unknown until the advent of the gold-miner. The Provincial Government of Canterbury, in the early days of that settlement, did indeed make some endeavour to explore the country, but neither the character of the country nor the climate was to the taste and liking of the eastern pastoralist. There were no extensive tracts of open land suitable for sheep- or cattle-raising; and the incessant rains, which a bush-clad country enhanced the discomforts of, led to Westland being regarded as a wild, inhospitable, and utterly impracticable country for the purpose of settlement. And so through the early years of the Canterbury Settlement the West Coast remained in its primeval state till 1863, which was the year of Whitcombe's ill-fated expedition to the West Coast. Gold was found by Whitcombe's companion, Louper, but confessedly as the colour only, or but a very poor prospect.* At this time the existence

* "Handbook of New Zealand Mines," p. 103.

of gold at many parts on the west coast of the island had been ascertained. Meanwhile Europeans who from the seaward visited the coast had found indications of gold; and from the settled districts of Canterbury, also, various persons went on a prospecting tour to the west coast of the province. These latter also found gold; but, meeting with many difficulties, on their stock of provisions being exhausted they were compelled to return,* it would appear, without having effected much in the way of discovering gold. In the meantime the Provincial Government of Canterbury began to take an interest in the matter of opening up some parts of the country, and had cut a number of tracks along the more accessible routes of travel, establishing, at the same time, for the supply of the parties engaged in this work, a dépôt of provisions, &c., at the mouth of the Grey River;† but it does not appear that the works then in hand were undertaken for the purpose of furthering the discovery of gold. Some of the workmen engaged, however, availed themselves of the opportunity thus offered, and prospected for gold in various directions, and "some of them remained in and about the Little Hohonu and Greenstone Creeks, near the junction of the Teremakau, prospecting for gold, which could be found in small quantities in the banks of the creeks and low gullies, but no good or fair finds were reported. It does indeed seem strange that gold should have been found by many different parties, and in different parts of the country, without any of these finding any but a comparatively trifling amount of the precious metal; and, as in cases these finds were made in localities that afterwards turned out exceedingly rich in gold, it must be concluded that the difficulties were very great, and the means of prospecting very limited, or that the comparative failure in each case was due to a lack of knowledge of the proper methods of saving the gold. But," says the work from which are taken the above extracts, "at about this time an experienced miner, named Albert Hunt, had been exploring the accessible hills for many months, going through as far as the Wairau on one occasion. He at length attached himself to Mr. Drake's survey party on the West Coast, and, when not required on Government work, took every opportunity to explore the country and examine likely spots for gold. When no longer required on the survey, Hunt was so impressed with the appearance of the Hohonu that he returned with a party; and, when his mates had despairingly left him, owing to the Provincial Government dépôt at the Grey not being available for a constant supply of provisions to those remaining on the spot, Hunt contrived to stay behind, and in a few months got together about 20oz. of gold." Subsequently, Hunt set to work in a regular way, with a Maori for a mate; and it was afterwards reported that, from his prospecting at this time, the average result was gold at the rate or value of £2 a day. On the 11th of July, 1864, Hunt was with his Maori mate working at Maori Point, Greenstone Creek, and on that date was seen by Messrs. Revell and Hammett to wash 4½oz. of coarse shotty gold, which, he stated, was the yield for the day for two men; and on the 19th of that month these gentlemen proceeded overland to Christchurch to report the discovery of gold at the Greenstone, bringing at the same time 16oz. of coarse gold with them. In the meantime others had been prospecting at the Grey, and French and Smart had obtained 4gr. to the dish in several places.‡ Thus and in this manner gold was discovered on that part of the west coast of the South Island with which this report more especially deals. A rush set in, and on the 12th September Mr. Revell reported that the majority of the diggers were making from £2 to £5 a day. In October, one hundred and fifty diggers had gone out from the Greenstone to prospect the ranges between the Teremakau and Hokitika, and it was reported that at that time seven hundred men were on the field; and that same month 500oz. of gold was exported to Nelson, evidently a part only of the earnings of the miners.

It matters not at this date what then were the sentiments of the bulk of the Canterbury people on its being known that a prosperons goldfield had been discovered on their own territory. The stockowners and pastoralists, and to some extent also the agriculturists, had shared in the benefits arising out of the gold discoveries made in Otago since 1862; but there had been a tendency to increased wages and an unsettled condition of the working population, and a reflux of the unsuccessful and impecunious element, always to be found on the most successful diggings, had ere this set in towards Canterbury, and her farmers and squatters cared little that it should be a burden upon them. At no time had the Provincial Government of Canterbury favoured or given much encouragement to prospecting for gold on the west coast of the province; and now that a goldfield had actually been discovered, and proved payable, if the *Lyttelton Times* of the date of the 30th July, 1864, is to be regarded as an exponent of the public sentiment, these found expression in the following words: "If a goldfield is, after all, to be forced upon Canterbury, without the consent and contrary to the expressed desire of the settlers, they must nevertheless submit to fate; and, should the natural feelings of discontent, swelling up in their prudent bosoms when Fortune's golden favours are thrust into their hands, be somewhat hard to subdue, the consolation exists that the goldfield has turned up in the remotest corner of the province." Nevertheless, the importance of the West Coast as a gold-producing country continued to increase day by day. Great numbers of experienced miners arrived from Otago, Victoria, and other parts; and to the discerning mind it was now very evident that, in spite of all drawbacks and discouragements, permanent settlement was about to be established. The rush from Otago and Canterbury is graphically described by Dr. von Haast, the Provincial Geologist of Canterbury, in these words: "In the autumn of 1864 several hundred gold-diggers went there (to the West Coast) from Otago as pioneers; they first worked in the Greenstone Creek, flowing into the Teremakau River, but after a few weeks they removed to the goldfields discovered in the meantime at the Waimea River, six miles south of the Teremakau. The letters of these people to their friends, in which they described the extremely rich finds, and the repeated remark that brilliant 'prospects' might be expected almost wherever a pick and shovel was put into the terrace or bed of a creek prospected, soon had the effect of making the numerous diggers who were working in the Otago goldfields leave them in crowds and set out far the West Coast. Besides the restlessness of a goldfield population, which is proverbial,

* "Handbook of New Zealand Mines," p. 112. † *L.c.*, p. 113. ‡ *L.c.*, p. 117.

the prospects of the mild winter on the West Coast, with its inexhaustible forests, presented such favourable contrast to the severe continuous cold and the violent snowstorms in the sub-alpine country of Otago, where there is great scarcity of firing, that it served as an additional incentive to migration. Quite eight thousand gold-diggers set out from Otago for the New Eldorado. Towns like Queenstown and Kingston, on the Wakatipu Lake, soon stood almost entirely deserted, and the few inhabited houses sheltered for the most part the female part of the population, who only waited for decided news from the West Coast to follow their husbands with their children. Houses, which a few months before could not be bought for less than several hundred pounds, were got rid of for a trifle. Strange to say, in just the same feverish haste, these very people hurried away from the place (the West Coast) to which they had so lately come through numerous privations and dangers."* The writer is here speaking of the contingent of Otago, which reached the West Coast at the time stated in the above extract; but no one will believe that without good reasons these men abandoned the field they had so lately sacrificed so much to reach. Some, indeed, returned to Otago, but as a matter of fact the great bulk of them remained on the coast—a fact that may be attested by the presence of the miners on the coast at the present time. Such men were not of that class who lightly yield to difficulties even under a considerable amount of hardship and discouragement. It was the non-practical and inexperienced, recruited mainly from the Canterbury eastern district, who constituted the bulk of those who returned without having given the field a fair trial, or proved aught except their own unfitness for the work they had undertaken. Dr. von Haast himself makes this sufficiently clear when, further on in the report which has just been quoted from, he says, "Whoever is acquainted with life on the goldfields"—which, by the way, Dr. von Haast was not—"will understand that, with the gold-diggers proper, the whole population which follows in their train immediately departed. Not only the storekeepers and packers, artisans, and publicans, but also the *demi-monde*, sharpers, and idlers of every kind, resembling marauders who follow an army, moved like a living stream through the country."

It might be inquired, if under any possible circumstances the population of Christchurch, or the more respectable part of it, were shifted to a new and more salubrious situation, would not those classes which have been mentioned by name as following the migrating diggers also forsake their haunts in the old Christchurch to maintain or better their fortune in the new town? Assuredly such would eventuate. But no doubt the good people of Canterbury were occasionally shocked at what they had sight of, shall we say, for the first time. Dr. von Haast's narrative continues thus:—

"In the meantime the gold fever had not only attacked the population of the Otago Province; all New Zealand, and even the Australian Colonies, were more or less affected, and numerous steam and sailing vessels unloaded their living freight on the formerly desolate West Coast. Thousands of men who, in consequence of their usually sedentary lives, were the least fitted to bid defiance to the elements, to carry heavy burdeus on their backs, and at the same time put up with scanty and bad food, would not be warned, but followed in pursuit of the gold which, as report said, was so easy to obtain. The clerk left his desk, the artisan his workshop; even doctors, lawyers, and merchants, whose sphere of action was not quite what they desired, preferred to give up their professional position and domestic life in pursuit of the uncertain wealth in the distance. As a matter of course, most of these people returned without having attained any results, while many, terrified by the mountain torrents, and being, to their advantage, soon sobered down, came back again when they had scarcely gone half way. . . . .

"On the 29th of March I left Christchurch with three horses and accompanied by three men; the weather was glorious, as it nearly always is in the latter part of our summer, not a cloud in the deep blue sky, and travelling was pleasant and easy, as a well-made road only a few miles distant from the sea-coast leads from the capital for thirty miles north to the Waipara. What stirring life was on the road! Wagons of all kinds came and went, bringing provisions and other goods to the Waitohi Gorge, where the wagon-road ends. An endless train of gold-diggers with packhorses, packers driving horses before them, and even women walking stoutly along by the sides of their husbands, and often leading packhorses, all going to the new El Dorado. Travellers on foot with heavy packs on their backs, and shovels and pickaxes in their hands, were also there, many of them already having come several hundred miles. It was easy to see from their appearance that most of them were accustomed to such journeys with their accompanying privations and hardships; but an experienced traveller could easily descry among them single groups whose outfit and appearance showed at once that they were novices, and hardly in the condition to bear the fatigues before them. . . . .

"The traveller could not help being especially struck here with the feverish movement of a population hastening to a newly-discovered goldfield. Many of the diggers and storekeepers who had brought loaded wagons from Otago, in the belief that they could take them at least to the foot of the saddle which leads over the central chain, were now obliged to leave them behind, and take their stores on with packhorses. Many large wagons were therefore sold for a trifle, while others which did not immediately find a buyer were simply left behind. And what a busy active life was here to be seen! Everywhere tents and camp-fires, around which several hundred persons were encamped, most of them making preparations for continuing their journey, and often speaking in different languages, English being of course predominant. During the whole of the afternoon, and late in the evening, travellers kept arriving. . . . . As I observed the different groups, I could not help noticing, in spite of the commotion and the noise, how very earnest the people were. There was very little drinking, and still less singing; each one was too much occupied with putting up tents, cooking, and especially with his preparations for the journey, and was thinking no doubt at the same time of the difficulties before him. At the Waitohi Gorge I met several parties of diggers who were on their way back to Christchurch, not being able to endure the hardships of the journey;

* "Geology of Canterbury and Westland," p. 66.

they had been compelled to make their way back overland as soon as their means were exhausted. Most of them were dreadfully ragged, and looked quite famished and fallen away, and they could not say enough about the horrible condition of the road, and the dangers they had gone through. The gold-diggers by profession did not, however, consider it worth while to listen to them, as they saw directly that they did not belong to the right class of men to undertake such journeys successfully."

Dr. Haast himself was bound for the new goldfield for the purpose of examining the geology of the country, and the nature of the auriferous deposits. After a variety of adventures on the way, he reached the Greenstone Creek, the scene of the first discoveries by Hunt, and thence made his way to the mouth of the Teremakau River, whence a smooth beach led uninterruptedly to Hokitika. His description of this town, then in its infancy, will, I take it, be best given in his own words. He says:—

"The next morning, April 21st, we started early for Hokitika along the beach, which, during ebb-tide, offers generally fine travelling-ground on a hard sandy bottom. The whole way appeared like a great main road rather than an ocean-beach. Horses and riders, packhorses and their drivers, men with swags, wagons drawn by horses or bullocks—the whole a picture of earnest activity—proved that we were advancing towards the great centre of the goldfields. At the mouth of the small Waimea River, distant about five miles from the Teremakau, we found a settlement of small extent, consisting of about thirty shanties and canvas houses, mostly stores and publichouses. There the road leaves the coast for the extensive diggings at the head of this creek. A similar but larger township was found at the mouth of the Arahura, which we passed after a march of a few hours. The nearer we approached Hokitika the more the traffic became animated, and, when we at last entered that city of yesterday, we could not conceal our astonishment that in so short a time of only a few months such a large place could have sprung up, which, being literally built on sand, seemed at the same time healthy and clean. The principal street, half a mile long, consisted already of a large number of shops, hotels, banks, and dwelling-houses, and appeared a scene of almost indescribable bustle and activity. There were jewellers and watchmakers, physicians and barbers, hotels and billiard-rooms, eating- and boarding-houses, and trades and professions of all descriptions. Everywhere the English language would, of course, be heard in its principal dialects, as well as German, Italian, Greek, and French, and several other tongues. Carts were unloading and loading, and sheep and cattle driven to the yards; there was shouting and bell-ringing, deafening to the passers-by; criers at every corner of the principal streets, which were filled with people—a scene I had never before witnessed in New Zealand. Hundreds of diggers 'on the spree,' and loafers, were everywhere to be seen, but principally near the Spit and on the wharf, where work went on with feverish haste."

I by no means insist that the whole of the foregoing account shall be accepted as a correct diagnosis of the state of society on the West Coast during the first year or two after the discovery of gold and the settlement of the country by a mining population, nor do I think that those now on the Coast, who had experience of those earlier days, would indorse all the statements made; but Dr. Haast's account is the only one that, as a contemporary narrative, is available to me.* For several years the West Coast continued to support a large mining population, but after the first two years new gold-bearing localities were discovered more rarely, and the richer parts of the old diggings showing signs of exhaustion, people began to consider the future prospects of the Coast, and to look at things more seriously. It was seen that the tendency of the gold discoveries was to be within a limited area, between the mountain ranges and the sea, and along the sea-beaches of the coast-line. Prospecting had resulted in but few discoveries being made within the bounds of the mountain region; and it was evident that the localities, being worked in the ordinary way of cradling and ground-sluicing, with a limited supply of water, would eventually become unpayable, Gradually, too, the black-sand beaches were becoming exhausted, and amongst reflecting people. very naturally, it was foreseen that something must be done towards the revival of mining.

With an ample and efficient supply of water the gold-yield of many localities, which had begun to decline, might again be brought to a satisfactory amount. And now commenced the era of water-races on a large scale, and gold-saving by means of hydraulic-sluicing. Large sums were spent by private individuals, companies, and by the General Government, for the purpose of bringing water-supplies on to the various gold-bearing areas of the northern district of Westland, and, on the completion of a number of these works, there was a consequent revival of mining. Several of these works had already been constructed and in operation, favourably affecting the returns of gold from the areas thus benefited, when, in August, 1876, the rush at Kumara broke out. This being a new field, and the ground being rich enough to work profitably without adopting the system of extended sluicing areas, it was not till the richer parts had been worked over, or driven out in the ordinary way, that sluicing areas began to be granted. But when extended areas were thus granted it was evident that a very large water-supply would be required on this field alone, and hence the bringing in and completion of the Kumara water-supply as one of the more important public works for the benefit of the West Coast goldfields.

The discovery of the Kumara goldfield was opportune in the interests of gold-mining in the northern part of Westland, and until now it has maintained a large population, which otherwise must have been put to serious shifts on the older and more exhausted gold-bearing areas. But the discovery did not do this alone, it indicated a new and vaster, if a less rich, source of gold than had with certainty been previously ascertained—viz., the auriferous glacier deposits, and the old river-drifts that underlie these. This class of mining is but being begun in Westland. Its prospects and probable extension will be discussed in a further section of this report.

Since the first of the rush, gold-mining has been carried on at Humphrey's Gully, in the Arahura Valley; but it was not till the end of 1881, or the beginning or 1882, that it was seen that the auri-

* This account by Dr. Haast formed part of a report to the Provincial Government of Canterbury on "the West Coast Goldfields," made in 1865.

ferous drifts of this part of the district were extensive enough to warrant sluicing-operations on a large scale. And it has required the latter examinations to be detailed in the further portion of this report to demonstrate the real extent and value of the auriferous deposits of Humphrey's Gully Range, and of like deposits of the same, or nearly the same, age in different parts of the district. Humphrey's Gully Claim, though, perhaps, it has not yielded up to the first-formed expectations of the promoters of the company, has yet to be looked at as giving returns leading to the conclusion that all the water that, at a reasonable cost, can be brought to bear on this or similar deposits in the same district, will, at least, pay interest on the capital requisite.

But while all this has been, and is so, as respects the development of mining over the low grounds of Westland, the discovery of gold-bearing or other metalliferous lodes in the mountainous interior part of the district has been slow, and the reefs that have been found and prospected have not yielded according to what might have been expected. Naturally enough, it was concluded that the district which supplied so much alluvial gold to the lower grounds must abound in rich auriferous reefs, and, although there were those who speculated as to the probability of a different source, undoubtedly the most natural inference was that the gold had been brought down from the mountains of the interior, and by various processes, distributed over the low grounds and along the coast-line by ordinary natural agencies, including the action of glacier ice as a means of transport.

As a result, early in November last, I was instructed to examine the country towards the head waters of the Arahura and Hokitika Rivers, with a view of ascertaining on what grounds these hopes and surmises might rest. I did not succeed according to my wishes in this respect; and the further interior country of the Hokitika watershed was not reached, owing to the season being a very unfavourable one for such explorations; more than half my time in the field was lost, due to this cause. Nevertheless, I collected a number of facts that bear strongly on the subject of my explorations amongst the mountains, and my work in the lower coastal region has not wholly been without result.

Examination of the District in connection with the Development of the Mineral Resources of Westland.

The principal object of the examinations made being the "discovery of any auriferous or other metalliferous deposits that occur in the country about the Upper Arahura and Hokitika Rivers," on my arrival at Kumara, as soon as possible I commenced the exploration of the Arahura Valley. Gold discoveries were, of course, to be expected, and the nature of the deposits in which gold is found in the lower valley had to be studied, as a guide to the rocks in which auriferous lodes might occur in the mountainous part. Being aware that detrital matter from the Upper Arahura watershed was spread over a considerable area, which is not now drained by that river, or any of its tributaries, but by the Kapitea Stream, and which also forms part, the southern side, of the long line of morainic hills that extend from Dillmanstown east to the western base of Mount Turiwhate—this area had also to be taken into consideration. Later on, it was ascertained that the gold-bearing gravel of the Waimea Valley, at least of the upper middle and main valley, had its origin from the Arahura watershed, and that the Waimea Valley has been the course of a river, of far greater volume than its watershed at the present day could supply. The probabilities are great that the Arahura formerly passed along the Waimea Valley in its course to the sea. In the same connection, the Blue Spur, Big Paddock, and Houhou Lead had to be examined, and the range of hills between Humphrey's Gully and the Kanieri watershed had, also, to be studied.

The gold-drifts on the coast-line, whatever their source and age—not being, in the stricter sense, valley deposits—though they may imply the auriferous character of the back country, yet from their mixed character and uncertain source, a study of them could be of little advantage in tracing the auriferous belts of the interior inland parts of the Arahura watershed. Neither the high-level terrace deposits, stretching from the north side of the Hokitika Valley below Kanieri north, across the lower Arahura and Waimea Valley, afford the kind of evidence required, being like the lower-level deposits of the coast-line, of marine origin.

The river terraces and low shingle-flats that lie on both sides of the lower part of the Arahura, away from the immediate banks of the river, have not yet been proved to be auriferous. The flat ground between Fox's Creek and the river, one would think should be auriferous; but they do not appear to be so, and the difficulties in contending with water in the low ground prevent its being bottomed. On the opposite southern bank of the Arahura, Mr. Boys, of Blue Spur, has driven a tunnel a distance of about 4,000ft. through gravel-drift, forming a terrace at a higher level above the river, and a second terrace yet higher at the back of that. Though the main object of this work was not to prospect the drift passed through, but to reach and drain deep ground situated nearer the saddle leading from the Arahura Crossing to the Blue Spur, it yet prospected the whole terrace, from the river-bed to where these were passed through and the blue Miocene bottom was reached. Of course, this tunnel did not prove whether or not gold occurred in the higher strata of these terraces, but it proved along the line of the tunnel the middle and lower parts with negative results.

On examination, the gravels proved scarcely different to what may be studied in the Arahura River-bed at the upper crossing, or higher up as far as the second gorge. The only distinction that could be made out was that there were fewer boulders of olivine and serpentine rock in the tunnel gravels than are to be met with on the river-bed.

At Fox's, Stony Hill, Greek's, Duffer's, and Callaghan's, the gold deposits are either morainic, or morainic material re-assorted by the action of running water, and are found resting on brown gravels ("Old Man bottom"), or on "blue bottom" (fine sands or sandy calcareous clays of Miocene age). The material of such deposits vary in different localities, but as a rule granite rocks predominate, and this at first sight might lead to the inference that the gold has been derived largely from the granites and gneissic rocks that lie to the westward of the mica-schist belt. Partly confirming this hypothesis, is the fact that the material of the Kawhaka River-bed is chiefly composed of

granite, and, from its source between Island Hill and Turiwhate to its junction with the Arahura, the beaches of this river have for the most part proved auriferous, and many of them have been worked more or less successfully. Payable gold, it is said, has been traced right to the very saddle leading into the valley of the Arahura-Wainihinihini. The morainic hills that lie between Fox's School-house and Whiskey Creek, and on the opposite side of the Kawhaka to the Arahura, opposite Humphrey's Gully, do not contain such a large proportion of granite stones as are to be found in the Kawhaka River-bed, and the granite masses of Turiwhate and Island Hill must be accountable for this difference.

The beaches of the Arahura were payable to work for gold as far up the river as the lower end of the first gorge, carved out of the huge moraine that has been already described; but the Humphrey's Gully Range, with its heavy deposits of older Pliocene gravels, extends to the sources of Caledonian Creek, and may have yielded thus far a large percentage of the gold found on the river beaches of the present day. But, at the same time, the morainic hills on the north side of the river have yielded gold, and are still considered worth prospecting; and these also would be, it is evident, a source of gold to the river-bed. The beaches of the Arahura thus far have been worked with good or highly payable result. After floods the same beaches were again worked, and are still worked, though with less payable results. Through the first gorge, and above it to the junction of the Arahura-Wainihinihini, the river-beaches, though not so rich as below the first gorge, yet paid to work for the first time. These are still being enriched by tribute from higher up the stream, or by the shifting of the river-channel, when new beaches are formed that are rich enough to be worked, though by no means are they equal to the beaches first worked.

A mile above the junction of the Wainihinihini, or at the junction of Mount Brown Creek, the granite belt is passed through and the mica-schist rocks are entered upon. The second gorge is cut almost wholly through mountains of mica-schist. On the south side of this gorge especially, there are heavy deposits of shingly matter, forming high terraces washed by the river. In floods, not only do the tributary creeks bring fresh material from the mountains, but cutting across these terraces they carry to the river channel large quantities of terrace material. This is carried along by the main stream, either into the flat country below the gorge, or, short of this, arrested for a time, it forms narrow terrace-flats along the lower part of the gorge, or beach deposits within the ordinary flood-mark of the river. Strange to say, though they yield a little gold almost everywhere, none of these deposits have yielded so as to lead to the systematic working of them. Prospectors finding a little gold in the deposits lodged in the gorge were led to believe that the gold came from the upper part of the river above the Crowbar Gorge, and usually made an endeavour to reach this part, where the river runs in a less confined course along a narrow mountain valley, and where also the rocks change from crystalline schists to the ordinary slates and sandstones of the Upper Taipo and the Otira Gorge.

Greater facilities certainly were afforded for the concentration of gold at particular places along this upper valley of the Arahura, but, though prospectors here and there worked a patch on a beach or the river bank, no regular workings, and so far as I have been informed, no paying deposits of any extent were ever found. For years past no attempt has been made to work for gold on any part of the Arahura above the first gorge.

Between Humphrey's Gully and the crossing of the Christchurch–Hokitika Road, the Arahura River-bed shows a great variety of different rocks and minerals. A collection of these was made, to indicate what might be expected from the rocks *in situ* in the upper part of the valley. The gravels being sluiced into the Arahura from the Humphrey's Gully workings are for the most part decomposed, so as to be easily distinguished from those brought farther down the river, and do not interfere with the determination of what belonged to the back country. Collections with the same object were made above Humphrey's Gully to the foot of the first gorge. The granite boulders of the river-bed were easily separable to Island Hill, and the Mount Tuhua Range on the opposite side of the valley. These seldom showed the presence of metalliferous minerals, except now and again iron-pyrites disseminated through the mass. But, in this connection, Mr. W. M. Harcourt obtained in the Kawhaka River-bed a granitic or gneissic boulder, intersected by a thin vein of quartz, highly charged with copper-pyrites. No such specimen could be obtained from the Arahura River-bed above the Kawhaka Junction. Report says that in cutting the Humphrey's Gully Water-race, along the slopes of Mount Tuhua, that a vein of quartz with copper was exposed. This would be in gneissic rocks or granite country; but I did not see the outcrop, as those with me had no knowledge of its exact whereabouts.

In the harder schist-rocks of the Arahura River-bed, copper-pyrites are plentiful, but generally as scattered crystals, disseminated through the other constituents of the rock, chiefly in highly siliceous actinolite schists. Copper also occurred disseminated through the softer grey mica-schists and sometimes in such quantity as to lead to the belief that particular parts of these schists might pay to work. In this case, the copper appeared to be intimately associated with the rock, and to the unaided eye does not exist as separate crystals.

Olivine and serpentine rocks are abundant in the shingle of the river-bed below Humphrey's Gully, and, higher-up, boulders of this class increase in number and in size greatly. These rocks frequently contain iron and copper pyrites and crystals of chromic iron. Many of the boulders of olivine rock resemble a dark form of jade or greenstone; thin splinters of the rock being translucent, and of a darker or paler green, according to the thickness of the specimen, and the manner in which it is viewed. Ruby-crystals, or ruby-bearing rocks, were also much sought for, as it was thought the valley of the Arahura would be as likely to yield these as that of the Hokitika.

Last year I accompanied Mr. Gordon in the course of an official visit to Rimu, Back Creek, and Ross. During this trip, while at Rimu on the 9th November, 1891, a student of the School of Mines at that place showed, as part of the collection of rocks and minerals collected from the claims in the neighbourhood, a sample of what in the school had been determined as corundum, or emery rock. This was massive, and of a dirty brownish-grey colour. Next day, in several of the

claims at Back Creek, and in the sluicing-claims in the face of the terrace overlooking the Hokitika Valley, the presence of much olivine and some pieces of true serpentine was noted. And, in a claim in the terrace-face, one of the miners pointed out a boulder which had before attracted his notice as being composed of very peculiar materials, and of excessive hardness. I obtained two small specimens from the mass, which I brought to Wellington and submitted to Mr. Skey for determination. Mr. Skey pronounced the crystals included in the pale-green mass of the stone to be ruby, or corundum. This was during the last week of December, 1891.*

Subsequent to the dates mentioned, Mr. William Goodlet, whilst on a lecturing tour amongst the various Schools of Mines on the West Coast, visited Rimu, and obtained samples of the ruby-stone. These at the end of his trip he took with him to Dunedin. And sometime afterwards he submitted them to Professor Ulrich, of Otago University and School of Mines, Dunedin. Professor Ulrich pronounced the crystals to be true oriental ruby, of a fine colour, and pointed out the valuable nature of the discovery, provided crystals of larger sizes could be obtained, or, if of lesser size, abundant enough to collect as a superior quality of emery.

Where to look for the ruby rock *in sitû* was the next matter to determine. One could but guess, since a stray boulder in the gold-drift at Rimu afforded little indication as to the whereabouts of the parent rock whence this had been derived. I somehow associated the ruby rock with the olivine and serpentine belt, much material from which had also become mixed up with the gold-drifts of Rimu and Back Creek. The evidence of the Arahura River-bed indicated a heavy band or belt of this rock somewhere along the upper part of the valley; but it was in vain I searched the river-bed for samples of the ruby rock. The gold-bearing sands of the more likely beaches were washed to see if minute or broken crystals of the ruby could be found in this way. Garnets in plenty could thus be collected, but no trace of ruby. Next, I examined the pannings-off of the Humphrey's Gully Tail-race, which, when washing-up, are usually thrown aside at a particular place; but these also yielded no result. The river was then followed to the Old Lake Basin above the first gorge, and the valley of the Arahura–Wainihinihini explored, and the left-hand branch of this, till the inaccessible mountain gorges of the Mica-schist Range barred further progress. Olivine and serpentine were comparatively rare in the valley of the Wainihinihini, and such boulders as were found seemed to have been brought thither by an off-set from the main body of the Arahura glacier which flowed up the valley, and escaped into the western low grounds through the saddle between Turiwhate and Island Hill.

A few blocks of white quartz were found at the foot of the gorge of the left branch of the Wainihinihini, but indications of metalliferous minerals were otherwise rare. The floor of the east side of the valley consists of gneissic schists, which also forms the eastern slopes of Turiwhate and Island Hill. The Mica-schist Range rises abruptly on the east side of the valley, and its slopes on this side expose only the lower series of the mica-schists, as a dark contorted mica-rock, abounding in garnets. A large mass of rhodonite (silicate of manganese) was the only mineral worthy of special notice collected from this tributary valley.

Mount Brown Creek joins the Arahura a mile and a half above the Wainihinihini Junction, and this also was explored, but without satisfactory results. Beyond the influence of the Arahura, when running at higher levels, or the lateral deposits of the main body of glacier-ice, great masses of sandstone were found in the bed of this creek, which seemed to indicate the existence of unaltered rock in the upper part of the creek, or on the higher part of the range. There were indications of a change in the nature of the rocks at the furthest point reached (1,000ft. above the sea), but there being an absence of quartz or other minerals of special interest, the further examination of the valley in its higher part was not proceeded with. Mount Brown Creek joins the Arahura at the entrance to the second gorge.

The second gorge of the Arahura, unlike the first or lower gorge, has been excavated across the rocks *in sitû* of the Mica-schist Range. The banks and rapids of the river are studded with large boulders of olivine rock, and great masses of schist fallen from the adjoining height, or with the huge blocks of sandstone that have been brought from a distance up the valley by the action of the stream or glacier-ice.

To trace the power of the olivine blocks was now my principal object, as there were distinct evidences that this would prove the chief mineral belt of this part of the country. About two-thirds the distance through the gorge a large creek coming from Lone Peak, on the south side of the valley, brings into the river-bed great quantities of olivine rock, and above this junction the green boulders in the bed of the river are not nearly so numerous as below the junction. A mile higher up they are occasionally met with, while further on towards the upper end of the gorge they are rare. On the south side of the valley there was some difficulty in getting to these rocks *in sitû* on account of the glacier-accumulations, which had filled the valley to a depth of nearly 1,000ft., and through which the rivers and creeks have cut their present channels. Beyond this, the mountains rise very abruptly, and it is not easy to get along the creek gorges, neither is progress less difficult by way of the cliffs and precipices of the range-slope. Finally, the mountain range had to be ascended, and the western ridge of Lone Peak followed to the point where it is crossed by the olivine and serpentine belt. This is from 300ft. to 500ft. in width, and divides the upper from the middle division of the schistoze rocks. It does not, as has been supposed, lie along the junction of the schists with the unaltered Palæozoic rocks to the eastward. Copper is widely disseminated through the olivine rocks, and in the schists associated with or adjoining the mineral belt. Some of the schists are so rich in copper that it would be possible to work these did they occupy a more approachable position. Their inaccessibility debars the hope of this at the present time. The sample brought to Wellington contains from 8 to 10 per cent. of copper.

* Unfortunately no record of this determination appears on the books of the department, the test having been made merely for my satisfaction in the first place, and subsequently it was omitted to enter the result in the Laboratory records.

On the opposite or north side of the gorge the mineral belt could easily be traced by the eye, but the river, for the most part, was too high to ford, and was at all times dangerous, so that on one occasion only could this part of the belt be approached or examined. The indications of copper and various forms of iron, according to Mr. R. A. Harcourt, who accompanied me as field-assistant, are on this side of the river much stronger than on Lone Peak Range. The third or higher division of the schists occupy the upper end of the gorge, and, gradually losing the character of metamorphic rock, are traceable as far as the Styx Saddle leading from the Upper Arahura into the valley of the Browning River; the dip of the strata being to the eastward, the mountains high, and the valleys narrow mountain gorges. The unaltered sandstone formation is found on the top of Lone Peak, west of where schist rock appears on the Styx Saddle. This, however, does not imply unconformity between the sandstones and the mica-schist series, but is accounted for by the rugged surface features which have just been indicated.

The middle division of the mica-schist series (actinolite schists) was examined near the junction with the olivine rocks for indications of ruby-rock, but without success. Gold can be obtained to the source creek of the river, but not in paying quantities. The absence of quartz from the rocks of the Arahura Valley is very remarkable. Below the junction of Mount Brown Creek some large blocks of white quartz were noted, but higher up the valley none seemed to be present. At least, no reefs were discovered, and scarcely any quartz boulders appeared in the terrace gravels or shingle of the river-bed. Thin bands of quartz are met with on the Styx Saddle. From the above account it will be seen that the beaches and banks of the Arahura get gradually richer in gold as the river is followed from its source seawards, and that paying deposits only begin after the river has passed through the upper and entered the low grounds between this and the first gorge, and that the best and richest deposits occurred below the first gorge. Above the first gorge none of the tributaries of the main stream afford gold in anything like paying quantities. Throughout the whole of the valley there is a remarkable absence of reefs of vein quartz. These facts led me to the conclusion that the gold is widely disseminated through the schist rocks, and, to some extent, also in the sandstone rocks near the source of the river; and that the sluicing of the great terraces in the second gorge affords the gold which is found between the first and second gorges. The denudation of the great moraine extending across the valley from the eastern slopes of Island Hill to Mount Tuhua, by which the first gorge was formed, resulted in the sifting and re-assortment of a vast body of slightly auriferous material, which yielded gold to the beaches and lower flats of the valley nearer the sea. Morainic accumulations, 200ft. to 300ft. feet above the level of the river, yielding gold are found on both sides of the river below the first gorge. On the south side of the valley, about midway between Olderog's Bluff and the junction of Caledonian Creek, a considerable amount of ground has been worked for gold. The material worked is re-arranged morainic matter resting on older Pliocene gravels (Old Man bottom). Higher on the range massive blocks of sandstone and hard schistose rocks indicate the presence of glacier moraines, now almost destroyed. These moraines and the older Pliocene gravels of the Humphrey's Gully Range, it would appear, have supplied gold to the terraces at lower levels.

The extensive sluicing operations carried on at Humphrey's Gully operate solely on the older gravels of Pliocene date, and a thin remnant of glacier-deposit resting on the surface of these. The source of these older gravels are a problem difficult to make out; unlike the younger gravels of the Arahura Valley, they contain no blocks of olivine, serpentine, or greenstone rock. And it is hardly conceivable that, since the deposit was accumulated, these could have decomposed beyond recognition. Otherwise, there is much granite, and the harder varieties of schist rock mixed with the predominating sandstones of the deposit.

At Fox's, the auriferous gravels are re-assorted glacier-material, resting on blue sandy clays of Miocene date, or as at Stony Hill, on "Old Man bottom." The upper part of Hatter's Gully, Red Jack's, was not visited; but the gold here is, from the position, clearly either in the Old Man bottom, or a re-wash from it.

On the north side of the Blue Spur, facing the Arahura Valley, rich deposits consisted of morainic matter resting on a steep slope, consisting of blue Miocene bottom. This is the bottom also on the opposite side of the spur, drained by the Three-mile Creek.

Just at the neck or saddle by which the road from the Arahura Crossing reaches to the Blue Spur Township, the marine beds of the Houhou Lead begin, and Simeon's Claim, opposite Boy's Hotel, is being worked at a height of 200ft. above the sea in these marine beds.

From the Arahura I went to the Kokatahi Plain, and from thence examined the lower part of the Browning, Kokatahi and Toaroha Rivers, which, by their union, form the Lower Kokatahi. Rocks from the olivine and serpentine belt proved comparatively scarce in all of these river-beds. Granite is met with on the north bank of the Browning, between where it enters the plain and the opening between the mountains leading to Lake Kanieri. The outer mountains bounding the valleys of the other two rivers are formed of schist. Through the mountains the Kokatahi and Toaroha have cut deep gorges. Beyond these schistose mountains, by a number of source-streams in each valley, the sandstone country of the main range is drained. In all of these streams quartz as boulders in the river-bed is rare; and I had with me a miner who prospected the valley of the Browning for some considerable time without raising more than the colour of gold. On the spurs between the Kokatahi, above the junction of the Browning and the upper part of the Kokatahi Plain, towards the Hokitika Gorge, a quartz-reef was discovered many years ago. It was opened out to some extent, and a trial crushing made, but without satisfactory results.

From the Kokatahi I went to the gorge of the Hokitika. The rocks at the lower end of the gorge are granite, the schist rocks beginning at about two miles along the banks of the river from the lower end of the gorge. Schist continues up the gorge to the lower slopes of Mount Meta, between the Hokitika River to the north and the Pass River to the south. Along Frew's Creek and in the upper third of the schist series the olivine and serpentine rocks have a great development, and from this large quantities of material are carried through the gorge, and form the coarse

shingle and boulders of the river-bed immediately below it. Here, as elsewhere, search for ruby-rock proved in vain. Mount Camel-back, on the north bank of the Hokitika, stands isolated and apart from the granite mountains on the south side of the river. Its higher part is formed of coal-measures dipping to the north, and in this hill the sequence of the formation as seen between Greymouth and Brunnerton appears to be complete, the Cobden limestone closing the series. The southern end of the hill appears to be granite, overlain in its lower slopes by morainic matter, and at a lower level by the terrace gravel of the Hokitika River. On the south side of the river no examinations could be made, but on the lower granite hills between the Hokitika Gorge and Constitution Hill, there were evident signs of the coal-formation overlying the granite, and forming plateau-topped hills. I also learned that on the eastern side of these table-topped hills the coal dips into the heads of the valleys in the direction of the Upper Totara River.

At Ross, which I visited for the purpose of comparing the gravels of the "Old Man bottom" with those of Humphrey's Gully, I found that in the head of Sailor's Gully not only had the upper coarser gravels been worked for gold, but the first 40ft. of the "Old Man bottom" had also been sluiced away. The difference in the nature of the "Old Man bottom" here and at Humphrey's is considerable, granite and schistose rocks being very poorly represented in Mont d'Or. I spent a day at Back Creek and Rimu, studying the material of the gold-drifts, comparing these with the materials of the Hokitika River-bed where it leaves the mountains at the upper end of the Kokatahi Plain. To a large extent the material is similar, and clearly derived from the same source.

I next examined the valley of the Kanieri River, and the gold-workings at the Kanieri Forks. Between the south branch of the Kanieri and the Kokatahi Plain a heavy moraine lies along the southern slopes of the hilly country, and extends in the direction of the Kanieri Forks, where it blends with the moraine-covered country lying between the Forks and the foot of the lakes, and which also extends along the southern side of Humphrey's Gully Range to Kanieri Township. The gold-workings at Kanieri Forks and along the north branch are in these glacier deposits. The shingle in the bed of the creek formed by the union of Smith's and Coal Creeks is, to a large extent, gravel formed by a rusty-brown micaceous sandstone, which also appears in the main stream to and below the Forks. This is derived from the area of coal-bearing rocks that lies between the Miocene deposits and the granites of Conical Hill and Mount Graham. At the time of my visit the weather was most unfavourable for exploring the country amongst the bush-clad ranges, and I was not able to determine whether or not the slates and sandstones of Mount Greenland and Constitution Hill underlie the coal-bearing rocks of this part and interpose between these and the granite; but it is certain that on the south side of the lake a considerable area, hitherto mapped as unaltered Palæozoic rocks of probably Carboniferous age, is occupied by granite at the surface. Also, the micaceous sandstones of the coal-bearing series are in their lower beds so much indurated that they might very well be mistaken for much older rocks.

The valley of Kanieri Lake was at one time the chief outlet of the glacier-ice of Mount Sale, and the upper part of the watershed of the Browning River, the ice from the Kokatahi and Toaroha rivers apparently blocking the passage by which it might have taken a more westerly course.

From the north branch of the Kanieri, glacier-ice carrying morainic matter from the back country has found its way into the head of the Three-mile Creek; these deposits, about a mile above Blue Spur Township, being at present worked for gold. While at Humphrey's Gully I thought that an off-set from the Arahura glacier might have supplied glacier material to the head of Three-mile Creek, but when at Kanieri Forks it appeared more feasible that it should be due to the Browning glacier, flowing through the valley of Kanieri Lake.

Opposite Humphrey's Gully, morainic hills occupy the country between the Arahura and the Kawhaka. These stretch across the Kawhaka, between Whiskey Creek and the school-house, one and a half miles nearer the Arahura Crossing. The western limits of these morainic hills is by Fox's to Duffers and Greek's Creeks to the source of the middle branch of the Waimea, and thence by Callaghan's Hill, Kapitea Creek, and Kapitea Hill to the upper end of Larrikin's Flat, near Kumara and Dillmanstown; and from Dillmanstown the line of bounding morainic hills returns to the eastward and blends with the lower slope deposits of Turiwhate. The area thus enclosed on the south, west, and north by hills of morainic deposit, on the disappearance of the ice, was partly filled by the waters of a lake fed by the Arahura River, at this time passing close under the southern slope of Island Hill. Why this lake did not find an outlet by way of the present lower valley of the Arahura it is perhaps needless to inquire in this place; suffice to say, the evidence is clear that a vast body of water passed down the middle branch of the Waimea, carrying with it much of the morainic matter that had been deposited over the area covered by this extension of the Arahura glacier. Thus the Waimea Valley was filled with a coarse granity wash, highly auriferous, that could not be supplied from its own watershed, as limited at the present time. The Waimea Creek deposits, and the superficial deposits of Larrikin's Flat, Kumara, are parallels of each other, in so far as concerns the source and manner of deposit of the auriferous material found at both places.

The Teremakau Valley, above the point where the river escapes from between the granite mountains, on its northern and southern sides, is, with the exception of what may be supplied along the valley of the Taipo, apparently without gold. The gold in the Taipo Valley itself seems to be confined to the Seven-mile Creek, and a few streams joining from the south-west, in the same line, or those coming from Kelly's Ridge further east.

The gold of the Seven-mile Creek is clearly derived from a line of reefs which has been opened and worked on Jackson's Hill within the watershed of the main valley. This extends south-west across the Taipo and Arahura watersheds into that of the Browning River, small quartz reefs being found on the Styx Saddle and along the western slopes of Mount Sale. These reefs occur in semi-metamorphic rock, or along the line where the mica-schists gradually pass into the unaltered slates and sandstones that occupy all the country to the eastward. The same line passes to the north-east. East of Mount Alexander, blocks of quartz of the same character are to be seen in the shingle of the creeks joining the Teremakau from the north, a little above the Otira Junction.

The line of serpentine and olivine rocks crosses the Taipo near Rocky Creek, above the Gorge and comes out on to the Christchurch Road near to Rocky Point. On the north side of the Teremakau Valley it is continued through the western spurs of Mount Alexander, along the creek nearly opposite Jackson's accommodation-house. In the same line it extends to the northern boundary of Westland.

Above the Otira Junction the Teremakau Valley differs not from what may be seen along the Otira to Arthur's Pass and the Canterbury boundary, until within three miles of the Hurunui Saddle, when a belt of red and green jasperoid and diabasic rocks make their appearance. With these rocks are strings, elliptic masses, and small leaders of quartz, but they seemed to me not more promising for gold than are the like rocks at the Cass in Mount Torlesse, or the Malvern Hills, Canterbury. These rocks in the Malvern Hills have been prospected for a long series of years under the belief that they are gold-bearing, but though this may have been proved, the practical results have not been satisfactory.

From the Upper Teremakau, during the greatest extension of the glaciers, a vast body of ice passed from the main valley through the opening between the granite mountains to the westward and the west spurs of Mount Alexander. This filled the bed of Lake Brunner, and spread detritus over the country as far to the south and south-west as the Upper Greenstone and into the New River watershed. There has, however, in this connection to be considered that a glacier from Granite Hill and the mountains in that neighbourhood flowed along the valley of the Crooked River. This, coming from a more promising gold-bearing country, and necessarily forming the western side or part of the united ice mass, may to some extent account for the gold found in the valley of the New River.

Apart from this, whether in the original morainic heaps, or in those modified and re-assorted by the action of Lake Brunner, or by heavy streams that have much affected the original deposits, it is pretty conclusively ascertained that the gravels brought from the Upper Teremakau Valley are not gold-bearing. The Greenstone Company's Water-race from the Big Hohonu River prospected the country to some extent, and duffer-rushes have occurred in the same area.

Considering the amount of gold obtained from the tributary valley of the Greenstone, and from the main valley at Kumara, with the barrenness of the middle and upper parts of the Teremakau, a fact which is admitted on all sides, speculations have been rife as to the possibility of the granite of Mount French, Mount Smart, and Turiwhate being the source of the larger part, or at least some part, of the gold. Whatever may be said of the eastern or gneissic part of this belt of granitic country, the western part—mostly true granite—gives no support to the theory.

The evidence to be obtained at Maori Point, in the Upper Greenstone, is quite conclusive as to this, and points to the Mica-schist Range and the Taipo Reefs as the source of the great bulk of the gold obtained from glacier material, or such material re-assorted by the action of running water.

Between the north branch of the Greenstone and the Big Hohonu River no payable gold has been obtained either from the terrace-leads, the morainic hills, or from the modern deposits of streams draining from the granite ranges. It is true that from the bed or banks of Mitchell's Creek, falling into Lake Brunner, a little gold has been obtained, but this, or the possibility of a little gold in the bed of the Big Hohonu, is far from proving the contrary of the statement here made. At Maori Point the evidence is quite conclusive. I made inquiries, but neither the information thus obtained nor my own observations led me to believe that the gold in this part of the creek had come from the upper part of its course amongst the mountains. The main stream, and all its tributary creeks, cease to bear gold as soon as they attain a higher elevation than has been reached by the morainic material of the Taipo-Teremakau glacier, which was deposited along the lower slopes of Mount Smart.

Reference has already been made to a probable former channel of the Teremakau from its present valley, which crossing the table-land from the back of the Greenstone Township to the Duke of Edinburgh Terrace, was again deflected to the south, so as to run along the south side of the Greenstone Valley to its junction with the Teremakau Valley, opposite Kumara. Where not yet proved by prospecting along the course of this old channel of the Teremakau, success might attend such efforts. I understand that gold as a fair sluicing prospect has been obtained on the level land between the Greenstone Township and the special settlement on the north bank of the Teremakau, but that there was a difficulty in bringing sufficient water on to the ground known to be auriferous. This certainly would be the case, because the principal amount of drainage from Mount French and Mount Smart is carried by the Greenstone and Big Hohonu Rivers, and only small streams of an intermittent character descend to the Teremakau.

At Donegal Creek, near the junction of the Kumara with the Christchurch–Hokitika Road, prospecting has lately been carried on with the view of proving the higher lands bounding the upper part of the creek valley. Formerly the bed, and at some parts the banks, of this creek were worked, but the area of payable ground not being great, this was soon exhausted, and no attempt was made to trace the source of the gold concentrated along the bed of the creek. The supposition was that the morainic hills cut through by the creek were the source of this gold, and, as at Kumara and Dillmanstown, there being sufficient fall for the tailings, hydraulic-sluicing might be conducted profitably along the sides of the gully. Early in March last I examined the creek, and the prospecting works then in operation. Some distance above the road-line the blue sandy clays of Miocene date show in the bed of the creek. Here had been the best of the old workings. The low flat of the creek-bank abutted against a terrace on the east side of the valley. Here two shallow holes had been sunk at the foot of the terrace-slope, and in in one of them, I was told, a fair prospect of gold was obtained. Under the impression that the wash dipped under the terrace, a drive of some 40ft. had been constructed, under the belief that the gold stratum could thus be reached; but no gold had been found in any part of the distance driven at the time of my visit.

The material passed through in the drive was morainic detritus in its original unsorted condition, while the material from the hole yielding gold was evidently modern creek-wash, so that, unless it was assumed that the terrace itself was only a slip from the higher morainic hills, this work as regarded its special aim was not likely to be carried to a successful issue, but gold occurring in the glacier-drifts might have been met with. The glacier-drifts here should be quite as liable to carry gold as at Kumara or Dillmanstown.

Further up the valley, and on the left bank of the creek, and some 40ft. or 50ft. above its bed, a short drive had been made into the precipitous side of the hill. At the creek level, and also in the floor of the drive, a laminated lake silt was exposed. On this rested heavy beds of coarse gravel of a browaish colour, resembling "Old Man bottom," or, more exactly, the gravel-bottom of Fox's, and the auriferous gravels of the Humphrey's Gully Sluicing-claim. A little gold occurred in the lower part of these gravels, but I saw no prospect washed from more than a foot above the bottom on which the gravels rested. These gravels are of considerable thickness, and extend under the moraines for at least a mile and a half in the direction of Kumara. They show also on the opposite side of Donegal Creek, and underlie the moraines in the direction of Blake's Look-out and the junction of the Loop-line Road with the Christchurch–Hokitika Road.

It is useless to speculate as to the paying character of these deposits until the further results of the prospecting are known; but if it be proved that a little gold is generally distributed through these gravels and the over-lying glacier deposits, some effort should be made to obtain a supply of water from Holmes's or the Government Water-race for the purpose of fairly testing the prospects of the locality.

Neither here nor further along the road leading to Kumara, so far as I am informed, has what might be considered a fair "driving prospect" been obtained; yet the presence of gold in the gravels under the glacier-drifts has been fairly proven at both places, and, could it be shown at either locality that these deposits can be made to pay by means of hydraulic sluicing, this would certainly open up a greatly-extended area of auriferous ground to what is being presently worked in the neighbourhood of Kumara.

Extracts from the Works of previous Observers who have dealt with the Geology of the Northern Part of Westland.

Although the literature recording all the geological observations made within the bounds of Westland is far from ample, I do not here intend to quote it in full, but only to give such extracts from the writings of the more prominent workers as shall serve to indicate their views on the general succession of the different formations present in the district, and such questions as deal with changes in the past condition and configuration of the country, more especially where it can be shown that these have influenced the mode of deposit and location of the auriferous gravels. This section, and some other parts of the present report, were mainly written prior to the last examinations made by me; and by an oversight during my absence in the field, engaged in the same district, the report of last year was sent to press, and I had not the opportunity of revising it as intended.

Dr. Haast was the first to investigate the geology of the west coast of Canterbury. This was in 1865; from his report for that year I have already made extracts. Towards the end of 1866 Dr. Hector visited the West Coast, and since that date has made several subsequent visits. During 1875–76 Mr. Cox and myself traversed the whole of Westland, from Greymouth to Jackson's Bay; and minor examinations and surveys within the limits of Westland have been made by Professor Hutton, Mr. D. Macfarlane, and others. There is, however, but a limited amount of written matter on the subject of the geology of Westland, more especially of that part to which the present report relates. Dr. Haast summarises the result of his work concerning the extent of the West-Coast goldfields in these words: "To sum up the results obtained, the examination of the country under consideration has shown us that there is one large area belonging chiefly to the Pliocene or great gold-drift formation, bounded in this province by the rivers Arnold and Grey to the north, and the Hohonu Ranges, whence the eastern boundary-line runs towards Abut Head, crossing the Arahura, Hokitika, Totara, and Mikonui, gradually nearer to their mouths, whilst the sea-shore forms the western boundary. In this triangle all the richest goldfields are situated. East and south of these lines Younger or Pleistocene strata have mainly been deposited, consisting of glacial beds, either moraines or glacier-mud, fluviatile boulders, shingle, sand, or loëss, amongst which in a lesser degree gold may be discovered, although, from the great scarcity of auriferous assorted drift, there is, in my opinion, very little hope of a goldfield of any extent. Again, east of these glacial deposits, the western base of the central chain is reached, consisting of the rocks which have formed the original matrix of the gold. Here we may expect either to find quartz-reefs or, under favourable circumstances, in the smaller creeks and gullies, auriferous ground of older age or formed during or since the Pleistocene epoch, with coarser gold than near the coast, although experience has already clearly demonstrated in New Zealand, as well as in other parts of the earth, that we can only expect rich ground when, after denudation on an enormous scale, aqueous agency has repeatedly reassorted the material derived from such sources, and concentrated the gold contained in it during numberless ages into much narrower limits." The above is taken from the first "Report on the West Coast Goldfields," published in Christchurch, in 1865. In 1879 he adds, "Not only are the principal goldfields here still being worked in the Province of Westland, where also the newly-discovered Kumara diggings are situated, but I have no doubt that still other and equally extensive beds will be discovered, all belonging to the same Pliocene fluviatile beds, running in a north-east and south-west direction, and gradually thinning out before Bold Head, south of the Mikonui River, is reached."*

In the Geological Reports for the year 1866–67, Dr. Hector, dealing with the goldfields of the West Coast, makes the following remarks: "The distribution of the gold-bearing alluvium on the West Coast is very different from the manner in which it occurs in the goldfields of the Province of

* "Geology of Canterbury and Westland," p. 105.

Otago, where it rests in the hollows in the surface of the schistose rock, which is either the auriferous matrix or belonging to a still older formation. On the other hand, the gold-drifts on the West Coast in the majority of instances rest on the surface of the most recent marine Tertiary rocks in New Zealand, having, in fact, been carried out from the mountains by the rivers, and deposited on a gradually-changing coast-line. They have thus a general distribution parallel to what was the western shore of the island at the epoch of their deposit; and by tracing the successive lines of their elevation, and allowing for the consequent changes which have occurred in the direction of the drainage-channels of the country, we are enabled to form an opinion as to the extent and position of the auriferous 'leads.'

"The distribution of these gold-drifts has already been treated by Dr. Haast in his "Reports on the West Coast Goldfields," published in 1865; and the development of the diggings since that date has completely borne out the general correctness of the views he then suggested. These have not yet been practically applied to assist the miners in their search for new auriferous 'leads,' but there will be no difficulty in preparing a map founded on the careful topographical surveys at present being made by the Survey Department at Westland, which map would show not only the existing workings, but also the direction of their probable future development.

"The auriferous alluvium on the West Coast may be classed under four groups:—

"*First:* The earliest-formed and most elevated of these drifts rests on terraces composed of marine Tertiary strata, where they have escaped denudation by the streams descending from the mountains. Extending in a north-easterly direction parallel with the main chain of mountains, 'leads' of this class pass into the Province of Nelson, and have been traced as far as the high terrace-land at the source of the Little Grey. The gold from these 'leads' has a coarse scaly character, and is found at a varying depth from the surface, in the red earthy gravels, resting on a denuded surface of marine clays. These leads have not a uniform level, but increase rapidly in altitude above the sea as they are followed to the north, and may be looked on as the first-formed drifts in the great valley which extends through the country south from Blind Bay, and is cut off obliquely by the sea-coast between the Teremakau and Okarito.

"*Second:* The second group of gold-diggings are those in the beds and alluvial terraces of streams which intersect the first-mentioned 'leads' and, by a natural sluicing operation, have redeposited the gold in a concentrated form by removing a large proportion of the lighter materials. The diggings at Ross and Kanieri are the best examples of diggings of this class which as yet have been worked.

"*Third:* The third-class are the beach terraces, which extend to an altitude of 220ft., and mark several changes in the level of the shore-line within a comparatively recent geological period. In this group also must be classed the gold deposits forming on the present coast-line by the action of the surf and currents, which distribute along the shore the fine gold brought down by the rivers.

"*Fourth:* The gold alluvium of the fourth class is formed by the erosive action of running streams on the auriferous rocks, and affords what are termed sluicing diggings. These are of two kinds, according to the nature of the matrix from which the gold has been derived. On the Otago goldfields I believe that most of the gold has been derived from schistose rock which has undergone mechanical and chemical metamorphism. Similar schistose rock occurs along the western slope of the mountain-range of Canterbury, and it is an important point, in considering the future discovery of gold deposits, that the continuation of this range must be looked for in the Spencer Mountains and mountains that trend towards the Pelorus Sound, rather than in the mountains in the north-west part of the Province of Nelson, as the latter are altogether detached, in a geological sense, from the central chain. In the district lying west of the main range thus defined there is a great diversity of geological formations, such as granites, slates, schistose rock, Palæozoic and Mesozoic sandstone, intermixed with plutonic rocks, both basic and siliceous in character.

"A district having this geological structure is peculiarly favourable to the development of mineral 'lodes,' and several have already been discovered, yielding copper, lead, silver, chrome, antimony, and gold.

"The 'lodes,' which are associated with a feldspathic and quartzose-rock, and a basic rock containing varieties of the hornblende minerals, combined with mundic or iron-pyrites, appear to be those which are auriferous, and thin irregular veins of quartz accompanying such 'lodes' constitute the second form of auriferous matrix which has been found in New Zealand. The 'lodes' occur in detached localities, especially in the range of mountains extending from the north side of the Grey River to Cape Farewell, and each of these localities may be expected to form a centre from which gold in greater or lesser quantities has been distributed in the alluvium. From this cause the diggings in the north-west district of Nelson have a peculiar and capricious distribution, there being no connected system of auriferous drifts, or similarity in the conditions under which the gold is found.

"Nearly all the diggings north-west of the Grey River belong to the fourth class, or sluicing diggings, where the miners have to work in the beds or terraces of streams. Of the principal exceptions are Collingwood, where there appears to be a local development of the older gold-drift like that in Otago, the Sherry River Diggings, near Wangapeka, and the Canoe Creek Terrace, seventeen miles north of the Grey River, in both of which the 'bottom' is the same marine clay as at Hokitika, and the fine or 'drift gold' diggings in the pakihis extending along the west coast as far as the Karamea. Sluicing diggings cannot be expected to support a concentrated population like the more steady 'leads' along the western flank of the main range, but there is no doubt that they will yield a large return of gold to the enterprising diggers who are able to prospect such rough and difficult country.

"I do not think that gold-diggings are likely to be discovered to the north of the Grey River which can be worked to advantage by large bodies of men, unless in the valley of the Buller River, or

between that river and the Spencer Mountains, where there is a large district not yet prospected, lying in a direct line extended from the best 'leads' further south.

"Latterly the diggers have been diverted from following this line by attractions offered by the fine gold 'leads,' as at Fox's and Pakihis; but—except at Canoe Creek, where there is a patch of old terrace-drift with coarse gold, and at Waimangaroa, twelve miles north of the Buller, where the stream cuts through a patch of rich 'lode' ground underlying the coal-formation, and where a considerable quantity of rough nugget gold has been obtained, and, lastly, the small quantity of rough gold obtained at an immense cost of labour and time by sluicing the beds of such rivers as the Karamea and Mokihinui—there has been no indication of the occurrence of anything but fine gold along the coast north of the Grey River.

"The immense quantity of fine gold, the extraction of which is at present employing a mining population of at least six thousand persons on the 'pakihis' along the coast north and south of the Buller, is, however, suggestive of the existence in the interior of a large quantity of coarse gold, as an equivalent to the proportion of gold in fine particles.

"These 'pakihis' are depressions in the shingle-flats once occupied by lagoons or river-courses, but are now covered by peaty matter, carrying a poor, heathy vegetation. The gold in these pakihis is obtained from layers of well-washed shingle, such as is seen along the banks of existing rivers, and also from the vegetable soil of the surface in positions where it might have been deposited during freshets. It is exceedingly fine in grain, and is easily suspended by water in motion; and, notwithstanding the great physical changes which would apparently be required to account for such an alteration in the drainage-system of the country, I believe that this fine gold must have been deposited by the Buller and other rivers, and that it is not due to the extension up the coast of the surf-carried gold derived from the 'leads' along the main range in the south.

"The Buller River and its tributaries have cut through a very large area of terrace-country; and if the fine gold of the 'pakihis' has been derived from the natural sluicing of these terraces, there must be some very rich diggings of the second class awaiting the miners in the district in question.

"The similarity in the chemical nature of some of the 'lode' rocks at Waimangaroa, Baton River, and other places in the north-western ranges, to the auriferous rocks at Coromandel and the east side of the Thames Valley, and also near Cape Terawhiti, in the North Island, leads to the expectation that gold may be found associated with the pyritous 'lodes' in a continuous line throughout the North Island. I think there is no doubt that these 'lodes' have their origin in the escape of the thermal waters, as the constant association of sulphurets in the 'lodes,' and the manner in which the superficial strata have been silicified, and the deep-seated strata deprived of their silica, points clearly to their agency.

"The view that thermal springs are the vehicles for the translation of the gold agrees with views recently advanced in the Transactions of the Royal Society of Victoria; and if the experiments originally made by Mr. Daintree, and lately verified by Mr. Wilkinson, are correct with respect to the deposit of gold from solution by contact with organic matter, it is quite comprehensible how gold would only be deposited when the waters reached near enough to the surface to be within reach of the necessary organic matter, and might fail to be reduced if the thermal waters escaped under the sea, or beneath marine Tertiary limestone, or other rock possessing a different chemical nature or free from organic matter.

"If this view be correct it may explain the relation which frequently appears to occur between the plentiful occurrence of gold in the alluvium derived from areas where the brown coal has been denuded from the schistose rock, notwithstanding that there is no gold in quartz-gravel apparently derived from the same rock, but associated with the brown coal in a manner proving that they are of contemporaneous formation, thus indicating perhaps that the brown coal, or solutions derived from it, took part in the subsequent deposit of the gold in the interstices of the underlying rock.

"The absence of gold from quartz-reefs of Miocene age, as has been demonstrated by Mr. Selwyn, Director of the Geological Survey of Victoria, may be due to the prevalence of marine conditions up to that period, and the absence of the necessary reagent for the reduction of the gold in the form of an abundant supply of decomposing organic matter consequent on terrestrial conditions.

"I would have it clearly understood, however, that these views only affect the distribution of the gold in the second or pyritous form of matrix of New Zealand, which appears to be common to districts in both Islands, where, in most cases, thermal waters are still escaping. I assume that the action of the hot springs is merely to translate the gold and other minerals to more superficial portions of the crust of the earth; and this hypothesis would require modification before it could be applied to such goldfields as those of Otago, where we have a great area of metamorphic rock apparently more or less auriferous throughout.

"The discussion of these views must be reserved until the facts I have in support of them can be more fully advanced, but sufficient has been stated to indicate that, although the richest goldfields of New Zealand may have already been discovered and worked, there still remains a large area of unexamined auriferous ground. If the present mining population were more equally distributed over the various goldfields, the yield of gold, which has fallen off considerably, would probably again for a time reach its maximum. There is no doubt that the time lost in changing from place to place in hope of securing good claims at new 'rushes' is the principal cause of the fluctuation in the yield of gold. The inducements for this continual migration are rapidly becoming fewer, and, unless some great attraction arises in other parts of the world to take the miners from this colony, in a few years the goldfields will have acquired a permanent population, scattered throughout the auriferous districts of Otago and the West Coast, combining mining with other pursuits; and, though the miners be individually content with a smaller return than at present for their mining labour, there will be produced at least an equal yield of gold for the colony as a whole."*

* Geological Reports, 1866-67, pp. 28-34.

During the latter part of 1875 and the beginnning of 1876, Mr. Cox and myself examined the West Coast from Reefton to Jackson's Bay. The report of this work by Mr. Cox is chiefly descriptive of the different formations met with, and further on will again have to be adverted to. Here, however, I may quote his remarks under the head of "Alluvial Workings." These he divides into four distinct heads, as under:—

"(*a.*) *On the Slate.*—These require but little attention on their own account. They occur in all gullies cut in the auriferous series, and the gold is generally coarse, and frequently associated with quartz, and evidences having travelled only a short distance.

"As a guide in the search after reefs, the gold found under these conditions is valuable, it being the only class which points to the immediate vicinity of a reef. Of course, round Reefton workings of this sort may be seen in almost every gully. At Moonlight, coarse gold is also got; and again in Black Ball Creek, at Bell Hill, Seven-mile Creek (in the Taipo Ranges), Butcher's Creek (Kanieri), in some of the creeks surrounding Mount Greenland, and in McDonald's Creek, Lake Mapourika. In none of these cases, except at Reefton and the Taipo, have auriferous reefs been as yet found, although it is absolutely necessary for them to be here for the gold in the creeks to be derived from.

"(*b.*) *In the Conglomerate Formation.*—This heading comprises a very large proportion of the sluicing-claims of the district under consideration. They are universally to be found in the gullies, every one of which, I think I may say, has been tried, with better or worse results as the case may be. The bottom which has caught the gold throughout this formation is the brown sandstone, which the conglomerates overlie quite conformably, and through which a colour of gold can be got at almost any point. It is, however, only in the gullies, where these conglomerates have undergone a process of natural sluicing, that the gold is sufficiently concentrated to pay for extraction.

"At Ross the gold in this formation has frequently been worked more upon terraces, and generally upon false bottoms; as many as six of these occurring in the district. We are indebted to Mr. O'Connor for a very valuable map of this district, showing the elevation above the sea-level of these various bottoms at different points, which was compiled with a view of settling disputes between the various claims on the subject of drainage. It is however, invaluable for other reasons, giving much information which even now it would be impossible to obtain, and in a few years still less opportunities will offer for obtaining any history of the workings of a few years back.

"(*c.*) *In the Glacial Drifts*—At places, as at Hokitika, the Greenstone, &c., extensive and rich claims have been worked in these beds, tons upon tons of gold having been obtained from them. These are principally interesting inasmuch as they must owe the origin of their gold, in all probability, to the slates which occur beyond the metamorphic zone, or, in other words to the lower beds of the Maitai slates, of which the glacial drifts are chiefly composed; and they point to the occurence of a far more extensive tract of auriferous ground than that represented by the Taipo Range, which is the only point at present at which auriferous reefs are known in these beds.

"(*d.*) *In the Black-sand Beaches.*—The sands, as I have before remarked [see same report, p. 73], are derived from the crystals of magnetic iron which occur disseminated through the chlorite-schists. I thought it possible that the gold might occur associated with these *in sitû*, but Mr. Skey's analysis has proved that this is not the case. The gold, then, must have been derived from the Maitai slates, which are brought down in such immense quantities by the glaciers. The diggers generally have an impression that the gold runs in 'leads' through the sand, but I believe this idea to be erroneous, as there is no reason why it should occur in leads, and absolute observation tends far more to make it appear that it has simply been deposited in patches." *

It will be seen that there is general but not a strict agreement between the writings of the three geologists from whose works I have made the above extracts. All of them allude to the gold as having been derived from the western slopes of the present great mountain range, evidently under the belief that its different river-basins and mountain-valleys are contemporaneous with the earliest liberation of the gold from its rock-matrices, and disregarding the possibility of its being derived in part from another area now submerged beneath the waters of the sea, or from the region of the present mountain-chain at a time when its present features had not developed themselves.†

TABLE OF FORMATIONS PRESENT IN THE NORTHERN DISTRICT OF WESTLAND.

SEDIMENTARY.

I. Recent.
Glacier, river alluvia, littoral.

Ia. Pleistocene.
High-level old river-channels and terraces.

II. Pleistocene and Younger Pliocene.
Extended glacier-deposits outside the limits of the mountains. River-deposits formed prior to the advance of the glaciers. Marine-gravels, &c., containing black-sand leads.

III. Older Pliocene and Upper Miocene.
Humphrey's Gully Beds. Old Man bottom. Brown-sands.

IV. Lower Miocene. Marine Tertiary-beds.
Blue fossiliferous sands and marly clays.

VI. Cretaceo-tertiary.
Upper, Middle, and Lower series,

X. Triassic (?)
Beds in the Upper Teremakau Valley, resembling the jasperoid and diabasic beds of the Selwyn Gorge, Canterbury.

---

* Geological Reports, 1874–76, pp. 92, 93.

† Drs. Von Haast and Hector both give due weight to the consideration that the process of concentration of the gold involves the denudation of several successive alluvial deposits belonging to different periods; but underlying this is the idea that the gold has originally been derived from the western slopes of the Southern Alps, except that Dr. Hector recognises the former existence of a great western valley, which has been obliquely cut off by the present coast-line.

XII. Carboniferous.
Maitai series = Westland formation of Haast.
XIII. Devonian.
Slightly-altered sub-metamorphic rocks.

METAMORPHIC.

Mica-schists.
Upper, Middle, and Lower mica-schists.
Gneissic schists.
Crystalline schists and metamorphic granite.

PLUTONIC.

Massive and intrusive granites.

I.—*Recent.*

In the Westland District there are no satisfactory means for determining what are exclusively Recent deposits, and what should be regarded as the higher or younger beds of the Pleistocene period; perhaps there is no true distinction to be made. Fossils are absent; and, even if present, marine mollusca would be unsatisfactory evidence; while the remains of land animals—moa-bones, &c.,—would not more enlighten us as to the distinction between Recent and Pleistocene. The elevation of the land along the coast-line, or the widening and deepening of a river-valley, are equally unsatisfactory as affording tests whether a particular deposit belongs to the Recent period or not. The limit must therefore be determined arbitrarily, and as a mere matter of convenience for the description of the beds that may be thus included. The recent deposits of the district may be for the most part dealt with under the heads—Glacier, River Alluvial, and Littoral deposits.

Glacier Deposits.—The most northern permanent snow-fields of the Southern Alps are to be found on Mount Rolleston, at the source of the left-hand branch of the Otira River. Here, and in the head of the Bealey, glacier-ice is formed; this clings to the mountain-sides, or, breaking away in masses, falls into the valley below, usually disappearing before another fall takes place, or, at all events, melts during the course of the summer season. Around the sources of the Taipo and Arahura, some of the mountain valleys, supplied by snow-fields at a higher level, retain their ice throughout the year; but it is only within the valley of the Hokitika River that lateral and terminal moraines are being formed at the present time. Derived wholly from the sandstone mountains of the main range, these morainic deposits are not likely at any point to be auriferous to such a degree as to pay for working. Gold-bearing rocks are found in the Upper Taipo, and at the source of the Wilberforce, on the Canterbury side of the range; so that at places the *dèbris* thus brought into the valleys, and partly sorted by the action of mountain-streams, may yield a certain amount of gold, and in some cases what appears to be a paying prospect. These deposits are generally of a patchy character, and, unless the gold be nuggety or coarse, it is likely that much work may be done that in the end will not be sufficiently remunerative. The writer has had personal experience of this result among the sandstone mountains of the south-west part of Canterbury bordering on the Otago goldfields, and many others. Experienced miners vainly, through a series of years, prospected the same district in the hope of finding more than strong indications of gold in these mountains. Small glaciers and mountain torrents, except under special circumstances, tend rather to disperse and distribute the gold through the non-auriferous material, the latter always much more abundant than that yielding gold, and it is not till natural sluicing has concentrated the gold to a very considerable extent that, excepting patches of coarse gold, such deposits can be expected to pay for working. In the vastly greater morainic accumulations that overspread the low grounds between the mountains and the sea the case may be different. The morainic matter has travelled much farther, and in the latter part of the journey has not been so roughly treated, but being still in motion, and often mixed with water, the gold would naturally tend to the lower levels, and thus a rude sort of concentration would take place. Where, also, coalescing ice-streams convert lateral into medial moraines, the different speed of motion affecting the ice, not from the same source, would produce a grinding and shaking motion along the junction of the morainic matter properly belonging to each of the ice-streams. This also would have a tendency to assort and concentrate the heavier material, such as gold and ores of the less valuable metals; but above all, the action of running water, whether on the surface or beneath the mass of the glacier, would to a certainty have the effect of grinding and removing the rocky material and would tend to concentrate the gold; yet these concentrations would ever be liable to be ploughed out and again mixed with raw glacial material; the final result being that, in the lateral and terminal moraines of the more extended glaciers, there are patches of gravel, and often limited or more extended deposits of fine stratified silt, which are to the present time quite undisturbed, and in other cases have been more or less crushed and tilted by the subsequent action of the glacier. These conditions do not affect the smaller glaciers at the present time, which are confined to the steeper slopes of the high mountains of the central chain.

River Alluvial.—The New River, in the formation of its valley, has cut through heavy deposits of gravel belonging to the older Pliocene or Upper Miocene period. These are known to be auriferous in other parts of the district; besides which gravels and glacier deposits of younger date may also have contributed gold to the recent gravels of the beds and banks of the main stream and its tributaries. Throughout the entire watershed, the rocks underlying the gravels mentioned are Tertiary sands and clays, or Cretaceo-tertiary strata of marine origin, and, therefore, the gold must have had its immediate source in the overlying gravels, which themselves were derived from outside the watershed of the New River. The action of the New River has, therefore, been to sluice and concentrate gravels already comparatively concentrated, and the result has been the rich deposits in the valley, in the ground that has been worked.

In the case of the Teremakau River, it has been already shown that its gravels are non-auriferous above Jackson's and the opening in the mountains between Mount Alexander and Mount French. Below this point the schistose rocks are soon pounded up into mud and fine sand, but the more

refractory sandstones derived from the east and north-eastern parts of the watershed are carried along the bed of the river to the sea. It is a somewhat remarkable fact that abreast of and above the higher part of Mount Alexander there are no signs of lateral moraines or high-level terraces in either the Teremakau Valley or in that of its tributary the Otira, coming from the south.

Two large shingle-fans oppose each other, and considerably constrict the width of the river-bed and the low grounds along its banks at Jackson's. The one on the north side of the river has derived its material from the middle and higher division of the mica-schists, while that on the southern side has been formed by the *débris* of the Taipo Range, in the neighbourhood of the quartz-reef on Jackson's Hill. Both of these great shingle-fans should be, to some extent, gold-bearing; but the material is rough and unsorted, and what gold may be contained is too widely distributed to pay for working either of the deposits. The alluvial grounds between the Teremakau and Lake Brunner have been arranged in their present condition by the action of running water; but either because the gravels cannot be easily bottomed, or that they are not derived from auriferous rocks, gold workings have never been carried on in this part. The same may be said of the re-arranged glacier-deposits to the south-west of Lake Brunner as far as the watershed of the Greenstone. The Taipo is, to some extent, a gold-bearing river; but the main stream is too rough and confined in its bed, and has too great a volume of water to admit of profitable gold-working under these conditions.

The Seven-mile Creek on the northern side, and some tributary creeks on the southern side of the Taipo Valley, have yielded a considerable amount of gold. These were comparatively rich, on account of their valleys lying along the line of the southern extension of Jackson's Reef, and others that may exist parallel thereto. Having a less volume of water, these streams could be coped with, and the deposits in their beds and banks worked. Also, the greater slope of the beds of these mountain torrents acts as a rude concentration of the material, leaving the rougher gold behind. The Seven-mile Creek, near its junction with the Taipo, has accumulated a delta-flat, formed by the scourings of its upper course, and this at the present time is being worked for gold.

Where the Taipo debouches on the Teremakau Valley heavy terraces of shingle have been formed, but here there was an inevitable mixing of the Taipo and Teremakau deposits, and, as a consequence, they have not been worked for gold.

Below the Taipo Junction, on the northern side of the valley, the granite mountains expose the rocks *in sitû* almost to the level of the river-bed, and if the gneissic rocks of this part are to any extent auriferous, the mountain slopes are unable to retain the metal, it is swept into the Teremakau River-bed and dispersed among an ever onward moving mass of shingle of a non-auriferous character.

On the opposite side of the valley, between the Taipo and the Big Wainihinihini, sloping lands rise from the low grounds of the river-bed to the foot of the Mica-schist Range. These are formed of talus-heaps and creek-fans; and, whatever may underlie, the surface-deposits are for the most part piles of coarse masses of angular rock unlikely to carry regular or rich deposits of gold.

The same is the case between the Rangiriri and the north-west slopes of Turiwhate, while, although the valley of the Big Wainihinihini might in its middle and upper parts be expected to carry gold, gold-workings have however not been opened along any part of its course.

Below the junction of Waimea Creek, abreast of the south-western slopes of Mount Smart, the Teremakau flows in a broad valley, bound by glacier morainic hills to the south, and on the northern side by a table-land and ridge of hills of the same description, underlain by "Old Man bottom" and marine Miocene beds. When flowing at a higher level the Teremakau passed across the table-land to beyond what is now the Greenstone Valley, as has already been described; but these deposits more properly should be considered as of Pleistocene age.

The valley-deposits along the banks of the Greenstone are of limited extent. The Greenstone, like the New River, has cut its channel out of a pre-existing table-land, covered with glacier-deposits and river-gravels of older date.

The terrace plain, extending from Kumara to the sea, and from the north bank of Kapitea Creek to the southern bank of the Teremakau, may be indifferently regarded as being, in its upper and higher parts, of Recent or Pleistocene age. Between the railway-line and the sea it is undoubtedly of Recent date, and in part is of littoral origin.

All the inland deposits have contributed material towards the formation of this sloping plain, and, although the cubic measure of the shingle material is very great, the shingle is comparatively concentrated compared with the ruder material that characterizes the more inland deposits generally, and there is, therefore, a greater liability to the occurrence of gold in particular places.

Recent deposits in the Upper Aruhura Valley are comparatively limited. In the second gorge there are scarcely any, the river here acting as a vast sluice to carry the material supplied from the mountains or denuded away from the Pleistocene terraces into the lower lands between or below the second and first gorges. The Recent deposits of the plain, occupying the bed of the Old Lake Basin, between the first and second gorges, extend some distance up the valley of the Arahura-Wainihinihini, but, flanking both the eastern slopes of Island Hill and the western slopes of the Mica-schist Range, the higher terrace-lands must be considered as of older date. Below the first Gorge to Humphrey's Gully the valley excavated in the morainic deposits of this part is narrow, and only flats of inconsiderable extent are formed, sometimes on the one bank and sometimes on the other bank of the stream.

Below Humphrey's Gully to the Kawhaka Junction the Recent deposits are confined to the flat land near the present level of the river. At and above the Kawhaka Junction a moderate-sized flat lies on the northern bank.

Along the upper course of the Kawhaka there are scarcely any Recent deposits, the first of any extent being where the Christchurch–Hokitika Road reaches the river-bank at Blake's Farm. Below this the river cuts its way through morainic deposits till reaching the end of the road leading to Fox's Diggings. Below this point a broad alluvial flat commences, traversed by the Kawhaka

on its east side and by Fox's Creek on the western side. This blends with the low alluvial lands of the Arahura below the bridge on the Christchurch–Hokitika Road, which, towards the lower crossing, becomes narrowed by the near vicinity of the Pleistocene terraces and hilly country on the south side of the Waimea Valley.

From a little below the Upper Crossing, a large triangular swampy bush-covered flat extends towards the coast-line, reaching, in its western part, nearly to the Three-mile Creek, and blending with the littoral zone of the coast-line. The auriferous character of the Recent deposits of the Arahura Valley has already been described.

Kokatahi Plain is evidently the bed of an old lake, drained by the cutting down of the barrier once existing across the valley at and near Kanieri Township. None of the source-rivers of the Hokitika watershed retain in their valleys the proceeds of denudation to any considerable extent, but pour these through their various gorges into the lower channels of the Hokitika and Kokatahi Rivers. The plain is being gradually raised along the present courses of the Hokitika and the Kokatahi, and there is a tendency of the plain to be low and swampy away from these river-channels. Below the Kanieri a triangular plain opens out towards the sea. The river-gravels of the upper part of this gradually blend with the old beaches and black-sand deposits of the littoral zone of the present coast-line.

Ross Flat is the only other considerable extent of Recent alluvial land in the district, the upper valleys of the Totara and Mikonui Rivers having but limited areas of this formation.

Littoral Deposits.—These comprise the black-sand beaches at low levels along the present coast-line. Generally they are limited by a terrace escarpment of the more elevated lands on the inward side, which runs nearly parallel to the coast-line, but near the mouths of the larger rivers they recede inland, and become less marked, and here the deposits of the littoral zone blend with that brought down by the rivers.

These littoral deposits have been a great source of gold on the West Coast. From the mouth of the Grey River to the Mikonui, the active living beaches at all places yield gold, and at many localities have proved extremely rich. By the continued action of the surf, the heavier materials, gold, and black-sand are associated together, and there, between high and low-water mark, accumulate to what appears as a stratum of black-sand which, varying in thickness, may be either exposed at the surface or buried under a variable thickness of ordinary grey-sand. The gold usually is very fine, and special means for saving and collecting the same had to be devised. At one time a large population of miners were remuneratively employed on this and the older inland beaches between the tide-mark and the terrace escarpment marking the limits of Pleistocene erosion and the last elevation of the land. This elevation has been but slight, and the strip of low land between the terrace escarpment and the sea indicates rather a cessation of erosion than an elevation of more than a few feet. As a consequence—the rivers supplying the material—the beaches were built-out from the foot of the cliffs, and the auriferous black-sand beds, whether at the surface or covered to a variable depth as above described, were further covered up by deposits of drift-sand, carried inland from the beach within tide-mark by the westerly winds. There has thus been formed a line, and often a double line, of low sandhills between the present beach and the higher grounds. These Æolian deposits are underlain by old black-sand beaches, not differing from and often continuous with that formed and exposed by the action of the sea at the present time. Where the sandhills form a double line, the depression between is sometimes bared of drift-sands by subsequent action of the winds, or swamps and shallow lagoons may be present. Between the sandhills and foot of the terrace escarpment, where present, there is usually a swampy depression, on the inland edge of which, so far as it could be worked seawards, gold under similar conditions to that on the beach and under the sandhills has occurred, but the water at present prevents this being further worked without the application of special dredging and pumping appliances. It is not the function of this report to point out how the remaining gold is to be won; but, being well satisfied that a large amount of gold is yet to be obtained from these deposits, the appliances in use will have to be perfected so far as to cope with the difficulty of its extraction in a satisfactory manner.

Along the different lines that have been worked, these deposits are usually spoken of as "black-sand leads," but to me the term is misleading, as I am well satisfied that a more or less continuous stratum of gold-bearing sand will be found from the foot of the cliffs to the present beach, or, where these are absent, from the point where the fluviatile deposits of the rivers give place to the deposits of the littoral zone.

The source of the black-sand gold within high-water mark, and the lower black-sand leads parallel thereto, is supposed to be mainly the fine gold carried along the beds of the larger rivers, and distributed to the different beaches by the action of the sea. That gold in this manner does reach the coast-line, and is so distributed, is not to be doubted; and as an instance in illustration the Arahura River may be cited, the beaches of which for the first ten miles up the valley were rich in gold. The New River also is proof of the same thing. However, in the one case—to wit, the Arahura—the gold may have been directly derived from the rocks *in situ;* in the other case, that of the New River, it has been derived from pre-existing auriferous gravels. But apart from such considerations, to refer the whole of the beach gold to the golden sands carried along the beds of the rivers to the sea implies a greater richness of these than seems to be borne out by the facts which have already been cited, and such rivers as the Teremakau and the Hokitika, apparently, do not play an important part in the accumulation of gold upon the beaches—that is, if we judge of them by the comparative barrenness of their gravels along the greater part of their courses. It is more probable that no inconsiderable part of the gold found on the beaches must be referred to the action of the sea in cutting away and re-assorting the older deposits of the more elevated black-sand leads, and the auriferous gravels of older Pliocene or Miocene date, where these latter have been or are exposed to its action. Where the high-level marine gravels are absent, as, for instance, between the mouths of the Hokitika and Totara Rivers, and glacier deposits are present, to these latter must be referred no inconsiderable part of the gold found on the black-sand beaches.

Ia.—*Pleistocene.*

Without attaching any particular meaning to the term Pleistocene, under this heading it will be necessary to describe deposits widely separate and at different levels.

In the case of river-deposits, those now to be considered are mainly distinguished from those already described by a difference not so much of material as of position.

Before the erosion of the river-valleys to their present level, channels were formed, sometimes carrying the waters of the river in quite another direction to that in which it at present flows. Where the subsequent changes have been very great, it is difficult to regard such Old high-level river-channels as belonging to the Recent period. They are also marked off from the older Pleistocene, and modify the deposits of that period.

High-level Old River-channels and Terraces.—In the New River district the high grounds between the main stream and the left branch, and between their various tributaries, are thickly covered with bush, being broken country and difficult to explore, but little has been done to trace the fragmentary remains of the old river-channels existing at high-levels. If such exist, they can scarcely be due to the action of the New River since its present watershed was determined, but to the action of a far greater body of water coming from the north-east and east. What changes determined the present outlet of Lake Brunner, and the course of the Arnold River, it is not easy to say, but it is certain that on the disappearance of the glaciers from the region west and south of Lake Brunner large torrential streams washed over, and to a great extent modified, the glacier deposits between the southern sources of the New River and Greenstone watershed. The distinct proofs of this are the great extent of comparatively well washed-gravels that spread over this part of the district, while at the same time there yet remain patches of morainic matter, even towards its western extremity, that have escaped destruction or modification. One such morainic remnant, it has already been pointed out, is to be found on the height of land between the Blackwater and Fuchsia Creek on the Greenstone–Greymouth Road. Over this part of the district these gravels do not appear to be gold-bearing.

The alluvial tract between the present channel of the Teremakau and Lake Brunner has already been dealt with as a Recent deposit. The old channel of the Teremakau, leaving the present valley between the special settlement and the western slopes of Mount Smart, and reaching the Greenstone Valley at the township, has also been described. The eastern banks of this old channel are very well to be distinguished on the road from the Greenstone Township to Maori Point. The general depression is noticeable, also, on the road from Kumara to the Christchurch Road at Harris's. The gravels contained within this old channel are known to be auriferous between the Greenstone Township and the special settlement. Across the present course of the Greenstone Creek this old channel of the Teremakau passed to the Duke of Edinburgh Terrace but, barred by the older Pliocene or younger Miocene gravels to the westward, the stream was again deflected to the opposite or southern side of the present Greenstone Valley, which course it maintained till it again entered the proper valley of the river near the present Greenstone Junction. Throughout the course described, the gravels of this old river-channel are auriferous, and many claims are now being worked in them.

On their southern side, the morainic hills extending from the slopes of Turiwhate to Dillmanstown are terraced by the action of running water to the present level of the Kawhaka River at Blake's Farm. The gravel-beds resting on glacier-deposits within the Kapitea watershed may be considered recent, they having been formed by the action of the present stream, subsequent to the drainage of the extensive sheet of water that filled its watershed above a line drawn from Callaghan's Hill to Kumara.

The great bulk of the auriferous drifts along the middle branch of the Waimea belong to this period, and they are the deposits of a stream of far greater volume than that which exists at the present day, which could or has modified these gravels to a very limited extent. I have already hinted that the valley of this middle branch of the Waimea was the former outlet of a lake fed by the waters of the Arahura. The auriferous character of the gravels of this old Waimea or Arahura need not be referred to here, they are well known.

In the Arahura Valley, gravels of this age lie along its southern side, and are of limited extent; the chief development is on the northern slope of the Blue Spur. The chief characteristics of these gravels have been noted under the head of "Prospecting," when describing Boy's tunnel. Above Humphrey's Gully deposits of this kind are likely to be found on the slopes of Humphrey's Gully Range.

In the Hokitika Valley at Rimu there is an old channel of the Hokitika River, the gravels of which are auriferous, and constitute the Rimu diggings.

Between Limestone Creek and the Halfway House on the road to Ross, well-worn gravels appear exposed in the road-cuttings. It is not quite clear whether these underlie or overlie the glacier-drifts, that appear nearer and farther on the same line of route, and therefore they are mentioned here as only possibly belonging to this group of deposits.

At Ross the reconstructed glacial-deposits on the inland edge of Jones's Flat, and occupying the hill-slopes from Mont d'Or to near the Mikonui, should be classed under this head. In the Ross United Claim, at Ross, the lower auriferous stratum resting on the "Old Man" or "Terrace bottom" perhaps should be referred to river action prior to the advance of the glaciers, but, whatever the facts of the case, this it is now difficult to decide. These deposits at Ross have in the past yielded gold to what may be considered an enormous extent, and it is well-known that they are even now very far from being exhausted. It is the difficulty of following the gold-bearing gravels into the deeper portion of the flat that prevents or retards the working of them.

II.—*Pleistocene and Younger Pliocene.*

The deposits of this period embrace the vast development of glacier morainic matter that has been denuded from the mountainous region to the eastward, carried forward and deposited over the

lower grounds between the outer mountains and the sea; also the river deposits that preceded the invasion of the lower grounds by glacier-ice, and, perhaps, with less propriety, a series of marine gravels underlying have also been included.

Extended Glacier Deposits outside the limits of the Mountains.—The largest and most connected area of these lie towards the southern part of the district between the Hokitika and the Totara Rivers. Over three-fourths of this area, between fifty and sixty square miles in extent, the morainic character of the deposit is evident and unquestioned. The material has clearly been derived from within the present watershed of the Hokitika River. The character of the country is hilly, without any regularity in the disposition of its features other than arises from the action of a number of comparatively small streams, draining chiefly into Lake Mahinapua, its outlet, or the Totara Lagoon.

Below Camel-back Hill, on the northern bank of the Hokitika, there is an isolated low stony ridge, comprised of morainic matter which has escaped destruction owing to its being protected by the greater and more enduring mass of Camel-back Hill. The greater part of what is now the Kokatahi Plain was probably at one time covered by such detritus, which subsequent river action has re-assorted, swept away, or covered up.

On the northern side of the Kokatahi Plain, and reposing against the southern flanks of Mount Graham and Conical Hill, a massive lateral moraine extends north-west in the direction of the forks of the Kanieri River. As this is followed to the north-west it loses its terrace-like character, and blending with the moraines of the Browning glacier, or that part of it which occupied the bed of the Kanieri Lake, forms broken hilly country surrounding the junction of the three branches of the Kanieri River. Thence to Kanieri Township the united moraines extend as irregular ridges and low hills, flanking the southern slopes of Humphrey's Gully Range, while through a saddle in this, a portion of the morainic matter has found its way into the upper part of the valley of the Three-mile Creek. With the exception of the re-assorted morainic deposits south of the Totara, all those yet described belong to the drainage basin of the Hokitika. In the head of the Three-mile Creek and at Kanieri Forks they appear to be gold-bearing. The Kanieri Forks Claim best illustrates the character of the material and the mode of working the deposits. Here, between the north branch and the main stream, the only important sluicing-claim in the district is situated. A proportion of the material worked is fairly rounded by the action of running water; at other places it is an agglomerated mass of huge angular blocks of slate and sandstone, and mixed up with this rougher matter appears to occur the richest patches of gold. The face of the claim overlooking the main branch of the river has for the present been abandoned, owing to the small returns, and the encroachment of the tailings poured into the river adjacent to private lands. The face now being worked discharges tailings into the north branch of the river, and, as I saw it, this certainly displays the roughest material worked for gold in any part of the district.

In the Arahura Valley, glacier matter chokes and fills the deeper part of the upper or second gorge. This has already been sufficiently described. The first gorge, also, it has been shown, has been excavated out of a vast moraine, stretching across the valley from the southern slopes of Island Hill to the vicinity of Lake Kanieri. Outside the mountains an extensive field of ice pressed westward, even on to the higher slopes of the Waimea Hills, and north-west to Callaghan's and the neighbourhood of Kumara. The evidences of the former existence of glacier-ice is, on the southern side of the Arahura Valley, much less marked, and do not extend down the valley beyond the crossing of the Christchurch–Hokitika Road. What barrier existed in the lower valley to check the flow of ice in this direction I have not been able to satisfactorily determine, but, notwithstanding, it is most evident that there was a persistent tendency of the glaciers to seek an outlet towards the north. During its maximum development, glacier-ice carried morainic material high on to Fox's Hill, and to equal heights on the slopes of the southern Waimea Hills to the present source of the main branch of the Waimea River; and the same evidence is to be met with at Callaghan's Hill. In time, the supply of glacier-ice from the mountains diminished considerably, and the terminal face in the low grounds did not reach so far to the west and north-west. Between Fox's Hill and the hills on the south side of the valley, east of the road leading to the Blue Spur, the Arahura and Kawhaka Rivers have completely destroyed the sub-lateral and terminal moraines formed during the greatest extension of the ice, but it is not difficult to trace where these must have lain. The inner line of morainic hills follow exactly the same curve, and maintain a mean distance from the former and outer line of deposits. They spring from the southern side of the valley between Humphrey's Gully and Olderog's Upper Camp, and trend so as to cross the Kawhaka between Fox's School-house and Whiskey Creek near Blake's Farm. Thence the morainic ridges trend north-west to the west side of the big dam of the Kumara Water-race in Kapitea Creek, and due north across this to Kapitea Hill. Although the glacier was diminished in size it still hugged the line of greater morainic heights between Dillmanstown and the western foot of Turiwhate.

Glacier-ice still flowed through the Kawhaka Saddle from the Upper Arahura, probably supplemented by an ice-stream from the Teremakau Valley by way of the low saddle between Turiwhate and the Mica-schist Range.

The ice-supply from the mountains diminished to a third stage, and then was formed the moraine cut through by the Arahura to form the first gorge. During this stage glacier-ice no longer flowed through the Kawhaka Saddle, nor from the Teremakau Valley into that of the Arahura by the route which has just been indicated. On further shrinkage the ice was wholly confined to the mountain region, and its further behaviour no longer falls under this heading. We have further to look at the condition of the area once covered but now abandoned by the ice of the Arahura glacier. As the shrinkage from its furthest extension was relatively sudden, compared with the halts at the second and third stages, the lower ground between the morainic ridges would contain either a series of tarns and small lakes, or a more extensive sheet of water nearly filling the whole. The drainage of

the watershed would be discharged into the outer series of these, and thus would begin the erosion of the outer moraines, the drainage from which, it has already been hinted, was probably by way of the middle branch of the Waimea River, carrying into that small watershed a vast amount of re-assorted morainic material, and concentrating along the course of the outlet the gold which the moraines held in a widely-dispersed condition. Shrinkage of the ice again taking place, the Kawhaka Lake was formed, the outlet of which may have been, and probably was, in the same direction; but on the recession of the ice-face till it no longer reached as far west as the eastern slopes of Island Hill, a lake at a higher level was formed, which had its outlet by way of the southern side of the valley, along the northern slopes of Humphrey's Gully Range. Thus the direction of the Arahura's waters were altered; and, as the deviation took place at a level which is now between 700ft. and 800ft. above the sea, and as the sub-lateral and terminal moraines of the furthest extended ice between Fox's Hill and the western end of Humphrey's Gully Range were probably at a lower level than this, the way would be paved for the assumption by the river of its present course, and as a result the destruction of the western and south-western outer moraines would follow.

From the Teremakau Valley a great body of ice passed to the north, through the low grounds between the Granite Mountains and Mount Alexander. On the south side of Lake Brunner there are preserved high-level lateral moraines 700ft. to 800ft. above the level of the lake. These rest on the northern slope of Hohonu Peak and the other heights of the same range. This terrace blends with morainic hills and lake-terraces between the south-west corner of Lake Brunner and the Big Hohonu River. South-west of Lake Brunner, the greater part of the morainic deposits have been re-arranged by the action of running water, into a sloping table-land broken by low ridges.

Were it not for the undoubted presence of undisturbed moraines on the road from the Greenstone to Greymouth, it might with reason be supposed that glacier-ice did not extend thus far west of Lake Brunner. The great body of ice that passed from the Teremakau Valley north, and overspread the country around Lake Brunner, was but a portion of the Upper Teremakau glacier, a volume of ice almost equal to it continuing its course along the present valley below Jackson's, and was supplemented by the Taipo glacier, which would be of nearly equal volume. This certainly was united with the Arahura glacier on the low saddle between Turiwhate and the Mica-schist Range; but whether the Teremakau glacier gave a part of its ice to supplement the Arahura glacier, or *vice versâ*, is a matter respecting which there might be a difference of opinion. In any case, the main flow continued down the valley, having a decided westerly tendency to the western base of Turiwhate, where it was met by the Arahura glacier pressing north. The Arahura glacier was of sufficient volume and power to keep that of the Taipo-Teremakau in check, and even to compel it to a more northerly course. This could not at once be effected. But on passing the western slopes of Mount Smart, being relieved on its northern side, the Taipo-Teremakau glacier spread over the country in a northerly direction as far as the Upper Greenstone, and the western side of the valley opposite the Greenstone Township. Here it was again met and held in check by the south-western tendency of the other great body of ice that had passed the mountains by way of Lake Brunner, and which I have shown reached into the country north of the Blackwater Junction. Here the terminal faces of this part of the glacier must have been—and there is abundant evidence of this as far down the Greenstone Valley as the Three-mile Creek (from the township). The main body of the glacier, however, still continued to run parallel with the northern margin of the Arahura-Kawhaka glacier, and both brought material toward the accumulation of the vast medial moraines that mark the limits of each, now extending as a range of hills from the western foot of Turiwhate to Dillmanstown.

The vigour of supply slackening, and the glacier becoming somewhat smaller, the medial moraine grounded, and as the volume of ice on each side lessened, lateral moraines were formed both on the Arahura and the Teremakau sides of the ridge. How nicely poised were the opposing forces may be judged from the fact that the terminal moraine of the Taipo-Teremakau glacier between Dillmanstown and Kumara is not more advanced into the low country than that of the Arahura, lodged between it and the eastern slopes of Kapitea Hill and surrounding the head of Larrikin's Flat.

The remarkable recession in the line of the morainic hills between Turiwhate and Dillmanstown, along the course of Waimea Creek, can hardly be due to the action of Waimea Creek since the disappearance of the glacier filling the Teremakau Valley: more probably it is due to a body of clear ice descending from the hard granite mass of Turiwhate deflecting the south lateral moraine of the Taipo-Teremakau glacier, and causing a lesser deposit at this place.

As in the Arahura Valley, it is probable that in the Teremakau Valley above Dillmanstown, on the disappearance of the ice, a lake was formed, held back by the heaped-up lateral and terminal moraines of the glacier. This had outlets at different levels and at different places which have already been noted or described.

Had the valley been filled with the morainic deposits of the glacier, and afterwards cut down by the removal of these by the river, terracing of its sides would have taken place, and heavy bodies of river-wash would still rest on the slopes of the morainic hills. Such are absent. On the other hand, no lake terraces have been formed; but, considering the rapidity with which the different outlets were cut down, and the lake drained, this is not a surprising matter. The different old river-channels are not traceable inside what was the passage through the terminal moraine. That at Dillmanstown is the most marked on the southern side of the valley. This has run along the Saw-mill Terrace, and along the site of the upper part of the township to the gap in the hills (artificial) opposite Dunedin Flat. The outlet on the northern side of the valley, reaching into the present Greenstone watershed, has already been described.

River Deposits formed prior to the Advance of the Glaciers.—These at places underlie the morainic heaps of the terminal moraine, while at places they are covered only by the reconstructed material derived from the moraine. Possibly, also, they exist at places not reached by glacier-ice; but it will prove difficult to distinguish these deposits from the more modern gravels of the same character, and no attempt has been made to do so.

It is usually supposed that the ice invaded the low grounds, due to an increase in the amount of primal snows in the mountain region caused by an elevation of the land, which, at the maximum extension of the glaciers, was considerably greater than at the present time. Many consider this, and this alone, the cause; and no doubt were the elevation sufficient, it would account for all that has taken place. Others, like Professor Hutton, consider that a greater amount of moisture was deposited on the New Zealand mountains than is now the case; hence he speaks of a "Pluvial period." Others, again, following the lead of Sir James Hector, deny the necessity for a great elevation of the land, and hold that a greater mean elevation of the mountain-region and a somewhat moister climate would be accountable for all that has taken place; that the disappearance of the ice has not been due to a depression of the land so much as to its mean level amongst the mountains being lowered by denudation, principally brought about by the action of glaciers. I do not wish to discuss the merits of these various theories, further than to account for the facts that have come under my own personal observation.

It is an undoubted fact that vast torrential rivers descended from the interior high lands before the ice invaded the low grounds. Not only was there a great body of water, but there must also have been a steep grade of the river-beds, between the point where they left the mountains and where their deposits are for the most part now found. Under the morainic hills of Kumara and Dillmanstown the principal gold-deposit is a very coarse river-wash, reposing on a sub-angular gravel, which passes downwards into fluvic littoral or marine beds. The junction between the coarse river gravels under the morainic hills and the higher part of the underlying series is denominated a "false bottom," the beds below for some distance not being gold-bearing to a workable or paying extent. West of the morainic hills of Dillmanstown, in Larrikin's Flat, these old river-gravels are present as the first bed lying on the false bottom, or absent, as the case may be; but, when present, have been covered up by the scourings of the morainic hills, in which case it is not easy to distinguish between the upper and the lower deposit. As the upper and more recent deposit necessarily towards its eastern limit overlies the glacier-deposits, it requires well-defined sections to show that the lower stratum passes under the morainic hills, and in tracing the sections from west to east there is a liability to consider the whole of the gravels of Larrikin's Flat as superior to the deposits of the Dillmanstown terminal moraine. Last year I was of opinion that they did so, but this opinion has been contested by Mr. Aitken, manager of the Kumara Water-race, whose opportunities are ample for determining the point at issue. During the present year many of the claims have displayed better sections illustrating this matter; and, especially, Lee's Cut, made through the hills since my first visit, shows unmistakably a continuous stratum of coarse wash underlying the morainic deposit, and extending through the hills from the Dillmanstown side to Larrikin's Flat; but even this does not conclusively prove that the central and western parts of Larrikin's Flat have these gravels present. On the contrary, they, together with the material of the morainic hills, are likely to have been subjected to a process of re-arrangement, and jointly constitute the gravels of more recent date, resting on the "false bottom." Except as a matter of theoretical explanation this is of no great consequence. The fact is, the gravels are there, or what is left of them; they have yielded largely in gold, and to a large extent have been washed away. The question of more importance is the true relation of the gravels that are seen to underlie the morainic hills of Dillmanstown. The overlying morainic deposit, having to be got rid of in order to reach the old river gravels that underlie this, is effected by hydraulic-sluicing on a large scale.

The question at issue is, Do the gravels at the base of the morainic deposits contain the bulk of the gold obtained from those claims that sluice away the overlying morainic deposit? It seems to be the general opinion that they do, and, in the face of the fact that much ground of the nature of a river-gravel has been driven out before the advent of hydraulic-sluicing, is a sufficient evidence in proof. Still, the morainic material is not without gold, and it is generally admitted there is a little gold all through it, and a nugget of considerable size—the largest piece of gold ever obtained at Kumara, is, by common consent, referred to the glacier deposits. Do they pay, then, the cost of the water that washes away these morainic hills? presumably they do, and this is a most important point, for, if it were otherwise, where these hills are not underlain by the old river-gravels under consideration, it would be of no avail to commence sluicing operations on them, and the miners would have to be well satisfied as to the presence and auriferous character of the river-gravels before they brought on water and commenced work at the point selected.

The action of the glaciers must have, to a great extent, ploughed out and carried forward towards their terminal faces the gravels of these old river-beds, just as an advancing glacier is supposed to destroy its first formed moraines. Thus, mixed, but in many cases mixed imperfectly, or more completely assorted and comparatively well waterworn material, is likely to occur as patches in what would otherwise be pure angular morainic mattter. Claims are thus occasionally worked in such material. The working-face of the Kanieri Forks Claim, at the time of my visit, seemed to be of this character, as the bulk of the material, from its great size and angularity, clearly indicated its glacier origin, while waterworn material was not absent.

At Kanieri, the dredging operations carried on in the bed of the Hokitika River seems to be on a deposit of this nature. The workings on the north side of the river very much resemble those of Kumara and Larrikin's Flat. There is a similar line of morainic hills, on the seaward side of which are well-washed auriferous gravels. On the eastern or inland side a line of old workings also extends. These latter, while working the superficial deposits, have, at the same time, struck upon and followed a gold-bearing stratum that passes under the morainic hills, and, to reach this, portion of the overlaying morainic deposits have been washed away; but being at a lower level, and not having the same water-supply, or anything like that obtainable at Kumara, the workings are much less extensive.

At Back Creek, old river-gravels are well developed underneath the morainic deposits that cover most of the country between Rimu and Ross. The claims at Back Creek are being driven out, to obtain the auriferous wash that underlies the glacier deposits, there being no efficient water-supply

to deal with the ground in the way of hydraulic-sluicing. Hydraulic-sluicing is carried on in the face of the terrace overlooking the Hokitika Valley, and, with the limited supply of water at command, a good deal of work has been done.

At Ross, these old river-bed deposits are probably present as the lowest gold-bearing stratum of coarse gravel, resting on the "Old Man bottom." This, however, cannot now be easily determined.

Marine Gravels, &c., containing Auriferous Black-sand Leads.—The direct proofs of the relationship that subsists between these and the next Older or Younger series are such that I have had some difficulty in assigning them their position in the general sequence. That they are unconformably older than the recent black-sand deposits of the littoral zone is not to be questioned, but that they antedate the period of the furthest extension of glacier-ice is not so certain. From information obtained during my recent trip to Westland, it appears to be beyond doubt that in the middle district of Westland, south of the Waitaha River, some of the high bluffs on the sea-coast, the lower and middle parts of which are formed of glacier detritus, are capped by beds of marine sands containing sea-shells. These, at the present time, may be from 200ft. to 250ft. above the level of the sea, and would, therefore, correspond with the terraces of marine-gravels that form the Big Paddock, Houhou Lead, Blue Spur, &c., between the lower parts of the Hokitika and Arahura Valleys, and the same beds stretching further north across the lower valley of the Waimea to the mouth of Kapitea Creek. But in this northern part of the Westland District their relation to the extended moraines of the glacier-period is not so clear. Last year I concluded that the line of morainic hills crossing the Hokitika Valley at Kanieri was due to a second advance of the Hokitika glacier, at a time considerably later than that of the greatest extension of glacier-ice, when the morainic hills between Rimu and the Totara River were formed. I came to this conclusion on a study of the line of morainic-heaps between the bridge over the Hokitika and Woodstock, and a comparison of these with the moraines at a higher elevation along Back Creek, and in the country to the south and west. I do not even now say that this first conclusion is not correct, but there is a possibility of the phenomena displayed by these different glacier deposits being otherwise explained, and elsewhere I could not satisfy myself that there had been a second advance of the glaciers to any great extent after shrinkage had once began.

The deposits of the Big Paddock and Houhou Lead doubtless extended across the Hokitika Valley to its southern side, but their presence on the southern side of the valley has not been demonstrated up to the present time. In the direct line of the valley they have been breached through and carried away by the action of the river; and, further to the south, if it be correct that their deposit antedates the advance of the glaciers to the extreme limit attained, the marine-beds have either been destroyed or covered up. Hence their apparent absence.

Between the top of the terrace at the southern end of the Houhou Lead and the terrace opposite Blue Spur Township, on the north side of the creek, glacier-ice never reached so far west as to encroach on the area covered by these beds; and under the shelter of Mount Misery, Mount McKay, and the Humphrey's Gully Range, they have escaped destruction by forces operating from the landward side.

On the north slope of the Blue Spur, overlooking the Arahura Valley, the extreme extension of the Arahura glacier just reached to the eastern limit of the marine-gravels now treated of. In a reconstructed form the glacier-deposits rest against the side of the spur of the Humphrey's Gully Range, and here, as towards the mouth of the Hokitika River, the marine-gravels of the Blue Spur and Houhou Lead have been carried away to the level of the river, and terrace-gravels of a later date deposited in their place. Thus it can hardly be said that at this place the glacier-deposits are in contact with the marine-gravels, but, so far as it goes, the evidence is that of the, two the glacier-deposits are the younger.

The same kind of evidence is to be met with in the Lower Waimea. The stream that carried glacier detrital matter from the area of the Upper Kapitea and Kawhaka watersheds, as they at present exist, broke through the terraces of marine-gravels and sands stretching across the lower valley, and, although this may have happened subsequent to the recession of the ice, as has been shown, it probably took place before the marine-deposits under description were removed or cut down to their present level in the lower valley of the Arahura.

The relationship of these beds to those of Sandy's Hill, near Kumara, will have to be discussed in another part of this report, but it may be remarked, in passing, that if the Sandy's Hill beds are identical as a continuous deposit with those of the Blue Spur and Big Paddock, then there can be no question but that all of these beds are older than the morainic deposits of the time when the glaciers were most extended. I now proceed with the description of the more westerly beds of the Big Paddock, Blue Spur, and Lower Waimea. The beds indicate and mark a former depression and subsequent elevation of the country prior to and during the formation and advance of the glaciers into the low grounds between the mountains and the sea. Their chief present development extends from the north side of the Hokitika Valley, between Kanieri and the sea northward, as already indicated, with a gradually narrowing breadth of exposure, till they disappear between Sandy Creek and the mouth of the Kapitea.

In the southern part they have been worked for gold chiefly along their eastern border, the celebrated Houhou Lead lying along this line. This lead crosses the Three-mile Creek at the Blue Spur Township, opposite which Simpson's claim is the most easterly being worked in these deposits at the present time. On the opposite northern, or Arahura, slope of Blue Spur younger deposits overlie and obscure these marine beds, while in the lower grounds of the river-valley they have been removed by the action of the Arahura. Allowing for this, there is every reason to believe that at lower levels, and under the superficial gravel-deposits of the valley, the marine beds extend continuously to the southern slopes of the Waimea Hills. No attempt has been made to prove the correctness of this very reasonable theory. Without doubt the beds are present; but, before attempting anything in proof of this surmise, it has to be considered that no very payable deposits were found to the westward of the Houhou Lead in the area of the Big Paddock, and that the

northern continuation of the Houhou Lead has probably been destroyed in the cutting-down of the eastern margin of the deposit by the action of the Arahura River.

The same beds again appear north of Hatter's Gully, in Ballarat Terrace, within the Waimea watershed. The auriferous deposits of Quin's Terrace and Piper's Flat are due to the action of the Waimea, when that river had its course at a higher level than now. The lower slopes from Batchelor's Claim to the level of the river are of the same character.

On the northern side of the Waimea Valley, by way of the lower parts of German Gully and Sandy Creek, the inland boundary of these beds gradually approaches the sea, and they are not distinctly traceable beyond Kapitea Creek. These beds have been and still are of great consequence to the mining interests of Westland. North of the Teremakau they are perhaps of less importance, but this seems to be partly because their limits in that direction have not been closely defined; but in the neighbourhood of Rutherglen they should be present, and thence extend, broken only by the lower valley of the New River, to the vicinity of Greymouth, north of which they appear along the Cobden Range in Darkie's Terrace.

Marine Gravels of Sandy's Hill, &c.—These form the terrace and table-land of Sandy's Hill, south of Kumara, and, together with the higher sub-angular material forming the false bottom, underlie the upper auriferous deposits of Larrikin's Flat. In sinking the prospecting-shaft on the west side of Larrikin's Flat, the sub-angular material of the false bottom was found to be underlain by well water-worn gravels, indicating the action of the sea or a large lake. As seen on Sandy's Hill, and thence to the Big Kapitea Creek, they show the characteristics of a marine formation; hence the title under which they are being discussed. The beds rest on the eroded surface of the blue marine rocks of the district, and they are likely to prove much more extensive than the exposure at the surface would seem to indicate. They extend under the morainic hills on the south side of the Teremakau Valley as far to the east as Donegal Creek, near the junction of the Kumara and Christchurch–Hokitika Roads; one or two exposures of them take place in the road-cuttings in the intervening space. In Donegal Creek they are underlain by a thick bed of laminated lake-silt, thus indicating their mode of deposition in that place. Well-rolled sandstones form the bulk of the deposit, but there is a considerable admixture of granite-boulders, generally in a state so far decomposed that on exposure to the air they fall to granite-sand. The sandstones also are oxidised to a brown colour, unlike the beds at Kumara and on Sandy's Hill, and this while the latter are more exposed to atmospheric influences. Hence there is some doubt as to the propriety of associating the beds at the two places, and I have hesitated as to the placing of these Donegal Creek beds, whether with the lower beds of Sandy's Hill and Larrikin's Flat, or with the higher beds of the next succeeding series, under the head of "Older Pliocene and Upper Miocene." In dealing with the Older series, the same difficulty applies in connection with the heavy beds of auriferous gravels in the Humphrey's Gully Range, these being apparently younger than the great bulk of the "Old Man bottom," and, being underlain by silts containing strata of angular stones, indicating glacier action preceding the accumulation of the bulk of the gravels overlying the gravels of the true "Old Man Bottom," passing gradually into the brown sands of the upper part of Greenstone Creek, and these, in turn, resting more or less comformably on the fossiliferous blue sandy or marly clays of Miocene date. Apart from this difficulty, the formations are here stated in what appears to be their due succession from younger to older beds.

The beds under this head at Kumara are of great interest, on account of their being the scene of the operations of the Kumara Prospecting Association.

Last year, Messrs. Gordon, Gow, and myself indicated a site at which the Association should begin operations with the view of proving the deeper levels on Larrikin's Flat. This met the approval of the Association, and, other preliminaries arranged, the work was begun. Up till the month of November of last year the shaft had failed to pass through the gravel-drift, and doubts began to be expressed as to the success of the undertaking on account of the quantity of water that had to be coped with; but, subsequently, at between 90ft. and 100ft. from the surface, bottom was touched, and a prospect of gold was obtained from the wash on reaching the blue reef. The dip of the under-surface on which the gravels rest appears to be away from the bottom of the shaft in all directions, save to the south-west and south, and, as anticipated it would be, it appears that the prospecting-shaft has been placed on the point of an out-running ridge of Miocene rock, extending from Kapitea Hill into the low ground in the direction of Dunedin Flat, a particular part of the surface area that has been already worked for gold in the high deposits. In as far as concerned the advice tendered with respect to the position of the prospecting-shaft, and the possibility of reaching bottom at that place, the undertaking has thus proved a success. Gold also has been obtained from the bottom of the shaft itself, and, although this may not have been sufficient to pay, under the circumstances, it is still encouraging, seeing the existence of gold at the lower level is now a proven fact. Before leaving Kumara, however, I heard complaints that the shaft was not placed so as to prove the deeper ground in or towards the middle of the flat. To this I can but reply that, had the shaft been so placed, it is very unlikely that the prospectors would have succeeded in reaching bottom at all.

III.—*Older Pleiocene and Upper Miocene.*

The deposits coming under this head consist mainly of gravels and brown sandy beds underlying. The upper beds may in part be the equivalents of the lower beds treated of in the previous section, as it does not seem possible to make a hard and fast line of demarcation between them. So also it may be said of the lower beds to be dealt with under this head. The brown sands of the Greenstone and Brighton Terrace, opposite Kanieri, though alternating with coarse gravels in the upper part, rest on, and are closely related to, the marine Miocene beds.

There is some appearance of unconformity between them along the left bank of the Greenstone, and as an unconformity must exist somewhere between the marine and terrestrial beds of

this and the previous section, it hardly seems possible to place this otherwise than at the base of the brown sands of the Greenstone and Kanieri.

Humphrey's Gully Beds.—These, underlain by the blue clays of the Miocene marine series, form the greater part of Humphrey's Gully Range. The gravels are 300ft. to 400ft. or more in thickness, and cover a considerable area between the Arahura and Kanieri Rivers. The same gravels appear at Fox's, in Stony Hill, underlying the auriferous surface-deposits at that place, and they may be present in other parts of the district. They chiefly deserve mention on account of their auriferous character in the Humphrey's Gully Range. The Humphrey's Gully Sluicing Company have opened a heavy face in these gravels, and since the commencement of operations have passed a vast amount of material through their tail-race, with results that should have satisfied and paid the company had not the initiatory costs been very great. The vast quantity of auriferous gravel that is present here and in other parts of the range might very well maintain many more enterprises such as the Humphrey's Gully Sluicing Company, and it seems that the only reason why such other companies have not been started is the costly nature of the water-supply, which would have to be brought on to the ground at a high level; but in spite of this I have no doubt that all available water will eventually be utilised on one or other part of the auriferous gravels of this age, and the overlying deposits in this part of the district. The gravels extend east to the sources of Caledonian Creek, and the area covered by them may be estimated as from four to five miles in length, and from one mile to one and a-half miles in width. Morainic matter, or fragments of moraines undisturbed, overlie the gravels forming the mass of the range, but these are reckoned auriferous also and sluiced with the gravels that underlie. Three to four miles above Humphrey's a sluicing-claim has been opened out in the partly re-assorted glacier-drift on the lower slope of the range, while a mile lower down the river there are workings in the Humphrey's Gully-beds themselves.

Various reports describe the character of the deposits at Humphrey's Gully, and indicate the prospects there before the company. That the prognostications made have not been fulfilled is true; but these on the whole might have been of too sanguine a character, for though the facts of one day or a short period may be perfectly true, if they are taken to indicate the results of several years' work the chance has to be considered that the material may not be equal throughout in richness, and also that usually there is a falling-off in the value of the results, seeing that work is usually commenced where the gronnd is known to be good. Of these reports, the last, by Mr. Cox and Sir James Hector, may be here given. In a report dated March, 1884, Mr. Cox says:—

"Since I last visited this claim the company has been greatly increased. The original company was wound up with the view of amalgamating with two other companies known as the Miners' Amalgamated and Clarke's, the whole property now comprising 200 acres of ground, in which the thickness of wash-dirt varies from 150ft. to 500ft., the quality being alluded to in a former report." *

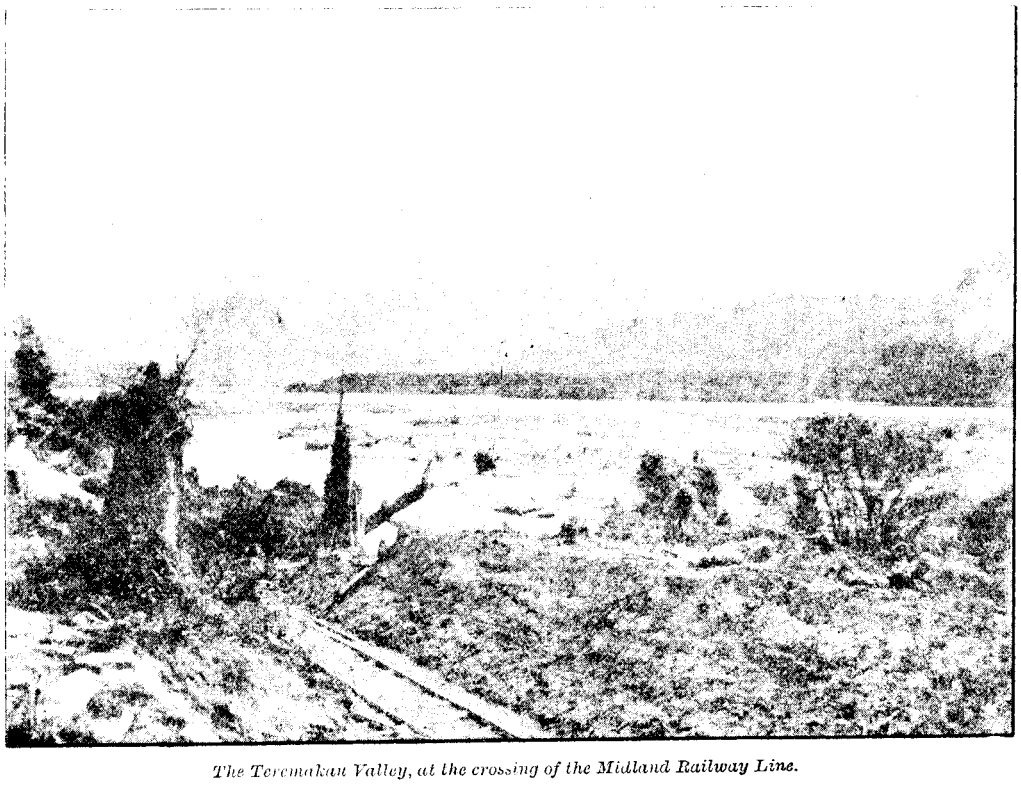
"The principal operations of the company have consisted in bringing in a water-race, which is 5ft. square in section, constructed to carry 100 heads of water; and this work has progressed very favourably, with the exception of a tunnel near the outlet end of the race, in which the occurrence of a drift containing a great deal of water has for a time completely suspended all work. This difficulty is now, however, overcome, and the work of driving is now being carried forward at the rate of a chain a week; and, as there yet remain 20 chains to drive, it is probable that five months will elapse before water can be brought to bear on the face. The head-works from the tunnel upwards are now completed as far as the site of the dam, this including a flume of nearly three-quarters of a mile in length; and the contract for the formation of the dam, which is estimated to take five months to complete, is to be let shortly. This dam has an area of 11 acres and 25 perches, from careful surveys, and is estimated to hold fifty-five heads of water for a twenty-four hours' supply, and by continuing the head-race over 100 heads is estimated to be available. As soon as this work is completed a constant supply of about twenty heads of water will be available, and this is to be directed on to the face which has been opened up from Macdonald's Gully, where a tail-race is being brought up by means of storm-water whenever this is available. A few trial sluicings have been made from time to time, the results of which have been very satisfactory, but of course no reliable information yet exists from which to estimate the yield per cubic yard of the field."

"In view, however, of the large expenditure which is being incurred by the company, it will be well to mention some of the results which have been obtained in similar claims in America, in order to show the profitable nature of this form of mining, when efficiently managed. Companies have sluiced wash from 40ft. to 260ft. in thickness, with a yield from 1¼d. to 9¾d. per cubic yard; and the amount of gravel moved per day varies from 2·73 to 20·36 yards per miner's inch, which, calculated at the rate of 6d. on the highest quantity of gravel treated, gives £20 sterling per head per day. The character of the gravel at Humphrey's Gully is such as to place it most favourably in the scale, and probably as much as 20 yards per miner's inch can be moved, which will give a total quantity of 16,000 yards per day, or 4,800,000 yards per year of 300 days, for 20 heads of water; or, when the total supply of 100 heads are in, the total quantity moved would be 24,000,000 cubic yards per year, if full work could be obtained; and guarantees at least a very large quantity of gravel will be treated in which even a very small return would pay.

"The works throughout are of a most substantial character, and have all been well and carefully constructed, and in the course of about six months should be so far completed as to allow of mining operations being commenced, with about 20 heads of water available.†

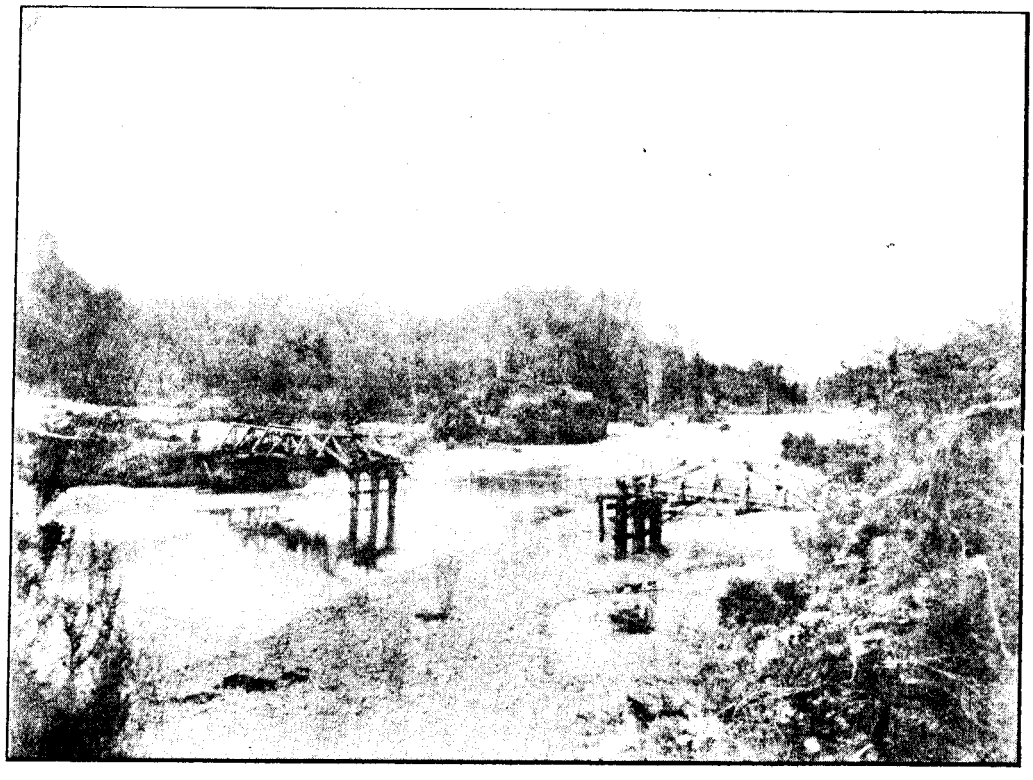
* With reference to the quality of the wash-dirt in the report alluded to (Geological Reports, 1882, p. 54) Mr. Cox says no more than that the gold is of a coarse description, and that gold was present in every prospect taken from the face, no matter from what part of it. I have since been informed that many such prospects may be washed without finding a colour of gold. The gold is generally fine.

† Geological Reports, 1883–84, pp. 90, 91.

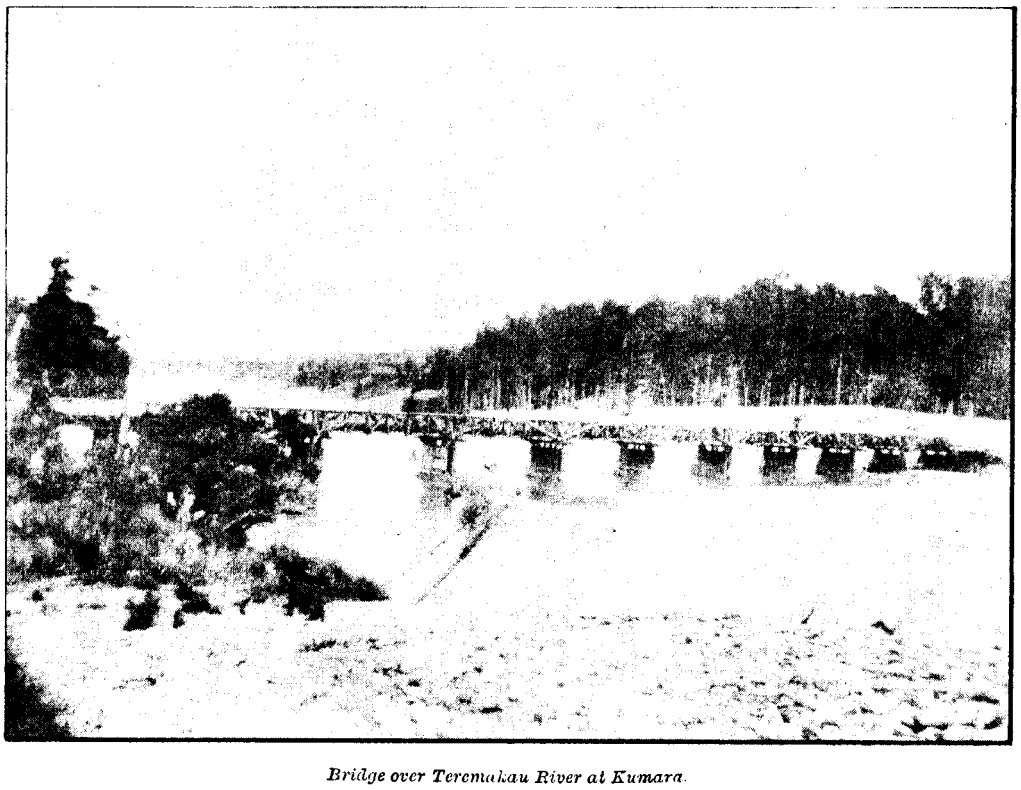


The Tercmakan Valley, at the crossing of the Midland Railway Line.

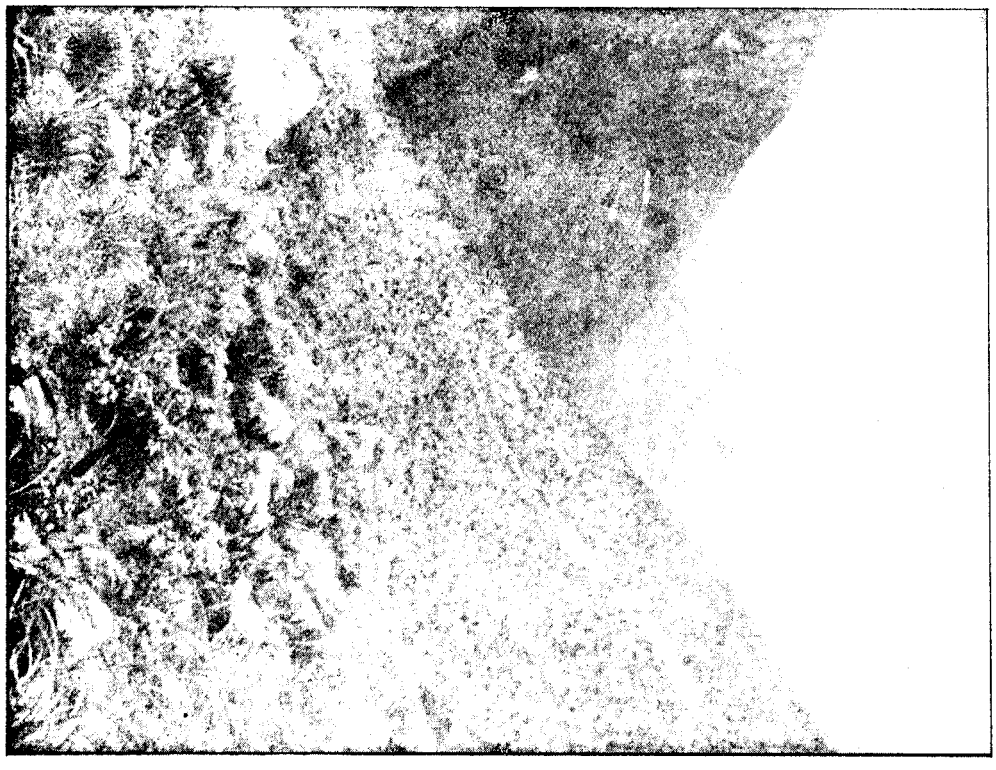
Sailor's Gully, Mont d'Or, Ross.



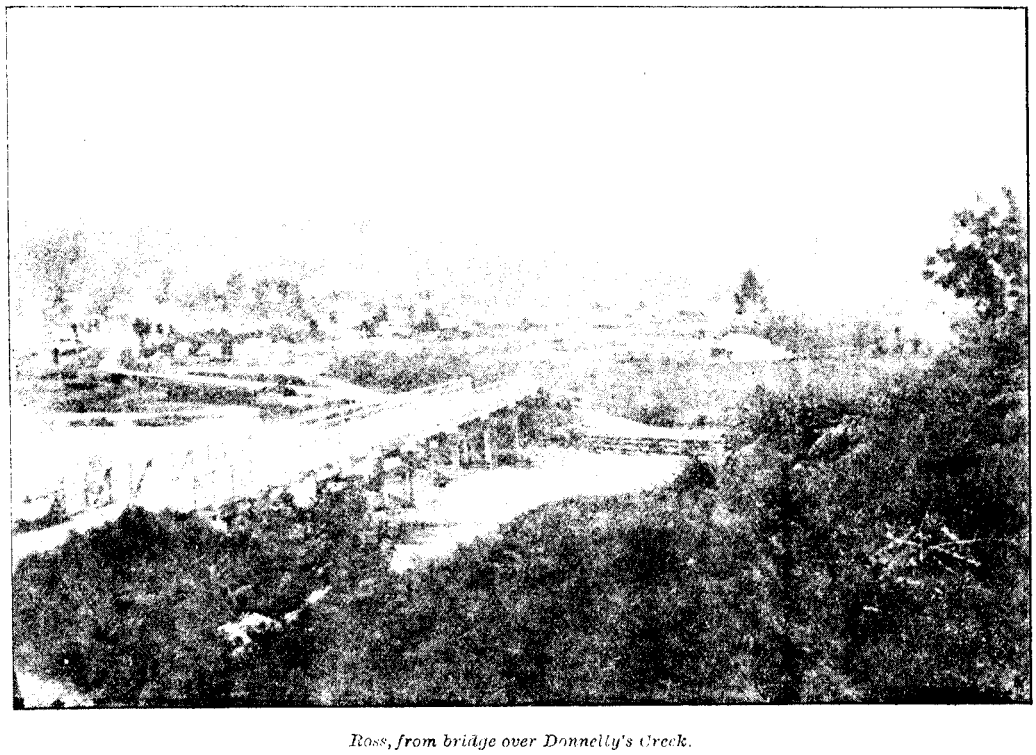
Junction of the Blackwater, Greenstone Valley



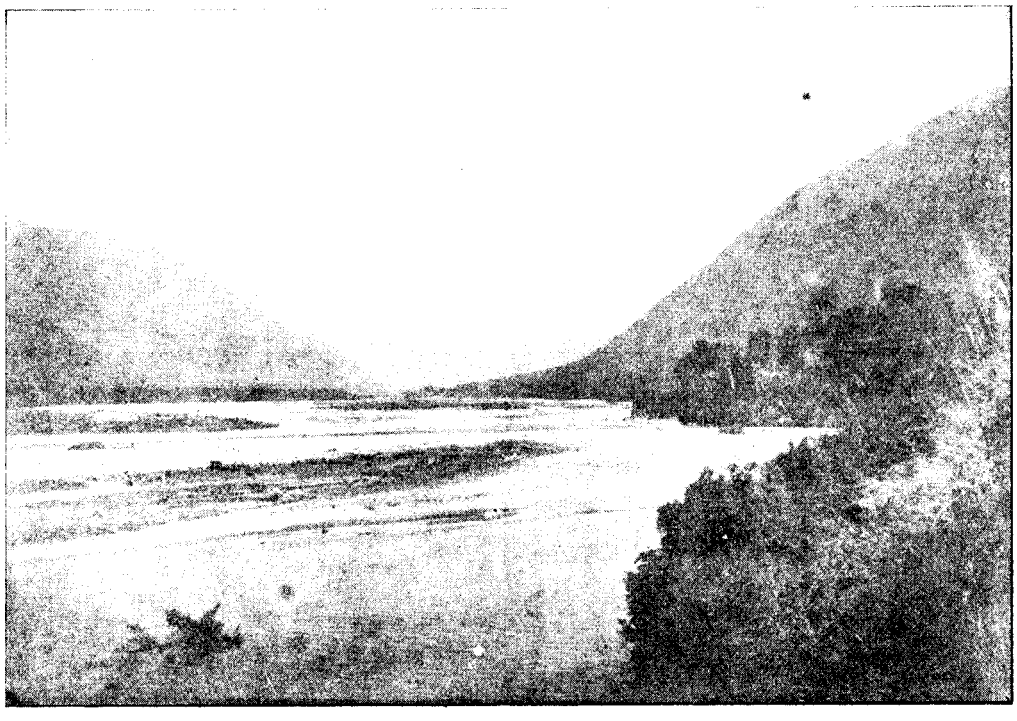
Bridge over Teremakau River at Kumara.



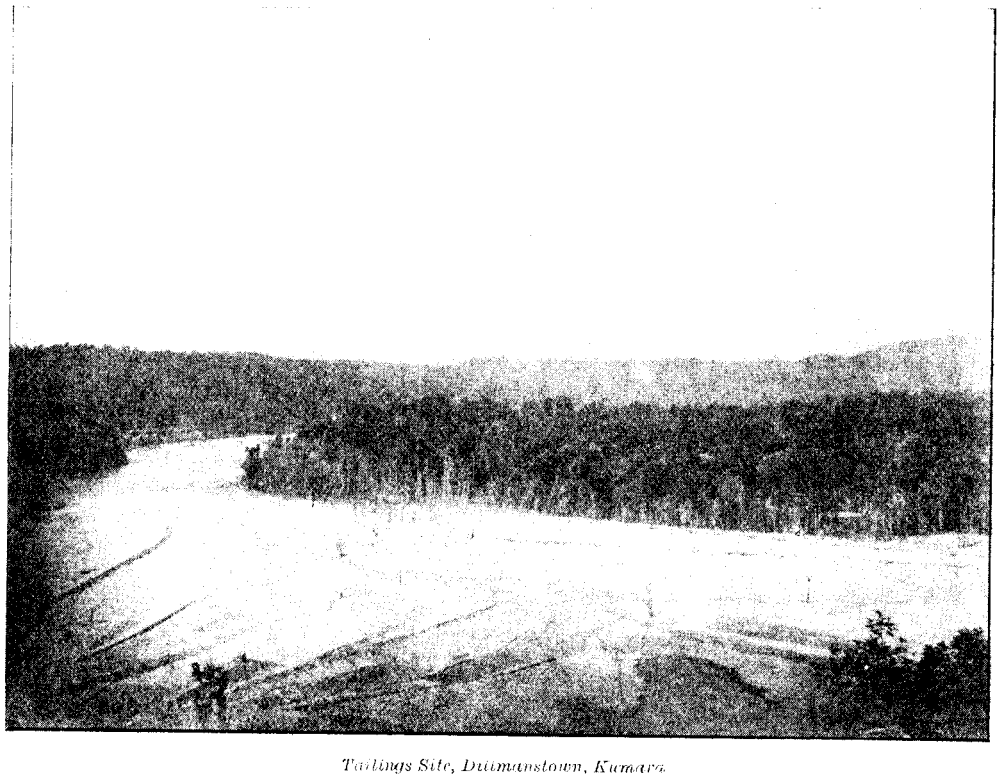
East source of the Otira River, Teremakau Valley.



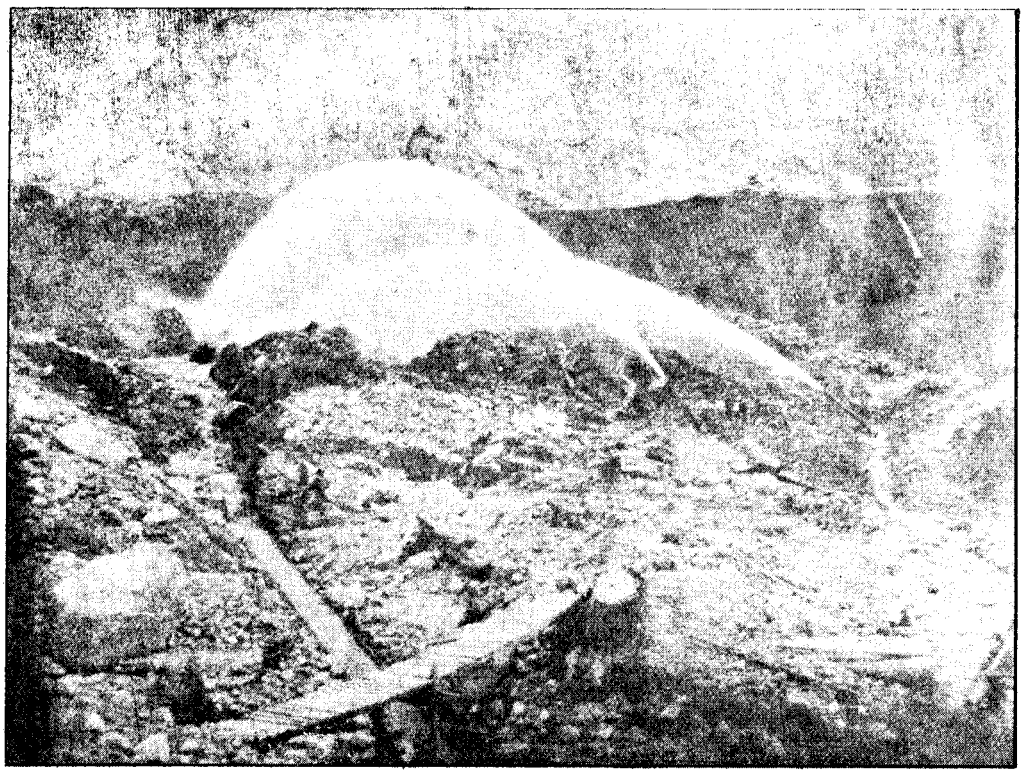
Ross, from bridge over Donnelly's Creek.



The Teremakau Valley, from Rocky Point, looking east.

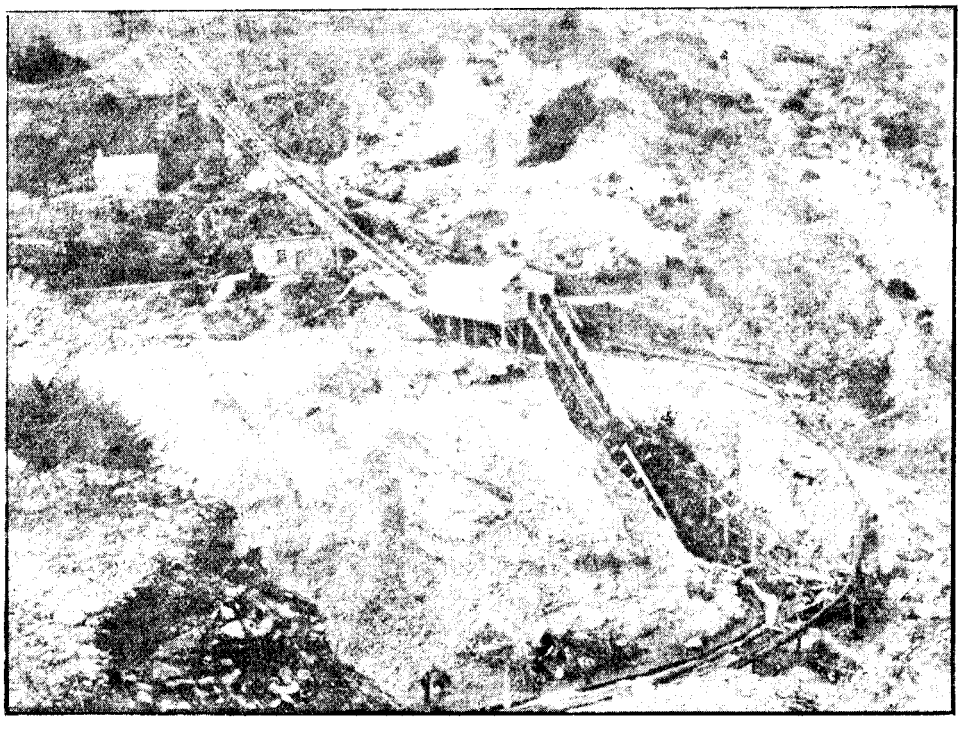


Tailings Site, Dunmanstown, Kumara.

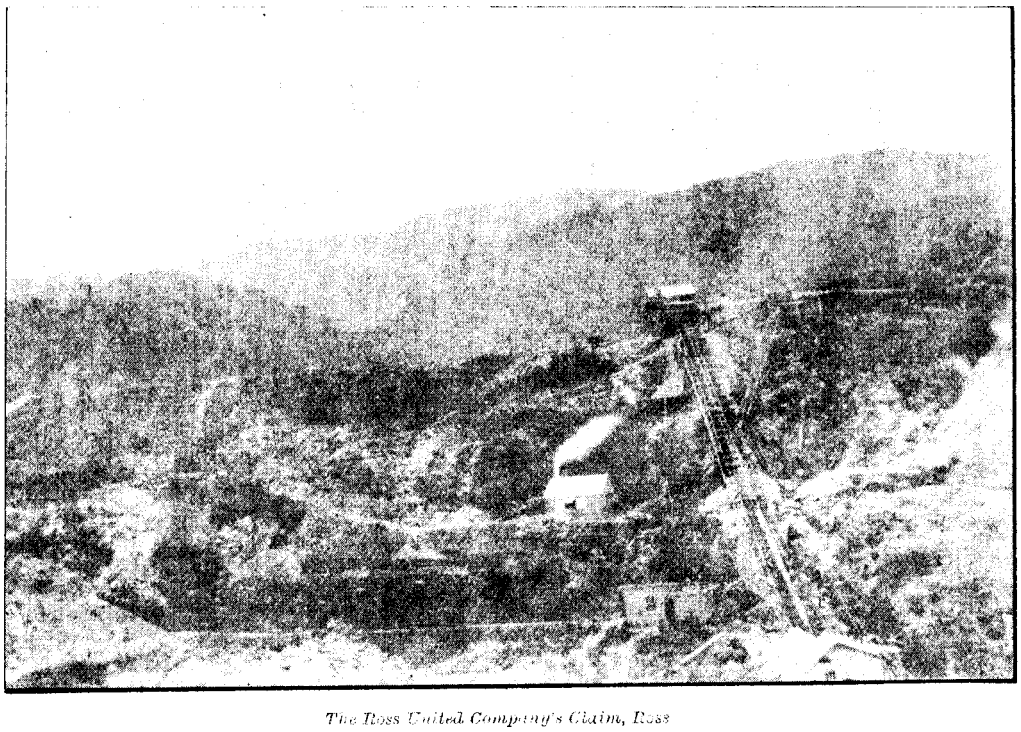


Humphrey's Gully Company's Works, Arahura Valley.

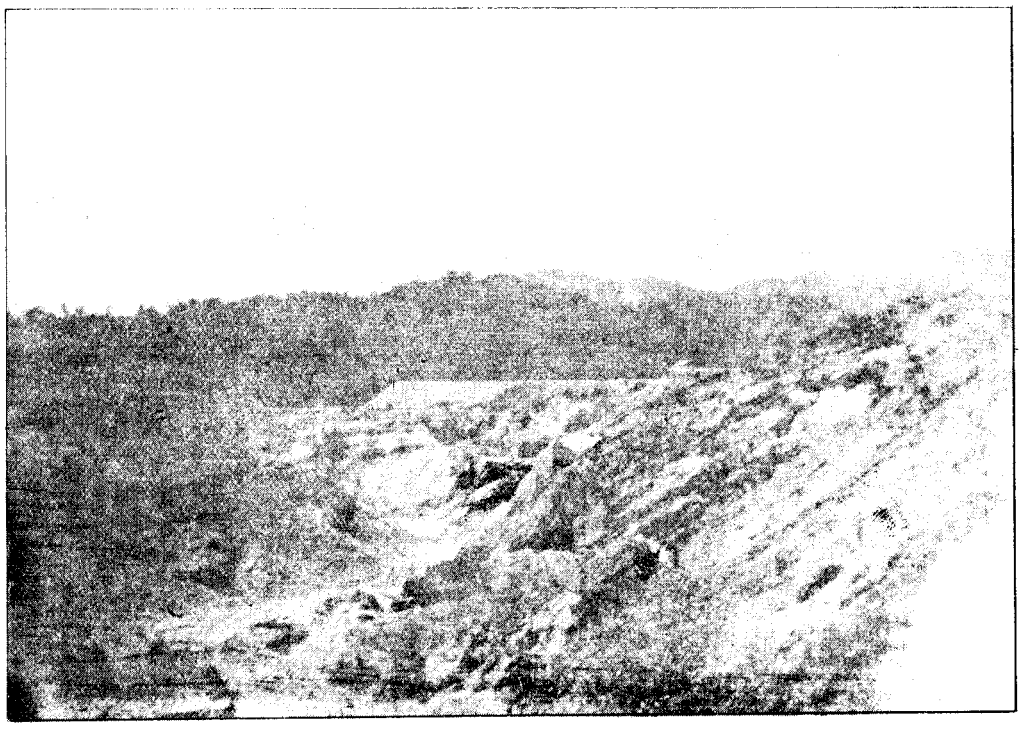
Embankment, Big Dam, Kumara Water Supply, Kapitea Creek.



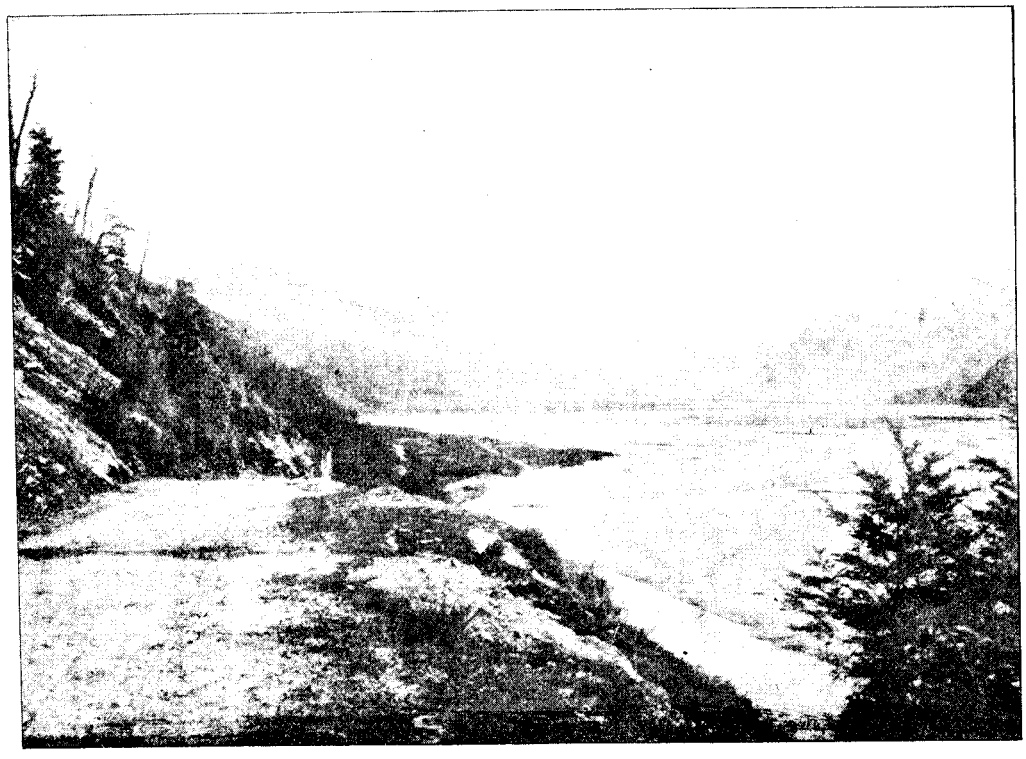
The Ross United Company's Claim, Ross.



The Ross United Company's Claim, Ross



Claim Works of Ross United Company.



The Upper Waimakiriri, from the Bealey Crossing.

In the preface to the same volume of reports, the Director, Sir James Hector, dealing with the same subject under head of "Hydraulic Mining in Westland," makes the following remarks: "This will be the great industry of the future in Westland. In former reports I have pointed out the distribution of the gold-drifts, and the manner in which the enormous discharge of water from the alpine sources had re-arranged and concentrated the auriferous drifts that had given the enormous yield of gold in proportion to the number of miners which has so characterized the Westland Goldfield."*

"But this very violent action has, by cutting deep river-channels through the first-formed gold-drifts left undisturbed large areas of these drifts at a level inaccessible to the ordinary drainage systems. By the construction of water-races, and by the system of hydraulic mining, the re-sorting can be effected artifically and with profit. I had an opportunity of inspecting one of the most promising of these adventures about twelve miles from Hokitika, where at Humphrey's Gully all the small claims are now being amalgamated, so that about 200 acres is held by a company in one block. It forms a triangle in the junction of two tributary valleys to the Arahura River, so that it lies favourably for getting rid of the tailings, which is the most important element in the success of a sluicing-claim. The thickness of the gravel is from 150ft. to 500ft., as the bottom on which it rests dips into the hill, which also rises rapidly on the surface. The gravel is of two kinds, *b* and *c*, which rest on *a*, a silt clay with lignite seams, which passes downwards into the blue reef† or marine fossiliferous clay-marls of Miocene-tertiary age that are so largely developed in the flat country on the West Coast. This silt deposit marks the transition from marine to fluviatile deposits in the district, or, in other words, the passage from Miocene to Pliocene formations. The gravels (*b*) which belong to these passage-beds were the first-formed river-beds on the coast, and are generally the richest, though the gold is hardly, if at all, sorted out in these gravels in the form of defined leads. This gravel is easily sluiced away, as the pebbles are of moderate and about equal size, and are, moreover, rotten and decomposed, so that their surface washes away and all the gold is set free. In ordinary gravels, as miners are well aware, the pebbles are hard, and the gold is set in a dense ferruginous cement that adheres with great strength to the surface of the stones. On the top of the terrace is (*c*) the newer gravel, of very heterogenous materials, being, in fact, a morainic deposit formed by glaciers that in late Pleistocene times descended from the Alps and spread over the plains and river-beds of the earlier period. This deposit (*c*) contains huge blocks of stone mixed with sand and fine gravel. The two deposits, *b* and *c*, are the chief repositories of gold on the West Coast, but *c* is not so uniformly auriferous as *b*; *d* is the ordinary flanking deposits of the existing valleys, and is auriferous or not just according to whether the river is traversing the older gravels in the upper part of its course.

"Now, as to the richness of these gravels, *b* and *c*. They have been tested in various ways—(1) by surface-workings at various points; (2) by tunnels driven through the hill in various directions; and (3) by sluicing the faces of the terraces. I made about twenty trials in the first way from various points, and never failed to get a few specks of gold to each dish. The average from the middle of the deposit *b* gave ten specks to the dish of stuff, or about 15lb. weight. These specks averaged 0·095 of a grain each; and as the stuff averages a specific gravity of 2·7, this would give the value per load (equal to 1 cubic yard) of 1dwt. 4gr. for each speck present, or for my trials, 11dwt. 20gr., equal to £2 6s. per load. The layer near the junction of the deposits *b* and *c* in like manner gave £1 1s. 6d. per load on the average, and the deposit *c* gave an average of £2 14s. per load. These results are very remarkable, but I do not see how they can be erroneous; but, still, experience shows that when sluicing on a large scale is commenced, while much coarser gold is obtained than by prospecting, the total average falls short of what was anticipated. The tunnel works were purposely so put in as to follow the richest layers, so that there is no wonder that they make the stuff appear even richer than the pan-prospecting.

"The third source of information is the best, and I understand that sluicing 500 loads of the gravel *b* gave about 62½oz. of gold, or about 10s. per load, which is probably about the real value of the stuff. Reducing the area to 100 acres, and the thickness to 100 yards on the average, the claim will contain 60,000,000 loads of stuff, and it is only the question of the cost of getting that remains to be considered. On this point I do not think that any hitch is likely to occur. When the dam is finished it will have an area of 11 acres, and afford 55 heads for 24 hours, with a possible inflow in dry weather of 100 heads. A short tunnel (the undertaking of which was a mistake, as it caused delay) has only to be completed now, when 20 heads will be at once available for sluicing. Under the circumstances, 20 heads should sluice 16,000 loads per day; when, taking one speck of the smallest size (*viz.*, ·02 of a grain, valued at one-fifth of a farthing) to each load would give £12 10s. per day, or £3,750 per year of 300 working days, which would be about half the interest at 10 per cent. on the capital aready invested; so that two specks would pay the interest, and, if it were an average-sized speck to the dish, which is a very moderate estimate from the trials I have seen and described above, the yield would be £800 to £1,500 per day, and taking the lowest of these figures the claim will contain at present £3,000,000, and at the about rate will be worked out in twelve years." (Geological Reports, 1883–84, pp. xxviii.–xxx.)

If the results obtained from the working of these gravels in Humphrey's Gully Claim have not equalled what are indicated above, they have yet been of such a character as to show that with prudent expenditure and careful management the undertakings of the company should at least pay, even as things stand, No doubt there is this drawback, that out of the present earnings heavy

* I have quoted Sir James fully on this subject in the preceding and succeeding parts of this report, and the reader is referred to these extracts from his writings for the fuller descriptions above indicated.

† This is more exact information than I could obtain, probably on account of the present condition of the claim. Some time since a large fall from the face took place, and when I last visited the claim the fallen material had not been removed. I saw angular glacier or sub-glacier matter in beds and scattered through the laminated clays on which the auriferous gravels rest, but no beds of lignite were noticed by me.

interest has to be provided for what is perhaps a rather large amount of capital expended on preparatory works, &c., and a considerable sum also for keeping the works in repair and good order.

The claim is now being worked, I understand, on a tribute to the company of two-thirds of the gold obtained; and, as by last accounts the tributers are well satisfied with their earnings, although the claim has not always yielded at the same rate in the past there can be little doubt that this claim, and it is to be hoped others yet to be opened out in the same gravel-deposits, will be made to pay interest on the capital employed in their development; and if the prospects are really such as have been stated in the reports quoted above they should be made to pay handsomely.

Old Man Bottom: Moutere Gravels of the Geological Survey Classification.—These rocks are widely distributed over the Nelson District and the west coast of the South Island. Northern Westland has an ample share of them, especially between the Greenstone, Lower Teremakau, and the Grey Valley. Immediately south of Greymouth they form a range of front hills between the limestone range and the sea. They are again largely developed in the New River District, and between New River and the lower part of the valley of the Greenstone. They occur forming the higher part of the northern portion of the Waimea Hills, and the same is the case with respect to the southern part. They are present also between the outlet of Kanieri Lake and the south branch of that river, on the south side of the Hokitika Valley between Brighton Terrace and Back Creek, and in the southern part of the district between the Totara and Mikonui Rivers, on the eastern slopes of Mount Greenland, and on the top of Mount Greenland itself. They are worked for gold on the very summit of Mount Greenland, nearly 3,000 feet above the sea, where a constant and sufficient water-supply is an impossibility. In Sailor's Gully, Mont d'Or, they have been worked to a depth of 30ft. or 40ft. over a considerable area, and to some extent in the Ross United Company's Claim on Ross Flat. On the Waimea Hills, or north of the Teremakau, I am not aware of any claims being worked in these gravels; but it is well known that the colour of gold may be got in them at many places. If the Humphrey's Gully gravels, and those of Donegal Creek on the Teremakau, be included as similar and scarcely distinguishable gravels, it will be seen that there is a likelihood of a revival of mining in connection with them. Since wherever there are facilities for getting rid of the tailings, and a large body of water can be brought to bear upon them, even though they prospect but a few colours to the dish, they can be made to pay. At Maori Point, an isolated conical hill on the west bank of the creek is capped by these gravels; and at the junction of Blackwater Creek, in the Greenstone Valley, they are largely developed, also in the hills west of the lower part of the Blackwater itself. They are largely developed in the range of hills on the south side of the New River watershed, but at all these places they do not seem to have been much prospected for gold. Probably they were tried during the early days of gold-mining on the Coast, but, not yielding results such as would satisfy the miner of those days, they have since been considered as containing too little gold to pay for working. No doubt this is generally true; and it is only where an abundant supply of water and the other facilities requisite are obtainable, that they are likely to pay now or in the future; but the likelihood of a steady if moderate yield of gold from these gravels makes them worthy of more consideration than is accorded them at the present time.

There can be no doubt that the destruction of these gravels, and the concentration of the gold thus set free, has yielded to the more modern gravels of the streams, or the black-sand deposits of the present or ancient sea-beaches, a large percentage of their gold; and this will help to explain the extraordinary fact that the Recent river-gravels inland of a particular line are to but a small extent gold-bearing, or almost devoid of the metal.

Brown Sands.—These beds are well developed in the middle and upper parts of the Greenstone Valley, and on the south side of the Hokitika opposite Kanieri. They alternate with thin or thicker bands of granity conglomerate; beds of this conglomerate, up to 10ft. or 15ft. thick, being seen in the Middle Greenstone. So far as I know, these beds have not been prospected for gold.

IV.—*Miocene Marine Tertiary Beds.*

Blue Fossiliferous Sands and Marly Clays.—These beds underlie the more superficial deposits over most of the low grounds of the district. They are present over nearly the whole of the New River watershed, and probably underlie the re-assorted moraines and terrace-gravels between there and Lake Brunner. They are present in the lower part of the Greenstone Valley, and at intervals show in the banks of the Teremakau to near the sea, and as far east as Donegal Creek, near the junction of the Kumara with the Christchurch–Hokitika Road. They are the lowest observable rocks of the Waimea Hills, and from the Blue Spur and Houhou Lead they underlie the other rocks of Humphrey's Gully Range to within a short distance of Kanieri Lake. Underlying the whole of this range, they appear above and below the forks of the Kanieri River; and on the southern side of the Hokitika Valley they appear at different places, or immediately underlie the brown sands that show at the surface along the foot of the terrace escarpment. Between the Totara and Mikonui Rivers these beds form the outer flanking hill of the Mount Greenland Range, the fossiliferous beds attaining an elevation of 800ft. or 1,000ft. between the Totara River and Donnelly's Creek. Toward the Mikonui they fall in elevation, and between the Totara and the Mikonui they are, for the most part, tilted to a considerable angle, and have a westerly dip; while at other parts the dip of the beds is, for the most part, at a moderate angle, and generally in the direction of the coast-line.

Fossils proving the age assigned these beds can be collected abundantly in some parts of the New River district, in the Greenstone Valley, at Callaghan's Hill, and at many places along the different branches of the Waimea River. At Fox's, Blue Spur, and on the Kanieri River, fossils are abundant, and are also plentiful at Ross. These consist chiefly of the shells of mollusca, but the bones of marine mammals, sharks' teeth, &c., are also often found.

VI.—*Cretaceo-tertiary.*

Upper Series.—This is represented by the Cobden limestone, and the dark marly strata that immediately underlies the more calcareous rocks. Further south the limestone is represented by a heavy deposit on the northern spur of Camel-back Hill, towards the southern side of the Kokatahi Plain. This limestone is in some respects very similar to the Whangarei limestone, or the lower part of Abbey Rocks limestone in the southern part of Westland.

Middle Series.—This consists for the most part of greensands, or greenish marly clays, and except, it may be, in Camel-back Hill, is confined to the neighbourhood of Grey Valley. The beds stretch between the Cobden limestone range and the coal outcrop. They can be studied at various places on the banks of the Grey, and in the hills on the south side of the river. Only in the lower portion have these beds proved fossiliferous, *Cardium brunneri*, Hector, MS., appearing in the beds at Brewery Creek on the north bank of the river.

Lower Series.—The highest of this is a compact moderately fine-grained or coarse quartz sandstone. It is well exposed in an island in the Grey River; hence called the "Island Sandstone." The grits that overlie the coal-measures in Coal Creek, and the valley of the south branch of the Kanieri River, probably represent the Island Sandstone. Finer grained sandstones and bands of black shale are associated in the lower part of the series, and constitute the coal-beds of the Kanieri. Coal occurs at this place, but the seams are highly inclined and not of sufficient importance to warrant any great expenditure in opening them out. In Camel-back Hill the coal-measures, from what I could observe without actually having visited the mine (which cannot be entered), dip at a moderate angle; and if a seam of workable thickness has been discovered, this is so placed as to afford good facilities for working level-free for at least some distance.

On the whole, the area of coal-bearing rock in Northern Westland is rather limited, and even where the coal-measures are present they are either so situated that they cannot be readily worked, or the seams themselves are irregular and unworkable.

X.—*Trias.*

Diabasic Beds of the Upper Teremakau.—The occurrence of these beds has already been noted under the head of "General Geology." There is little more to add in this place. I had occasion to visit the locality where they are displayed, under the impression that a gold-bearing reef of some consequence had been discovered near the source of the river. It turned out, however, that only patches and strings of quartz had been found, of such a character and so situated, that, unless, indeed, it yielded rich stone—of which I saw none—it is not likely to engage much attention for some time to come.

XII.—*Carboniferous.*

Maitai Series.—With these are included beds showing on the top of Arthur's Pass and extending along the higher part and eastern slopes of the main water-divide for some distance to the south, which by Sir James Hector have been regarded as of Permian age. I was not able to discover any decisive proof of the age of these beds. Along the Christchurch–Hokitika Road, in the Bealey Valley, the rocks resemble those in the vicinity of the City of Wellington, which are supposed to be younger than the Maitai series; but in the absence of fossils, and a but slight difference in the character of the rocks from those on the western side of the range, regarded as belonging to the Carboniferous period, I have thought it better to treat of the whole as one series.

On Arthur's Pass the dip changes from west to east. The principal rock is a hard grey or greenish-grey sandstone, with which is associated bands and thick masses of slaty shales. This part of the series is of great thickness, and continues on the Westland side of the mountain-range to and for some distance north of the foot of the Otira Gorge. They appear barren of useful minerals, and have no quartz-reefs associated with them. They extend south-west, and they, or similar rocks, reach as far as the Hokitika watershed. From Kumara to Rimu the old river-beds and glacier-drifts contain masses of a decomposed sandstone known as "coffee-stones," which in their undecomposed state seem referable to the indurated grey or greenish-grey sandstones of Arthur's Pass and the continuation of the range to the south-west.

In Kelly's Ridge there is a change to a predominance of black slaty rocks, the sandstones being less abundant than farther to the eastward. At the Otira junction with the Teremakau sandstones are again predominant. In the Upper Teremakau Valley sandstones and indurated conglomorates ("pudding-stones") are more plentiful than in other parts of the district in the same rocks. In the lower part of the formation reefs of white quartz are present. The reefs on Kelly's Ridge occur in the lower third of the formation, and in a different horizon to those on Jackson's Hill. The map accompanying shows approximately the boundary and southern continuation of these rocks. It was not possible to follow them through the higher mountain region on account of the extremely unfavourable weather experienced in the back country of Westland last season. The same rocks occur in Mount Greenland, west of the granite belt in the southern part of the district, and the Cedar Creek reefs occur in the lower and slightly metamorphosed part of the formation. In less altered rocks and higher in the series, in the north-west side of Mount Greenland, small reefs of quartz are found in the upper part of Donnelly's Creek, the prospecting of which is going on at the present time.

The older rocks of the range on the south side of the Grey River, opposite Brunnerton, belong to this series. To the westward these are overlain by coal-measures, while to the south they are overlain by the Tertiary series of New River and Mount Riley. The older rocks of this range have not been thoroughly explored. On the opposite side of the Grey, quartz-reefs, and the antimony lode of Langdon's, occur in a continuation of these rocks, and it is more than possible that similar deposits occur also in the area within Westland.

Devonian.

Slightly-altered Sub-metamorphic Rocks.—The lower-beds of the Maitai series are not apparently separated from these by a marked unconformity, nor can any distinct boundary be determined between these and the schists that underlie. Upwards they pass into indurate sandstones and blue or black slaty shales, downwards into phyllites and fine silky micaceous schists. They are best seen in Jackson's Hill and along the banks of the creek leading to the quartz-reefs and gold-mine on the higher part of the range. Here in association are sandstones, quartzites, and beds of silky micaceous slates that must be considered metamorphic. The beds strike south-west and dip to the eastward. They extend by way of the Seven-mile Creek across the Taipo to the Arahura watershed above the second gorge, where in the range separating the two river-valleys in the part indicated they have a considerable development. On the Styx Saddle, leading from the Arahura into the Browning River, they contain a number of small reefs or leaders of quartz; but so far none of these are known to be auriferous. The beds are no doubt continued to the south-west into the watershed of the Upper Hokitika, but for the reasons already stated they were not followed thus far.

From these rocks have been derived the gold of the Seven-mile Creek, and the other auriferous creeks of this part of the Taipo Valley. Jackson's Reef occurs in them, and traced in the opposite direction they seem to form the eastern spurs of Mount Alexander, and in this direction extend to the northern boundary of the district. Quartz-reefs are reported as occurring in these beds on the north-east slopes of the Mount Alexander Range.

METAMORPHIC.

Mica-schists.

Upper Mica-schists.—These rocks, which insensibly pass upward into the last described, are not so much metamorphosed but that they frequently indicate their sedimentary origin. In the Teremakau Valley they are well seen between Jackson's and Rocky Point, where, for the most part, they are fine-grained silky mica-schists. In the upper part of the second gorge of the Arahura River they form a coarse, grey schist, with the sedimentary bedding often not defaced, and showing as contorted lines; while at other places the original deposit seems to have been a slaty breccia, the pieces forming which can still be traced, although throughout the rock is of a schistose character.

Middle Mica-schists.—These rocks are thoroughly metamorphosed, and consist of talcose schists, bands of steatite, and pure mica, chlorite-schists and heavy masses of quartzose actinolite schists, hornblende schists, &c. Various ores of iron and copper are found in these rocks, and to them also belong the greenstone or axe-stone of the Maoris, usually found in the alluvial auriferous wash of the lower grounds. Garnets, usually as pale-yellow or straw-coloured crystals, abound in this formation. These rocks have their prime development in the second gorge of the Arahura River. They reach across the Taipo to the Teremakau Valley at and a little below Rocky Point, and they here develop steatite rocks of a granular texture, of a pale, creamy colour, which might be made use of as a building-stone. The same rock occurs on the western spurs of Mount Alexander. Bands of muscovite rock occur in close association with these steatite bands. This muscovite is of no commercial value, being built up of small flakes or crystals. The actinolite-schists are developed throughout the length of the district, the gravels of the Hokitika River-bed at the foot of the gorge betraying their presence as an abundant rock in the middle or upper part of the gorge.

These rocks give more evidence of the existence in them of metallic and other useful minerals than any other of the older series of rocks within the district. Between them and the upper schists there is a belt or thick band of olivine-serpentine rocks, usually also impregnated with the ores of copper and iron. Judging by the amount of material, olivine and serpentine, and other allied rocks, composing the shingle-beds of the Hokitika River, there must be a very large development of these rocks in the upper part of the valley. While at the Hokitika Gorge I collected samples of these rocks from the river-bed, and these being noticed, I was, without putting the question, informed that I should have to go up the valley to Frew's Creek before meeting with this rock in the solid. Frew's Creek is a small tributary of the Upper Hokitika, above the junction of Pass River. The information being quite voluntarily given is no doubt correct; and as the locality mentioned lies in the direct line of the southern continuation of the belt, as determined along that part of it between the Teremakau and south side of the Arahura Valley, there can be no reason to doubt the information given. No copper specimens were obtained from the Hokitika River-bed, nor from the northern extension of the belt in the Teremakau Valley, and the ore of this metal could but rarely be detected in the boulders of the Browning River. It seems for the most part to be confined to the Arahura Valley. Samples of cupriferous slate from the contact of the olivine belt with the underlying schists yielded as much as 9 per cent. of copper; and as this is a rock impregnated with copper, and not a mineral vein, and of considerable thickness, portions of it may be payable to work. Several minerals and ores collected have yet to be determined or analysed, so that they cannot be definitely spoken of in this place. A list of the more important will appear at the end of this report.

Lower Series of Mica-schists.—These are grey flaggy mica-schists in the upper part; the lower part forms a dark-grey mica-schist, in places full of iron garnets, sometimes of considerable size. These rocks extend throughout the length of the district, and towards the north-east they either pass into or are underlain by foliated mica-schists, with laminæ of quartz similar to the foliated schists of Queen Charlotte Sound or Central Otago. They are characteristically developed in Mount Brown Creek, and the lower part of the second gorge of the Arahura River, and thence in a north-east direction they form the western slopes of the Mica-schist Range to where the Taipo River enters the Teremakau Valley. North-east of this they alter somewhat the direction of their strike, and continue along the south side of the Teremakau Valley to within a mile of Rocky Point, and on the opposite side of the river from the last outrunning spur of Mount Alexander. Few minerals of interest

were found in these rocks—a mass of rhodonite (silicate of manganese) excepted, which was noticed in the gorge of the left branch of the Arahura-Wainihinihini. These lower mica-schists have not, however, been sufficiently prospected. Further south they contain quartz-reefs within the Hokitika water-shed, the reef at one time prospected near the junction of the Kokatahi and Toaroha Rivers being in these rocks. The same rocks may perhaps form Wooded Peak or Doughboy Hill (as coloured granite, &c.,) standing isolated from the Mica-schist Range on the eastern part of the Kokatahi Plain. These rocks cross the Hokitika River towards the lower end of the gorge, and trend in the direction of the upper valley of the Mikonui, where they occur east of the granite belt.

Gneissic Schists.—The last described rocks are sufficiently clearly marked off from the gneissic schists which underlie, although banks of dark mica-schists alternate with the latter. The harder gneissic rocks bind the whole formation, of which they are the principal part, together, and the lower mica-schists, yielding readily to the weather and other denuding agents along the line of junction, has thus favoured the formation of the remarkable low depression that has been described as separating the granite rocks from the mica-schists, which is so marked between the Arahura River and the northern boundary of the district. The gneissic schists contain ores of copper and iron, and probably also of other metals. In Turiwhate I examined a supposed quartz-reef, close to where the Rangiriri crosses the Christchurch Road; but this proved to be only a quartz gniessic band overlying mica-schists. Thin quartz-veins were observed in some of the masses fallen from the mountain; and from the bed of the Kawhaka River Mr. William Harcourt collected samples of quartz containing copper pyrites, which occurred as a thin leader of quartz in a gneissic boulder.

There is every probability of gold-bearing quartz-reefs occurring in this formation, both in Turiwhate, and in the mountains on the north side of the Teremakau, in the eastern parts of Mount Smart and Mount French, where they descend towards the Teremakau from opposite the Big Wainihinini to opposite the Taipo. Hitherto the whole of the rocks forming these mountains have been regarded as being granite, and consequently have been thought unlikely as containing auriferous quartz-lodes, and as a consequence they have been very little prospected. But it is quite possible that they contain auriferous or other metalliferous lodes, and in future should not be overlooked. With these rocks, perhaps, should be associated the quartzose foliated rocks of Bell Hill.

Plutonic.

Massive and Intrusive Granites.—While the greater part of the so-called granite mountains may rightly be referred to the gneissic schists above described, towards the west the mountains, apart from the Mica-schist Range, contain rocks that cannot be distinguished from true granites. These form the western part of Turiwhate and of Island Hill, also the mountains on each side of Kanieri Lake, and between the lower part of the Hokitika Gorge and the Upper Mikonui River. To the north of the Teremakau the same rocks form the western slopes of Mount Smart and Mount French, and the western end of Hohonu Peak Range; probably, also, the western part of Tekinga and Granite Hill on the northern boundary of the district.

Red or pink-coloured intrusive granites are largely present at the western base of Mount French, from the Big Hohonu River to Maori Point, on the Greenstone Creek. In the Big Hohonu River-bed grey granites are seen, veined by a yet darker hornblendic variety of intrusive rock. In and to the south of Turiwhate much of the granite is poor in mica, and at places it is porphyritic, with large crystals of felspar. Many blocks of granite in the terminal moraines of the Teremakau and Arahura glaciers contain abundance of felspar crystals, larger than can generally be met with in the rocks *in situ*.

Concluding Remarks.

I have in the preceding pages brought together a considerable body of facts and observations, the result of the labours of the different workers specified, and now it remains to be seen what is the rational and logical outcome of the whole. The first and foremost, and by far the most pertinent question is: What are the prospects of Westland as regards its future production of gold? Broadly, the answer is easy. Its heyday of suddenly-discovered rich and easily-worked but local auriferous deposits is gone. In the northern district, in the early days, no sooner was one gully or creek valley "rushed," than the restless spirits, or unlucky members of the community, scattered themselves over the surrounding country, and, by a multitude of trials, succeeded in finding another locality equally rich in gold; but this is no longer the case. In every auriferous country those days are soon over, and the richer parts of its auriferous deposits exhausted. In the feverish earlier days of the rush, prospecting is carried on at every accessible spot, and to regions that under ordinary circumstances were wholly inaccessible. Then the prospecting element of the population, baffled or exhausted, falls back upon the mining centres that have already been established, now yielding steadily, if less richly than before. Meanwhile, the total yield increases in yearly volume, and externally, and, as yet, in reality, there is every evidence of continued prosperity on the goldfields. But the population continually being augmented, the area of wages-paying ground begins to be no more than equal to the needs and requirements of those already on the field, and there is new necessity, and new incentives to fresh discoveries. Again a wider field is prospected, and again with but partial or insufficient results. No longer able to maintain themselves within the bounds of the particular goldfield, a portion of its mining population, as inducement offered elsewhere, would take their departure. Meanwhile, greater experience in dealing with the peculiarities of the occurrence of the gold, and the adoption of labour-saving appliances, for the purpose of securing very fine or widely-scattered gold, would have come into use, and large areas, formerly unworkable by the first methods in vogue, would now be rendered productive. But with the new methods of increased power, and greater exactitude, would also be ushered in the period of costly preparatory works necessary to the efficient application of these. Hence capital would be required, and those who had it not would be reduced to the condition of wages-workers. And whether as such, or as employers, the desire of those engaged in mining, and, indeed, of the whole commumity, would be to see the limits of the

field extend, and if possible the gold traced to its source in the rock formations, whence as alluvial gold it had been derived. The discovery of gold-bearing reefs becomes an aim early in the development of every field, but necessarily at first is less attended to than the finding of rich alluvial deposits, since capital is needful, and delay is almost certain. Usually it is the case that reef-discoveries are made, and for a time held tentatively, or again abandoned. If the district abounds in gold-bearing reefs yielding sufficiently, this form of gold-mining is soon established on a firm footing; if not, sooner or later speculations are indulged in as to the whereabouts of the source of the gold; and, if this is deferred till the last stage of alluvial gold-mining has set in, and become general, few care or are inclined to personally prospect at their own cost. Then it is that prospecting associations are formed and parties fitted out, which may or may not discover what they are in search of. As a rule, at this stage prospecting is a failure, since the more energetic individual search of earlier times would probably have been successful did the lodes exist, or were they easily found. Next comes the stage in which the Government of the country is called upon to aid in the development of the mineral riches of the district, either by direct subsidies, or by the employment of expert knowledge.

Although I here have sketched what is the usual process of the development of a goldfield, and the evolution of those processes by which it continues to be remunerative, in theory only, roughly this may be applied as illustrating the progress of mining in Northern Westland; and, as part of the outcome of all this, I made the examinations here detailed, and have written this report.

From the foregoing parts of this report it will be seen that it is an undeniable fact that the valley of the Teremakau is not auriferous, in the sense of affording paying ground, above Jackson's, and the opening leading through the mountains on its northern side to Lake Brunner. Nor has the Arahura or the Hokitika given different results. And yet the auriferous rocks are said to lie far back towards the sources of these rivers. In the case of the Taipo Valley and the Taipo Range there seems to be proof in support of this theory. The rocks in this part belong to the lower part of the series of unaltered, or but slightly altered, metamorphosed slates and sandstones that, lying to the eastward of the crystalline series (granites and metamorphic schists), form the western slopes of the northern extension of the Southern Alps, and in the case of the Taipo Ranges appear to, but do not in reality, reach forward (to the westward) beyond the general boundary-line. Here the rocks are locally impregnated by auriferous quartz-lodes which have yielded rich alluvial patches of heavy coarse gold. This coarse gold has been traced along the course of the smaller streams on the Taipo Range and Kelly's Ridge, and there can be no doubt that its source is the reefs, discovered and to be discovered, which exist in that range. But for some reason or other no such discoveries have been made in the same rocks within the valleys of the Arahura or Hokitika Rivers to the south-west, or within the main valley of the Teremakau to the north-east.

Differently situated, because lying to the west of the granitic and schistose belt of rocks, is another area of unaltered rocks forming Mount Greenland and its outrunning spurs to the westward at the back of Ross. There can be no doubt as to the identity of these with the Taipo rocks, or with the unaltered strata of the main range east of the crystalline belt. In these rocks on the eastern slopes of Mount Greenland gold-bearing reefs are found, the Cedar Creek reefs being so situated. It is said, also, that reefs are abundant on the opposite side of the Upper Totara Valley in the direction of the Hokitika Gorge. And here again there is distinct evidence of the auriferous character of the Maitai slates and sandstones. On the other hand, although generally more accessible to the prospector, the granite and schistose rocks of the same region, so far as these have been tested and proved, are devoid of gold-bearing reefs, and, with the exception of a narrow belt of magnesian rocks developed in the valleys of the Arahura and Hokitika Rivers, there are no other rocks in the district in which gold-bearing reefs might be expected to occur.

The alluvial gold in many instances, and also the reef-gold obtained from this part of the district, being of a coarse description, the inference is that, if the Maitai rocks have been the source and chief repository of the gold obtained from the alluvial deposits of the lower lands, the higher part of the formation now denuded away must have been more abounding in reefs, and these of a richer description than are to be found in that part of the formation which yet remains. This inference, however, is not well sustained by proofs, since there has been comparatively little gold obtained from the river-valleys, where they might reasonably have been expected to be rich in alluvial gold. In the case of the Buller Valley, Sir James Hector pointed out that, assuming that the bulk of the fine gold got along the coast to the north and south of the river, after leaving the lower gorge, had been brought down by the river from the inland districts, there must be rich gold-bearing areas and great quantities of coarse gold in the upper valleys of that watershed. (See quotation *ante*, pp. 155–58.) This inference has since been proved correct, but, in so far as the same might apply to the valleys of the Teremakau, Arahura, and Hokitika, it has failed of realisation. But, however, it was not so applied: on the contrary, in the same report, but without specifying its different source, Sir James points out that the manner of occurrence and the character also of the West Coast gold south of the Grey River are quite different, and that it belongs to a valley-system that now no longer has existence, except as a depression trending north-east and south-west, broken through and crossed by the present drainage-channels of the country, the older alluvial deposits in which "may be looked on as the first-formed drifts in the great valley which extends through the country south from Blind Bay, and is cut off obliquely by the sea-coast between the Teremakau and Okarito." Sir James points out that this old valley is raised towards the north, while to the south, what has to be assumed as its western bounding-slopes are gone, and the floor of the one-time valley is cut obliquely at a long acute angle by the coast-line. The raised character of the northern part is continued beyond the valley of the Little Grey into that of the Upper Buller, and culminates on the line between the eastern slopes of Mount Owen and the southern end of the Dun Mountain and Ben Nevis Range near Tophouse. Along this line the gravel deposits attain a height of 3,000ft. above the sea. Northward of this the surface gradually slopes north to the sea at the head of

Blind Bay, and the alluvial gravel-deposits in this part fill the whole depression between the Dun Mountain Range and the mountains to the west of the Whangapeka and lower Motueka Rivers.

There is but little difference in the character of these gravels, either as to size or material, at whatever locality they may be examined; and the question arises, Did the river which was the main agent in their deposition flow to the north, or to the south; or were several distinct rivers concerned in their production? Or, it may be asked, are they the direct product of river-action at all, and not littoral deposits along an open coast-line, and are they in their present positions due to the direct action of the sea? Much depends on the correct solution of this problem, and the evidences must be carefully examined.

In the first place, it is quite conceivable that the drainage of the Upper Buller Valley may have found its way across the Bog Saddle into the Grey watershed, and in following the gravels to the south everything would be in conformity with the assumption that this was the direction of the drainage till the open sea-board south of Greymouth was reached. Here the gravels reach sea-level, and between Greymouth and Marsden are largely developed, but to the seaward side of the main depression. To the south of this, unless high land to the westward has, since their formation, disappeared, the gravels cannot be considered as a valley deposit, or, at least, deposits in a valley trending north-and-south; and, more to the south, from the Waimea to Ross, they must be considered as being in their lower beds considerably below the level of the sea. Thus, it appears that on the water-parting between the Buller and Motueka watersheds the gravels have their highest elevations above the sea, and here they show even now the greatest thickness of deposit, but at the same time indicate no closer proximity to the source whence they have been derived than they do at other places. As the slopes from this high land exist at the present time, it is necessary to assume that the deposits to the north were formed along a river-system distinct from that which drained south-west to the sea between the Teremakau and Okarito. But, again, on the water-divide between these two river-systems the deposits are as thick, and as characteristic of long-continued rolling and abrading action, as at either extremity of the valley depression, and being near the supposed sources of the streams concerned in their production, the gravels of the Upper Buller should be of a coarser and more angular description; but, as has been said, such is not the case, and therefore it is evident that, notwithstanding the levels at which they are found at the present time, if considered as river deposits, it is necessary to regard the whole as the product of one grand river-system. Whether this discharged its waters to the north-east or to the south-west has also to be determined.

Assuming the former existence of such a river, supposing this had its source to the north-east, the high lands which constituted its main source must have been situated within the area now occupied by Blind Bay, and the drainage from these and the bounding ranges to the east and west must have been carried south into and across the Upper Buller watershed into that of what is now the Grey River system, and thence continued southward to a point no longer to be determined. Thus it will be seen that both the source and the lower course of this hypothetical river are now beneath the level of the sea, and, having opportunity to study the deposits of its middle part only, it is not easy to say in which direction its current may have flowed. The course of the river may as well as in the opposite direction, have been from the south to the sea in Blind Bay, and in this case the auriferous character of the gravels along its middle and upper course would seem confirmatory of this having been the actual direction taken by it. The gravels of the northern slope north of the Buller watershed are not known to be auriferous, and there are other reasons for supposing that the source of this river lay to the south and south-west of Hokitika.

But, as the physical configuration of the country now is, it is clearly impossible that under any circumstances the Hokitika, the Arahura, the Teremakau, and the Grey could be affluents of a large river discharging into Blind Bay; to serve the present purpose, such proofs of this must be presented that the theory based thereon may appear reasonable.

One thing has been overlooked. During late Miocene times the sea invaded parts of what is now this valley depression, and Tertiary marine deposits of that date are to be found within the area of its northern and southern extremities. In the north these deposits are not found far inland from the shores of Blind Bay—that is, assuming the Sherry River-beds to be of Cretaceo-tertiary date; otherwise the Tertiary beds must be considered as extending south to the north-eastern base of Mount Owen. Tertiary beds, fossiliferous, and of the same age, begin at Ross in the southern extension of this old valley, and although now at many places and for the most part overlain by well-rolled gravels and sub-angular glacier-deposits, they may be traced into the valley of the Mawhera-iti, or Little Grey, a distance considerably greater than the same beds extend south from the shores of Blind Bay; and a question to be considered will be, how far the presence of these deposits is compatible with the theory of ordinary action in the production of the gravels of older date throughout the period of depression.

These Tertiary clays and sands are for the most part resting in a nearly horizontal position, but near the foot of the higher ranges and outcrops of older rock they are generally, though not always, tilted at considerable and very often at high angles, showing that since their deposition very considerable changes have taken place in the disposition of the strata and configuration of the country. The relation of the gravels to these marine strata is somewhat close: at many places the passage is gradual, and evidences the conformable succession of the beds; at other places the lower beds are absent, and the gravels are underlain by shaly clays and lignite beds resting on older rocks, and generally the gravels have been considered as unconformably overlying the marine Tertiary clays and sands.

The gravels are mainly composed of sandstone, but much granite and the harder parts of schistose rocks are widely and more markedly locally associated with the predominating sandstones, and it seems also that these variations as respects a particular rock are more prominent when that rock exists in the neighbouring ranges.

We have next to consider these gravels as the products of denudation carried to the shore-line by torrential rivers, and rounded and arranged in thick stratified beds, or unstratified through great thicknesses, as now found, by the action of the sea. To this end it may be necessary to suppose that at the time when their formation was commenced the land stood at a lower level than at present. The beds reach to 3,000ft. on Mount Greenland, and are 300ft. below sea-level on Ross Flat, not more than five miles to the north-west. To the north-east they are found at all intermediate heights, till attaining a second time a height above the sea of 3,000ft. on the water-parting between the Buller and Motueka Rivers. To submerge the country to the extent requisite to bring the highest of these deposits to sea-level would be to leave but a narrow backbone of the main range and a number of outrunning spurs above the water-line, and very largely we should thus cut away the supply-source from whence these gravels could have come.* Before the deposition of the gravel formation a moderately deep sea would fill those parts of the depression over which the marine sands and clays are found, and these deposits do not indicate any considerable depth over the same area at the time of their deposit. Hence, apart from the question of the whence of the gold, there seem difficulties in the way of accepting even this theory of the origin and mode of the formation of these gravel-beds; since an essential part of the theory is that the hypothetical river, taking its rise considerably to the south of Ross, ran to the sea in or to the north of what is now Blind Bay; but as it is clear that its valley-bounds to the west were broken through by the sea during a period of submergence, on the land reappearing it is surprising that the drainage did not flow through the breach in the mountains on the west side of the valley, the more so as this would be the tendency of the drainage of the present time. All this merely points to the fact that the drainage-system of the whole region was unlike what it is at the present day. Most of the intelligent miners on this part of the West Coast have come to the conclusion that a great part of the gold has not been derived from the mountains to the eastward, and, without being able to show in what manner, express the opinion that it must have come from the seaward. Such a theory, to be correct, implies the former existence of land in that direction, and a system of drainage that would tend to bring the products of denudation into the valley depression which has already been described. It is necessary, therefore, to formulate a hypothesis that will meet these requirements, and then to examine and test this by the geological facts bearing on the question, with a view of ascertaining how far the supposition is supported, in order to its acceptance as a reasonable theory, or mayhap an unavoidable conclusion. The existence of land, and of a high mountain-range now depressed below the waters of the sea, in the area west and south-west of Hokitika has more than once been spoken of or hinted at in the writings of those geologists who have dealt with the physical geography and geology of the west coast of the South Island, or the South Island as a whole. I have already ventured some views on the subject, but these had a different purpose from that of assuming a correct knowledge of the whence and mode of deposition of the auriferous deposits of the region here dealt with.

Dr. Hochstetter may be said to be the first who expressed an opinion as to what was probably the distribution of the land in past times. In his work on New Zealand (English edition), the following passages occur:—

"At the time when the neighbouring Australia, one of the oldest continents of the earth,—at least as regards the eastern and western portions of it, the latter consisting principally of Palæozoic strata,—arose from the depths of the ocean, there were also portions of New Zealand already projecting above the mighty main as ragged, barren masses of land; their shape, of course, was very different from the present appearance of the archipelago; they perhaps stood in connection with larger continental bodies that long ago have been submerged again in the depths of the watery abyss. But, while the eastern and western portions of Australia since the close of the Palæozoic period have been quiet, and the soil rarely disturbed, upon which plants and animals found ample chance to grow and propagate themselves in an uninterrupted succession up to the present time: New Zealand, on the other hand, was till within the latest period a scene of the grandest revolutions and convulsive struggles of the earth, which, continually changing the original form of the land, gave it by degrees its present shape.

"Numerous observations made on the North and South Islands lead to the conclusion that not until within the most recent period of the earth, after the Tertiary period (probably with the commencement and during the time of the volcanic action on both Islands), large portions of the land were raised by quite 2,000ft., some parts even by 5,000ft., above the level of the sea; not all at one time, but by slow and gradual cyclic elevations, perhaps with larger and shorter intervals of perfect stagnation. To this height ascend the Tertiary strata upon the North and South Islands, with numerous embedded shells; and the same height is reached by the deposits of the drift formation and the peculiar terrace formation in all the larger river-valleys of both Islands, as well as by the shingle and gravel deposits upon the broad plains on the east side of the South Island.

"Yet, while the land was greatly enlarged by elevation, by alluvial deposits, and by the eruptions of volcanoes, other portions, on the other hand, were simultaneously submerged in the deep. It is to such an event that the formation of Cook and Foveaux Straits probably owes its origin.

"A glance at the map of New Zealand shows us the very peculiar shape of the northern part of the North Island; on the east coast, steep promontories, peninsulas, numerous cliffs, and islands, inlet upon inlet, bay after bay; and on the west coast, where the predominant west wind piles up long rows of sandhills, instead of bays or inlets the dammed-up estuaries of the rivers. All this conspires to make the impression of a land once of a far greater extent, of which only the higher parts, the mountain ridges and peaks, are still towering above the sea, while its low lands, 'bottoms,' and valleys are overflowed, coming forth in time of low water in the shape of shallow

* This assumes that up till late Miocene times the New Zealand area was greatly depressed, as described by several writers, and also that the outlines of the area submerged were not greatly different from what they are at present.

GEOLOGICAL MAP OF THE NORTHERN DISTRICT OF —WESTLAND.—

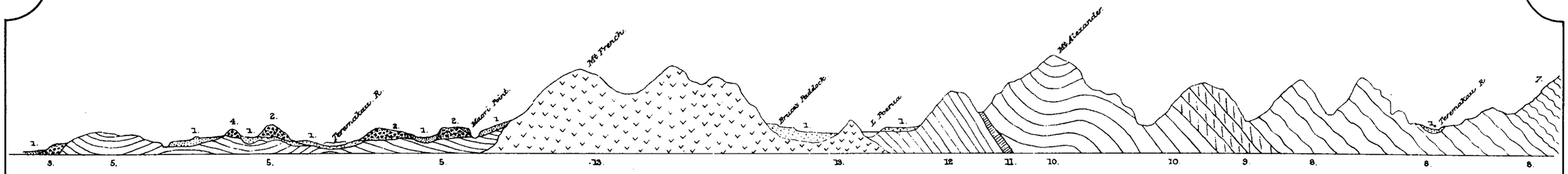
To Illustrate Report by Alexander McKay F.G.S. Mining Geologist 1892.

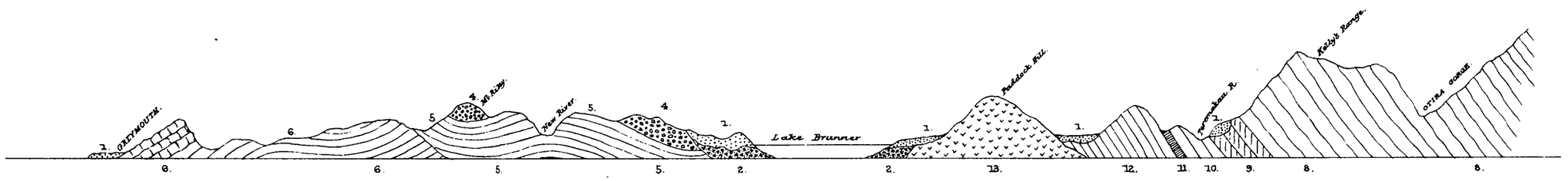
REFERENCE.

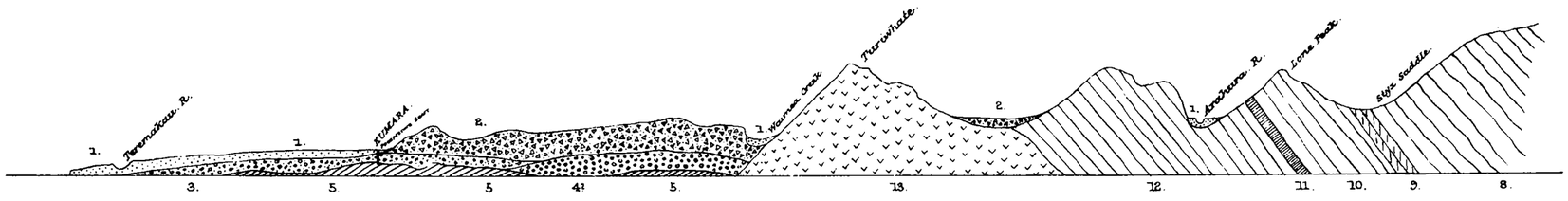
1	Recent & Post Pliocene Reconstructed Moraines &c	6.	Cretaceo Tertiary Coal bearing formation.
2	Pleistocene & Newer Pliocene Moranic Deposits.	7.	Triassic
3.	Marine Deposits prior to the advance of Glaciers.	8.	Carboniferous.
4.	Older Pliocene & Newer Miocene Humphrey's Gully Beds	9.	Devonian (Semi-metamorphic)
5.	Lower Miocene Blue bottom	10.	Upper Schists.
		11.	Magnesian Rocks or Mineral Belt.
		12.	Middle & Lower Schists
		13.	Gneissic Schists & Granite

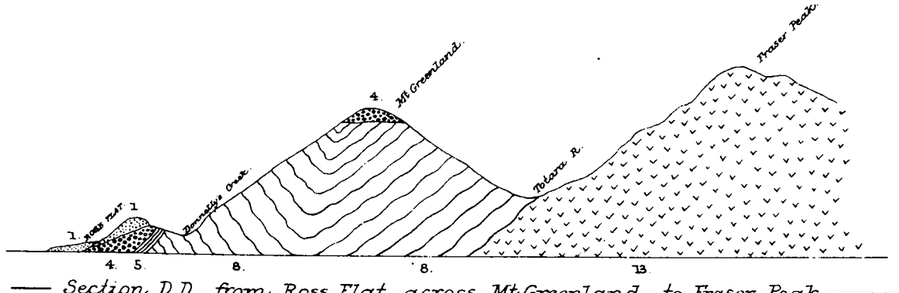
Pt Elizabeth
Grey River
COBDEN
GREYMOUTH
Nelson Creek
Saltwater Creek
New R.
Teremakau R.
Kapitea Creek
Waimea Creek
Arahura R.
Houhou Creek
HOKITIKA
Hokitika R.
Totara R.
ROSS
Mikonui R.
Takawau 1462
MARSDEN
KUMARA
STAFFORD
GOLDSBOROUGH
GREENSTONE
LARRIKINS
DILLMANSTOWN
CALLAGHANS
OAKS
BLUESPUR
HUMPHREYS GULLY
KANIERI
RIMU
MARINAPUA L.
KANIERI L.
Island Hill
Turiwhate 4487
Mt Tuhua 3680
Central Hill
Mt Brown
Lone Pk
Mt Sale
Mt Julius
Mt Misery
Mt Robinson
Mt Dieffenbach
Mt Franklin
Mt Alexander 6460
Paddock Hill 3723
Tekinga 3918
Granite Hill 3198
Hohonu Pk
Mt French
Mt Bruce
Mt Smart
LAKE BRUNNER 281'
Big Hohonu R.
Hohonu R.
Arnold R.
Grey River
Maori Ck
New R.
Humphreys
Kawhaka R.
Kaniere R.
Hokitika R.
Totara R.
Arahura R.
Taipo R.
Rolleston R.
Otira River
Otira Gorge
Otehaka R.
7 Mile Ck
Kelly's Hill 4568
Hills Pk 5364
Arthur's Pass
Worsley's Pass
Browning R.
Browning's Pass 4815
Mikonui R.
Beatrey R.
Hurunui R.
Hurunui Pass 3141
Hurunui R. (South Branch)
Bell Hill
T. HAUPIRI
L. MINCHIN
L. POERUA
Scale of Miles 0 5 10

C H Pierard. del









Geological Sections to illustrate Report on the Northern District of —WESTLAND—

by

Alexander Mc Kay. F.G.S.
Mining Geologist.

Note — For reference to Formation numbers see Map

C.H. Pierard. del.

mud-flats. The peculiar features of the northern peninsula of the North Island are only to be accounted for by adopting the theory of a gradual sinking of the land. This sinking process, however, seems to have extended more or less over the whole western coast of the North and South Islands, whilst the east coast was raised at the same time, so that an imaginary line drawn parallel with the west coast of South Island, not at too great a distance from it, prolonged through North Island and terminating on its east coast in Tauranga Harbour, would represent the axis of elevation on one side and of depression on the other."*

In "The Geology of Canterbury and Westland," Sir Julius von Haast quotes from a "Report to the Secretary for Public Works" (Province of Canterbury) "upon the Practibility of constructing a Bridle-road through the Gorge of the Otira, and upon the Character of the Passes through the Dividing-range of the Canterbury Province.—By E. Dobson, C.E., Engineer of the Lyttelton and Christchurch Railway," as follows: "The next feature to be noticed is the jointed structure of the rocks. Although they cross each other in all directions, apparently without order, there are two systems of joints which are to be met with throughout the whole valley of the Waimakariri, and which have an important influence on the configuration of the passes. These are: (1) A system of vertical cross-joints at right-angles to the stratification, and running in unbroken lines for great distances with such regularity that they might be mistaken for planes of stratification, were it not for the frequent occurrence of beds of trap-rock, the outcrop of which marks unmistakably the true bedding; (2) a system of joints more or less inclined to the horizon, not running in parallel planes, but arranged in a series of curves radiating from a common centre. The effect of this system of jointing is to produce a rectangular arrangement in the plans and sections of the ravines; the rivers and watercourses running either on the strike of the beds, or in the direction of the cross-joints, or in a zigzag course, following alternately these two directions."†

In the same place Von Haast remarks, "Mr. Dobson, in the same report, points out a very interesting and suggestive fact which had not before been noticed—namely, that all the principal valleys, from the Hurunui in the north to the Makaroa in the south, radiate as it were from a common centre, situated about fifty miles to the north of Mount Darwin, or about forty miles west of Hokitika. This remarkable phenomenon is more than a coincidence, and it would not therefore be too rash to conclude that, during or shortly after the rocks now forming the Southern Alps had been thrown into the huge foldings they now exhibit, some abyssological force of enormous power, situated near that point, had laid the foundation of this remarkable orographical feature by which the country appears starred; just as we find it in volcanic regions—Lyttelton Harbour, for instance."‡

At another place in the same work we read, "It is a remarkable coincidence that the granitic zone stretching from the south of the Waitaha round Lake Brunner to the west coast, twenty miles north of the River Grey, forms a segment of a circle round that point" (fifty miles north of Mount Darwin and forty miles west of Hokitika); also, referring to the Mount Cook region, "It is a remarkable fact that here, where the Southern Alps attain their highest elevation, the mountains are not only much narrowed in lateral extent, but the Island itself is also much compressed, notwithstanding the great extension of the eruptive rocks, if we do not take the Canterbury Plains into consideration. It thus appears that the abyssological forces, by forming here the highest foldings, did so at the expense of the breadth. Moreover, it is clear that the highest mountains, being the greatest condensers of humidity, could offer an enormous supply from their *névés* to the gigantic glaciers at their base, and thus aid effectually in their own destruction. . . . .

"The change of level in Canterbury and Westland" in more modern times "was evidently greatest during the middle division of our Tertiary epoch (the Oamaru formation), when some portions of Canterbury were at least submerged for 5,000ft. . . . . New Zealand appeared then above the sea-level only as a number of high, rocky islands, generally striking in a south-west and north-east direction, with narrow straits between them, and flanked on both sides by a number of smaller rocky islets, just rising above the sea-level. . . . . Towards the end of the Pliocene period the country had nearly assumed its present form, but the mountains were higher and more plateau-like, the valleys not so deep and wide; and, moreover, extensive Cretaceo-tertiary and Tertiary strata were lying on both sides of the high alpine ranges, often blocking up the valleys, or covering the lower regions with their deposits."§

In lectures on "Mining in New Zealand,"‖ Sir James Hector remarks:—

"It is desirable that I should state briefly the leading features of the geology of New Zealand. The whole group of islands may be looked upon as a narrow mountain-ridge, rising from a deep ocean-bed, and extending in a N.N.E. and S.S.W. direction. The form of the coast is determined by the outstanding bluffs of harder Primary formations, or by massive volcanic rocks that belong to the latest Tertiary periods. These hard rocks, and especially those last mentioned, have been the means of preserving patches of Upper Secondary and Tertiary formations, which occupy a larger proportional area in the North than in the South Island, where the mountains are loftier and occupy a greater breadth of country.

"We find, on closer examination of the structure of the mountain system thus described, that it is by no means uniform throughout, but that the rocks composing its southern portion are of much higher antiquity, and show evidences of having been subjected to chemical changes at a greater depth in the earth's crust. This difference is evidently due simply to the southern mountain-mass having been elevated to a greater extent as compared with the sea-level than that in the north, and, in consequence, a much thicker layer of superficial unaltered rocks has been removed by atmospheric denundation. . . . .

"It is therefore to deficient elevation towards its northern extremity that we must attribute the absence at the surface of many of the rock-formations which are prominent in the southern portion

* Hochstetter's "New Zealand," pp. 68–70. † See "Geology of Canterbury and Westland," p. 175. ‡ *Ibid.*, pp. 175, 176. § *Ibid.*, pp. 242–248. ‖ "Transactions of the New Zealand Institute," vol. ii., 1869, pp. 361–71.

of New Zealand; and we must conclude that in the north the same rocks exist at greater depths, and are probably still undergoing chemical changes that have ceased to operate on their southern equivalents.

"The sequence of geological formations in New Zealand is abruptly broken about the close of the Lower Mesozoic period.

"All the formations prior to this have been, wherever they occur, more or less cleaved and jointed, so as to be hardly distinguishable from the oldest Primary slates and sandstones, combined with which they constitute the main part of the rocky framework of the Islands, and form some of the highest mountain-peaks.

"The subdivisions of the oldest stratified rocks have not been determined, but the fossils already obtained show that they represent groups from the Upper Silurian to the Triassic periods. . . . . Let us now turn to the formations that belong to the periods after the break which has been described as occurring in the Mesozoic period, and we find a successive repetition of terrestrial beds with seams of coal and plant-remains, with clays, marls, limestone, and sandstone, in the manner usual in Secondary and Tertiary formations. The earliest plant-remains show many forms that are now extinct; but associated with them are a few that cannot be distinguished from those of the existing flora. In the newer Carbonaceous strata the resemblance to the existing forms is still greater, some of the peculiar and characteristic trees of the New Zealand forests, such as the kauri, being well preserved. There is therefore very little doubt that since the Upper Mesozoic period dry land has existed continuously, and that some part or other of the New Zealand ridge has always been above water. . . . .

"The Southern Alps, which are near to the West Coast, in the latitude of Mount Cook, are continued northwards through Nelson Province to Cook Straits by the Spencer Mountains, forming a well-marked range that defines the headwaters of the streams flowing to the east, and is characterized by the line of eruption of the Mesozoic diorites. The towns of Nelson and Hokitika are, according to this view, equally situated on the west side of the mountains; and between Blind Bay, at Nelson, and the west coast, at Hokitika, a well-marked depression extends in a south-west direction for one hundred and forty miles, separating the central range from a triangular area of mountain country that has its northern termination at Cape Farewell and its southern one at the Grey River. This latter district is extremely rugged, and displays a greater variety in its geological structure than any other part of New Zealand.

"Frequent changes in the formation are common in this area, from hornblende rocks to schist and clay-slates, while the summits of the mountains are frequently capped with outliers of the Upper Secondary coal-formation and marine limestones, while in the majority of the streams that radiate from it, gold is found under such circumstances as to indicate that auriferous lodes occur in rocks throughout the district. A few quartz-reefs have already [1869] been discovered, such as at Moonlight Creek, on the Grey River, and Waimangaroa near the Buller, and at Wangapeka and Collingwood, in the north; but as a mining field it is still practically undeveloped. The alluvial gold has, on the other hand, been extensively worked, the yield up to the present time [1869] amounting to 2,235,591oz. The alluvial gold occurs in well-defined 'leads,' of which there are three distinct kinds, without including the local 'sluicing' diggings in the valleys of the mountain torrents already alluded to as generally distributed throughout the area. Unlike the gold-drifts of Otago, which rest on the denuded surface of their parent rocks, the auriferous gravels in the western district, as a general rule, rest on the surface of the recent Tertiary rocks of marine origin, having, in fact, been carried out of the mountains by the rivers and deposited along a gradually-changing coast-line. They thus have a general distribution parallel to whatever was the western shore of the Island at the time of their deposit.

"The earliest-formed and most elevated of these 'leads' extend in a north-east direction from near Ross, where they are cut off obliquely by the sea-coast, into the Nelson Province, running parallel with the main range, and have already been traced as far as the high terraces near the source of the Little Grey River. They have here their greatest altitude, though still resting on the marine strata, and slope steadily to the south, till at Ross the main lead is actually beneath the present sea-level, and worked by true 'deep-sinking.' Those leads have been intersected by more modern streams, and a second class of leads thereby formed; while the third class of alluvial workings is formed by the ancient and modern sea-beaches, along which the gold has been drifted by the action of the waves and surf. These workings extend for more than two hundred miles along the coast, and, as they are undergoing constant renewal, they will afford a permanent source of employment.

"The peculiarity of the Westland alluvial diggings that requires most to be impressed upon the mind is that, in the majority of cases, the streams have cut their channels much below the surface of the country, leaving the richest leads in positions very inaccessible to the water-supply required for mining, without adopting a thoroughly organized system of irrigation. . . . . Gold-drift consists of sand and gravel containing gold, and is formed by the action of running water in the streams, or water in motion, as along a sea- or lake-beach. The same action causes the re-assortment of the materials, so that the heavier particles become separated from the lighter; and it must be borne in mind that no other agent than water in motion can exercise this sorting influence. It is therefore not merely the existence of auriferous rocks at the surface in a district which determines the extent and richness of the alluvial diggings, but we must also take into account the amount of disintegration of these rocks, and also the degree of concentration to which the detritus has been subjected."

Professor Hutton, in treating of the land-movement within the New Zealand area, remarks that towards the close of the deposition of the Maitai formation, "(that is to say, towards, perhaps, the middle of the Jurassic period), the whole country was again elevated, and the chain of the New Zealand Alps formed." He continues,—

"The proofs of this elevation are—(1) that all the rocks of pre-Cretaceous age partake in the main foldings of the strata; (2) the absence of all rocks belonging to the Upper Jurassic and Lower Cretaceous period; and (3) the total unconformity between the Putataka and Waipara formations. . . . . The foldings of all the rocks older than the Waipara formation show that this Upper Secondary elevation was no local affair, but part of a large movement, which probably resulted in the upheaval of a continent. How far this Antarctic continent extended we have yet no means of knowing, but that it probably extended to South America is shown by all the formations later than this upheaval containing fossils related to, or identical with, those of Patagonia and Chili. Since this upheaval the New Zealand Alps have never been submerged.

"Subsequently (Upper Cretaceous period) this continent subsided, and at the close of the Mesozoic era the north part of this" (the South) "Island was 6,000ft., and Otago was 3,000ft., lower than at present. This is proved by the height to which the Waipara formation extends in Marlborough (Benmore) and Otago (Mount Hamilton) respectively. That the Alps were not entirely submerged is shown by the Waipara formation, which was deposited during the depression, abutting against the older rocks, and occurring in such positions as to show that it could never have overspread the whole of the Alps. . . . . New Zealand was now reduced to a narrow chain of islands, and from that time to the present it has always remained isolated from any large continental area.

"At the commencement of the Tertiary era New Zealand was again upheaved. This upheaval was not so violent as the last, and probably therefore did not affect so large an area. Still, in Otago, Marlborough, and Nelson a certain amount of folding of the rocks took place, and the lately-formed beds of the Waipara formation were caught up in them. In Canterbury, however, this was not the case, and the Waipara beds still continued in a horizontal position, although elevated above the sea. . . . . It was this Lower Eocene upheaval that gave the final form to the internal geological structure of the Alps, for all the rocks of a later date are, with local exceptions, more or less horizontal, and circle round the bases of the hills formed by Mesozoic and Palæozoic rocks, thus showing that since the deposition of the Tertiary strata no great *internal* changes in the position of the rock-masses have taken place, although vast *external* changes, caused by denudation, have torn the Tertiary rocks into fragments. But not only was the last touch given at this time to the geological structure of the Alps, but the chief valleys were also marked out at this period." . . . . And the facts given are said to "prove convincingly that the Alps had undergone enormous denudation before the close of the Eocene period, and that most of the present valleys in them had been hollowed out to a considerable extent at that time; but they also prove that at the close of the Eocene period Otago was again depressed to about 1,500ft. or 2,000ft. below its present level. . . . . During the Upper Miocene period the whole of the South Island was considerably depressed, and, if I am right in supposing Mount Prospect, near Lake Te Anau, is composed of rocks of that age, Otago must have stood at least 3,246ft. lower than at present. No marine rocks of Older Pliocene age are known in any part of New Zealand, and consequently I infer that at that time the whole country stood at a higher level than at present. . . . . The subsidence that followed this last elevation was continued until Otago stood at a much lower level than at present; and that it was subsequently followed by an elevation, which may probably be going on, is proved by many facts." *

Mr. H. A. Gordon, in his last year's "Report on the Mining Industry of New Zealand" (Wellington, 1892), after in part quoting the passage in Hochstetter's "New Zealand" which has already been given, and referring to my map showing the principal lines of earthquake-rents and faults discovered in New Zealand, says:—

"The whole information gathered by Mr. McKay relating to the fissures and earthquake-rents in the Middle Island indicates that a terrible cataclysm has taken place, and that land extending far to the westward of the mouths of the Totara, Mikonui, Waitaha, Big Wanganui, and Wataroa Rivers has since been submerged, and at the time this took place it dragged, as it were, the western side of the main range down for a certain distance with it, which would easily account for the auriferous drifts being found at the deep levels on Ross Flat, at 240ft. below the present sea-level.

"If the coast of New Zealand extended for 100 miles, less or more, further to the westward than it does at the present, it is likely that very high land existed, and instead of the older gravel-drifts coming from the present backbone of the Island, they may have come from an opposite direction, and possibly from lands situated some thousands of feet at a higher elevation than the tops of our highest mountains, and that these high lands were highly auriferous. Dr. Hochstetter, in the same chapter of his book previously referred to, states, with reference to the auriferous character of the West Coast: 'The western slope and part of the central chain consists of crystalline rocks and metamorphic schists, highly auriferous, and resting on a basis of granite. . . . . To the eastward of the crystalline zone stratified sedimentary rocks appear, such as slates, sandstones, conglomerates, indurated shales, interstratified with trappean rocks of a dioritic or diabasic nature. These compose by far the greater part of the eastern side of the central chain, exhibiting everywhere these huge foldings. . . . . The eastern foot of the mountains is formed by Tertiary and alluvial deposits broken through by volcanic rocks. The period of volcanic energy was one of upheaval, and since it closed we have no evidence of there having been any submergence of the Island on the east side, while on the West Coast the evidence derived from the mountains rising directly from the sea, and penetrated by the fiords, indicates rather a gradual submergence.'

"As to the deposition of these auriferous older gravels on the West Coast, they were never brought there and deposited by glacial action entirely. They certainly have been subjected to the action of a flowing stream, as all the stones are highly rounded and worn greatly. There are very few large stones in the drift, and the whole of them are in a greatly decomposed state. It is very

* "Report on the Geology of Otago," Dunedin, 1875, pp. 75–78.

evident from the configuration of the country and the direction in which many of the old river-channels can be traced, following a totally different course to the present rivers, that New Zealand has undergone many changes; also, there is evidence, by the amount of material in these ancient channels, that it has been moved by a flowing stream, and that the drainage basins of these streams or rivers were of much greater extent than they are at present. If a large area of country to the westward has been submerged, then these older auriferous drifts may have come from the seaward, and not from the denudation of the present mountain-chain. The same character of auriferous wash is obtained in portions of the Mont d'Or and Greenland Claims, which are 3,000ft. above sea-level; but at the time these gravels were deposited on the low lands near the ocean-beach this land was in all probability at nearly as high an elevation as the top of Mount Greenland is at the present day, and that a gradual subsidence took place to the westward. Rivers were formed in different channels, following the lines of fissures and rents produced by volcanic or other similar agency, causing sudden shocks to take place; material was brought down from what is now the main range of the Island, forming a new deposit on the top of the older auriferous drifts on the lowlying lands, while the mountains became denuded and supplied this material."

These extracts, made at some length, show the opinions of the principal geologists who have laboured in the New Zealand field; and it has now to be considered in what light they place the supposition that much of the gold of the West Coast was derived, not from the mountains to the eastward, but from land to the westward now denuded away or depressed below the level of the sea.

Dr. Hochstetter points out that the true north-east and south-west axis of the Islands lies to the west of the coast-line on the west side of the South Island. Von Haast recognises the fact that the Southern Alps as they at present stand form but the eastern slopes of a vastly greater mountain-range, the structural core of which is to be seen in the granitic rocks now standing apart from, and to the westward of the mountain-range; and it cannot be doubted that the western slopes of this extended far to the seaward of the present limits of the land.

Sir Julius Von Haast also, quoting Dobson, refers to an area surrounding a point sixty miles to the north of Mount Darwin and forty miles west of Hokitika, as the seat of "some abyssological force of enormous power" by the action of which, and radiating from this point, fractures were produced, along one or other of which almost all the important streams of the South Island have their courses. The period at which this force was active is however not indicated in a precise manner in the work quoted, but from the context this may be referred to late Palæozoic times. Also this writer would lead us to the belief that the great anticline was denuded of its western and central parts not earlier than the middle of the Palæozoic era, nor later than the Triassic period. The Westland formation (in part of Triassic age) had its younger beds deposited on the denuded crown of the great anticline. Any land that previously was above the sea in the region of the "abyssological force" had therefore long before disappeared, and could have had no influence on the supply of alluvial gold in the sands and gravels of the present day. Formations in time subsequent to the Triassic period are described as filling and blocking up the valleys already sculptured out of the western slope of the mountain-range, or as spreading over the lower lands towards the coast-line. Clearly, then, Von Haast does not favour the idea of there having been high land to the west of Hokitika during late Tertiary times; and this, too, while at the same time he describes the Southern Alps at the period immediately preceding the greatest extension of the glaciers as being not only higher but far more plateau-like than at the present time.

Sir James Hector clearly indicates the mountains of the north-west of Nelson as being structurally distinct from the eastern mountains of the main water-divide, and as being separated from them by the valley depression commencing in Blind Bay, and extending south-south-west to Ross, where the older auriferous gravels filling the depression are below sea-level, and shorn at an acute angle by the coast-line. It is easy to see that he favours the theory of a south-west continuation of the western mountains far beyond their present termination near Greymouth. The valley depression would thus be continued to the southward, while the western mountains would make junction with the main range abreast of Mount Cook; but, at the same time, it has to be shown in what manner the sea took possession of the lower grounds between Ross and the junction of the Little Grey, and enabled the formation of the Upper Miocene marine strata underlying the older auriferous gravels. This in itself is a difficulty: there is also the disappearance of the whole of the western side of the valley south of Greymouth to be accounted for, and the presence of Cretaceo-tertiary rocks in the low grounds of the depression has also to be taken into consideration.

Professor Hutton admits that various elevations and depressions of the land have taken place since the commencement of the Tertiary period, but these have been elevations and depressions of the country as a whole, and he is clearly opposed to any movements which, to any great extent, would locally affect the outlines of the country or the relative levels of different parts. Fracture and local tilting of the Tertiary rocks he admits, but contends that these have had no influence on the internal structure and physical outlines of the country, which had already assumed the conditions under which they are now presented to us. Denudation, operating differently as the country was elevated or depressed, is with him sufficient to account for all that has taken place. The erosion of a valley between two mountain-ranges where the land stood at a high elevation, and the subsequent submergence of the lower grounds, and this again followed by elevation, would account for most of the facts, and it is indeed so that Professor Hutton specifies these different and distinct movements. But he gives no hint of land to the westward except in a very general way, or by inference, as a consequence of the existence of a continental tract of which the more elevated parts may well be supposed to have been within the New Zealand area.

For my own part I favour the assumption of high land having existed in the region indicated. Such land would lie along the theoretical axis indicated by Von Hochstetter. Such land would connect the West Coast and Sounds district of Otago with the west and north-west districts of Nelson, and this line of elevation, being the structural core of the great anticline, would have what

is now the Southern Alps merely as its eastern slopes in the first instance, and as a flanking range at a later date. If it be as supposed by Haast—a theory which has not been challenged by the other geologists cited—that the Southern Alps of the present day are but the eastern slopes of a much greater mountain-range, the western and central parts of which have been removed by marine or sub-aërial denudation, is it surprising that where this line of elevation is highest the rocks of the crystalline axis lie wholly to the seaward of the coast-line? Naturally the central axis and western slopes of such a range should have a breadth comparable at least with that of a portion only of the eastern flank or wing of the anticline. Therefore, on this showing, it is probable that land existed west of Hokitika, the heights of which bounded the valley depression which has been described.

But the question most pertinent to this inquiry is, When did this land finally disappear below the waters of the sea? Clearly, to serve our present purpose, there must have been high land in that quarter subsequent to the deposition of the Upper Miocene marine strata on the west coast of the South Island which fills the valley depression from Ross to the junction of the Little Grey. There is in this fact a difficulty to be met, if it be supposed that the high land to the westward formed a continuous mountain-chain connected with the mountains of the north-west part of the Island, and coalescing with the main chain in the south opposite to or north of Mount Cook. The only way out of this difficulty is the assumption that none of the great physical features of the South Island had come into existence at the time of the deposit of the Upper Miocene marine strata on the West Coast.

But that a mighty mountain-range rose from the sea, possibly towering to heights far above the limits of eternal snow, since the Miocene period, and that its central and western parts were subsequently depressed, till the ocean removed or now rolls over its highest peaks, is a supposition that to many minds will appear very much like the fairy tale of Aladdin's palace in the Arabian Nights.

Yet the change in the area and configuration of the land here supposed may have taken place, and in what manner I shall endeavour to show.

During Tertiary times, up to the close of the marine deposits of the Miocene period, New Zealand was greatly depressed, and by far the greater part of its present area was below the level of the sea. At the period of greatest depression, Von Haast sketches us the South Island as consisting of a line of rock-islets formed by the outstanding higher peaks of the main range of mountains; but it is not clear that even these stood above the water-level. And if it be contended that a consideration of the fauna and flora of these Islands at the present day, in comparison with what characterized former geological periods within the same area, necessitates the uninterrupted existence of land, it does not follow that this land must have been the crest of the Southern Alps. Such land may have lain to the westward of the present coast-line, but more probably it lay to the eastward in the line of the older axis of New Zealand, trending in a north-west and south-east direction. The north-east and south-west line of elevation is modern compared with this other, and probably was but feebly marked prior to the elevation at the close of the Miocene period. My creed in this respect is well known; and I have already, in a previous report (Geological Reports, 1890–91, p. 1), dealt with the subject of the mode of the appearance of the main chain and other mountain-ranges of the northern and central parts of the South Island, and to the remarks there made have here but to add, that during my recent examination of the district between the Teremakau and Mikonui Rivers, I noted nothing that could be said to be antagonistic to the theory put forth in last year's reports. On the contrary, the manner in which the Younger Miocene and Cretaceo-tertiary strata are tilted and faulted so as to form nearly vertical strata in contact with the crystalline and older sedimentary rocks between Kanieri Lake and the Hokitika River, and the manner in which the same and even younger beds are involved along the western base of Mount Greenland, and at the same time appear on the top of the mountain and far below sea-level within a horizontal distance of some four to five miles, shows conclusively that very great displacements have taken place.

As the land rose, dislocations along certain lines began to take place; and on the map accompanying the report referred to* thirteen of these principal lines of fracture are shown, all of which involve the youngest rocks along the lines traced on the map; and all of them give evidence of having modified the physical outlines of the country to an enormous extent within comparatively modern times. These dislocations and displacements are as strongly marked on the West Coast as they are on the eastern side of the Southern Alps in Otago, or in Marlborough; and if I have succeeded in showing that the Kaikoura Mountains, seaward and inland, are wholly due to this action—dislocation and displacement along certain lines—since the commencement of the Pliocene period, aided by atmospheric denudation, it may be reasonably granted that in given areas the same process might for a time elevate, and afterwards tend to lower, the level of the land.

I have noted the fact that, where there is an intersection of two or more of these lines, there we have an area relatively depressed compared with the surrounding region; and, by further reference to the map accompanying the second part of the "Report on the Geology of Marlborough and South-east Nelson," it will be seen that six of the principal lines of fracture converge, and intersect each other within the area west of Hokitika, within which the hypothetical high land is supposed to have been situated. In this way, therefore, the disappearance of the land may be accounted for; and there is a sufficiency of facts in support of the assumption that it so disappeared, if it ever had existence at all. The opinions of different geologists who have studied this part, and the geology of the West Coast generally, have been given; and the argument is unassailable that the western wing of the great anticline, if not the central knot of the whole mountain system, must have occupied the area referred to; and it may be taken for granted that elevated land did extend to the westward of Hokitika as indicated, and that it also disappeared owing to the causes and in the manner which have been described.

---

* Geological Reports, 1890–91, facing p. 1.

Such land may therefore have supplied the bulk of the gold found in the older gravels of the district, or which, found in younger deposits, have been derived from the destruction of these older gravels. Of course, it is not contended that the gold found in the glacier deposits of Kumara, the Greenstone, and Ross has been so derived, nor even that which is found overlying the "Brighton bottom" at the Kanieri, Rimu, and Back Creek. And it is equally admitted that a part of the fine beach-gold may have been swept down the rivers from the eastern ranges, and by the action of the tide distributed along the coast-line: yet, granting all this, the conviction is with me, as with the bulk of the miners, that much of the gold could not have been, and was not, supplied to the low grounds from an easterly direction. The importance of the older gravels overlying the "blue Miocene bottom," and underlying the morainic deposits of the glaciers extended into the low grounds between the mountains and the sea, will now be sufficiently apparent, and the increasing attention given to these is a proof of their importance.

With respect to the other metalliferous productions of the northern part of Westland, they are not of great importance at the present time. Silver has been found in the Mount Rangitoto Range, and the tract of mineralised country in which the ores of this metal are found extends across the Upper Mikonui and Totara Valleys, in the direction of the lower part of the Hokitika Gorge. So far, however, nothing has been done to trace the Mount Rangitoto deposits in this direction. Further to the north-east there is no reason why the same ores should not occur in the gneissic rocks of the eastern parts, Turiwhate, Mount Smart, and Mount French, or along the same line to the northern boundary of the district.

Something has already been said as to the occurrence of copper-ores in the rocks of the second gorge of the Arahura, and, although no rich concentrations of copper-ore in the form of true lodes were discovered, it will not be doubted that such exist; and in this respect the second gorge of the Arahura is well worthy of being subjected to further examination. That considerable bodies of the yellow sulphides of copper exist in this direction is scarcely to be doubted, since masses of such ore have been found in the auriferous drifts of Kumara. Manganese occurs as a silicate of manganese (rhodonite) in the Mica-schist Range, at the source of the Arahura-Wainihinihini, and as an oxide its occurrence is probable at many places, but usually mixed with other ores. Antimony probably occurs and may be looked for in the older rocks immediately south of the Grey, opposite Brunnerton, and should also occur in the southern part of the district, in Mount Greenland, and wherever the lower beds of the Maitai series or Devonian rocks are present.

Various iron-ores are abundant, and, with the lower sulphides of iron (pyrrhotine, &c.) indications of nickel should also be found.

Of non-metallic minerals, coal is certainly the most important; but it is only in the neighbourhood of Greymouth where this can at the present time be profitably worked. It is doubtful if the coal at the Kanieri can be rendered valuable to the present generation, and excepting for the supply of settlers on the Kokatahi Plain, or the burning of lime near to where it occurs, the coal in Camel-back Hill is not likely to come into greater use. In the last-mentioned locality it is the distance from Hokitika, and the comparative thinness of this seam (I did not see it), that is likely to discourage coal-mining at this place, the lie and disposition of the measures not being unfavourable as at Coal Creek, on the Kanieri. On the south side of the Hokitika River coal-measures and coal-seams also occur, but up to the present they have not been studied. All that is known of them has already been stated earlier in this report. Amongst precious stones, ruby occurs, as stated, in the gold-bearing gravels of Woodstock and Back Creek. The sample boulder obtained and taken (all of it, I believe) to Dunedin by Mr. Goodlett, to my mind, is evidence of the existence of a continuous rib of rock probably of the same quality and perhaps abounding in much larger crystals; but it is sufficient to say that I searched for this in vain.

Building-stones of various kinds may be had amongst the granite mountains and the rocks of the Mica-schist Range. Few of these, however, would dress easily with chisel and mallet. As an exception to this rule, there is found in the upper part of the middle division of the mica-schist series a granular form of steatite, that, to all appearance, would make an easily-worked and excellent building-stone. This occurs as large blocks in the second creek west of Rocky Point, in the Teremakau Valley, and is within less than two miles of the main road. A list of all the metalliferous ores, minerals, and rocks collected during the examinations of the past season is being prepared, and, with the analyses of such as require determination or are of importance, will appear as an appendix to this report.

ALEX. MCKAY.

1st June, 1893.

APPENDIX.

List of Minerals and Rock-specimens collected during the Progress of the Examinations described in the foregoing Report.

A complete list of the collections of minerals and rocks at various times obtained from the District of Westland, being more than could be accomplished at the present time, such has not been attempted. The list therefore contains reference only to such specimens as were collected during the past season, or are specially mentioned in the body of the report, as for example the mass of ruby-crystals found at Rimu, samples of which I collected last year. The collection accumulated was made not with the intention of securing rare and interesting minerals, but especially with the view of illustrating the rock formations that have been described. So much of the time at my disposal was spent in the interior parts of the country east of the granite and gneissic belt, that less attention was given to these rocks than they really deserved; and when, finally, the high country of the interior was abandoned, there was simply a choice of confining my attention to the rocks of the granitic belt, or to a study of the distribution of the different gold-bearing drifts over the low grounds of the northern district of Westland. For very evident reasons I elected to pursue the latter course of study, the extent and limits of the granitic crystalline rocks being known sufficiently

for the purpose of mapping, which was not the case with respect to the fragmental formations of the low grounds; while the importance of these as gold-bearing deposits rendered it the more necessary that the remaining time at my disposal should be devoted to these. Hence it is that but few samples have been obtained from the granitic and gneissic rocks.

The schistose rocks received more attention, mainly on account of the fact that near the upper third of these there is a remarkable belt of magnesian rocks strongly charged with ores of copper and iron, in searching for which, as was natural, the rocks of this belt were largely collected from, more especially within the valleys of the Teremakau and Arahura Rivers. In this magnesian belt, or in the immediately underlying actinolite schists, it was also hoped that the matrix of the ruby-crystals found at Rimu would be discovered, but as already stated all search for these was unavailing. The upper schists, sub-metamorphic rocks, and the sandstone country to the eastward were less collected from, partly because of their lesser interest, but mainly because they lie towards and occupy the high interior and inaccessible parts of the district, excepting along the line of the Christchurch–Hokitika Road, by which the Westland District was first approached, and which it was not considered needful to traverse a second time. The list of rocks and minerals here given does not therefore claim to be anything like complete, as representing all or the most of what may be found in Westland, but is merely that of the collections made as above stated.

1. *Contorted Mica-schist, with Foliæ of Quartz.*—Locality: River-bed, lower end of the gorge of the Hokitika River.

2. *Compact Limestone.*—Locality: Upper Teremakau Valley. This rock occurs in connection with those rocks in the upper part of the valley that have been referred to the Triassic period.

3. *Silky fine-grained Clay-slate (Phyllite).*—Locality: Jackson's Hill, Teremakau Valley. This is a sub-metamorphic rock, and with quartzite of a like nature, and sandstones to all appearance unaltered, forms that part of Jackson's Range on which is found the quartz-lode that has been prospected and partly worked for gold.

4. *Crystalline Limestone, as Marble, having a fibrous and schistose structure.*—Locality: River-bed, Hokitika Gorge. This is a most interesting specimen, and indicates that it has been derived from the upper part of the actinolite schists close to the olivine-serpentine rocks of the mineral belt.

5. *Magnesian Rock, intermediate between Serpentine and Olivine.*—Locality: Arahura River-bed. This is one of many specimens of a rock resembling olivine, but which on analysis is found to contain with remarkable regularity about 6 per cent. of water, as constitutional water, which prevents it being regarded as being olivine on the one hand or serpentine on the other. There seems to be no difference as regards the percentage of water in specimens taken *in sitû* or from the river-beds of the district.

6. *Actinolite, as fan-shaped bands of Crystals in flesh-coloured siliceous Schist or Quartzite.*—Locality: Arahura River-bed. Although the majority of the samples of quartzite or siliceous schist containing radiating crystals of actinolite, were taken from boulders in the Arahura and Kokatahi River-beds, the rocks *in sitû* comprise a large part of the middle division of the mica-schist series. They were largely collected from in the Arahura Valley before the horizon in which they occur had been determined.

7. *Grey, slightly calcareous Mica-schist, with Crystals of black Mica.*—Locality: River-bed, Hokitika Gorge.

8. *Vein of Pale-green Siliceous Rock in Serpentinous Schist.*—Locality: Arahura River-bed.

9. *Serpentinous Schist, with Crystals of Magnetite.*—Locality: Arahura River-bed, *in sitû* in second gorge.

10. *Magnesian Rock (intermediate between Olivine and Serpentine), with Iron-pyrites.*—Locality: Gorge of the Hokitika River.

11–12. *Siliceous Schist with Black or very Dark Crystals of Actinolite.*—Locality: Arahura River-bed. Derived from the upper part of the middle division of the mica-schist series.

13. *Quartzose Schist with Actinolite, Garnets, and Iron-pyrites.*—Locality: Junction of the Browning and Hokitika Rivers.

14. *Amphibolic Marble.*—Locality: Hokitika Gorge. This rock, on being treated with weak acid, leaves a residue of grey actinolite crystals.

15. *Quartz.*—Locality: Mount Brown Creek, Arahura Valley, at foot of the second gorge.

16–17. *Semi-crystalline Limestone.*—Locality: Camel-back Hill, Kokatahi Plain, Hokitika Valley. This limestone occurs in heavy beds, closing the sequence of the coal-bearing rocks in Camel-back Hill. In position it should correspond to the base of the Cobden limestone at Greymouth. A lime-kiln has been constructed, and the stone is being burned for local needs, and, to a certain extent, finds a market as far as Hokitika. As yet, however, Greymouth or Westport coal has to be used in burning the stone. The production of lime at Camel-back Hill is not likely to be highly remunerative. The local coal-seam has not been opened-out so as to be available, and I was assured that the forest timber of the neighbourhood was insufficient for the purpose. Could this stone be burned cheaply, it would, as lime, command ready sale among the farmers of the Kokatahi Plain for the purpose of improving agricultural and grazing land. The samples collected yielded on analysis 69·38 per cent. of calcic-carbonate.

18–20. *Mica Rock (Muscovite, in small scaly plates).*—Locality: Second creek west of Rocky Point, Teremakau Valley. This is a rather rare and remarkable rock. It is only found in the locality mentioned, and is, as stated, composed of small scales of mica from $\frac{1}{5}$in. to $\frac{1}{10}$in. in diameter, arranged so that the rock splits freely in one direction, but not in the others. It occurs *in sitû* close to the magnesian belt between the upper and middle division of the mica-schist series.

21–3. *Quartzose Schist, with Dark-green or Black Actinolite.*—Locality: Browning River, Hokitika Valley.

24.—Same as No. 9.

25–7. *Granite.*—Locality: Western slopes of Mount Turiwhate.

28. *Syenite.*—Locality: South-eastern lower slopes of Mount Graham, forming part of the granite mass on the southern side of Lake Kanieri.

29. *Micaceous Quartzose Schist.*—Locality: Arahura Valley.

30. *Jasper Rock.*—Locality: Arahura River-bed. Derived from the sandstone country of the interior, and probably brought into the lower valley by ice, considerable blocks of this rock being found near the Arahura crossing of the Christchurch–Hokitika Road.

31. *Dark Fine-grained Mica-schist with Magnetite.*—Locality: Second gorge of the Arahura River.

32. *Magnetite.*—Locality: Mineral belt of the second gorge of the Arahura River.

33. *Schistose Quartzite.*—Locality: Jackson's Hill, Teremakau Valley. Mr. D. Jackson informed me that a quantity of this rock, which occurs *in situ*, not far from the quartz-lode on Jackson's Range, was put through the battery and yielded gold, the amount not determined.

34. *Quartz.*—Locality: Upper Teremakau Valley. I paid a visit to the locality where this quartz occurs under the impression that a valuable find had been made, but saw nothing to warrant the statements made concerning it. The quartz occurs as thin veins and irregular masses in the supposed Triassic rocks of the Upper Teremakau Valley.

35. *Mica-schist.*—Locality: Lower end of second gorge of the Arahura.

36. *Mica-schist with Crystals of Garnet.*—Locality: Second gorge of the Arahura, opposite the junction of Mount Brown Creek. Taken from a boulder in the river-bed. This rock is probably from the lower part of the middle division of the mica-schist series.

37. *Magnesian Rock resembling Serpentine, but with a Schistose structure.*—Locality: Hokitika River-bed, at the foot of the gorge, upper end of the Kokatahi Plain.

38. *Amphibolic Schist.*—Locality: From the Arahura River-bed at the foot of the second gorge. This rock, though not taken *in situ*, clearly belongs to the middle division of the mica-schists, distinguished as the actinolite schists.

39. *Magnesian Rock, intermediate between Olivine and Serpentine.*—Locality: Lone Peak, on south side of the second gorge of the Arahura. This rock is from the mineral belt containing ores of copper and iron.

40. *Dark Green or Black Actinolite in large Crystals with Quartz.*—Locality: Second gorge of the Arahura.

41. *Magnesian Rock, intermediate between Olivine and Serpentine.*—Locality: Second creek west of Rocky Point, Teremakau Valley. The magnesian mineral belt is here not so thick as farther to the south-east, it crosses the sources of this and other creeks to the low grounds of the Teremakau Valley at Rocky Point; but in the cuttings of the Christchurch–Hokitika Road it cannot be detected, and for some distance it appears to occur as elliptical masses in the upper part of the actinolite schists.

42–43. *Crystalline Limestone.*—Locality: Hokitika River-bed, at the lower end of the gorge. Like all others collected at the lower end of the Hokitika Gorge, this rock has been brought down the river from the vicinity of the magnesian mineral belt crossing the valley above the gorge.

44. *Splintery Micaceous Quartzite, with Black Crystals of Actinolite.*—Locality: Arahura River-bed.

45. *Siliceous Rock, crowded with Bunches of Fan-shaped Radiating Crystals of Straw-coloured Crystals of Actinolite.*—Locality: Second gorge of the Arahura, at the junction of Mount Brown Creek.

46. *Limestone.*—Locality: Upper Teremakau Valley. From the Triassic rocks of that part of the district. This rock has 71·24 per cent. of carbonate of lime.

47. *Red Jasperoid Rock, streaked with White Veins.*—Locality: Upper Teremakau Valley.

48. *Serpentine.*—Locality: Upper Teremakau Valley.

49. *Fine-grained Breccia, consisting of Pieces of Quartz and Black Slate.*—Locality: Upper Teremakau Valley.

50. *Mica-schist.*—Locality: Lower end of the second gorge of the Arahura River.

51. *Quartz Schist, with Black Mica.*—Locality: Lower end of the second gorge of the Arahura River.

52–53. *Serpentinous Rock.*—Locality: Hokitika Gorge.

54. *Grey Mica-schist.*—Locality: Lower end of second gorge of Arahura River.

55–91. Various samples of rocks from the magnesian mineral belt between the upper and middle divisions of the mica-schist series. Collected from the Arahura, Browning, Kokatahi, and Hokitika River-beds.

92. *Mica-schist.*—Locality: Teremakau Valley.

93–4. *Slaty Quartzite, with Garnets.*—Locality: Second gorge of the Arahura River.

95–6. *Slaty Quartzite, with Magnetite, Mica, Garnet, and Actinolite.*—Locality: Second gorge of the Arahura River.

98. *Quartz, with Actinolite, in about equal proportion.*—Locality: Second gorge of the Arahura River.

99. *Quartz, with Crystals of Black Actinolite.*—Locality: Kokatahi River-bed.

100. *Mica-schist.*—Locality: Rocky Point, Teremakau Valley.

101. *Splintery Micaceous Quartzite.*—Locality: Wainihinihini Creek, Teremakau Valley.

102–5. *Quartz Rock, abounding in large Radiating Crystals of Actinolite.*—Locality: Arahura River-bed.

106. *Quartz Rock, with Actinolite and Garnet.*—Locality: Arahura, second gorge.

107–124. *Quartzose Rocks, containing Crystals of Actinolite, Grey to Light-green, Dark-green, and almost Black.*—Locality: Arahura and Browning River-beds.

125–29. *Splintery Micaceous Quartzite.*—Locality: Gorges of the Arahura and Hokitika Rivers.

130–31. *Jasperoid Rock.*—Locality: Arahura River.

131–40. *Samples of the Garnetiferous Lower Division of the Mica-schist Series.*—Locality: Arahura and Teremakau Valleys.

141. *Quartz with Actinolite.*—Locality: Arahura Valley.

142. *Splintery Quartzite.*—Locality: Arahura Valley.

143–46. *Semi-metamorphic Slate.*—Locality: Jackson's, Teremakau Valley.

147–50. *Micaceous Sandstone.*—Locality: Coal-measures, Coal Creek, and south branch of the Kanieri River.

151–52. *Quartz.*—Locality: Jackson's Reef, Teremakau Valley.

153. *Crystallized Quartz.*—Locality: Western end of Lone Peak Range, second gorge of the Arahura.

154–56. *Quartz.*—Locality: Arahura River-bed.

157–59. *Felspar and Mica.*—Locality: Kawhaka River-bed.

160. *Quartz.*—Locality: Near Bark Hut, second gorge of the Arahura.

161. *Crystalline Limestone.*—Locality: Arahura River-bed.

162. *Black and Grey Actinolite.*—Locality: Hokitika Gorge.

163–221. Various rocks collected from different parts of the Arahura Valley.

222–24. *Granite.*—Locality: Near lower-end of the second gorge, Arahura Valley.

225–46. *Specimens of pure Actinolite Schist.*—Locality: Near Rocky Point, Teremakau Valley.

247–302. Specimens from the mineral belt of the second gorge of the Arahura. Most of these were collected for the indications of copper which they contain. In some of the samples, copper is present to the amount of 10 per cent, of the whole.

303–53. *Rock Samples requiring determination.*—Locality: Arahura River-bed.

354–61. *Green Actinolite.*—Locality: Second creek west of Rocky Point, Teremakau Valley. These samples are formed of interlacing crystals of the pure mineral.

362–76. *Samples of Magnesian Rocks of a type intermediate between Olivine and Serpentine.*

377. *Mass of Iron-pyrites.*—Locality: From Fox's diggings, Fox's Creek, Arahura.

Samples Analysed.

378. *Coal.*—Locality: Williamson and Cloudsley's Lease, Broken River, Canterbury. Analysis:—

Carbon ...	57·55
Water ...	4·22
Earthy matter	38·23
	100·00

The sample is thus an anthracite, and its occurrence at the base of a seam of unaltered brown coal is somewhat remarkable. There are no floes or intrusion of aqueous rock in connection with the coal-measures whence the specimen comes. Faulting has taken place along the margins of the coal-bearing area, but there the coal, though broken and crushed, is little, if at all, altered. The anthracite occurs in a bed about 18in. thick, close to the palæozoic rock on which the coal-measures rest. It has a remarkable primatic structure, vertical to the bedding of the seam.

379. *Magnetite.*—Locality: Second gorge of the Arahura. Contains 98·66 per cent. of magnetite, equal to 71·42 of iron.

380–83. *Four samples of Copper-bearing Rock*, of which 381 is from the Kawhaka River-bed; the others are from the mineral belt in the second gorge of the Arahura. No. 380 is iron-pyrites, with a trace of copper only. Nos. 382 and 383 is a schist, containing copper in a finely-divided form, which, on analyis, in the case of 382, 9·64 per cent., and 383, 8·11 per cent.

384. *Actinolite.*—Locality: Rocky Point, Teremakau Valley. Analysis:—

Magnesia	32·73
Lime ...	5·15
Iron oxide	10·42
Silica ...	50·04
Water ...	1·66
	100·00

385. *Magnesian Rock.*—Locality: Mineral belt, second gorge of Arahura River. Contains 5 per cent. of water. This rock can be placed neither as olivine on the one hand, nor serpentine on the other; and this may be said to be characteristic of the whole of the rocks of the mineral belt.

386–87. *Samples of Schist*, the poorer parts of the band of copper slate in the mineral belt of the second gorge of the Arahura. The samples contain respectively 1·71 and 1·98 per cent. of copper.

388. *Rhodonite.*—Locality: Arahura-Wainihinihini, from the gorge of the left-hand branch. Analysis: Rhodonite, 66·23 per cent.; remainder, quartz.

389. *Limestone.*—Locality: Camel-back Hill, Kokatahi Plain. Analysis:—

Carbonate of lime	69·38
Carbonate of magnesia	2·79
Iron and alumina	4·40
Siliceous matter ...	23·21
Water ...	0·22
	100·00

390. *Limestone.*—Locality: Upper Teremakau Valley. Contains 71·24 per cent. of carbonate of lime; the remainder is principally siliceous matter, iron-pyrites, and carbonate of iron.

391. *Talcose Rock.*—Locality: Near Rocky Point, Teremakau Valley. Analysis:—

Silica ...	50·42
Lime ...	1·09
Iron oxide	4·20
Alumina	Trace
Magnesia	31·84
Carbonic acid	8·02
Water ...	4·43
	100·00

This rock appears to be, from these results, a mixture of silicate of magnesia with the carbonate or talc and magnesite."

392. *Limestone.*—Locality: Hokitika Gorge. Carbonate of lime 66·86 per cent. The remaining substance largely consist of actinolite.

METALLIFEROUS WORKINGS.

MANGANESE.

There has been a steady output of manganese-ore in this colony since 1878, and for the first three years over 2,000 tons per annum was exported which had an average value of £4 per ton; but since then the price of manganese has gone down considerably, and last year only 221 tons was exported having a value of £1,239, which is equal to about £2 7s. 7d. per ton. During last year Messrs. John W. Jaffray and Co., engineers, of Hay Street, Sydney, acquired the right of mining over 950 acres on Waiheke Island, and intend carrying on more extensive operations in manganese mining than has been done for the last twelve years, as will be seen from the following article culled from the *Australian Mining Standard*:—

"Waiheke Island, situated in the Hauraki Gulf, on the eastern shores of the North Island, at a distance of about twelve miles from Auckland, has become one of the most favoured summer resorts of Aucklanders. Nor can it be wondered at when one sees its beautiful sandy beaches for bathing, its splendid facilities for boating, and its highly picturesque scenery; all of which, however, must be seen to be properly appreciated. Its promixity to Auckland, with regular steam communication, its accessibility in any season, being nearly a land-locked passage, must always recommend it to those who are desirous of avoiding the more exposed weather in the gulf. Waiheke, besides possessing these advantages, is very rich in minerals, but hitherto it has been principally celebrated for its great manganese deposits. Dr. John Storer, mining expert, says he has viewed nearly all the large manganese mines in Spain, Portugal, America, and all worth seeing in Queensland, New South Wales, and the other colonies, and in no case has he seen any indication so good as that at Waiheke, adding, that it is without doubt the biggest thing of the kind he has seen. In his report he says: 'From the northern end of the island there is traceable for a distance of some seven miles an intrusive belt of rock giving abundant indications of manganese on the surface. At two points during past years manganese has been worked, and some thousands of tons mined and shipped before the freehold passed into the hands of the present owner. About four miles from the northern end of the island the formation has been opened out by me at a point selected after the undergrowth had all been burned off. The result has been that a large body of manganese-ore has been bared and followed for nearly a quarter of a mile. Three trenches were cut, and the ore found at about 3ft. from the surface. So far it is found 15ft. wide, broadening as it is worked on. There are other points which I observed equally worthy of being tapped, and I may say that the surface indications lead me to the conclusion that there exists in the course of this lode-formation an extensive body of good, workable ore. I find from analysis made of the ore that it is free from phosphorus—an important matter in the manufacture of steel, for which manganese is now so extensively used.'

"The portion of the island on which Dr. Storer reported is known as the Ardrossan Estate, consisting of about 6,000 acres, and lately owned by Mr. Thomson. Negotiations for the purchase of this estate were entered into by Messrs. John W. Jaffray and Co., of Sydney, and they sent a representative there, who thoroughly prospected the property by drives at different positions and levels right over an area of about eight miles, but most particularly at Trig Hill, Hook's Point, and Crabshell Hill. The results of this inspection were so satisfactory that the firm mentioned have concluded the purchase of the mineral rights on this estate, and have commenced operations at Crabshell Hill, where the drives already put in show at least 60ft. of manganese, and the bottom not reached.

"Mr. Dunn, the Victorian expert, visited the estate some time ago, and in his elaborate and exhaustive report he observes: 'Gullies with small but permanent streams intersect the property. Ti tree and large timber, useful for fuel and mining purposes, covers a considerable tract. On the south side of the property water-access to it is furnished by Man-of-War Bay, in which a substantial jetty has been built. From this point ores could be readily shipped from the southern half of the estate. On the west side there is a small bay, where scows and other small craft can be conveniently loaded, and this commands the northern portion of the property.' Of the manganese deposits Mr. Dunn says: 'Manganese-ore occurs in a more massive form than I have ever met with elsewhere, and its excellent quality is shown by the results of two assays made by Mr. Ponds of two quantities of 30 tons each, taken from different portions of the Ardrossan Estate, as follows: No. 1, metallic manganese, 56·63 per cent.; No. 2, metallic manganese, 56·34 per cent.'

"In conclusion, Mr. Dunn remarks: 'In dealing with such an ore as manganese, it must lie in abundance, be of good quality, and there must be facilities for cheaply extracting it and conveying it to the ship's side for exportation. At Waiheke these conditions appear to exist, and I firmly believe that under proper management the deposits of ore there would yield enormous profit.' Apart from the manganese deposits, Mr. Dunn predicts that heavy deposits of copper ore will be found, as well as other minerals. Gold and silver have also been discovered, and these discoveries may lead to important results by development.

"Messrs. John W. Jaffray and Co., engineers, of Hay Street, Sydney, who have been long identified with mining in this colony, have acquired the sole right to the Androssan Estate, and have commenced work there already. They have also purchased the freehold of another portion of the island known as the Awa-awa-roa Block, consisting of 950 acres, through which the same manganese lode has been traced to run, good indications of copper and other metals, kauri gum, &c. Messrs. Jaffray have also secured contracts for 2,000 tons of manganese per month for two years, and have inquiries for as much more."

The following lots were exported last year: 106 tons from Parua Bay; 90 tons from Mangapai; 40 tons from Otonga; 201 tons from the Colonial Manganese Company, at Waiheke; and the balance from other places.

Antimony.

The principal mine where antimony-ore is being worked is at Endeavour Inlet. The former company that owned this property went into liquidation, and it was purchased back by the original shareholders who sold to the company referred to. During last year work has been carried on continuously with from twenty to twenty-five men, getting ore from the No. 5 and No. 7 levels. During last year there was a small profit on the working of this mine, but the profits, instead of being divided amongst the shareholders, have been expended in prospecting operations and opening out the mine. The ore from this mine is all dressed up to a certain percentage of antimony and forwarded for sale in Europe. It is said that the profit on working of this mine is equal to about £2 for every ton of ore that is shipped.

There is also a mine at Barewood, where a very good quality of antimony is found; but the lode is not regular, it being more in blocks and patches. The cost of transit from the mine to the railway, and by rail to Dunedin, adds considerably to the expense of procuring it; and, there being no appliances at the mine for concentrating the ore, the same as at Endeavour Inlet, the lode here has to contain a fair quantity of good ore before the workings can be made remunerative.

Again, at Waipori antimony-ore is being got; but the same remarks apply here as at Barewood, only the cost of transit from the mine to a shipping port is more from Waipori than from the other place. It depends entirely on the size of the lode and the quality of the ore as to whether these mines, where there are no concentrating appliances, can be made to pay for working or not, as all the sorting has to be done by hand-labour.

Antimony-ore is largely distributed through many parts of the colony; it is found in the Carrick Range, and other places in Otago: and on the west coast it is found in combination with gold in quartz-reefs, such as the Welcome Reef at Boatman's, and the Golden Treasure Reef at Murray Creek. It is also found in some of the auriferous quartz-lodes at the Thames and Coromandel, and it is very widely distributed in the vicinity of Puhipuhi; but, so far, very few of the antimony-mines have proved remunerative ventures for those interested in them.

Quicksilver.

It has been known for many years that there is ore containing mercury at Ohaeawai, but the place where it was found was the seat of thermal-spring action. In one locality here there are hot springs, and in a basin where there are a number of hot pools, there is a deposit of black sediment having quicksilver distributed through it in the finest globules. Through the centre of this basin there is a lode of cinnabar which has been acted on by the heat in combination with potash which exists in the ground and given off the quicksilver. On my first visit to this locality the remains of a small furnace were standing which had been used by some one in collecting the quicksilver out of the fine black sediment referred to by placing it in retorts in charges, and volatilizing the mercury, and collecting it by the same process as that in retorting amalgam. At the time of my visit to this place there were several Natives bathing in the hot pools, which are said to be efficacious for rheumatic complaints, and also for skin diseases; and, judging from the quantity of quicksilver mixed amongst the mud, as well as the steam and sulphurous vapour which is coming out of the ground at the cinnabar-lode, a sanatorium could be erected here for certain diseases which could not be surpassed in the world.

Some time ago a syndicate of gentlemen from New South Wales purchased some land in this locality, and recently they have constructed an adit-level into the side of the hill, and discovered a lode of cinnabar. The lode, however, is broken up, and has more the appearance of rubble than a solid lode. A good deal more work will have to be done before any one can say whether this discovery will prove a valuable one or not.

Scheelite.

There is a good deal of scheelite in different portions of the Middle Island, and many inquiries are now made respecting it. In a recent letter forwarded me by Mr. George G. Blackwell, 4, Billiter Buildings, London, E.C., and 25, 26, and 27, Irwell Chambers, West Liverpool, he states that he is prepared to take 200 tons per annum, in lots of 10 and 20 tons and upwards. He quotes the value of ore, testing 55 to 60 per cent. of tungstic acid, on the 24th April last, to be 10s. per unit; and in a previous communication he stated that ore testing 40 per cent. was worth from £12 to £14 c.i.f. London. There is plenty of this mineral in the colony. It is to be found at Waipori, McCrae's, Hyde, and at the head of Lake Wakatipu, in Otago; and some have been found

at Wakamarina, in the Golden Bar Reef. The price given by Mr. Blackwell is merely quoted to show those who may be induced to look for this mineral its value; and if a good lode were discovered the working of it could certainly be made a profitable undertaking.

MINING MACHINERY.

There is no element in connection with mining that deserves closer attention than mining machinery. New processes for saving gold and for the reduction of ores are coming into use time after time, and it becomes a necessity for mill-men to look closely into any new machine in connection with milling ores that is invented, to see if it can do the work more economically than that which they have been accustomed to use. There have been numbers of machines invented in the past, and will no doubt be in the future, perfectly valueless; but at the same time valuable improvements are being made from time to time in machinery, and these should be closely investigated before any one rushes to expend money in erecting a new description of plant that has not been properly tested. Almost every one acquainted with machinery will acknowledge that there is a great waste of power in a stamp-mill owing to the stamps being lifted after each drop from a state of rest, and a great many machines have been invented to supersede the stamp-mill, but none of these have yet been successful in fully accomplishing this object. The Globe, and also the Lamberton mills were highly spoken of by those who witnessed their trials, but when they came to be in daily use for crushing quartz, the wear and tear and expense in connection with working them was far more than on a stamp-battery. Then, again, there are the Krom Rolls, the Huntington Roller-mills, and many others which answer very well when properly constructed with all appliances in connection with the working of them; still the majority of those interested in mining prefer the improved stamp-mill to any of these machines. The same thing occurs, but not to the same extent, with amalgamating machinery. There is not an amalgamating-pan at the present time having a continuous discharge that is capable of saving a large percentage of the precious metal in the ore. If such a machine could be perfected to save 90 per cent. of the bullion in the ore it would cause a revolution in mining, as plenty of low-grade ore now valueless could be made remunerative for working.

My object in mentioning mining-machinery is to call attention to the fact that unless a far higher percentage of the precious metals is recovered from the ore at a reasonable cost many of the auriferous and argentiferous lodes on which a large number of men could be employed will never be opened out. It is true that the Cassel process gives a fair percentage of the gold in ores if carefully worked, but even this process is not suitable for low-grade ores, owing to the expense in connection with its application, and the royalty that is charged for its use by the patentees—a patent which is severely criticized in the American mining papers as one which ought never to have been granted, and which seems to have been to some extent, according to newspaper reports, disallowed by the Attorney-General in South Africa. Cyanide of potassium, nevertheless, is a remarkable re-agent for gold, but, as mentioned previously, too expensive to use in the treatment of low-grade ores. We have to look forward to a more inexpensive process to make the low-grade ores pay for working them; therefore every labour-saving machine that is invented in connection with mining is a step towards lessening the cost of working the lodes.

Latterly one machine—namely, the Lührig Vanner, has been introduced into the colony which is well worthy of being carefully investigated, as it is a machine that is capable of separating different minerals in the ore according to their specific gravity, at a comparatively low cost. There is also another machine, the Otis Ore-Crusher, which the patentees are trying to get introduced into the colony. They have made an arrangement with the Waihi Company to erect one of their machines, and given that company a guarantee that should it fail to do the work as represented, with the power mentioned and with the wear and tear as set forth by the manufacturers, the machine is not to be charged for.

THE OTIS ORE-CRUSHER.

The illustration appended depicts an ore-reduction mill, manufactured by the Austral Otis Engineering Company (Limited), South Melbourne. The patentees claim that, besides being effective in the crushing of almost any ores, it is specially applicable to those in which the mineral is fine. This machine has already made a name, and it is to be found at work in all parts of the world crushing gold, silver, copper, and lead ores, as well as basic slag, bones, plumbago, emery, &c. In order to show the crusher in actual work, a No. 2 machine has been erected at the company's ore-testing works, South Melbourne, where over 200 tons of different kinds of ore have been crushed to different meshes, from 100 to 5,000 per square inch. As will be observed on reference to the sketch, the interior of the crusher is in the form of a drum composed of six segments, *a*, which are made of rough cast-steel, about 3in. thick, having a number of $\frac{5}{8}$in. holes in that part where the balls fall on to it from the other segment. These holes are counter-sunk on the inside, and have a long taper from the outside. Each segment has flanges which bolt to and are fitted into recesses in the cheeks, *c*, both faces being turned true; and the insides of the cheeks have chilled cast-iron plates, *b*, bolted to them to protect them from the action of the ores and the balls. The opening between the edges of the segments is partially closed by perforated plates, *g*, connected to the return elevator-plates, *f*. On the outer rim of the flange of the segments is secured a steel screen perforated with slots of suitable mesh. This screen has openings for the return elevator-plates, *f*. Outside this screen are finer sieves, which are secured to light angle-iron frames when used for wet crushing, and to wooden frames when crushing dry. These sieves are also provided with openings for the return elevator-plates. The whole machine is enclosed in a dust-tight casing. The drum formed as described is secured by the two cheeks to a strong steel shaft revolving in heavy bearings. The self-acting feeder is fitted on this shaft in the hopper, *h*, secured to one of the cheeks. One of the segments

has a manhole, *t*, fitted to it, which can be readily removed, for obtaining access to the inside when cleaning up or renewing the balls. In the inside of the drum is placed a number of balls made of a special tough steel forged under the steam hammer. These balls are of three sizes, 3in. 4in. and 5in. The total weight of a set of balls is 13cwt.

Motion is transmitted to the machine through suitable gearing, driven either by belt or by an engine coupled direct on to the pinion-shaft. The crusher may be erected either on a concrete foundation, or upon light steel girders or timber framing. In operation the ore is fed to the machine in proportion to the quantity it will crush per hour, which is in accordance with the degree of fineness desired and the nature of the ore to be crushed. Regular feeding is essential to the efficient working of the machine. The ore is crushed by the rolling and falling action of the balls against the segments and against itself. When broken up, it at once falls through the holes in the segments, and, if fine enough, it passes through the coarse screen, *i*; if not, it is at once returned to the inside by the return elevator-plates, *f*, to be further crushed. If, after passing through this screen, it is fine enough to pass through the fine sieves, it does so; or, if not, it is again returned to the inside by the return elevator-plates. This action prevents the formation of slimes, as the moment the ore is crushed fine enough to pass through the required mesh it goes away, the screening surface exposed for the ore to pass through amounting to 1,250 square feet per minute. The machine answers equally as well when working dry as wet, provided the ore to be crushed is thoroughly dry. The output is from 17dwt. to 36dwt. per hour from the No. 2 crusher, according to the mesh and nature of the ore. When crushing wet, the water is forced through the fine sieves from a pipe having a number of jets running across the face of the drum, inside the casing, so as to meet the sieves at the point where the ore is returned to the inside when not fine enough to pass through the sieve. This keeps the sieve clean, and assists in returning the uncrushed ore into the crusher.

From actual experience it has been found that the principal wear is in the steel balls, which lose from 10lb. to 30lb. in weight per 250 tons of the ore crushed, according to the nature of the ore. The wear on the steel plates is practically nothing, they lasting at least three years; and owing to the screens and sieves being protected so that heavy pieces of uncrushed ore cannot come in contact with them, they last from six to twelve months. When dry crushing, the sieves are made of phosphor-bronze wire, and when wet, of steel wire. When crushing dry, a dust-pipe is led from the upper part of the machine to a dust-receiver; this prevents all dust in the crushing-room. The machine revolves at the slow rate of twenty-five revolutions per minute, by which, with the thorough ventilation provided, all heating of the machine or ore crushed is prevented when dry crushing.

The advantages claimed by the manufacturers for this machine over stamper-batteries and other crushers are: Less weight: the total weight of a complete No. 2 machine being 7½ tons, and of the heaviest part 15cwt. Less wear and tear: the renewals not exceeding 20lb. of steel balls per 250 tons crushed, or about one halfpenny per ton. Larger capacity and smaller power: the large output per hour, viz., from 17cwt. to 36cwt. per hour, with a maximum of eight horse-power, with the No. 2 crusher. Dry crushing: this is the only ore-crusher which will crush ores dry as well as wet, the dry crushed ore being uniform in size. No dust escapes while crushing dry. These crushers are the only ones that grade the ore suitable for treatment with the cyanide-processes.—*Mining Standard.*

CARR'S DISINTEGRATOR.

This machine consists of a series of four strong cylindrical iron cages, of various sizes, formed of bars with open spaces of from 3in. to 4in. between them, arranged concentrically one within another, around and parallel with the shafts or axles, and rotated therewith with extreme rapidity in contrary directions to one another by means of an open and a crossed strap, the first and third cages rotating to the right, and the second and fourth to the left; so that while there are only two motions in reality yet, from the way in which the cages intersect one another, there are relatively four. The material is thrown in at the central orifice, either by shovels or elevators; and after the lumps, if very large, are broken by a stationary knife (fixed that its blade may extend into the interior of the innermost cage, but never used with very hard materials), they are thrown out by centrifugal force from the first cage at a tangent to its circle, precisely as stones are hurled from a sling, and at a speed equivalent to that at which the beaters of the said cage are rotating (which is usually 50ft. per second). When meeting the beaters of the next cage moving in an opposite direction (usually at 60ft. per second), a collision ensues similar to that which takes place between a cricket ball and bat—the shock thus produced being compounded from the aggregate speed of the beaters and the speed and weight of the material meeting them. The projectile-impetus of the flying material is thereby arrested, and a fresh impulse given in an opposite direction to meet the beaters of the third cage travelling the reverse way, and so on in like manner with the fourth one; when, if the material is of a friable and non-fibrous nature, it is shattered by these successive blows into a fine granular state, usually like that of gunpowder, and in less than a second delivered in a radiating shower at a tangent to and from every portion of the periphery (like coruscations of the firework known as the "catherine wheel"), and then arrested in its flight by an external casing of wood or iron enclosing it and usually formed like the paddle-box of a steamer (see detail drawings).

The 6ft. 3in. size, made extra strong, with steel bars and steel shafts and stout wrought-iron disc-plates turned true, is much the best adapted to satisfactorily cope with wholesale quantities of hard ores, of which it has been found to pulverise as much as many pair of heavy cage runner mills could do in the same time. Not only will it effectually pulverise ores, but the important discovery has been made that it will also, to a very great extent, simultaneously separate their metallic constituents from the useless mineral ones, especially if the separation be further assisted by cylindrical riddles or by washing. In France this has been practically proved most satisfactorily at some iron-ore smelting works; and in Norway the same is also being done at some zinc works with blende and calamine, whereby a considerable amount is saved both in the fuel and in the re-agents or fluxes used in the blast-furnace, which can thus be built of much smaller dimensions, and a lower tem-

perature and less prolonged suffices, while the yield of metal is improved in quantity and quality as well as in cheapness.

The power required varies from 8 to 10, 12, and even 14 and 16-horse, according to the following circumstances: Firstly, the gross weight of material to be operated on per hour; secondly, its hardness, tenacity, and specific gravity; thirdly, the degree of fineness to which it has to be reduced; and, fourthly, the amount of speed requisite to accomplish the results desired—for, as these four constitute individually and collectively a certain amount of work done in a given time, the power to execute the same must necessarily be proportionate thereto; the greater the speed, and the larger the quantity operated on, the more the power requisite. Where, however, the engine is deficient in power for the work it is required to do, and it is desirable to increase it by working it to the best advantage, great care must be taken not to multiply the speed of the disintegrator too much against the engine in proportioning the respective sizes of the pulleys, or the engine will be overloaded by the adverse leverage it has thus to contend with, and will, therefore, not be able to attain its proper speed whereby its power (deficient, as it was, to start with) will be still further diminished instead of increased; for the faster the engine runs the more cylinders full of steam (or, what amounts to the same thing, the more cubic feet of it) it uses per minute and, therefore, the more power it gives out in the time, providing, of course, the boiler is large enough and has sufficient grate and heating surface to consume sufficient coal and generate sufficient steam to keep the engine running at an increased speed without diminishing the pressure of the steam.

The speed that the machines are driven at varies with the hardness of the material and the degree of fineness to which it is to be reduced. When hard materials, such as ores of zinc, are to be reduced to a very fine granular powder, 600 revolutions per minute for the solid shaft and 400 for the hollow one is found sufficient; and for ordinary purposes, such as coal and artificial manures, 450 for the solid shaft and 300 for the hollow one is very suitable. The reason why the solid shaft can be run much faster than is advisable with the hollow one is because the bearings of the former are of much smaller diameter and are of wrought-iron instead of cast, while the cages this solid shaft carries are also lighter, and, being placed inside or between the said bearings, they are free from the overhang appertaining to the cages of the hollow shaft. As regards the pulverising properties of the machine, the difference of speed is of no practical consequence.—*Victorian Mining Report.*

LÜHRIG CONCENTRATING PLANT.

There is a small plant of the Lührig class erected in the building of the Norfolk Battery at Tararu Creek, Thames. It may be termed merely a testing-plant, it being merely erected by the company who have purchased Lührig's patent-rights in the Australasian Colonies for the purpose of getting it introduced into this colony. At the time of my visit to this plant it was being employed in concentrating some of the tailings from the North Star Mine. According to the report of Mr. G. S. Pitcairn, the manager of the Lührig plant, 12½ tons of the tailings were treated, being the quantity collected from crushing thirteen loads of stone—about twenty tons. Therefore, this shows that 7½ tons of the material that was crushed passed away in the water, and was run to waste; and that the actual amount of bullion in the quantity of tailings saved in the buddles does not represent the actual quantity in the ore that passed over the quicksilver and blanket-tables; a considerable quantity of it was carried away with the water. The assay-value of the 20 tons of stone crushed was said to be £13 15s. per ton—£275. The value of the gold obtained from the plates and berdans was £115 9s., or £5 15s. 6d. per ton. This left £7 19s. 6d. per ton which was not recovered by the ordinary battery process. The assay-value of the tailings saved from this 20 tons of ore, according to Mr. Pitcairn, was only £1 19s. per ton. This would leave bullion being carried away with the water to the value of £6 0s. 6d. per ton—a result which one can scarcely credit; and probably fair average samples have not been taken either of the ore in the first instance or else from the tailings, which would account for this large percentage which is said to be lost; but, be that as it may, it is evident that some other process will have to be adopted when it is shown that only 41·9 per cent of the bullion in the ore is saved. This would not apply to the yield from rich specimen-stone, but to the average material crushed on the field. The percentage of the bullion saved from the average class of ore got on the Thames field has no doubt been very small. The total assay-value of the 12½ tons of tailings is given by Mr. Pitcairn as £24 7s. 6d. Out of this he got 2¼ tons of concentrates, worth £19 4s. 9d., and in the refuse sand the value was £3 8s. 4d., thus showing that bullion to the value of £1 19s. 5d. was carried away by the water.

The following is Mr. Pitcairn's report to the directors of the North Star Company on the result of the concentration:—

"Thames, 13th April, 1893.

"To the Directors of the North Star Gold Mining Company, Auckland.

"Dear Sirs,—I herewith beg to forward results of the concentration of 12½ tons of your company's tailings from the recent crushing of thirteen loads of quartz at the Moanataiari mill, Thames:—

——	Bullion.	Gold per ton.	Silver per ton.	Value per ton.	Total Values.
	Oz. dwt. gr.	Oz. dwt. gr.	Oz. dwt. gr.	£ s. d.	£ s. d.
Tailings, 12½ tons	·2 18 19	0 8 4	2 10 15	1 19 0	24 7 6
Concentrates, 2¼ tons ...	10 5 19	1 17 12	8 8 7	8 11 0	19 4 9
Refuse, 10 tons	0 4 21	0 1 15	0 3 6	0 6 10	3 8 4
Loss	...	...	...	...	£1 14 5

"The percentage of minerals in the tailings is equal to 18 per cent.

"The percentage of saving effected by coucentration is equal to 78·9 per cent.

"The concentration of this ore, from the above results, may be considered satisfactory; but a few remarks must be made as to the time when concentration must begin. The above 12½ tons were collected in long buddles, where the refuse from 20 tons of quartz ought to have been all deposited.

	Total Value in Quartz treated.	Per Cent.
20 tons quartz, value £13 15s. per ton	£275 0 0	100
Gold got from plates and berdans	115 9 0	41·9
Tailings ought hence to be equal to ...	£159 11 0	58·1

Hence the total value of the 20 tons of tailings passing from the tables, blanketings, and berdans is equal to £159 11s., or £7 19s. 6d. per ton.

"A certain quantity of these tailings, as skimmings and blanketings, were treated in berdans, the refuse or waste from which assayed as follows:—

	Bullion per ton. Oz. dwt. gr.	Gold per ton. Oz. dwt. gr.	Silver. Oz. dwt. gr.	Value per ton. £ s. d.
I. ...	4 1 16 ...	2 1 12 ...	2 0 4 ...	8 11 0
II. ...	4 0 0 ...	1 19 4 ...	2 0 20 ...	8 1 8

"The sample from which the above assays were made was almost pure iron—very, very fine—and it is worthy to note that the finest particles are the most valuable.

"The difference in the value of the tailings which were collected in the pits, and that which they ought to be by calculation from the original value, and that value received as gold, is simply astonishing, and goes to prove that the very fine particles have been carried out of the pits by the large amount of water necessary to pass such heavily mineralised ore over plates; indeed, the percentage of saving is remarkably good, considering the class of ore.

"It is, nevertheless, absurd to treat such ore by the ordinary battery process, without concentrating the tailings immediately they leave the plates or blanketings, and by treating in such a manner 85 per cent. of the original value of the ore would be obtained.

"To verify the above statement, look at the following figures: 12½ tons settled from 20 tons and assayed only £1 19s. per ton; whereas by calculation from the original value, these 12½ tons ought to be £159 11s.; hence 12½ tons is equal to £12 15s. per ton.

"Hence we treated 62·5 per cent. of the bulk, containing 152 per cent. of the value, thus proving conclusively concentration must be introduced immediately the tailings pass from the blanketings.

"An analysis of the concentrates proved them to be pure iron, with a small percentage of silica."

There is no doubt that any one introducing a new machine tries to make the most of it, and show his process to be better than any other. Therefore, in considering the advantages of such a machine or appliances for saving gold, one has to be careful not to accept everything that is said in its favour until the appliances have been thoroughly tested. It is a well-known adage, that "A new broom always sweeps clean," and in many instances men are liable to grasp at anything that is likely or said to be capable of recovering a large percentage of the bullion in the ore, and more especially at the present time, when the mine-managers on the Thames goldfield are taking every precaution to find the assay-value of the ore as it is crushed, and which, up to the time of my visit, the results of assays made from the pulp, taken as it came through the screens of the battery every 15 minutes, show that only about 50 per cent. of the bullion is recovered from the average stone crushed. This does not include specimen-stone, with which great care is taken.

Some years ago, in referring to the loss of gold in the Thames District in one of my reports, it was then stated that not more than from 40 to 50 per cent. of the gold, if the whole of the stone crushed on this field was taken, was obtained. This is exclusive of rich specimens; and the recent results show this statement to be correct. There is far more care taken in crushing stone now than there was in the early days of the field; and if only 50 per cent. is now saved of the bullion, one would naturally conclude that there was a much greater loss in the early days, when battery-managers were not so well acquainted with the work. This, however, is digressing from the Lührig concentrator, but it shows that other methods will have to be adapted to save a larger percentage of the bullion in the ore, and the question is, Will this new appliance meet the case?

As far as a concentrating machine is concerned, it is superior to the Frue vanner, but it is questionable if it will save a larger percentage of the fine concentrates than the convex buddles. It has, however, this advantage, that it is cheaper in the first instance, and will operate on equally as large a quantity of material. It also has the advantage of sorting the concentrates according to their specific gravity—for instance, zinc blende will not travel on the belt so far as copper pyrites, and the latter will not travel as far as galena ore. It therefore has the advantage of assorting the different mineral substances according to their specific gravity.

First Operation.—The tailings were first put through a 5-head stamp battery. The manager stated that this was more for the purpose of puddling and mixing them than for crushing them into a finer pulp. From the battery the whole of the pulp and water was lifted by a small centrifugal pump, 12in. in diameter, having a disc of iron ¼in. in thickness, having semi-radial vanes on each side, also ¼in. in thickness and ½in. in depth. This pump is driven at 900 revolutions per minute, and said to be capable of lifting 2,700 gallons of water per minute to a height of about 12ft. The pump is set in a well, where all the water and pulp flow into, and the discharge pipe is only 3¼in. It seemed to me improbable of the pump having the capacity Mr. Pitcairn attributed to it; but as he had some of these pumps in stock, and wished to dispose of them, he offered to guarantee that they would lift the quantity of water as stated. The pump is a patent of Mr. Lührig's, and if

they have the capacity Mr. Pitcairn states, they would be a capital pump for lifting water on a dredge employed in dredging the rivers for gold. The cost of them would not be above one-tenth of the cost of some of the centrifugal pumps at present in use for lifting water for washing purposes.

Second Operation.—The centrifugal lifts the whole of the water and pulp into a pyramidal trough having three or four divisions. This trough, in addition to being wide at the top and narrow at the bottom, increases in width at the top, from the place where the water and pulp is first discharged, until the water finally flows away. That is to say, if the width of the top at the intake end is 2ft., the width at the other end is 5ft. The same angle on the sides is maintained, and this has the effect of its being about three times the depth at the discharge end, as it is on the intake, and the trough is divided into three divisions, the top of each division being a little lower than the ends and sides of the trough. There is also in each division another board, fixed at an inclination of about 20 deg. from vertical, having the top inclining towards the outlet, and this board goes down to within a little of the bottom of the trough. The water and pulp, coming into the narrow end of this trough, strikes against the inclined board, and passes under it, and comes up and goes over the top of the first division, and under the second inclined board, and over the top of the second division, and so on with as many divisions as there are in the trough. The result is that the coarser concentrates stop in the first division, the medium in the second division, and the fine concentrates in the third. The more divisions there are in this pyramidal trough the more the concentrates are assorted in proportion to their specific gravity and fineness. Although the pulp renders the water quite muddy when it enters the first division, as it passes through each division the mud and sand settles to the bottom, and the water passes off from the discharge end of the trough in a fairly clarified condition. If there were sufficient divisions, it would finally pass off nearly pure.

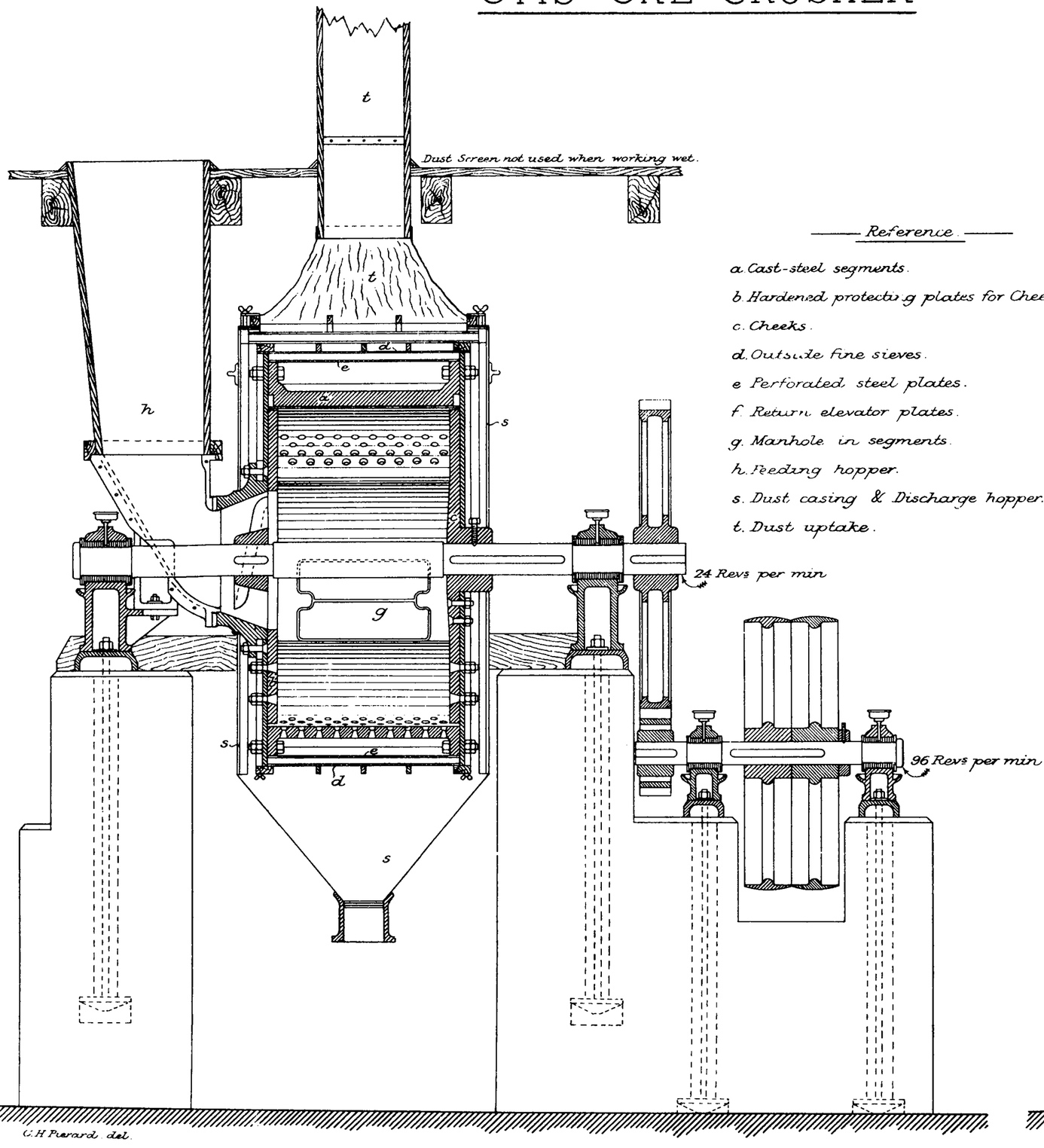
Third Operation.—This is the most interesting of the lot. In each division of the pyramidal trough there is a gas-pipe fixed, and by this means the pulp passes on to a vanner; each division having a vanner to operate on the class of materials which settles in it. There are three vanners at the testing-plant erected at the Norfolk Battery at Tararu Creek, corresponding with the three divisions of the pyramidal trough. Before describing the operation on the vanners, it will be necessary to give some idea of their construction. The vanners have each an indiarubber or vulcanized indiarubber belt 2ft. 8in. in width, and about 11ft. in length, having a roller 12in. in diameter at each end. Where it passes over the belt is double, and these rollers are in between the two plys at each end. There is a wooden frame, on which these rollers are fixed, and this frame is so made that there are tightening screws at one end to keep the belt always tight—that is, there are sliding plummer-blocks, in which one of the end rollers run, and by a tightening-screw these blocks can always be made to keep the belt to a uniform tightness. Directly under the upper half of the belt there is a series of small rollers about 3in. in diameter, and placed 6½in. apart. These tend to keep the belt on a perfect plane; while under the lower side of the bottom half of the belt there are three rollers, each 5in. in diameter, to keep it from sagging. The frame on which these rollers rest is made of strong but light timber; so that, while the front end of the belt is perfectly level, the bottom end can be canted a little to one side—that is, by twisting the frame to a slight extent. The frame on which the belt is placed has a spindle at each end, in the centre, which goes through the framing. At the bottom end there is a spiral-spring made of thin flat steel, to which the spindle is attached, and on the front end a lever stands up which is connected with the belt-frame. There is also a small double cam, which is driven by a belt, and each turn of the cam strikes the upright lever, bringing the belt-frame forward, and, the other end of the spindle being attached to the spiral-spring, it brings it suddenly back with a jerk. On the axle of the bottom end roller, which keeps the belt tight, there is a ratchet-wheel, having iron pawls attached to the framing on which the belt-frame is fixed. Every jerk given by the cam makes the pawl catch in the ratchet, and the strength of the spiral-spring bringing the belt-frame back, causes the rollers to revolve a certain distance each time, and the speed of travel of these belts depends on the class of material they are treating.

The vanner which deals with the first concentrates makes 160 jerks per minute, half an inch at each jerk. That causes the belt to travel at the rate of 6ft. 8in. lengthwise a minute. The second concentrator, dealing with the middle products, was making 140 jerks per minute, each jerk being half an inch; this made the belt travel 5ft. 10in. per minute; and the vanner for the finest product made 160 jerks per minute, having a quarter of an inch jerk—that is, a travel of 3ft. 4in. per minute. The centre of the belts lengthwise is set on a level, and they are also about level horizontally at the upper end; but the lower end is slightly canted, to make the sand and material flow off on one side.

The pipe conveying the sand and water from the different divisions in the pyramidal trough discharges into a small hopper placed above one side of the belt. There is a small inclined board in front of these small hoppers, on which there is a bar with small openings, set in a triangular form like an inverted Λ. Along the upper side of the belt there is another pipe having very fine holes, bored about half an inch apart. This pipe goes along the upper edge of the belt for some distance and then it is bent at an abtuse angle and goes slantwise across the belt, and which has also fine perforations, the extreme end of the pipe being about 12in. or 18 in. from the bottom end of the belt on the lower canted side. The small travel of the belt, with the numerous small jets of clean water from this perforated pipe, together with the slight cant that the belt has got at the lower end, causes the light sands and concentrates to pass off on the lower side into separate small chutes. For instance, the light sands are washed off first, near the centre of the belt, and the other concentrates go off according to their specific gravity. The heavy concentrates can be seen following down the belt not far from the water-jets and come off the side belt near the bottom end. All the different concentrates can be collected in small chutes along the edge of the belts according to their specific gravity.

—"OTIS" ORE CRUSHER—

NOTE. Can be built with wood foundation, or brickwork as shown.

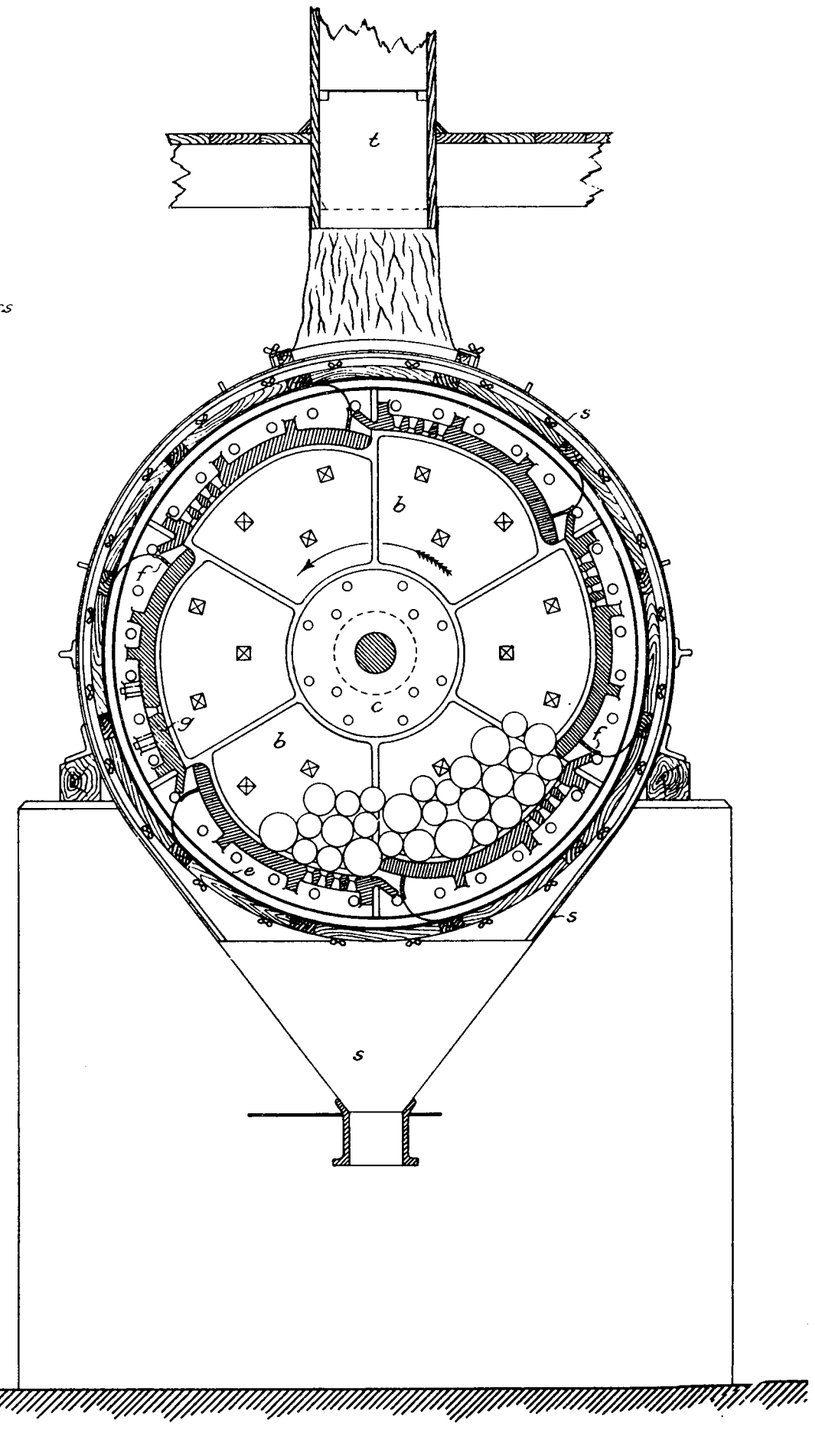


C.H Pierard del.

—— LONGITUDINAL SECTION ——

——— Reference. ———

a. Cast-steel segments.
b. Hardened protecting plates for Cheeks
c. Cheeks.
d. Outside fine sieves.
e Perforated steel plates.
f. Return elevator plates.
g. Manhole in segments.
h. Feeding hopper.
s. Dust casing & Discharge hopper.
t. Dust uptake.

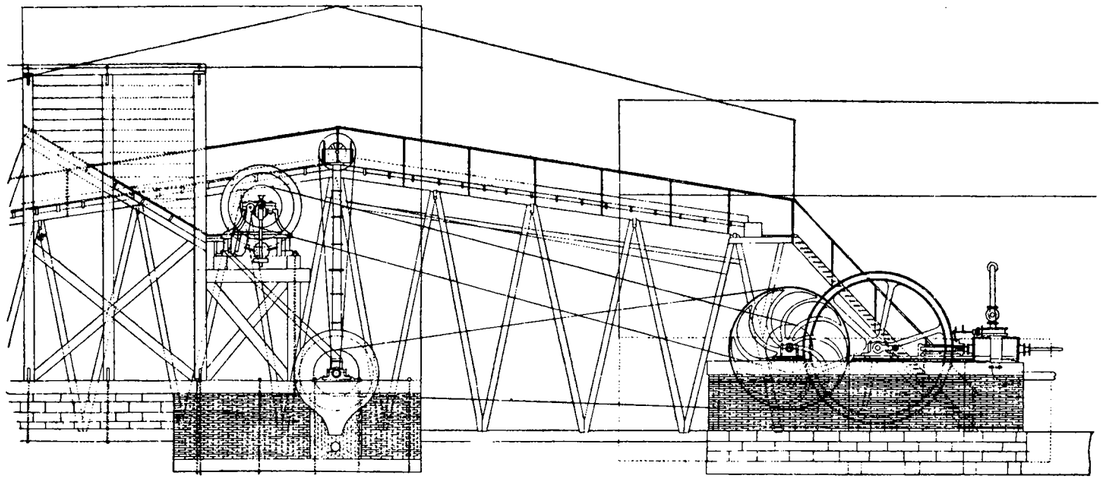


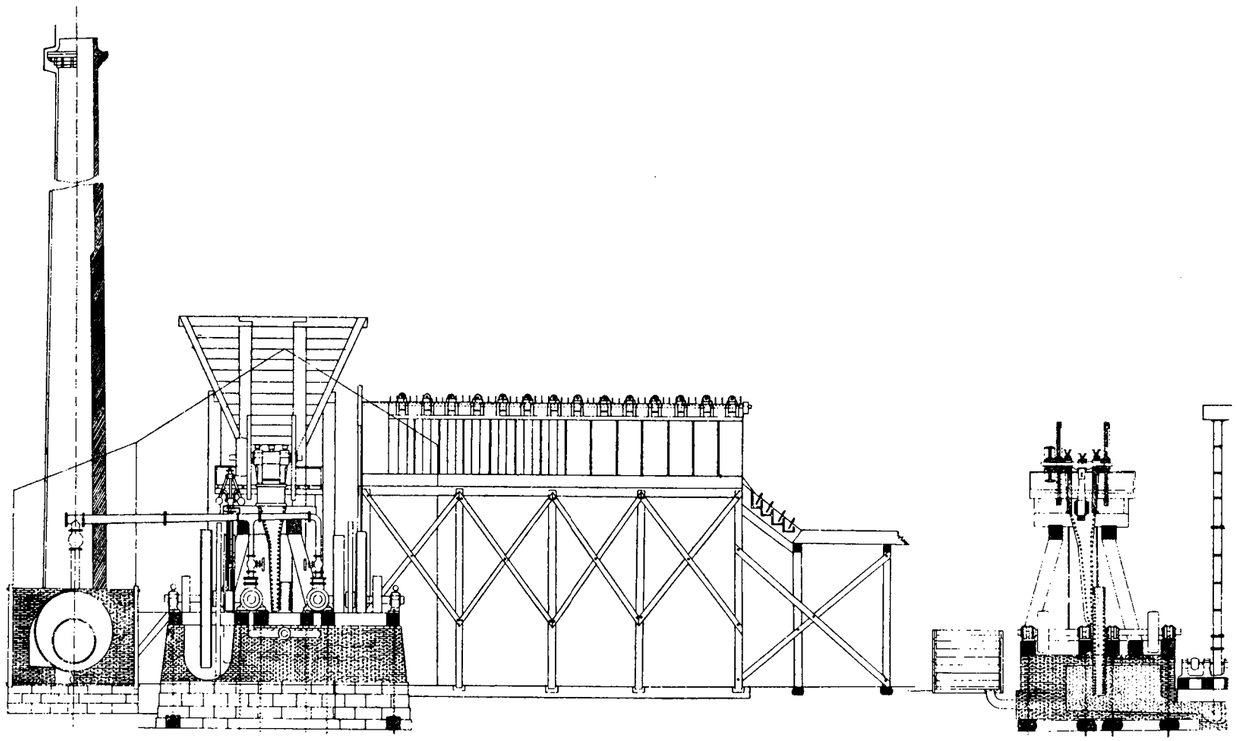
—— CROSS SECTION ——

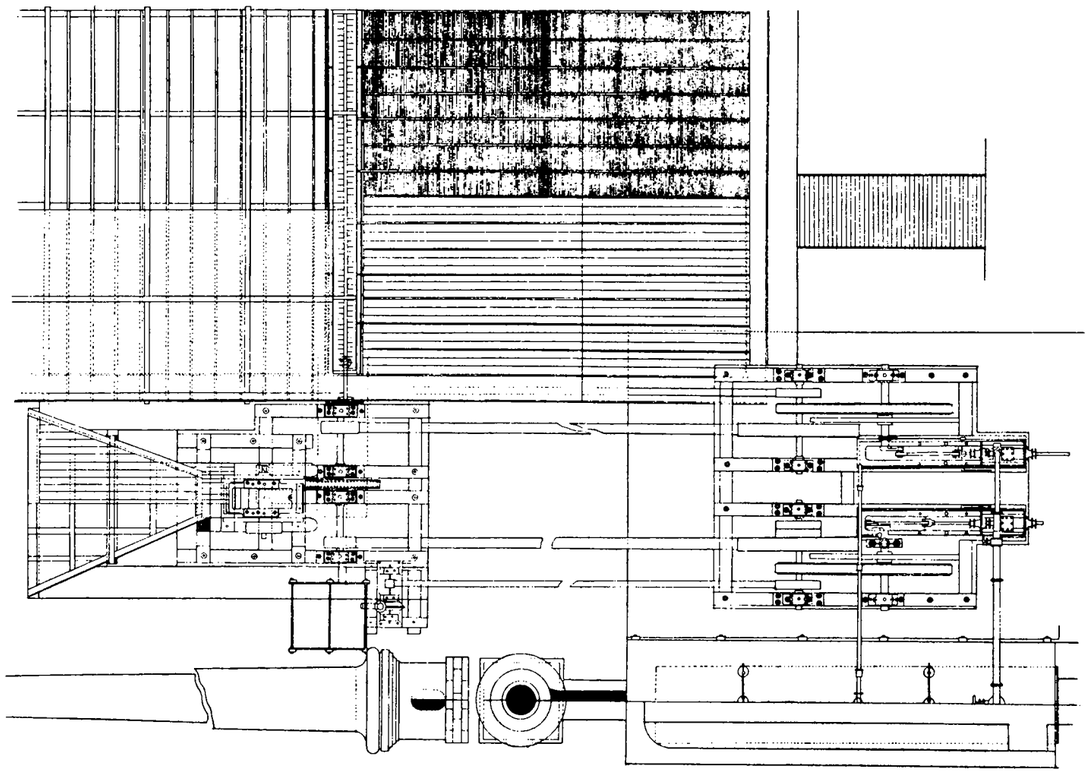
CARR'S DISINTEGRATOR FOR QUARTZ CRUSHING

Constructed & arranged by Angus Kennedy

Engineer Bendigo





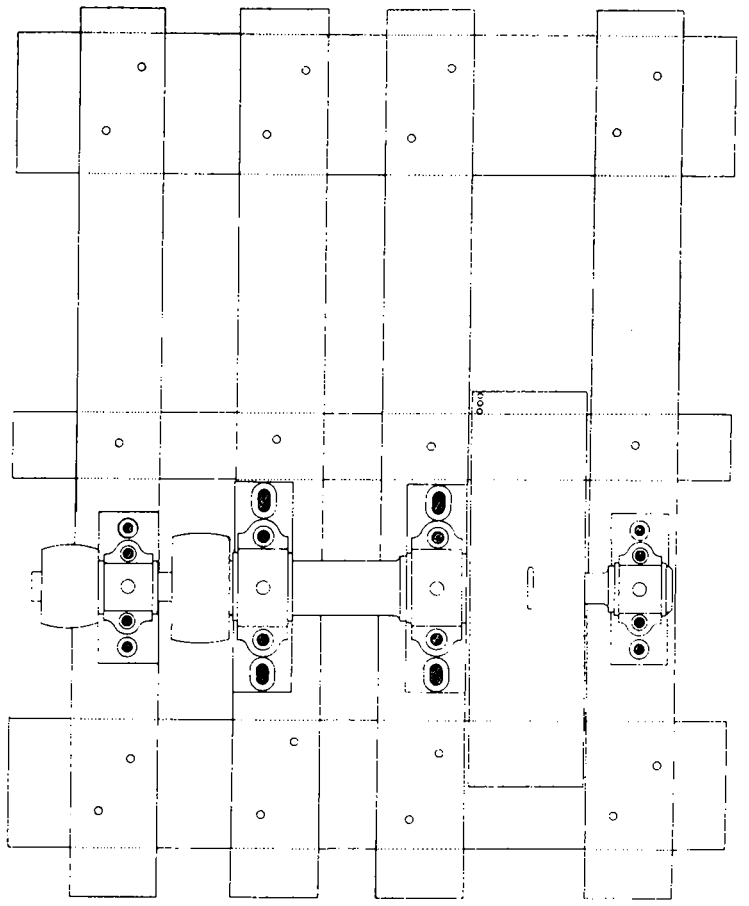


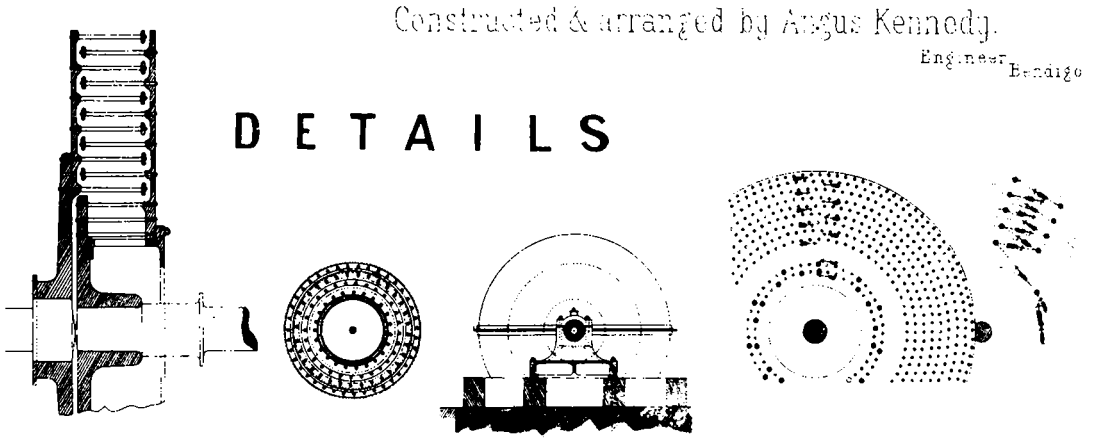
CARR'S DISINTEGRATOR FOR QUARTZ CRUSHING

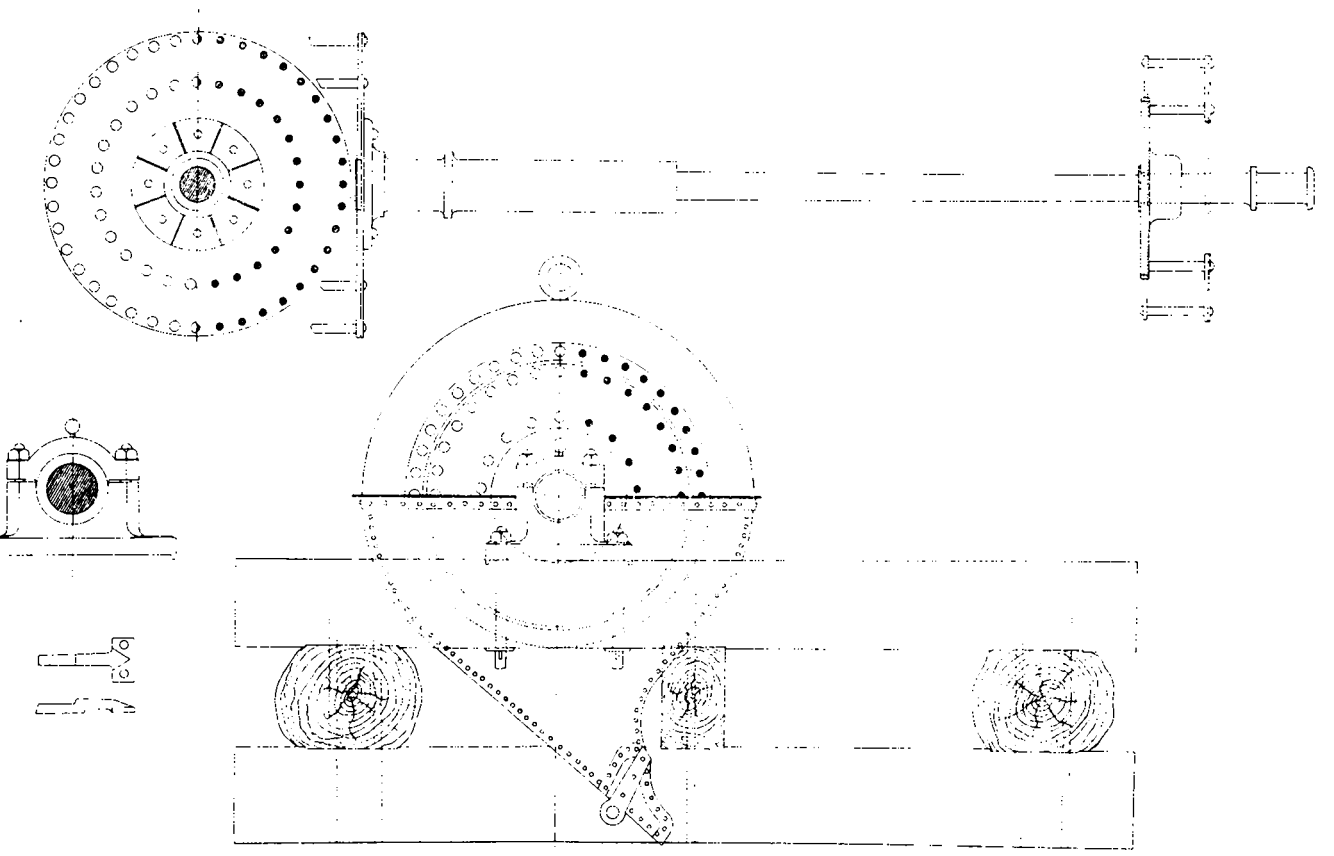
Constructed & arranged by Angus Kennedy.

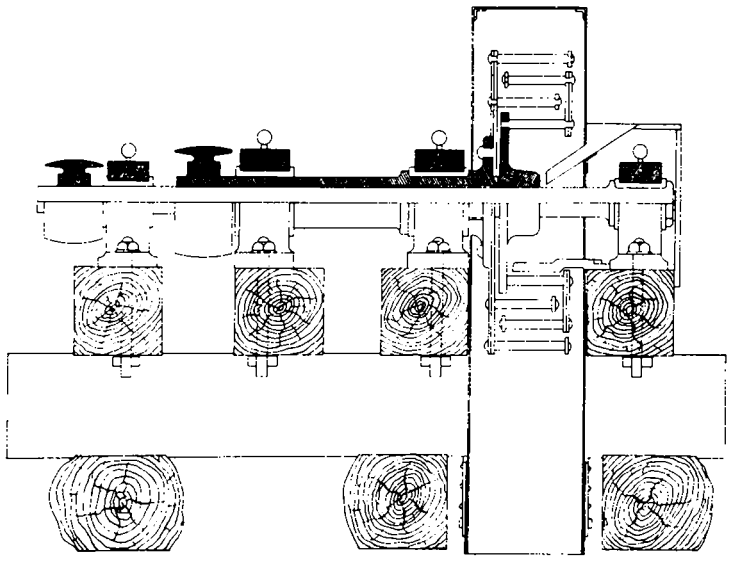
Engineer Bendigo

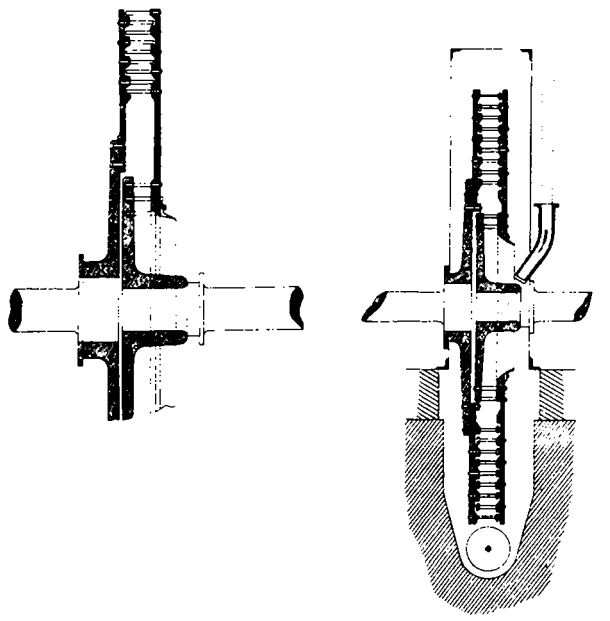
DETAILS

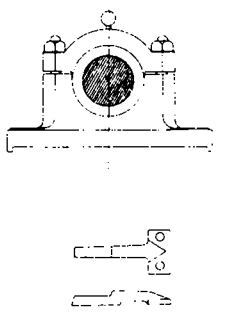


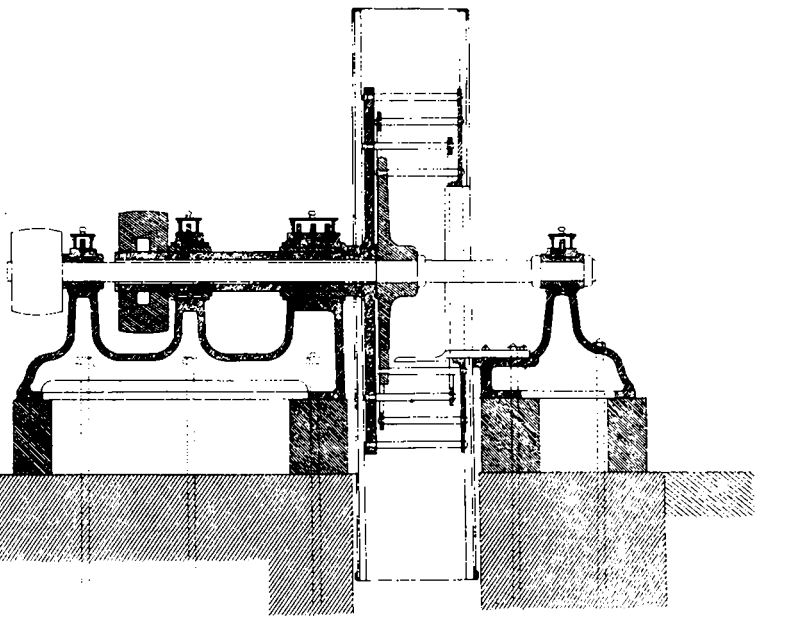


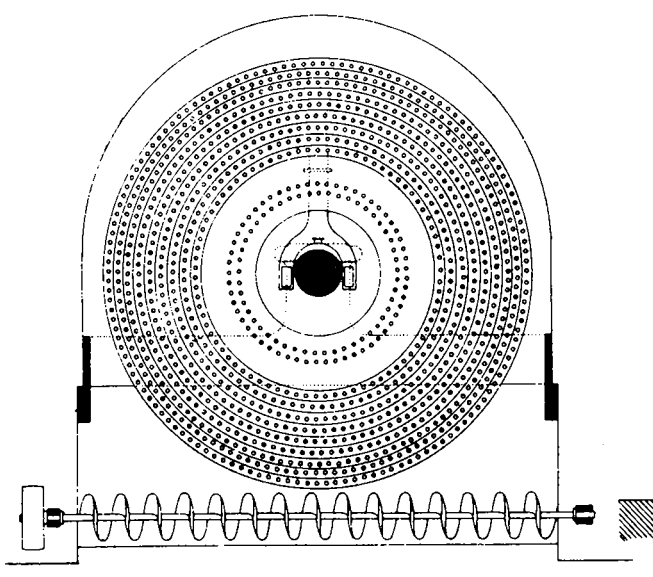


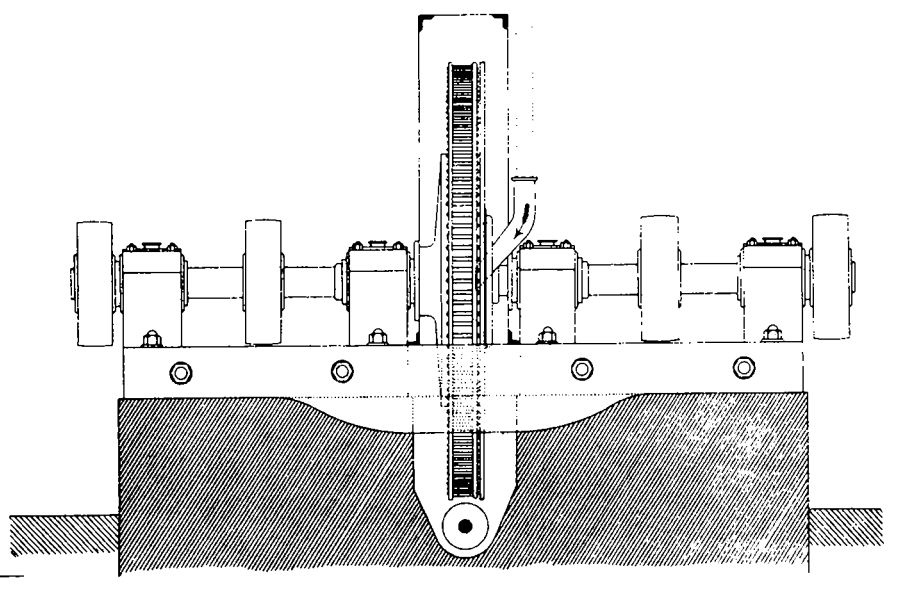










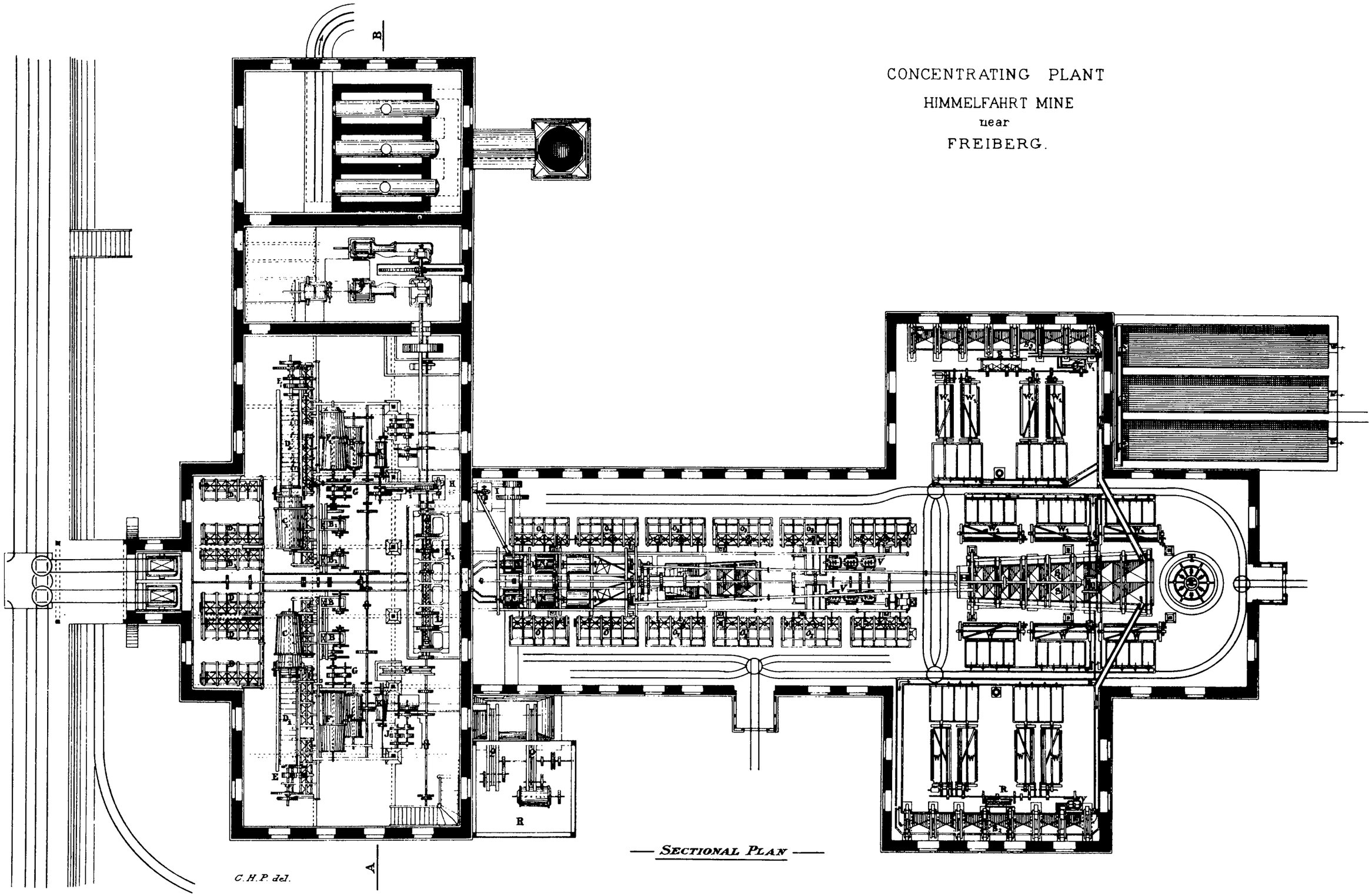


CONCENTRATING PLANT

HIMMELFAHRT MINE

near

FREIBERG.



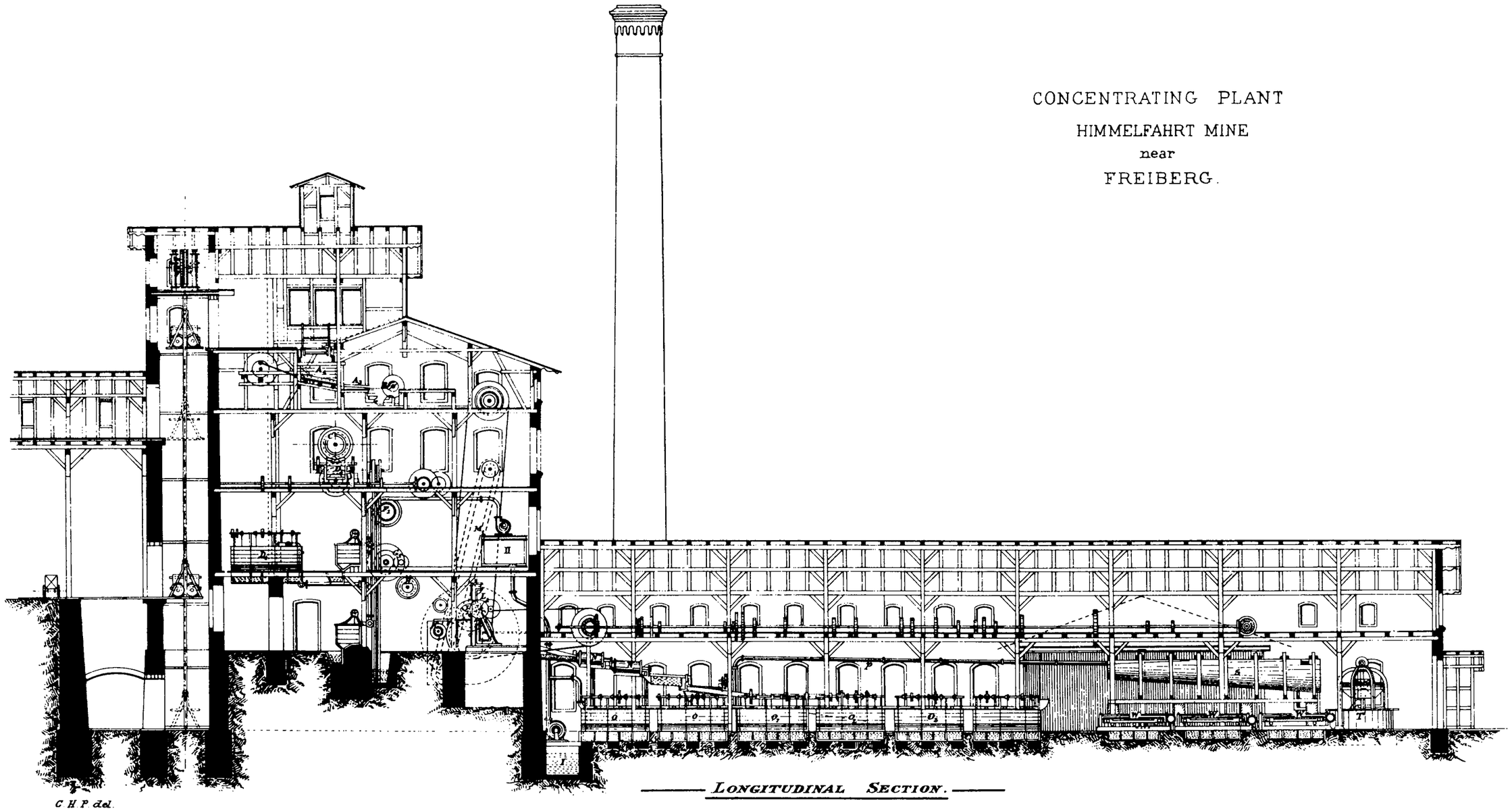
SECTIONAL PLAN

CONCENTRATING PLANT

HIMMELFAHRT MINE

near

FREIBERG.



C H P del.

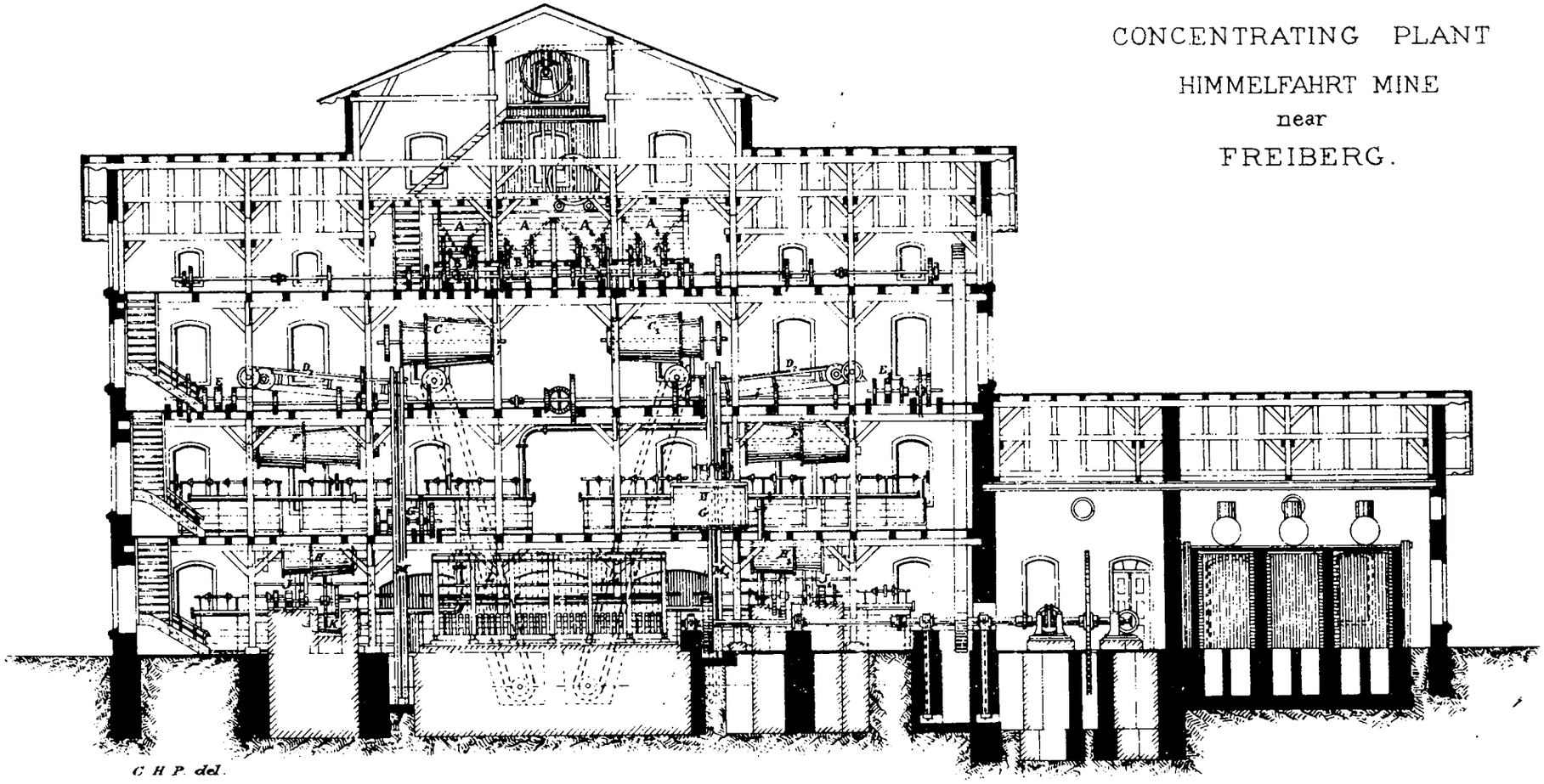
LONGITUDINAL SECTION.

CONCENTRATING PLANT

HIMMELFAHRT MINE

near

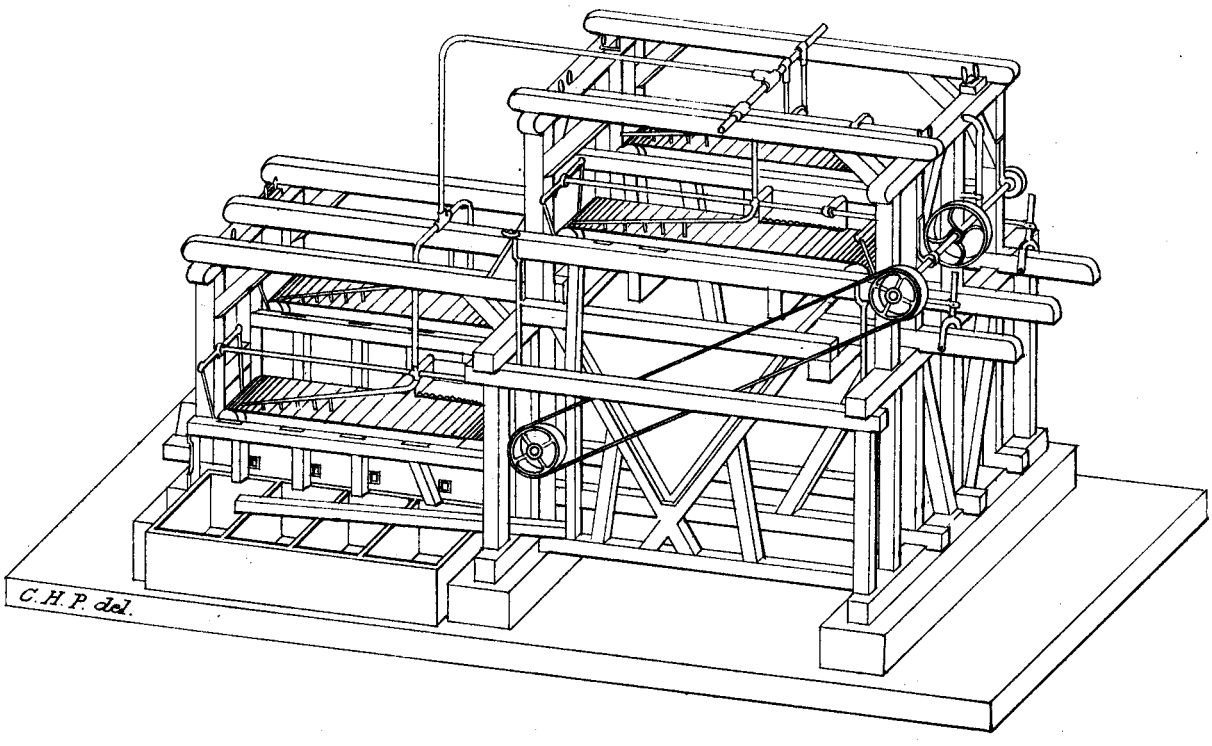
FREIBERG.



C H P. del.

CROSS SECTION.

THE LÜHRIG PATENT VANNER.



These appliances are suitable for concentrating ores; but it would be ridiculous to state that they are suitable for saving fine gold in a free state. There are plenty of ores in the Thames District in which there is a good deal of minerals which contain gold and silver, and it is upon these classes of ores that concentrating appliances can be advantageously employed. The Lührig vanner is undoubtedly a splendid concentrating machine; but it would be of very little use in saving some of the forms of ore which contain silver, such as proustite ore containing ruby-silver, or every sulphide of silver ores—a good deal of the silver would pass off with the water and gangue. They are, however, machines which could be largely used in many places in the colony wherever there is heavy mineral in the ore that is worth saving.

Mr. Newbery's Report.

In submitting his report on his experiments on the samples of tailings sent by the Minister of Mines, Victoria, to Europe, for treatment by the Lührig system, Mr. J. Cosmo Newbery writes as follows:—

"I had made numerous inquiries as to the other systems of concentration and ore-dressing, and satisfied myself that the decision we had come to in Melbourne to submit these ores to Mr. Lührig was correct, and I am pleased to say the results fully confirmed these views. All the lots were treated on the vanners working on his system at the washer of the Güte Gottes Mine, Scharfenberg, on the Elbe, near Meissen. Our first experiments demonstrated that without classification, *i.e.*, separation of the coarser sand-grains from the purer material, concentration was impossible. Owing to the limited quantity of the material it was impossible to make this classification in the large classifiers of the ore-dressing plant, and it had to be done by sieves. Assays were then made of the different grades obtained, the fine and coarse portions, and the results confirmed our Melbourne observations; for it was found from assays made by the Government assayers at Freiberg that the coarser sand practically contained no gold, and that there was nothing to be gained by re-crushing in a stamper battery, as is usually done here in treating tailings. Some much less expensive means of breaking up the lumps, separating the rough material, and setting the sand in motion in water without the expense of crushing the coarse grains may easily be devised. The cost of treatment per ton of sand treated, so far as the actual working of the machinery is concerned, will be very small. The main expense in dealing with the old tailings-heaps will be the cost of supplying water and putting the sand in motion. After this the material will flow on through the classifiers, where the coarser sand will be separated; and should there be any value in it in the form of coarse auriferous pyrites and other sulphides, it may pass on to jigs for concentration. If it contains nothing of value it will be discharged on the tailings-heap direct. In either case the fine-grain material separated from it will go straight to the vanners, and at once yield a marketable product.

"In our tests with the Bendigo, St. Arnaud, Burke's Flat, and Walhalla sands, all the gold was practically in the finest portions of the material, where it occurred as very fine free gold, gold in pyrites, and in oxide of iron (decomposed pyrites). From this fine sand there was no difficulty in obtaining good concentrates, leaving tailings with only a few grains of gold per ton. With some types of tailings—such as the St. Arnaud and Burke's Flat—it may be advantageous to use fine jigs as well as vanners, in order to relieve the latter and so treat larger quantities; but with Sandhurst and Walhalla I think that, after the classifiers, vanners only will be needed.

"With new tailings flowing from the batteries, all the expense connected with water-supply and putting the tailings in motion will be saved, so that very poor material may be treated if it be taken direct from the mill, moving in the mill-water. This point is of great importance, for there is a great deal of sand coming from our mills that is so poor that if it ever comes to rest it can never be profitably moved again; yet, if taken while in motion, it would pay to pass through classifiers and over vanners.

"The classifiers and vanners are only a small portion of the plant belonging to Mr Lührig's system, but they are the portion which are of most importance to the Victorian gold-miner. I append a full description of the plant for ore-dressing on the Lührig system erected by him for the Saxon Government, at Himmelfahrt, near Freiberg. This description was translated for me by Mr. Arthur G. Holroyd, from an official report made to the Government by Mr O. Billhartz, the director of the works. From this description it will be seen that the main point of Lührig's system is the gradual reduction of ore, never unnecessarily crushing a grain that does not require it, or filling up stone-breakers, rolls, or stamper-boxes with material that does not need to be crushed. By this system, as soon as the grains of ore are sufficiently reduced and sized they are classified, and sent at once automatically to the appropriate machines for separating ore from gangue. This system of gradual reduction very materially increases the capacity of the plant; and, what is equally important, it prevents the production of fine ore slimes, which are the real cause of failure of other systems.

"Besides the Victorian tailings I had certain other Australian ores with which to experiment; one was a hard quartz and felsite, impregnated with very fine grain galena and pyrites, from the White Rock Mine, New South Wales. The quantity of ore at my disposal was such that I could pass it through the whole of the Scharfenberg ore-dressing plant from the stone-breakers to the vanners; and without difficulty practically saved the whole of the ore contained in the stone, and I am satisfied that no other system could have produced any such result.

"I had also an opportunity of testing the Lührig system for separation as well as concentration with the Broken Hill mixed sulphides, an ore containing an intimate mixture of zinc-blende and galena, with about 10 per cent. of quartz, and found there was no difficulty in separating any minerals which could be divided from each other by crushing, and which had any margin of difference in specific gravity.

"I may here mention that unfortunately there has been a good deal of unnecessary ill-feeling and jealousy, in part caused by my advocating the 'Lührig system.' Rival ore-dressers, machinery manufacturers, and their agents, have had some slight ground to go on, owing to the careless

use of the expression 'Lührig process' instead of 'Lührig system.' As a matter of fact, Lührig has no 'process,' in the ordinary acceptation of the term; what he claims is to devise a system for the concentration or separation of any ore or ores the component parts of which may be separated from each other by crushing, and which parts have a difference of specific gravity.

"No two of his plants are necessarily alike; each is specially designed for the ore it has to treat. The stone-breakers, trommels, rolls, stamps, classifiers and jigs, are more or less like those in use by others. For his vanners he has patents; but the main point is that he studies the ores and arranges his machinery so as to obtain the best returns. His success in Europe is such that no other ore-dresser is able to compete with him, and many of the most noted ore-dressing plants have been or are being replaced by plants designed and erected by Lührig.

"An important feature in connection with this system is the quantity of water, and success cannot be obtained if the supply is insufficient; this must be remembered by all those who intend treating tailings which are now at rest. At Scharfenberg, where our ores were treated, there was an unlimited supply of water, and no means of conservation were necessary; but at Himmelfahrt, where the works are situated on a hill, all the water from the washer passes back to the dam and is used over and over again, except that which is lost by evaporation and that retained by the moist ore and tailings. There is a limit to the re-use of the water, as, through the decomposition of the pyrites and other sulphides, in time it becomes so charged with sulphuric acid and saline matter that it corrodes and damages the machinery. When this occurs it has to be run off and a fresh supply obtained.

"I am specially advocating the introduction of the classifiers and vanners for the treatment of our tailings and auriferous ores; but in this work it must always be remembered that the vanner is a machine very easily overloaded—the less ore it has to treat the better it does its work; and if all the ore has to be reduced to such a size that it will pass through the classifiers to the vanners, the extent of the plant will be proportionately increased. At best a single vanner can only put through a few tons a day. Its capacity is very limited; so that, when there is ore in the stone which may be sent to jigs, great care should be taken not to reduce it any finer than is absolutely necessary, and in this way to relieve the vanners of unnecessary work.

"The number of rival classifying, concentrating, and ore-separating appliances is legion, and many are, no doubt, excellent machines, which under proper conditions would produce good results; but as a rule they receive unfair treatment. When the inventor exhibits his machine at work, as a rule he prepares or makes up material to suit, in a way which cannot be carried out in practice. On the other hand, I have no doubt that numerous machines, now giving unsatisfactory results in practice, would be satisfactory if the crushed materials were classified first as it is in Germany, and the machines were fed with as even grade of ore as possible, and not overloaded with a mixture of fine slime and sand grains. If, for instance, those who are working Frue-vanners would only adopt classification, they would obtain infinitely better results, and would save a great deal of the rich finely-ground pyrites and a large proportion of fine free gold which now escapes.

"As long ago as 1867, the adoption of classifers, so as to admit of concentration, was strongly urged by my former colleague, Professor G. H. Ulrich, of Dunedin. Since then some forms have been adopted at South Australian copper mines by Mr. Hancock; at the tin mines, Mount Bischoff, Tasmania; at Herberton, Queensland; and at the Sylvia gold- and silver-mine, New Zealand; and there cannot be any doubt that without classification the ores of these mines could not be profitably treated; but I do not know of a single Victorian plant in which the system is at work, though I know of many people who complain of the bad work done by their concentrating machinery. There are various kinds of types or classifiers, but the German Spitzkasten or Spitzlütten seems the most simple. Good models of these appliances have been in the Technological Museum for many years, and a full description of modern types may be found in Lock's work on mining and ore-dressing. They are both pyramidal boxes. The number necessary, their relative size, and the inclination of their sides, must necessarily vary with the ore. Most authorities give the angle of the inverted pyramid as 50deg.; but Mr. Lührig, who prefers the old Spitzkasten, and considers it better than any of the modern varieties, told me that 70deg. was better; but he admits that none of the classifiers are altogether satisfactory, and, until they are made so, concentration can never be made perfect.

"In the treatment of our auriferous tailings we have two classes to deal with: Firstly, those which contain free gold only, such as the Madame Berry tailings, which were sent Home for treatment. The concentrates from this class would pass directly into amalgamators, which would at once collect the gold: secondly, the concentrates from the quartz-reef tailings, which will all, more or less, contain auriferous pyrites and refractory ore, must be dealt with by special processes. The competition for these concentrates is such locally and in Europe that the producer need have no anxiety as to obtaining full money value. They are quite as marketable as wool, wheat, or bullion.

"The details of the methods of gold extraction used at the chief works on the Continent are treated as secrets, and are not divulged to any visitor, or even to the students of the mining schools. In the methods used in the mine works I could not hear of any special novelty, and for the extraction of free gold by amalgamation I do not think there are any appliances better than those in use in Australia.

"Electro-metallurgy is making very rapid strides; and it seems almost certain that complex ores, such as those occurring at Bethanga, will be treated direct as raw ore for the gold, silver, and copper contents. The decomposition of common salt by electricity for the production of soda and cheap chlorine is occupying the attention of many leading electrical engineers and manufacturers, both on the Continent and Great Britain."

Mr. Newbury supplements his report with a memorandum in reference to some experiments with the Lührig vanner on the tailings samples recently collected by the Mining Department at Stawell, from the Magdala-cum-Moonlight tailings-heap. He says, referring to these tailings, that, upon assay, they gave the following results:—

	Dwt.	gr.	
"No. 161	1	15	per ton.
" 162	2	3	"
" 163	1	7	"
" 164	2	14	"
" 167	2	3	"
" 168	2	9	"
" 169	2	19	"
" 170	1	15	"
" 171	2	19	"

This represents an average of 2dwt. 3gr. per ton, which is equal to 10oz. 12dwt. 12gr. in 100 tons. It is estimated that there are in the mixed tailings 2 to 2½ per cent. of pyrites, assaying 4oz. 14dwt. 11gr., which can be extracted by classification and vanning. Mr. Newbury adds: "A plant capable of treating 100 tons per day would therefore give at least two tons of concentrates, containing 9oz. 8dwt. 22gr. of gold. The cost of obtaining these was given by Dr. Buss at 1s. 6d. per ton of raw sand, or £7 10s. per 100 tons. The cost of extracting the gold from the concentrates at any of our pyrites works is £3 per ton, plus cartage, and the percentage recovered is about 95. To the cost of concentration must be added water-supply, conveyance of tailings to the works, screening, breaking up lumps, &c. These items will vary for each locality, and will not exist when the tailings flow from a battery chute. To show that tailings containing as low as 2 per cent. of concentrates, and having an original assay of only 2dwt. 3gr. per ton of sand, can be profitably treated, the following figures are given:—

	£	s.	d.	£	s.	d.
"Gold in concentration (9oz. 9dwt., at £4)		...		37	16	0
Cost of concentration	7	10	0			
Cost of chlorination	6	0	0			
5 per cent. loss in extraction	1	17	0			
				15	7	0
				£22	9	0

The cost of a plant to treat 100 tons per day, with necessary buildings and erection, would be about £5,000; and if the above estimates are correct, the yearly profit, taking 300 working days, would be £6,735."

Mr. Lührig's Tests.

The report on the tests made with Australian tailings by Mr. C. Lührig, in the presence of Mr. Newbery, is too lengthy to reprint here *in extenso*. To summarise the statement of some of the results from the various samples of tailings. First, with regard to the Bendigo tailings: "The raw ore (old stamp sand from the dumps) contained 3dwt. 5gr. = 5 grammes gold, and 3dwt. 21gr. = 6 grammes silver, per ton of raw ore. The following concentrates were obtained from these tailings: First product, containing 5oz. 1dwt. 22gr. = 158·5 grammes gold, and 4oz. 16dwt. 11gr. = 150 grammes silver, per ton of concentrates. Second or intermediate product, containing 1dwt. 15gr. = 2·5 grammes gold, and 2dwt. 14gr. = 4 grammes silver, per ton of concentrates. Only traces of gold were found in the tailings." The tests showed that each ton of tailings, containing by assay 3dwt. 5gr. = 5 grammes gold, and 3dwt. 21gr. = 6 grammes silver, yielded 87·24 per cent. of gold and 73·16 per cent. of silver. "In order to be on the safe side," says the report, "we will presume that only 85 per cent. gold and 70 per cent. silver will be won, and that the raw ore (tailings) will contain only 3dwt. 5gr. gold and 3dwt. 21gr. silver per ton. One ton of tailings will yield:—

$$\frac{85}{100} \times \text{3dwt. 5gr. gold} = 65\tfrac{1}{2}\text{gr. gold.}$$

$$\frac{70}{100} \times \text{3dwt. 21gr. silver} = \text{65gr. silver.}$$

The value of the metal is (taking 1oz. gold at £3 17s. and 1oz. silver at 3s. 11d.) the following:—

$65\frac{1}{2}$gr. gold × $1\frac{1}{480}$d. = £0 10 $5\frac{1}{8}$
65gr. silver × $0\frac{3}{32}$d. = £0 0 $6\frac{3}{32}$
£0 10 $11\frac{7}{32}$

In the case of a plant treating 500 tons daily, the profit would be				£	s.	d.
500 × 10s. $11\frac{7}{32}$d.				273	7	$5\frac{3}{8}$
From this £273 7s. $5\frac{3}{8}$d. must be deducted:—						
(1.) Washing expenses, including repairs, steam, labour, &c., per ton, 1s. 6d.—500 × 1s. 6d.	£37	10	0			
(2.) Transport expenses, 6d. per ton, 500 × 6d.	12	10	0			
				50	0	0
Daily profit				223	7	$5\frac{3}{8}$
Annual profit (300 days)				£67,005	9	$4\frac{1}{2}$

"In order to be on the safe side, we will presume that about 3 per cent. highly-enriched concentrates will be obtained. Provided the above-named quantity be passed through the plant daily, the out-turn would be 15 × 300 = 4,500 tons concentrates. The cost of chlorinating, &c., per ton (the expenses of extracting the gold from the concentrates) amounts in Victoria to £3. The total expenses in connection with the extraction of the gold from the concentrates would therefore be

3 × 4,500 = £13,500. The total net profit would accordingly amount to £53,505, or 7s. 1⅞d. net profit per ton of tailings.

"According to the annual report of the Secretary for Mines for the year 1890, the principal mines in the Sandhurst District—namely, those at Bendigo and Eaglehawk, produced during that year 140,486 tons and 133,338 tons respectively, or a total of 273,824 tons of tailings. According to these figures, about 900 tons of sand are taken daily from the stamps.

"As there are, moreover, about 5,000,000 tons of old tailings lying in heaps, the total profit to be earned by the treatment of the above-mentioned quantities would be as follows:—

(1.) From the 5,000,000 tons of old tailings—5,000,000 × 7s. 1⅞d. ...	£1,790,000
(2.) The annual profit from tailings daily being taken away from the stamps—273,000 × 7s. 1⅞d.	97,000

"Next, with regard to the St. Arnaud's tailings, the raw ore in this case (old sand from the dumps) contained 3dwt. 21gr. = 6 grammes gold, and 5dwt. 19gr. = 9 grammes silver, per ton of raw ore. From this raw ore were obtained, according to the Freiberg analysis, a first product, containing 25oz. 4dwt. 17gr. = 785 grammes gold, and 28oz. 18dwt. 15gr. = 900 grammes silver, per ton of cencentrates; and a middle product, containing 9dwt. 12gr. = 14·8 grammes gold, and 2oz. 5dwt. = 70 grammes silver, per ton of concentrates. Only traces of gold and silver were found in the tailings. From 2,240lb. of raw ore, containing 3dwt. 21gr. = 6 grammes gold and 5dwt. 19gr. = 9 grammes silver, the yield was 88·15 per cent. of gold and 82·01 per cent. of silver. "Presuming also in this instance," the report states, "for safety's sake, that only 85 per cent. of gold and 70 per cent. of silver will be recovered, the calculations made on the basis of the tailings, provided the ton of tailings contains 3dwt. 21gr. gold and 5dwt. 19gr. silver, show that that would be 79 1·20gr. gold and 97 3-10gr. silver obtained.

"In the case of a plant treating 500 tons daily, the daily profit would be

500 × 13s. 5$\frac{3}{10}$d., equal to	£336
From which must be deducted washing expenses and transport expenses —2s. per ton × 500	50
Daily profit	£286
Yearly profit (300 days)	£85,800

"For chlorination expenses, if one should obtain about 3 per cent. concentrates from the tailings, £3 × 4,500 = £13,500 must be deducted; so that the total net profit amounts to £72,300—that is, the net profit per ton of tailings is, in this case, 9s. 7⅞d."

According to the report already named, 1,000,000 tons of these tailings are lying in heaps; the total profit, therefore, which can be made out of these tailings is 9s. 7⅞d. × 1,000,000 = £482,000. It is quite evident that, should the percentage of gold in the tailings be higher, the profit to be made will increase in a greater proportion than the percentage of gold, as the cost of washing and chlorination remains the same whether the tailings be poor or rich.

GRINDING-PAN FOR ORE.

Albert J. Taylor, of Silver City, Lyon County, Nevada, has obtained a patent for a grinding-pan for ores which has some new features in the arrangement of the grinding-rollers. A ring-die extends around the inner periphery of the inclined sides of the pan, and against these and upon the bottom dies the crushing and grinding takes place. Heretofore, it has been customary to employ a series of rollers set within the pan so that their peripheries roll against the side-die; but the irregularity of the pressure, and the amount of material which comes between the dies and rollers is such that after a short use the die will be worn into wavy surfaces, the irregularity of which is such that, if the pan is run at any reasonable degree of speed, it will throw the rollers entirely out of place; the pans thus become practically useless so soon that this style has become altogether abandoned.

In this invention Mr. Taylor employs one or more horizontal rollers lying on the side of the bottom-die and having their ends adapted to travel against the side-die. These rollers are placed at intervals between the vertical rollers or bowls which stand with the ends upon the bottom-die, and the sides rolling against the side-die. The horizontal rollers placed in this manner cause a rubbing friction between their ends and the side-die, and thus keep it worn smooth and level. Efficient grinding takes place between the ends of these rollers and the side-die, while the vertical rollers or bowls grind upon the bottom-die. By thus preventing the circular side-die from becoming irregular, the grinding is carried on as perfectly at all times, Mr. Taylor says, as when the die is new, and the dies may be entirely worn out without ever becoming irregular. In order to preserve the muller shoes and keep them perfectly in place, the shoes are made in long sections, with two or more fastening-lugs to each section. These sections are slotted, to form channels through which the pulp works to the outside of the pan. Mr. Taylor is confident that this construction is better than making the shoes in short independent sections, with a single fastening-lug, which does not hold them sufficiently well in place.—*Mining and Scientific Press.*

COMPLETE SPECIFICATIONS OF RECENT INVENTIONS IN MINING MACHINERY.

As any improvement in appliances for extracting gold from its ore is of considerable interest to those engaged in mining, it may not be out of place to quote the specifications of recent inventions patented in this colony. Of course, in order that a patent right be good, there must be something original about the machine or appliance, as the case may be; and, although patent rights may be granted, if what is claimed by the patentees is not original the patent is valueless, and any one can adopt the same principle. The specifications following are therefore given for the information of those interested in gold-mining ventures:—

IMPROVEMENTS IN AMALGAMATING MACHINES HAVING ROTARY MULLERS AND STATIONARY PANS.

"We, Stephens Wills Vale, of Forest Lodge, near Sydney, in the Colony of New South Wales, Mining Engineer, and William Caird Halliday, of Erskine Street, Sydney, aforesaid, Mechanical Engineer, do hereby declare the nature of our invention for 'Improvements in amalgamating machines having rotary mullers and stationary pans,' and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

"This invention relates to certain improvements in amalgamating machines which have rotary mullers and stationary pans, and it has been specially devised in order to produce a comparatively cheaply constructed and economically operated amalgamating-pan, which will effectually treat all classes of discrete metalliferous material for the amalgamation of the precious metals therein.

"In an amalgamating machine, having rotary muller and stationary pan constructed according to this invention, the rotary muller, in the form of a horizontal annular disc, revolves between a stationary annular grinder and the bottom of the stationary containing-pan. The upper face of the muller contains radial rubbing ribs, preferably wood, and is in triturating contact with the under-face of the annular grinder. The central portion of the muller is elongated upwardly as a tube or cylinder or open trunk, or it is attached at the top, where it gathers into or has a hood and boss to a central vertical spindle, by which motion is communicated to it; and at the top of the trunk or through its hood are orifices or openings. The bottom of the muller carries agitators or scrapers almost in contact with the bottom of the pan. The central spindle passes through the bottom of the pan, and is revolved by appropriate gearing underneath, though it might be actuated by gearing above said pan. The stationary annular grinder is adjustably suspended from crossheads or frames over or on the top of the pan, is fixed or fastened to the pan, and has on its upper face revolving scrapers attached to and carried by the trunk of the muller. This grinder has an upwardly extending central trunk or cylindrical guard outside and around the trunk of the muller, so that an annular passage is formed from the top of the muller trunk to the intake to the triturating space between the muller and the grinder. The outer part of the bottom of the pan is formed into mercury-wells and amalgamating surfaces, and the inner part is almost in contact with the agitators or scrapers on the bottom of the muller, while the central part is also upwardly extended as a trunk or sleeve around the central spindle. In the trunk of the muller, carried by sleeves around the vertical spindle, is a revolving turbine or creeper or elevator, the motion of which is given by independent gearing underneath the pan to an inner sleeve or hollow spindle passing through the pan and its trunk, and joining at the top another sleeve (outside of said trunk). This turbine or elevator is preferably a spiral blade or blades affixed to the last mentioned sleeve, almost touching the bottom of the pan and extending upwardly. When the machine is in operation, this central creeper or elevator causes a constant flow of material in the form of pulp from the bottom of the pan over the mercury therein, through the muller trunk, out through the orifices in the cap or hood, down the annular passage between said trunk and the grinder trunk or guard, to the triturating surfaces, between which said material will pass to regain the bottom of the pan, to be again drawn upward by the action of said revolving creeper or elevator or turbine.

"But in order that this invention may be clearly understood, reference will now be made to the drawings herewith, in which Figure 1 is a central vertical section of an amalgamating machine constructed according to these present improvements; and Figure 2 is a plan, partly in sectional plan, of the same; Figure 3 is a partial plan in reverse on the planes X, Y, Z, in Figure 1.

"The stationary pan has a circular periphery A, an outer mercury-well A^1, deeper than the annular mercury space A^2, formed by stop or step to surface or bottom A^3 (preferably an amalgamating surface), from which rises the sleeve or trunk A^4, around the central vertical spindle B, and a sleeve or hollow spindle thereon, hereinafter described, and having a bearing, A^5, on said sleeve or spindle. This central spindle B is supported at the bottom on a centre-pin B^1, in step-bearing, B^2, and at the top has a bearing B^3, in a cross-head or frame A^7, reaching from the upper peripheral edges A, of the pan. At its lower end it has affixed to it a bevel-toothed wheel, B^4, in gear with a bevel-toothed pinion C, of a counter-shaft C^1. The pan is set upon and affixed to a suitable foundation (preferably in the form of a frame D), on a base-frame or sole D^1, which also carries the bearing C^2 and may be the outer bearing of the shaft C. The rotary muller has an annular plate or disc E, and a central through trunk E^1 to the top of which, connecting it to the spindle B, is a cap or hood E^2, having orifices or openings E^3. The disc E carries on its upper face sector-shaped hard-metal shoes, E^4, forming recesses at their junctions for radial wooden battens or slats E^5, and it carries on its under-face curved agitators or scrapers, E^6. The stationary grinder has an annular disc F, and a central trunk or cylinder F^1, forming the annular space or passage F^2. This grinder has also hard-metal shoes F^3, but these are on the bottom face, and instead of having radial sides they are curved, and do not quite join, so that the grooves or spaces F^4 are left in the grinding surfaces, curving from the inner to the outer periphery thereof. This grinder is supported by hangers or rods F^5, from crosshead or frame A^7, and these rods have screwed ends, so that by turning hand-wheels F^6, the weight of the grinder may be lifted from the muller so as to obtain an easy start for the machine.

"This grinder is held to the stationary pan by means of snugs F^7, on guide-cleats F^8, on side A of the pan. On the top of the grinders are scrapers F^9, connected by arms F^{10}, to the hood or cap E^2, of the muller trunk E^1. In the trunk E^1, is a turbine or creeper or elevator formed of a spiral blade G, attached to pipe or sleeve G^1, which is joined by means of a collar and bearing G^2, to another sleeve or hollow spindle G^4, which passes inside of the sleeve or trunk A^4, to a footstep-bearing G^5, on the back of toothed-wheel B^4, and carries upon itself a collar G^6, by which it is prevented from lifting, and a bevelled-toothed wheel G^7, in gear with bevel-tooth wheel H on counter-shaft H^1, in bearings H^2, on frame D, and carrying fast and loose pulleys H^3. In order that the bearings G^2 and A^5 may be easily lubricated they have a race or well on their upper edges, and leading from thence the ports A^6 and G^3 as shown.

The counter-shafts C^1 and H^1 are revolved by any well-known or appropriate mechanism, say, by means of endless belts from a motive-power machine over fast and loose pulleys, and the material to be amalgamated is treated preferably in charges, although it might be treated in continuous supply and discharge, being supplied with water to the pan as a fine pulp, up to, say, the level marked *AA*. The bottom of the pan is supplied with mercury to, say, just above the level of the well A^2, so as to have an unbroken surface of mercury to the stop or step of inner surface A^3. Now, in operation, there is a continuous supply of the material to between the triturating surfaces of the shoes F^8 of the stationary grinder *F*, and the shoes E^4, of the revolving muller *E*, where it is finely ground, and thence finds its way by centrifugal action and gravity to the bottom of the pan, where it comes in contact with the mercury in wells A^1 and A^2, and while passing over said mercury and the surface A^3 is agitated and rolled into the mercury by agitators or scrapers E^6. All this time the spiral *G* causes a turbine action or elevates pulp by drawing it over the mercury (the step or stop formed by surface A^3 preventing said mercury moving towards the centre), and discharges it through orifices E^3 into space or passage F^2, whence it finds its way between the triturating surfaces E^4 and F^3. At the same time the scrapers F^9 agitate the pulp above the grinder *F*, and insure that the centrifugal action will cause the material to seek the bottom of the pan; there is, by this means, a constant and positive flow of material or pulp from the amalgamating material or mercury to the triturating surfaces, and back to the amalgamating surface or mercury, and, while this latter retains the heavier and valuable particles, the others are being almost continually under the grinding operation, while no grinding at all of the mercury takes place. When the charge is sufficiently treated, the pulpy tailings are run out of the pan to waste, or otherwise, through door, or through openings A^8 in its side, and when the amalgam is sufficiently rich, it is drawn off through plug-hole A^9. A false bottom, A^{10}, is attached to the pan bottom, so as to form a space to which steam might be introduced for the purpose of heating the pulp.

"In addition to the mercury-wells, there might be an amalgamating surface at the bottom of the pan, and further amalgamating surface, if it be desired, may be used by utilising the outer surface of the trunk G^1 and E^1, and the inner and outer surfaces of the trunk F^1, and the inner surface of the pan *A*, or any one of such surfaces.

"To preserve the mercury active in its amalgamating influence, it may be electrolysed in any well-known manner. In the machine hereinbefore described, a porous vessel containing an electrolyte, such as a sulphate of soda, would be placed in the pan with the anode immersed therein, while the mercury itself would act as the cathode. On the decomposition of the electrolyte, hydrogen being liberated on the surface of the mercury would preserve it as desired.

"Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

"1. In an amalgamating machine of the class set forth, the combination and arrangement with a pan having mercury-wells and amalgamating surfaces, and means for triturating the material under treatment, of a turbine or creeper or elevator adapted to cause a constant and positive flow or movement of the material from said amalgamating surfaces and mercury to between the triturating surfaces and back to the amalgamating surface, and so on, substantially as herein described and explained.

"2. In amalgamating machines of the class set forth, the combination and arrangement with a pan having mercury-wells in its bottom, of a muller having a central trunk, and a grinder also having a central trunk, and means for raising the material from the pan-bottom through said trunk, and discharging it so as to lead to and between said muller and grinder, substantially as herein described and explained.

"3. In amalgamating machines of the class set forth, the combination and arrangement with a pan such as *A*, having bottom with wells such as A^1 and A^2, and surface such as A^3, and a stationary grinder therein, of a revolving muller such as *E*, having a central trunk such as E^1, with orifices such as E^3, and connection such as E^2 to a vertical spindle such as *B*, and means adapted to elevate or move the material under treatment through said trunk such as E^1, and said orifices such as E^3, substantially as herein described and explained and illustrated in the drawings.

"4. In amalgamating machines of the class set forth, the combination and arrangement with a pan such as *A*, having bottom with amalgamating-wells and surface and with a revolving muller such as *E*, of a stationary grinder such as *F*, having a trunk or cylindrical guard such as F^1, to form annular space or passage such as F^2, substantially as herein described and explained and as illustrated in the drawings.

"5. In amalgamating machines of the class set forth, the combination and arrangement with a pan such as *A*, and a revolving muller such as *E*, with trunk such as E^1, and a stationary grinder such as *F*, with a trunk or guard such as F^1, of a vertical spindle such as *B*, with actuating mechanism and hollow spindle or sleeve such as G^4 (also with actuating mechanism), bearing and collar such as G^2, sleeve such as G^1, and on or driven by said spindle such as G^1, a turbine or fan or spiral adapted to cause an upward current in first herein referred to trunk such as E^1, substantially as herein described and explained and as illustrated in the drawings.

"6. In amalgamating machines of the class set forth, the combination and arrangement with the revolving muller and its central trunk and hood, and with the stationary grinder of scrapers such as F^9, having supports or drivers such as F^{10}, substantially as herein described and explained and as illustrated in the drawings.

"7. In amalgamating machines of the class set forth, the combination and arrangement with the pan having mercury-wells such as A^1 and A^2, and surface such as A^3, and with the revolving muller and its central trunk of agitators or scrapers such as E^6, on said muller bottom, substantially as herein described and explained and as illustrated in the drawings.

"8. In amalgamating machines of the class set forth, the combination and arrangement with vertical spindle such as *B* and driving toothed-wheel such as B^4, of hollow shaft such as G^4, having

bearings on said wheel as G^5, and on said spindle as G^2, substantially as herein described and explained and as illustrated in the drawings.

"9. In amalgamating machines of the class set forth, the combination and arrangement with the pan, the revolving muller, and the stationary grinder of a revolving spiral or helical blade such as G, in a trunk such as E^1, and having communication with pan bottom and by orifices such as E^3, and space or passage such as F^2 to the intake of the triturating surface, substantially as herein described and explained and as illustrated in the drawings.

"10. The particular combination and arrangement of mechanical parts, altogether forming an improved amalgamating machine, with rotary muller and stationary pan, substantially as herein described and explained and illustrated in the drawings.

"Dated this 5th day of December, 1892.

"HENRY HUGHES, Agent for the Applicant."

IMPROVEMENT IN AMALGAMATORS.

"I, Nathan Leroy Raber, of Corvallis, Benton County, Oregon, United States of America miner, do hereby declare the nature of my invention for improvement in amalgamators, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

"This invention is an improvement in amalgamators, and particularly in that class of such machines employing mercury, and the invention seeks among other improvements to provide simple means whereby the sand, pulp, &c., are properly directed to the mercury; also means for keeping the mercury constantly sensitive, pure, and active, and devices by which the adjustment of the main frame or box and the mercury-cup may be independently effected, so that either the main frame or the mercury-cups may be adjusted to different angles to the horizontal without necessitating a corresponding change in the other part.

"The invention consists in the novel constructions and combinations of parts hereinafter described and pointed out in the claims.

"In the drawings, Figure 1 is a vertical longitudinal section of my improved amalgamator, and Figure 2 is the top plan view thereof.

"In the construction shown I employ a main frame or box A, which is in the nature of a shallow box having vertical sides *1* and stepped bottom B, such bottom consisting of a series of steps, formed with what may for convenience of reference be termed the risers *2*, and treads *3*. These risers and treads and the sides *1* are properly joined, usually by rabbeting as shown, and are firmly nailed and clamped together.

"At its upper end the main frame or box is closed by a cross-board C, while its lower end is open, so that the tailings, pulp, &c., may freely discharge.

"The sides *1* are braced by tie-beams or bars M, extended between their upper edges, and firmly secured to both sides. I prefer to use one of these tie-bars M above each step, below the first or upper one, as clearly shown in Figure 1.

"These tie-bars not only brace the sides of the main frame, but they also serve as supports for the holders of the mercury-renewing materials, as presently fully described.

"At its four corners the main frame is provided with adjusting screws, or bolts, turned through threaded bearings at N, and against base supports or seats N^1, which may be on sills, as shown. By this means the frame or box may be adjusted to any desired inclination, both longitudinally and laterally, and so be set to suit the quality or quantity of the material being treated. Upon each step is placed a plate, D, of silver-plated copper, held at its upper edge and sides by cleats, E, and projecting at its lower edge beyond its supporting step, so that each plate overlaps at its lower edge the upper edge of the plate on the next lower step. Beneath the lower projecting edge of the plates D are arranged the mercury-cups or troughs F, which rest upon the steps, or may be otherwise supported as desired. These cups are supported so that they may be adjusted independently of the adjustments of the main frame, such independence of adjustment co-acting in permitting the angle of the main frame to be varied, to regulate the speed with which the material may pass through the apparatus, and, at the same time, enabling the angle of the mercury-cup to be retained or varied as may be desired. In the construction shown, the troughs are carried upon suitable brackets or supports, G, at each end, which are provided with adjusting screws, g g, bearing upon iron plates or carriers, H, rested upon the steps. These screws permit the adjustment of the cups as may be desired.

"These cups or troughs are formed of copper, silver-plated, and are of the cross-section shown in Fig. 1, the bottom being concave, to insure stiffness, and their rear edges preferably turned down and flared, to insure the free and easy delivery of the sand, pulp, &c. In operation, it will be understood the cup overflows on to the step, and the overflow passes thence down the plate into the cup of the next lower step, being discharged directly into such cup.

"At one end of each trough, and near its bottom, I provide a small copper silver-plated delivery tube, I, which leaves the cup beneath the level of the mercury, and then turns upwards and outwards, and empties into an overflow trough i, which extends beyond the frame, and may discharge into any suitable vessel. The purpose of this construction is to regulate the level of the mercury in the cup, and maintain it at a permanent uniform level, and automatically discharge the surplus mercury into a suitable receptacle. At the same time, this construction also permits the level of the mercury to be varied; as by bending the discharge end of the tube I, up or down, the level of the mercury may be raised or lowered. This construction for automatically drawing off the surplus mercury is especially desirable in connection with my devices for preserving the activity of the mercury in the cup, which include feeders for supplying constantly any of the well-known suitable chemicals used to cleanse and quicken the mercury. Sodium amalgam may be the preferred chemical, and it may be of any strength the work required renders necessary. The feeders shown

include cups, J' J' J', usually three for each trough, supported upon the tie-beams, M, and provided with discharge-pipes, K, which deliver the chemicals continually in small quantities to the middle of the mercury-cups. This construction enables me to secure a constant and automatic cleansing and quickening of the mercury in the amalgamating troughs.

"Immediately above the cups F, and in the rear of the discharge edges of the plates D, are arranged the copper-plates P P against which the material discharged from plates D strikes, and by which it is directed downward into the mercury. These plates P are supported, so that they may be adjusted to present a different angle to the material discharged against them, being to such end secured to a bar p, which is held in position by set-screws R, which serve to hold the gates firmly in any desired position.

"The purpose of this gate is to insure the delivery of the sand-pulp, &c., directly to the centre of the trough; and its adjustability enables this result to be accomplished, no matter what may be the angle of the main frame, or box, or the quantity or condition of the material being treated.

"In practice, the water, sand, pulp, &c., is fed in at the desired pitch to secure a suitable flow from any ordinary sluice-box, and falls from the upper step into the first amalgamating cup or trough, being directed thereto by the gate.

"By my improved apparatus, I am able to cause the water, pulp, &c., to strike the mercury with a certain force sufficient to give the desired contact. I also insure that the mercury itself shall be constantly kept clean and sensitive, to render certain the amalgamation of the precious metal as soon as it strikes it. It is important to regulate the fall of the material from the plates D to the surface of the mercury-cups, inasmuch as it is by such careful regulation of the fall the necessary contact is secured. This fall should be variable between 1in. and 5in., and this variation is secured as follows: by varying the angle of the main frame or box, by altering the level of mercury in the cups, by raising or lowering the ends of the outflow tubes, and by raising and lowering the amalgamating cups or troughs, and by the combined action of the several adjustments, as will be understood.

"Having now particularly described and ascertained the nature of my invention, and in what manner the same is to be performed, I declare that what I claim is:—

"1. In an amalgamator, a main frame or box having a series of steps, and provided upon the same with plates, said plates being arranged to overlap at their lower edges the next lower steps, substantially as set forth.

"2. In an amalgamator, a main frame or box having a series of steps, and provided with mercury-cups, supported independently upon said steps, and with devices by which to direct the material from each step into the mercury-cup of the next lower step, substantially as set forth.

"3. In an amalgamator, the combination of the main frame or box, devices by which the angle of such frame or box may be adjusted, the independent mercury-cups supported upon the main frame or box, and devices whereby to adjust the angle of said cups whereby the level or angle of said cups may be preserved or varied, irrespective of the angle of the main frame or box, substantially as set forth.

"4. In an amalgamator, the combination of the main frame or box having the stepped bottom, the plates secured upon said steps and extended at their lower edges to overlap the next lower step, and the mercury-cups arranged below the said extended overlapping portions of the said plate to receive the materials discharged therefrom, substantially as set forth.

"5. The combination in an amalgamator of the step-like frame, and the registering bolts arranged at the corners of said frame, and turning in threaded bearings therein, and projecting below the frame or box, whereby to serve as feet for the frame, and as means for adjusting the angle thereof, substantially as set forth.

"6. An amalgamator, comprising a series of inclined steps, a series of mercury-cups arranged to overflow on to said steps, and devices for discharging the material from each step directly into the mercury-cup of the next lower step, substantially as set forth.

"7. An amalgamator, comprising a stepped main frame or box, devices for adjusting the angle of the said box, plates secured upon and projecting below said steps to overlap the next lower step, mercury-cups supported upon said steps in position to receive the material discharged from the lower extended edge of the projecting plates, and adjustable supports for said mercury-cups whereby the angle thereof may be varied or retained irrespective of the angle of the main frame, substantially as set forth.

"8. In an amalgamator, a mercury-cup or holder provided with a level controlling-tube opening at one end into the said holder, below the normal level of mercury, substantially as set forth.

"9. In an amalgamator, the combination with the mercury-cup or holder of a level-controlling tube, opening at one end into the cup below the normal mercury level, and adjustable, whereby it may control the level in the cup, substantially as set forth.

"10. In an amalgamator, substantially as described, the combination with the main frame or box of the mercury-cup and the adjustable support for said cup, substantially as set forth.

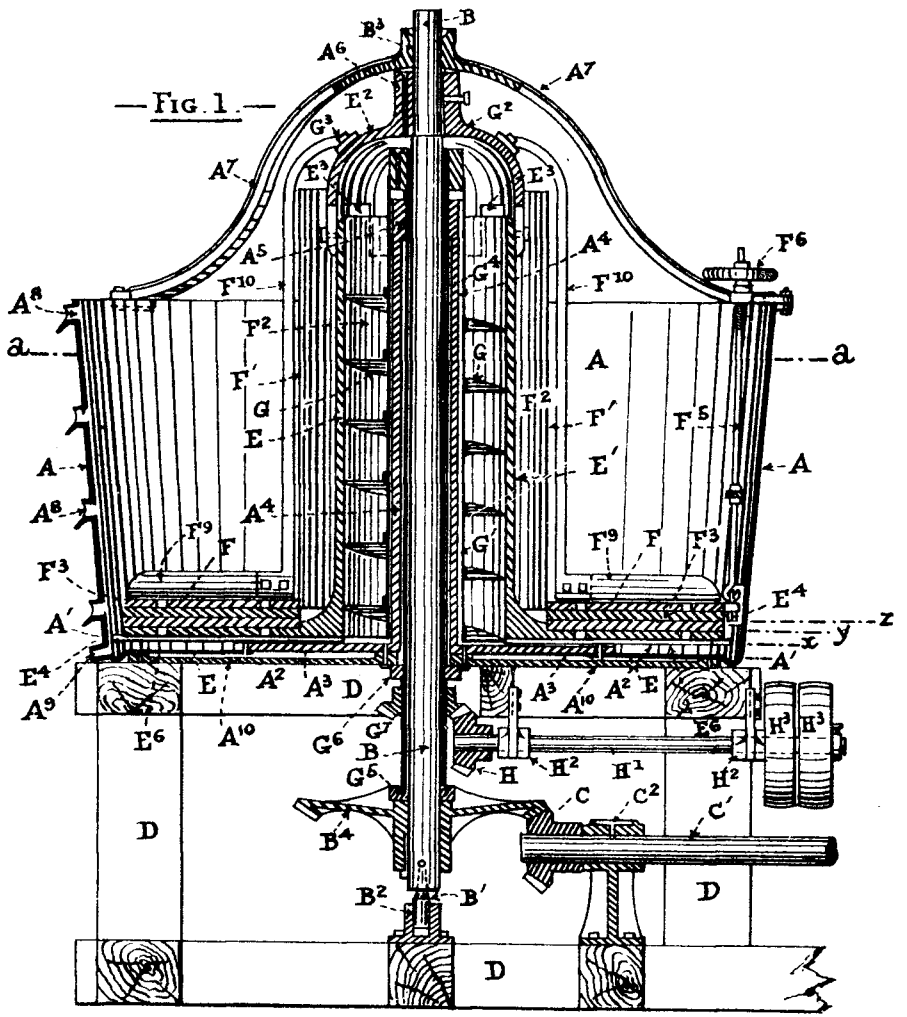
"11. In an amalgamator, substantially as described, the combination with the mercury-cup or holder of a feeder for automatically supplying chemicals to the said cup, and a level-controlling tube opening into the said cup, by which to maintain the level of mercury therein, substantially as set forth.

"12. The combination with a mercury-cup, having an off-flow whereby to limit the rise of mercury within it, of a chemical feeder adapted to discharge a continuous supply of chemicals into said mercury-cup or holder, substantially as set forth.

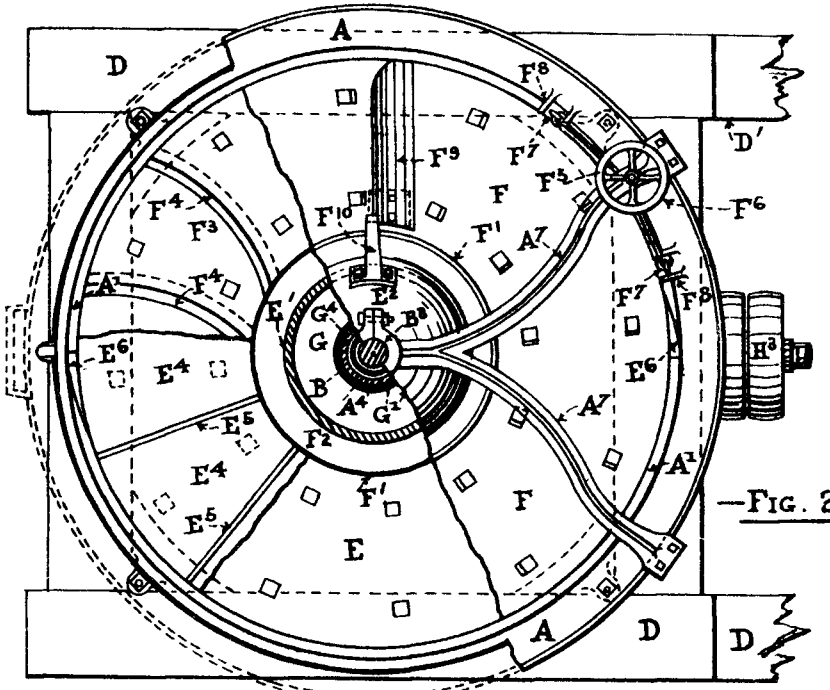
"13. In an amalgamator, the combination with a mercury-cup, and devices for discharging the material to be treated to said cup, of a gate arranged above the mercury-cup, and adapted to receive the supply of material and to direct it to the said cup, the said gate being adjustable, whereby it may be set to properly direct the material under different circumstances, substantially as set forth.

VALE & HALLIDAY'S IMPROVED AMALGAMATOR.

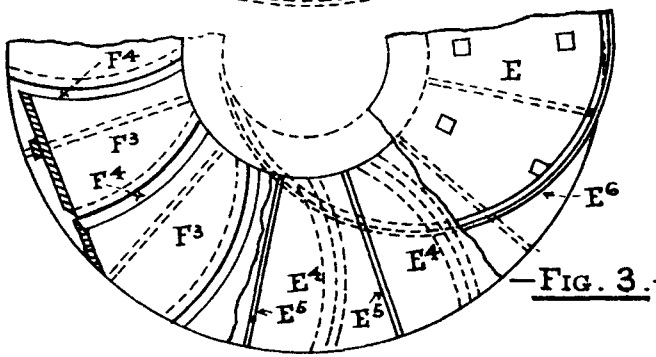
—Fig. 1.—



C.H.P. del.



—Fig. 2.—



—Fig. 3.—

RABER'S IMPROVED AMALGAMATOR

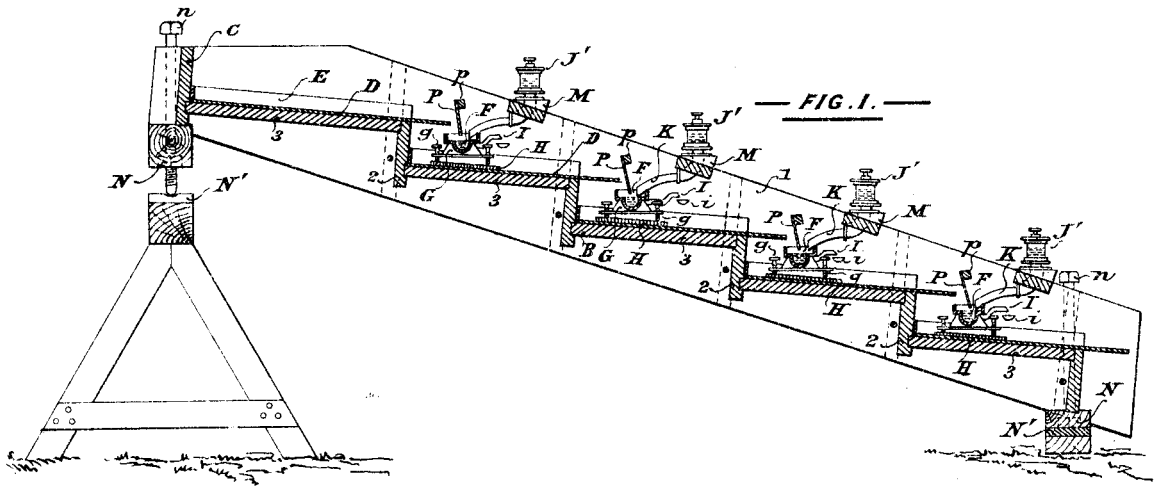
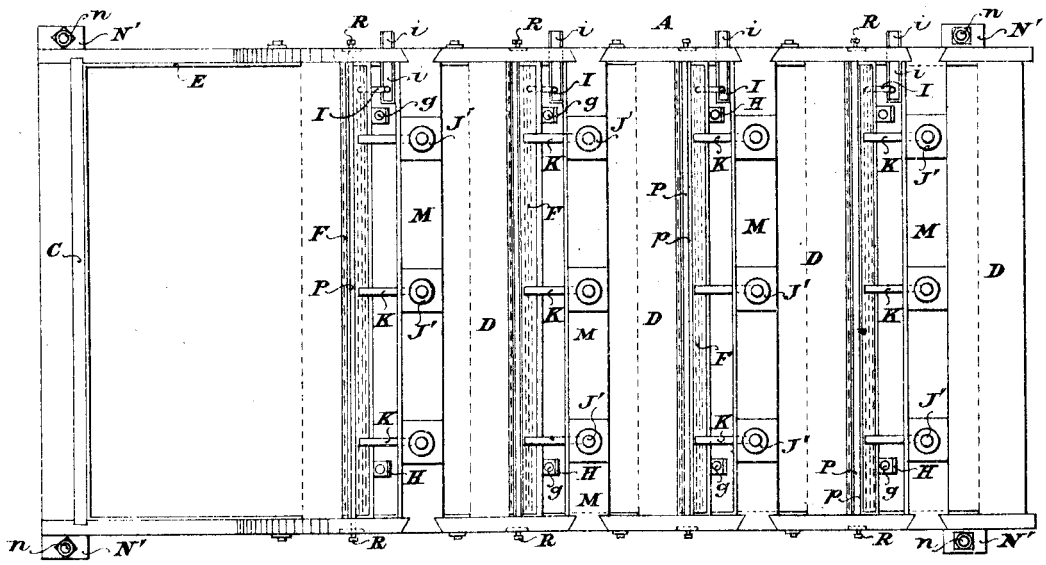


FIG. 1.

FIG. 2.



—— THE J.C.FRASER PATENT GRINDING & AMALGAMATING PAN.——

Fig. I

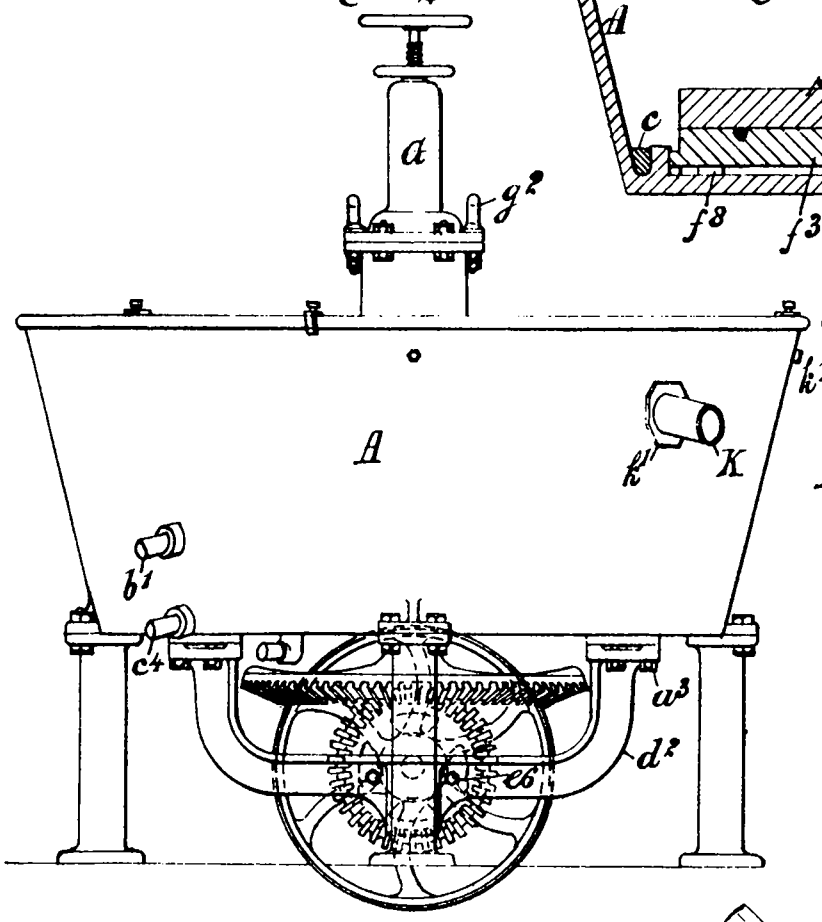


Fig. XI

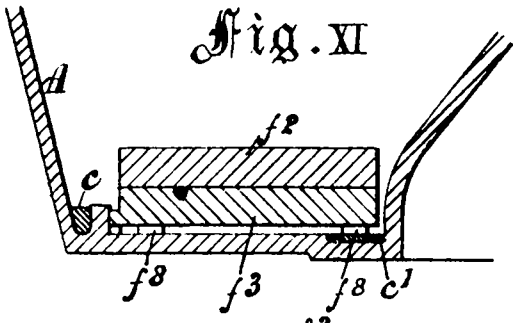


Fig III

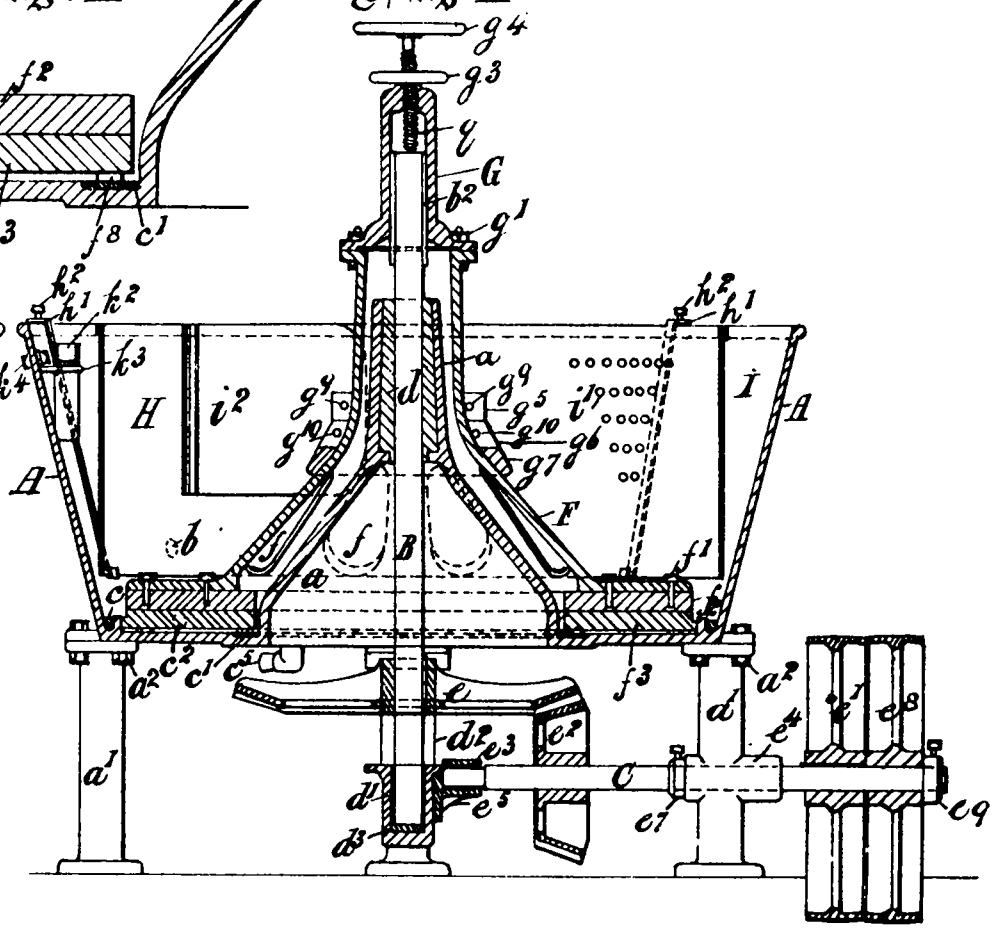


Fig. II

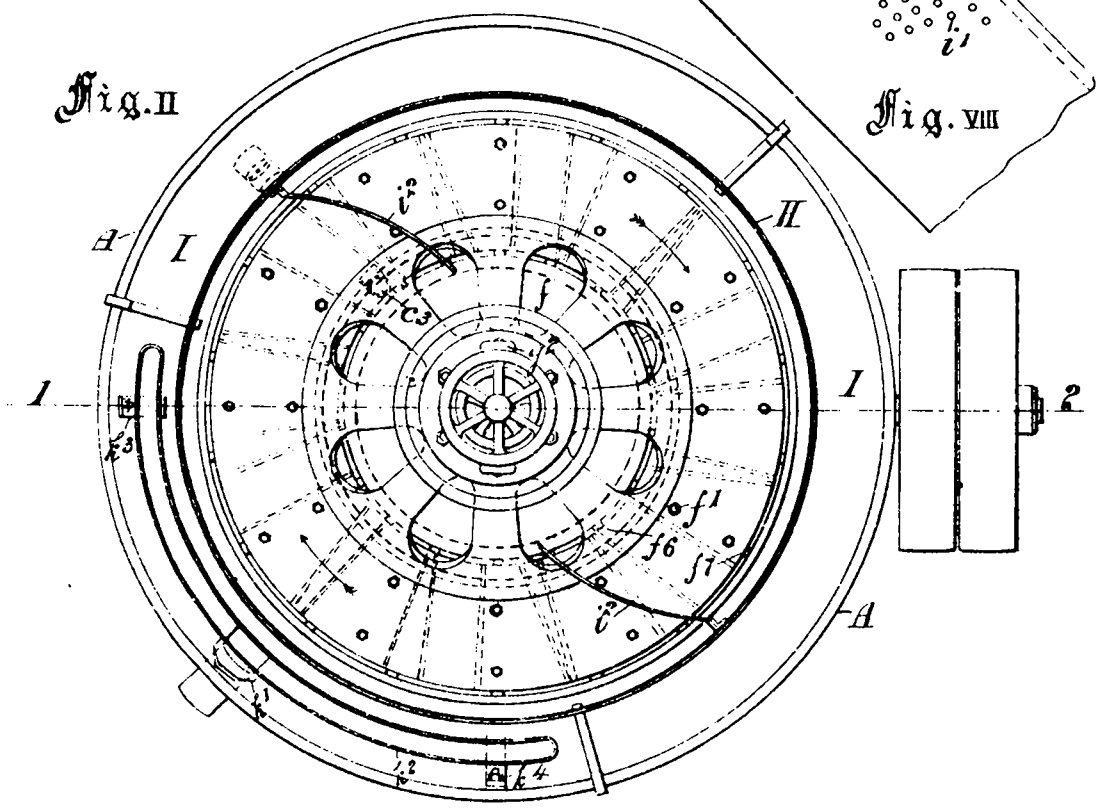


Fig. VIII

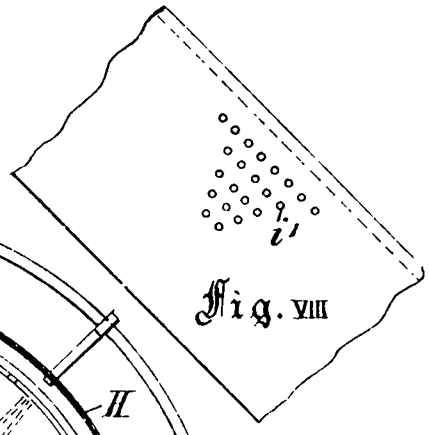


Fig. IX

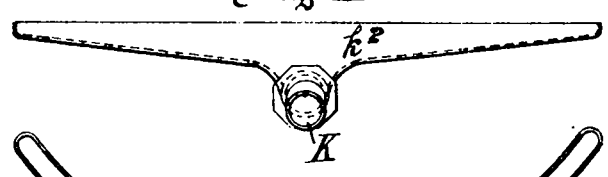


Fig X

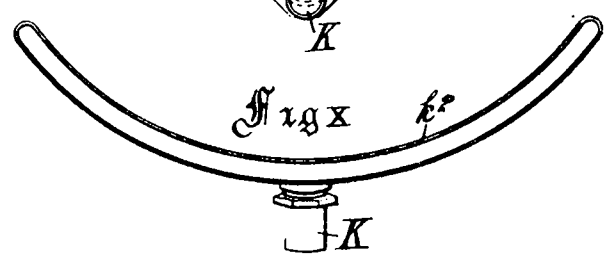


Fig. IV

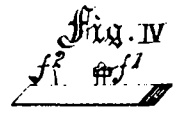


Fig. VI

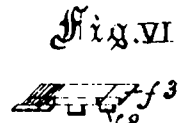


Fig. V

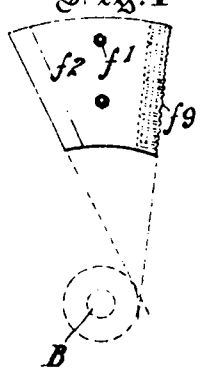
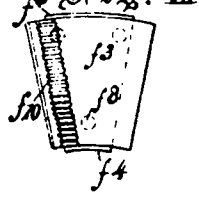


Fig. VII



"14. In an amalgamator having a mercury-cup and means for directing the material thereto, a gate by which to deflect the material to the mercury, and consisting of a plate, adjustably supported, whereby it may be set to suit the varying conditions of the material and the speed of the delivery, substantially as set forth.

"15. In an amalgator, the combination with the main frame or box and the mercury-cup, of an out-flow pipe extended from the mercury-cup, and a trough arranged to receive the discharge from said out-flow pipe, and to convey the same out of the frame or box, substantially as set forth.

"16. In an amalgamator, the combination with the stepped main frame or box, and the plate secured upon the step and projecting beyond the lower end of the same, of the mercury-cup supported below the lower end of said plate, and the gate arranged above the mercury-cup and in position to receive against it the material discharged from the plate and to direct the same to the mercury, said gate being adjustable, whereby it may be set to suit variable conditions, substantially as set forth.

"17. In an amalgamator, the combination with a mercury-cup or holder of a chemical supply, consisting of a vessel supported above the mercury-cup, and a tube connected with the said vessel and arranged to discharge continuously a supply of renewing chemical to the mercury-cup, substantially as set forth.

"18. In an amalgamator, substantially as described, the combination of the main frame or box having a stepped bottom, the sides and the tie-bars or beams connecting said sides, the plates secured upon the steps and extended to overlap the next lower step, the mercury-cups arranged below the lower ends of said plates, the gates supported adjustably above said cups and in rear of the extended step-plates, the holders or vesssels supported on the tie-bars *M*, and the tubes connected with said vessels and arranged to discharge into the mercury-cups, all substantially as set forth.

"19. The combination in an amalgamator of a main-frame or box, devices for adjusting the angle of said frame or box, mercury-cups supported on said frame or box, devices by which to adjust the angle of such cups irrespective of the adjustment of the frame, conducting devices for directing the material to the mercury-cups, and the gates supported adjustably above said cups, substantially as set forth.

"Dated this 18th day of October, 1892. "NATHAN LEROY RABER.

"Certified to be a true copy.—HENRY HUGHES."

IMPROVED GRINDING, SEPARATING, AND AMALGAMATING-PAN.

"Complete specification of John Cameron Fraser, of Coromandel, in the Provincial District of Auckland, in the Colony of New Zealand, engineer, for an invention entitled 'An Improved Grinding, Separating, and Amalgamating-pan.'

"The objects of my improvements are: First, to provide means for grinding ores, such as quartz, containing precious metals, more easily and finely than heretofore, and thus to separate the precious metals therefrom with greater facility; second, to classify the material thus ground in a better manner, and reduce loss of mercury and separated metal; third, to facilitate amalgamation by better distribution of the mercury; and fourth, to afford facilities for cleaning the pan and obtaining the amalgam therefrom.

"In order that my invention may be most easily understood, I will now proceed to describe the same, and for that purpose shall refer to the accompanying sheets of drawings, upon which similar letters of reference indicate corresponding parts in all the figures.

"Fig. 1 is an elevation of my Improved Grinding, Separating, and Amalgamating-pan. Fig. 2 is a plan of the same. Fig. 3 is a section of the same on the line 1—2 (Fig. 2).

"*A* is a circular pan, made preferably of cast-iron, slightly and gradually increasing in diameter from its lower to its upper part, and having a conical centre *a*, the uppermost part of which is higher than the top of the pan, as shown in Fig. 3; a^1 are legs or standards which support the said pan *A*, and are bolted to the same by bolts a^2; *b* is an orifice having a plug b^1, through which the water from the pan may be discharged when desired. Inside and around the bottom of the said pan I provide annular groves or recesses *c* and c^1, in section shaped as shown on a larger scale in Fig. 2. These grooves or recesses are provided with orifices c^2 and c^3, having plugs c^4 and c^5 for withdrawal of the amalgam, and to facilitate emptying and cleaning the pan.

"*B* is a vertical shaft working in a bearing *d*, in the conical centre *a* of the pan, and supported at its lower end by and running in a bearing d^1 in the hanging bracket d^2, which latter is bolted by bolts a^3 to the under-part of the pan. These bearings are lined (by preference) with Babbit's metal to reduce friction, and the bearing d^1 has also a steel disc d^3, upon which the lower end of the shaft *B* bears. Immediately underneath the pan, and keyed to the shaft *B*, is also a horizontal bevelled-wheel *e*, which receives motion from the pulley e^1 through the horizontal shaft *C* by gearing with the vertical bevelled-wheel e^2, which is keyed to the shaft *C*. This said horizontal shaft *C* works in and is supported by bearings e^3 and e^4. The bearing e^3 is carried in a bracket e^5, secured to the hanging bracket d^2 by bolts e^6, which bracket e^5 has slotted holes for the said bolts to allow of vertical adjustment of the horizontal shaft *C* and bevelled-wheel e^2. The bearing e^4 forms (by preference) part of and is solid with one of the legs or standards a^1. Secured to the shaft *C*, and working against the inner face of this bearing, is a collar e^7; e^8 is a loose pulley running on the shaft *C*, and held in position by the collar e^9.

"*F* is a grinder made of cast-iron, circular and conical in shape, and provided with holes *f*, as shown, for the better circulation of the water and material to be ground; it is also provided with a circular cap *G*, flanged as shown, and bolted to the grinder *F* by bolts g^1, and has grooves or key-ways for the keys b^2, on the shaft *B*, from which it receives motion in the direction shown by the arrow (see Fig. 2). Two of these said bolts have eyes g^2, to which tackle may be attached for

lifting the said grinder F, when desired. The upper part of the said cap G is screwed or threaded to receive the left-handed screwed spindle q, with its hand-wheels g^8 and g^4. At the lower part or base of said grinder F, and attached thereto by the bolts f^1 are grinding shoes f^2 made preferably of chilled cast hæmatite iron for hardness, the general arrangement of which and the manner of fastening the same are shown in the plan of my machine (Fig. 2), and in detail in Figs. 4, 5, and 11. It will be seen by reference to Fig 5, that the edges of the said shoes f^2, are so formed that if straight lines be produced therefrom they will form tangents to the circle as shown by the dotted diagram. The purpose of thus shaping them will be stated hereafter. Immediately below the said shoes f^2, and forming the lower grinding-surface, are shoes f^3, also made of chilled cast hœmatite iron, the general arrangement of which, and the manner of securing the same in position, are shown in Fig. 3, and in detail in Figs. 6 and 7. Referring to these figures it will be seen that these shoes f^3 have lugs, f^4 and f^5, which hold the same in position by fitting between suitable lugs f^6 and f^7 on the pan A, leaving spaces between and underneath each shoe to allow the water and ground ore to circulate more easily over the mercury in the annular grooves or recesses c and c^1. It will be further seen that the sides of these lower shoes f^3, are radial to the centre of the pan, thus producing a shearing and cutting action in conjunction with the upper shoes f^2. Both the upper and lower shoes f^2 and f^3, have front and back faces bevelled at an angle of 45 degrees, which I find to be the most suitable to allow the material to enter freely between the the same and thus be ground. The front edges, f^9 and f^{10}, are corrugated to further facilitate the entry of the material. It will be evident that as the said shoes wear in process of grinding, their weight and consequent grinding-power will be reduced; to compensate for which and keep the weight as nearly constant as possible, I provide weights g^5, g^6 and g^7, made annular in shape to fit on the grinder F, as shown. The lower weight, g^7, has an inner diameter large enough to pass over the flange of the cap, G, and the upper ones, g^5 and g^6, are made preferably in halves which are bolted around the said grinder F, by the bolts g^9 and g^{10}. These weights are lifted on when required to compensate for wear of the grinding-shoes.

"H is a ring or cylinder made of sheet-iron, resting on the hangers h^1, in the pan A, and capable of being raised or depressed by screws h^2, and easily moved when desired. This ring acts as a divider between the liquid in motion and the outer compartment I, and forms a settling chamber with comparatively still water at its upper surface. It is provided with holes i^1, arranged as shown in elevation in Fig. 8, through which the water and material sent out centrifugally by the grinder F, into the said compartment I, circulates back into the centre space and again into the grinder F, until reduced to a pulp or fine mud, when it passes into mouth-piece k^2 quietly to the refuse. It has also wings or guides, i^2, to circulate the material and direct the same to the centre of the pan and grinding-shoes.

"K is an overflow-pipe, shown in elevation and plan respectively in Figs. 9 and 10, fixed to the pan A, by nuts k^1, and through which the waste water and material find an exit. The said mouth-piece k^2, is capable of being adjusted and set accurately level by the brackets k^3, which have slotted holes for bolts, k^4, for that purpose.

"My apparatus is operated substantially in a similar manner to an ordinary amalgamating-pan. The ore having been crushed in a battery, or by any other usual or suitable means, to the fineness produced by stampers, is then conducted by a trough or other convenient method to any part of the pan near its centre; the said pan having been previously filled with water and the ripples c and c^1 charged with quicksilver. The machine is then set in motion at a speed suitable to its size, and the heavy matter supplied from the battery finds its way down to the inner rim of the grinder F, being assisted and guided thereto by the wings or guide-plates i^2, and thence passes in between the grinding shoes f^2 and f^3, by the centrifugal force caused by the grinder F. After leaving the outer edge of the rim of this grinder it is thrown against the outer case of the pan A, a part travelling upwards, and the very light particles reaching the surface and passing over the edge of the trough k^2, and thence into the waste; but the heavier particles are caught by a current passing through the holes i^1, and are thus returned again to the back of the grinding surfaces, thence again through the grinding-shoes, and the operation is repeated until the particles float in almost still water and find their exit through the trough k^2.

"In cases where it is deemed advisable to treat the ore in charges, a charge of from 10 cwt. to a ton (according to the size of the pan) is introduced. Enough water is run on to bring the whole to such a consistency that it will hold the quicksilver, when introduced, disseminated throughout the particles of ore. When this is ground for a certain time the quicksilver is introduced and grinding continued, the whole occupying from three to four hours. A stream of water is then permitted to run into the pan, and the particles of quartz worked off by the silent overflow as explained above. If a settler is used, the charge, after being ground as above, is then run into the settler and there dealt with in the usual manner.

"The novelty and utility of my apparatus consists, therefore, in being capable of adjustment so that the particles are ground until they attain the lowest degree of fineness, which is measured by the velocity of the outlet, which is reduced by the construction to the lowest limit.

"During each passage through the grinding-shoes the free gold is amalgamated with the mercury in the ripples, and can be withdrawn at convenient intervals.

"I am aware that prior to my invention grinding and amalgamating-pans have been made of somewhat similar construction. I therefore do not claim such a machine broadly.

"Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

"1. In a grinding and amalgamating-pan, the annular grinding-shoes, f^2 and f^3, as and for the purposes substantially as set forth.

"2. In a grinding and amalgamating-pan, the particular construction of the grinding or cutting-surfaces, having bevelled edges and partly corrugated faces close to those edges, as and for the purposes substantially set forth, and as illustrated in the drawing.

"3. In a grinding and amalgamating-pan, the ring *H*, acting as a divider between the liquid in commotion and the outer compartment *I*, forming a settling-chamber which is comparatively still towards its upper surface, such ring being easily adjustable and removable, all substantially as set forth and described.

"4. In a machine such as described, the discharge-orifice, k^1, having an extended mouth-piece, k^2, extending partly or entirely around the pan, as and for the purposes substantially as set forth and described.

"5. The trough c^1, placed around the bottom of the pan and the lower inner periphery of the grinder, and in close proximity to the grinding-surface, substantially as and for the purposes set forth and described.

"6. The annular-shaped weights g^5, g^6, and g^7, which may be lifted on and applied to the grinder when required, to compensate for wear of the grinding-shoes, all substantially as set forth and described.

"7. The general combination and arrangement of the several parts, substantially as described herein and illustrated in the accompanying drawings."

DREDGER FOR THE EXCAVATION OF GOLD-BEARING RIVER-BEDS, &c:

Annexed is an illustration of a dredger which has been constructed by Messrs. E. F. Lacour and Thomas Figee, of Haarlem, for the excavation of gold-bearing soil in the River Orba, near Alexandria, Piedmont, and which is of interest as a step in the direction of dealing on a large scale, and at a low cost, with alluvial deposits containing but a small percentage of gold, and which, therefore, could not be economically treated in the ordinary way. The machine comprises not only a dredger but also a washing plant for concentrating the dredged material, and at once getting rid of the bulk of the débris.

Referring to the longitudinal section and plan (Figs. 1 and 2) and to the two transverse sections (Figs. 4 and 5) it will be seen that the whole plant is mounted on a flat-bottomed barge of shallow draught, which, in addition to affording cabin-accommodation for the crew, also contains a laboratory and cabin for the metallurgists in charge. The dredging apparatus is of the ordinary bucket-and-ladder type, and requires no special description; it is driven by an independent engine, and its arrangement will be at once understood on reference to the views above referred to.

The dredged material is delivered by the buckets on to the screens at *B*, the frame *B*, which has a jigging motion imparted to it, containing three screens of different degrees of fineness, placed one above the other. Thus, the top screen is a strong one, having meshes 1·6-inch square, which receives the shock of the material falling from the buckets, while the second and third screens have meshes 0·4in. and 0·16in. square respectively, the latter screen being of steel wire-gauze.

Above the screens is a water trough *A*, which receives the water from a centrifugal pump capable of delivering 154,000 gallons per hour, and driven by an independent engine. The bottom of the water-trough is perforated all over with holes one-fifth of an inch in diameter, and through these the water falls in a shower on to the materials on the screens. By the action of the screens about four-fifths of the dredged material is separated from the rest, and passed on to the inclined pipe *E*, through which it flows, mixed with water, to be again deposited in the river-bed a sufficient distance in the rear of the dredger. The screens are also provided with a special arrangement which prevents any large pieces of gold from passing off to waste with the lighter débris.

By the arrangements just described, about four-fifths of the dredged material are, as we have already stated, at once got rid of; the remaining fifth passes through the finest screen and falls into the hopper *C*. At the bottom of this hopper is a distributing apparatus, which mixes up the sand and water, and causes a steady stream of the mixture to fall through the discharge opening in the bottom on to sluice *D*. This sluice is a kind of shallow canal, 82ft. long by 9ft. 10in. wide, the bottom being crossed by grooves or flutings, and it is supported by an iron frame at the stern of the vessel, the support being hinged in two directions, so that the level of the sluice can be adjusted either laterally or longitudinally. The former adjustment is necessary to counteract any list or cant which the vessel may have to port or starboard, which cant, if uncorrected, would interfere with the maintenance of a uniform depth of flow over the whole width of the sluice, a uniformity which is essential to its proper working. The lateral adjustment of level is effected by screws, while longitudinally the inclination of the sluice is regulated by a chain led from a winch placed on the deck (as shown in Fig. 1). This sluice can, when required, be inclined so that its inboard end is the lower of the two, as shown by dotted lines; the use of this we shall explain presently.

Referring to Figure 1, it will be seen that over the upper half of the length of the sluice there extends a shaft; this shaft carries eccentrics which impart motion to a series of distributing rakes, these rakes acting on the mixture of sand and water as it flows over the sluice. The teeth of these rakes also retard the flow of the water, the effect being that the heavy gold settles down in the grooves, while the sand passes off with the water over the tail of the sluice. The rakes also—practically covering, as they do, the upper half of the sluice—serve to protect the deposited gold.

When a sufficient quantity of gold or gold-bearing sand has been collected in this way, the dredging is stopped, the sluice altered into the position shown by the dotted lines, the rakes are lifted, and the material deposited in the flutings is raked out and washed down a pipe into the laboratory for subsequent treatment. After working for some five days with a dredger of this class, raising about 1,500 tons of stuff per day, it is found that the concentrated gold-bearing material taken off from the sluice into the laboratory amounts to but about four cubic yards. Altogether the machine is one which has been well designed to carry out a large part of the work of concentrating alluvial gold-bearing material with a minimum amount of manual labour.—*Engineering*.

RIVER-DREDGING IN OTAGO.

By T. A Rickards.

The first gold-seekers who prospected the sands of the Shotover and Molyneux Rivers restricted their search to the easily-accessible deposits which had accumulated under the shelter of rocky bars; and when the auriferous sands were found to extend under the waters of the river, they turned the stream by means of wing-dams. The rich alluvium was found, however, in places where this mode of operation was found impracticable or too costly; and in such places, standing shovel in hand, they snatched with difficulty the golden sand, which increased in richness the less accessible it became. The simple shovel was useless in a fast current; hence the next step was to contrive a ladle or spoon with which to scoop up the river-bed. A piece of hide fastened to an iron rim was arranged behind the modified blade of a shovel, and this at the end of a long pole helped to increase still further the area available for work. Soon, however, the distance from the shore, and with it the increasing depth of water, prevented further advance. A barge or punt was then built; the hole was lengthened to 20ft. or more; the scoop was enlarged so as to hold a barrowful; and the increased weight requiring other than mere hand labour, a winch and tackle were rigged up. This now became the "spoon-dredge," the forerunner of the numerous types of bucket-dredges which have started a new branch of the mining industry of New Zealand.

The spoon-dredge served its purpose, but the numerous mines along the banks of the river had begun to send down tailings, which soon covered the bottom with a rapidly-increasing thickness of valueless material. The spoon-dredge was not capable of coping with this fresh difficulty, but the rapidly flowing river suggested the greater power now needed to replace human muscle. A water-wheel took the place of the winch, and the "current-wheel dredge" was invented. This consisted of a simple bucket-dredge, worked by an undershot-wheel, placed at the side of the punt. The power needed to propel the machine severely restricted its usefulness, for it could not be employed in the back-waters, or, indeed, anywhere but in the full force of the river current, and the richest part of the channel had therefore to be left untouched. Steam was substituted for water-power, and the bucket-and-ladder type of dredge was advanced a stage further by the addition of revolving screens; winches for mooring, and pumps for raising the water were also required to separate the fine gold-bearing silt from the coarse gravel. This brings us down to to-day, when the river-sands and the sea-beaches of the South Island are worked by a force of over fifty dredges, propelled by water, steam, and electricity.

When I was at Dunedin, in 1890, it was difficult to find a man who had not located some acres of land on river-bank or sea-shore. Dredging properties were plentiful as "leaves in Vallambrosa," and the "potentialities of acquiring wealth beyond the dreams of avarice" were offered on every hand. Returning in March, 1891, I found that the number of dredges at work had largely increased, with a corresponding diminution in the dredging-fever. The results had been disappointing.

The success of the Dunedin dredge was the main cause of the dredging-fever. Directed by a man of great experieuce in this branch of engineering, and put to work in a part of the River Clutha which soon proved very rich, this dredge returned in ten months two-thirds of the paid-up capital of the company which owned it. One of the Shotover dredges had also been fairly successful, while on the sea-beach the Waipapa dredge, exploiting the titaniferous gold-bearing sand, had made, under many difficulties, very encouraging returns. It was at once found that the extent of ground available for this mode of working was almost unlimited; the river-channels and the sea-coast were soon covered with locations; claims were taken up and floated into companies, the vendor receiving, for ground which had cost him but a few shillings, a large sleeping-interest in a concern to the working capital of which he contributed nothing. Large areas were assumed to be valuable, on account of reported rich yields obtained by the diggers from spots representing a very small proportion only of the total field to be worked. No tests—or only unsystematic tests—were made. It was overlooked that the rapid rise of the river would prevent work during many months in the year. Moreover, in this form of mining, experience so far accumulated had been but small, and the saving of the gold was often attempted under conditions which were hopeless. Gradually the enterprising investor awoke to the stern fact that, like all other branches of mining, dredging required judgment, care, and experience.

The pontoon in this case has a length of 80ft., a width of 18¼ft., and a depth of 4½ft. The ladder is constructed to work to a depth of 20ft. below the surface of the water. The power to propel the machinery is derived from the river, and is transmitted as electricity.

The Dunedin dredge is working the bottom of the Clutha at a point about three miles above the town of Roxburgh. The deposit covering the rocky bed of the river consists here of 20ft. to 25ft. of barren drift, overlying a thickness of 2ft. to 2½ft. of gold-bearing wash. Sometimes the "pay" thins to 6in. The overburden of drift consists of small-sized gravel, but the pay-wash is composed of large boulders, among the interstices of which occurs the gold. Black-sand is found in both drift and pay-wash, that of the drift originating, together with the bulk of the material in which it occurs, from the mines along the river. The gold is similar to that obtained elsewhere along the Clutha, consisting of fine, flat flakes in a black iron-sand. Gold is not seen in the quartz of the pebbles.

This dredge has a double ladder of buckets giving 2 cubic feet each, twelve emptying per minute on each side, giving the machine a capacity of 106 cubic yards per hour. There are thirty-one buckets on each side, the material from which passes through the two perforated iron cylinders, the larger pebbles being ejected along an iron shoot which returns them to the river, while the fine gravel passes over a table 8ft. long by 7½ft. wide. The grade is 2in. per foot, and cocoanut matting is used to arrest the gold. This table and the similar one on the other side discharges upon a middle table, 8ft. long by 4ft. wide, which is provided with iron-bar riffles. From here the gravel falls into the river. The above comprises the whole apparatus employed in the saving of the gold. The cocoa-nut

matting is washed at regular intervals in a tank, the gold being subsequently separated from the black-sand by panning.

The motive-power for the machinery is derived from steam, the fuel used being the lignite which occurs at Coal Creek, three miles up the river. The price is 8s. per ton, delivered at the bank, whence it is ferried by boat. The daily consumption is 3 tons. Electric light enables work to be uninterrupted.

The dredge had just re-started at the time of my visit, after a stoppage due to the rise in the river, which was even then flowing nine knots per hour. During flood-time the rate of flow reached twelve knots, while the average is seven knots per hour. The working expenses are £250 per month. This includes the wages (£160) of nine men and a dredge-master. The coal-bill is £30. The balance of the £250 is taken up by repairs and supplies. The average of steady work is only four days per week of six working-days. This does not allow for the interruption, often for weeks, due to floods. From December, 1889, to October, 1890, dividends amounting to £4,080 were paid on a nominal capital of £7,200, and a paid-up capital of £6,240. After October, work ceased on account of the spring floods until the first week in December. The directors' report for the six months ending the 2nd of July, 1890, states that the gold obtained amounted to 884oz. 5dwt. 8gr. —value £3,316—out of which £1,680 was returned in dividends.

The Dunedin dredge is working the auriferous gravel lying upon the rock-bed of the swift-flowing Clutha; but the Waipori dredge, which we will next consider, is placed under much more favourable conditions. The Waipori River is a small stream, running through a flat valley surrounded by rolling foot-hills. A wide deposit lies in the hollow of the valley, and above it flows the present stream. The gold obtained does not lie upon the bed-rock of the original channel, which is much deeper, but at a horizon marked by a coarse sand—the "false bottom" of the miners.

The dredge is of the bucket-and-ladder type. The stream is of insufficient depth to float it, but the dredge makes its own waterway by the removal of the gravel. The capacity is 7,600 cubic yards per week of 125 to 130 working-hours. The movement of the pontoon is directed by four winches operating wire-ropes fastened to the shore. The engine is of forty-horse power, supplying the power necessary to work the buckets themselves, as well as the pump which gives the water necessary for the tables. The contents of each bucket as it comes up are emptied into a revolving sizing-cylinder, constructed of horizontal iron bars. The fine silt goes straight to the tables, while the coarse passes to another sizing-cylinder (this time of perforated boiler-plate), which separates the coarse gravel and boulders. These fall into the stream from an iron shoot, while the fine goes to the tables, which are arranged on either side, and are covered with coarse cocoanut-matting, with linen underneath.

The following figures will indicate the cost of operations during the period of a year:—

Repairs and alterations, £222 9s. 1d. This was chiefly in pins and bushes. The wear and tear is mostly about the buckets. The lips last for two years, and the pins on which the buckets are hinged have an average life of three months.

Wages, £1,192 16s. 4d. This includes the pay of eight men and three boys per day; one engineer, one winchman, and one boy to attend to the tables on each shift, making six men and three boys per twenty-four hours. Then there are to be added the dredge-master and a blacksmith.

Material, £272 9s. 5d. This includes the shed on the shore, which serves as an office, forge, and tool-house.

Coal, £507 12s. Firewood, £377 6s. The wood (manuka) costs £1 15s. per cord. Coal (from Westport) costs 55s. per ton, delivered.

Rent, £293. This is the amount (at 10s. per acre) paid to the Government as rent for the claim. During the year, the first two months were taken up by the erection of the plant, and in the remaining ten the gold obtained amounted in value to £3,095 8s. 6d. The cost of the dredge, including fees to the engineer, was £3,380 14s. 3d. The weekly cost upon the ground is £30 for labour, £20 for fuel, or (including repairs) about £65 in all.

Three typical weekly records are as follows:—

First week: Yield, 21oz. 16dwt. Time of actual work, 140 hours. Ground lifted, 8,400 yards. depth of lift, 10ft.; firewood, 10 cords.

Second week: Yield, 33oz. 13dwt. 18gr. Time, 126 hours. Ground lifted, 8,400 yards; depth, above 13ft.; firewood, 10 cords.

Third week: Yield, 29oz. 12dwt.; time, 126 hours. Ground lifted, 7,560 yards; depth, about 13ft.; firewood, 10½ cords.

Up to that time the dredge had handled very little virgin ground, the material consisting chiefly of the tailings carried down from old sluicing-claims. Since then it has reached solid ground; and the results, with the same expense, have reached 50oz. per week.

This dredge is working under conditions admirably suited to its capabilities. The working-cost is slight, the amount of capital tied up is very small, the area of the claim is large, and the danger of floods *nil*. The depth at which it is working varies from 10ft. to 15ft. The "false bottom" of compact coarse sand enables the buckets to get well under the pay-wash, and avoids a great deal of the wear and tear incident to working upon a rocky bed.

The material treated, while it is very similar to that of the mines on the Clutha, yet contains gold more shotty than that of the big river-claims. The gold of the Waipori flats came in large measure from the erosion of the neighbouring quartz-lodes—the O.P.Q. and other reefs. While on the dredge I was shown a round, white quartz-pebble, taken that morning from one of the buckets, which was of the size of a hand, and showed several splashes of gold as large as a small finger-nail. Such a find, very unusual in the alluvial mines of Otago, marks the somewhat exceptional conditions under which this deposit was probably formed.

Gold-saving.

The methods used are of the crudest kind. There is no doubt that the river receives back more than half of the gold contained in the material raised by the dredge. The tables at Waipori are somewhat larger than those of the Dunedin dredge; but in both cases it appears the height of absurdity to think that they can save a large percentage of the fine, flakey gold carried along in such a large flow of water, and amid so great a volume of sand and gravel. The report of the directors of the Dunedin Dredge Company says that "the dredge-master reports that the gold-saving appliances are all that could be desired." This is the severest satire upon the childish efforts made to save the gold, fully 60 per cent of which must be a mere passenger through the apparatus designed to arrest it. Over a hundred cubic yards of gravel, together with the water employed to transport it, are in this case handled by the dredge every hour, and of this a very large proportion passes over the surface of two tables covered with cocoanut matting, whose dimensions are 8ft. by 7½ft. There is no opportunity whatever given for a separation of the gold from the mass of heavy black iron-sand and the sediment in which it is enveloped. The surface over which it passes is far too small, and the distance over which it travels is altogether too short to enable it to be arrested by the simple means adopted. What is collected is in spite, rather than by reason, of the efforts made to catch it, and represents a small proportion only of the gold in the material, the larger part being lifted from the river only to be returned.

The Use of Mercury.

The use of mercury is not familiar to the alluvial miner of Otago, as it is to his brethren elsewhere. There exists a curious idea that it will not act in cold weather, due no doubt to the fact that the cleaning-up in the mills and mines is invariably done with hot water. Of course there is a substratum of truth in this idea, since amalgamation is as a rule* retarded by cold and assisted by heat, but within narrow limits only, and not to such an extent as to make the fact of any great practical importance. It certainly will not explain why the Otago digger has "left in the cold" one of the best friends of mining all the world over. From an examination of the conditions under which the gold of the alluvium of Otago occurs, particularly in the deposits of the Clutha and its tributaries, I am strongly of the opinion that the use of mercury will have to be resorted to if any large percentage of the precious metal is to be extracted.

In the case of the elevator-plant, the example of California can be followed, and mercury placed in the riffles of the sluice-boxes themselves. Then it requires but an extension of the idea of side-runs, preceded by under-currents, to permit the further use of quicksilver in wells or traps. With the dredges, one of the first alterations of existing methods which is demanded is the enlargement of the area over which the material passes. Dredges are now constructed at Dunedin to handle over 150 tons per hour. This requires a very large surface to effect even the roughest separation of the fine gold-bearing silt from the large mass of non-auriferous wash. The Wellman dredge at Waipapa† which is supplied with tables 24ft. by 30ft., having an incline of ¾-inch per foot, is designed on common-sense principles, and supplies an example to other dredges of Otago. But even the dispersion of the material over such an enlarged surface will not suffice to collect the finer particles of gold. Mechanical means must be assisted by chemical; gravitation must be followed by amalgamation.

The fineness of the gold in the New Zealand alluvium may be imagined, when it is stated that by actual count it requires six to seven thousand particles of the gold as found on the West Coast (best known by the Hokitika discoveries) to form a grain in weight. It will be said that, as a matter of practice, it has been noted that very little gold finds its way beyond the first strips of matting; and that on washing, the bottom strips are seen to collect scarcely any. The following experiments were made at Waipapa:—First experiment: The bottom cloths—those 16ft. to 18ft. from the head—were washed separately from the remainder, with the result: Amalgam for eight days—top cloths, 89oz. 16dwt.; bottom cloths, 4dwt. 5gr. Second experiment: The second row of cloths from the bottom, that is from 14ft to 16ft. were separately washed. The amalgam from the top cloths was 89oz.; the cloths from 14ft. to 16ft. yielded 8dwt.

It is necessary to add here that the produce becomes amalgam only in cleaning up, mercury being used simply in collecting the residues from the washing of the plush—which last does the direct gold-saving.

This is after the fashion of the mill-man who carefully assays his tailings, but fails to note how much gold he is losing in the slimes which are carried down stream to cheer the hearts of a tribe of Mongolians. The evidence obtained by such tests is an *ignis fatuus* to the miner, deluding him into blissful ignorance of his losses. The fact is that in such cases the gold lost is in an entirely different condition from that saved, and methods which served to arrest the latter are entirely insufficient to hold the former.

The character of the gold is in no way prejudical to amalgamation. In both river-banks and sea-beaches, it is bright, of high caratage, and not "rusty," or mixed with minerals inimical to mercury. On the other hand, its fine flakey character makes it particularly hard to arrest by purely mechanical methods. The thin plates of gold, especially when the edges are turned, as must often happen during the treatment the gravel undergoes, are especially adapted to be transported by water.

* In the mountains of Colorado, at an altitude of 8,500 feet, the amalgamation at the stamp-mills meets with no obstacle in winter. On the contrary, it is curious to note that the mill-men of Gilpin County unite in asserting that the cold weather is beneficial to amalgamation, for the reason that the warmth thins the mercury and causes it (with the vibration due to the falling stamps) to run off the plates.

† This dredge was idle during the time of my stay in Otago, owing to a change which was being made in its construction. An interesting description appeared in the records of the Mining Conference held at Dunedin in 1890, written by Mr. James Allen, a member of this Institute. This dredge is working the sea-beach, those portions where the titaniferous gold-bearing sand has been concentrated by the action of the prevailing winds.

The material used for the gold-saving is cocoanut matting, which within certain limits answers admirably. Owing to its porous character, it is usually supplemented by linen placed along the woodwork of the tables or sluice-boxes. Some of the dredges employ plush. The choice is largely a matter of expense. At the Island Block it was found that the plush used in the side-runs caught too much of the black iron-sand and got quickly choked. At Waipapa, with a very large proportion of fine black-sand, it answered well. The difference of experience is due probably to the quantity of water used, and the gradient over which the material passed.

The dredge has added largely to the area available for mining operations. In this branch of mining, Otago is opening up a new and important field. The practical result of the experience so far obtained proves that the bucket-dredge, though admirably simple and inexpensive, is best suited to the raising of auriferous alluvium lying upon a "false bottom." Upon a true bed-rock the wear is much increased, and the effectiveness much diminished. Everyone knows how difficult it is to scoop fine gold mixed with gravel *under water* by the aid of a shovel. It runs off. The bucket of the dredge is a modified shovel. For irregular bottoms, the suction-pump dredge, of which the Wellman is a good example, will be found best adapted. In this case a powerful centrifugal pump draws up the water, gravel, and gold, delivering them to the level of the tables. At Waipapa, stones 35lb. to 40lb. in weight have been sent up by the pump; and it only required an improvement in construction, giving durability and strength, to render it a most effective machine for this class of work. A dredge thus provided is able to sweep the bottom clean. After that, the extraction of gold becomes the great question; and in this direction, as we have seen, there is a wide margin for improvement.

Time, however, will remedy these defects, and the Otago miner may meanwhile point with pride to the fact that he has shown the possibility of working the sands of the sea-shore at a profit, when they contain but two grains of gold per ton.

This concludes my notes upon a mining-field but little known on this side of the equator. The chief lesson it conveys is, that we should seek to profit by the experience of others. Otago has much to learn from California in lode-mining and quartz-milling; but California would do well to study the steps of Otago in hydraulic-elevating and dredging. The miner should be the least conservative of men: his motto should be "pass it on;" the same difficulties should never require to be overcome twice; and thus should be avoided that worst of all wastes, the waste of experience.—*Mining and Engineering Journal.*

ELECTRIC PUMPING-PLANT AT NEWTON COLLIERY, NORTHUMBERLAND.

Messrs. Ernest Scott and Mountain (Limited), electrical and general engineers, Close Works, Newcastle-on-Tyne, have recently completed for the Newton Colliery an electric pumping-plant which suits the special requirements of colliery pumping, and more especially in such cases in which it is necessary to move the pump about. The complete plant consists of a steam-engine and electric generator, and of a set of horizontal pumps and motor. The steam-engine is of ten-horse power, and is fixed at bank, where it drives a Tyne compound-wound dynamo constructed to give an output of thirty ampères at an electro-motive force of 200 volts when running at a speed of 1,100 revolutions per minute.

The dynamo used is of the two-pole type, and the current from it is taken to a switchboard fitted with quick-break double-pole switches mounted on an enamelled slate base, on which also are fitted a volt-meter and ampère-meter for measuring the current and pressure.

The current from the switchboard is taken down the shaft by a pair of $\frac{7}{16}$-in. vulcanised cables. The pumps are of the two-throw type, the rams being 6in. in diameter by 10in stroke. As will be seen from the annexed sketch, the pumps are mounted upon two channel-iron girders, which are firmly bolted to distance-pieces, the centre distance-piece carrying the guides for the tail-rods. The crank-shaft and counter-shaft are mounted at one end of the girders, and upon the former is keyed a spur-wheel driven by a pinion on the counter-shaft. The motor is placed behind the pumps, and is completely encased by a strong brass cover, not shown in the engraving, intended to prevent dust and dirt getting to the working parts.

The power from the motor is transmitted to the pumps by an endless cotton belt, specially made to resist the wet. The whole framing of the pumps and motor is mounted on wheels, enabling it to run along the tram-rails in the pit. These pumps have been at work for some time, to the complete satisfaction of the colliery officials, delivering more than the guaranteed quantity of water.—*Colliery Guardian.*

SHEDLOCK'S PROCESS FOR REFRACTORY ORES.

In treating ore by this process, the rock is crushed in the usual way, either by rolls or stamps, the crushed ore being conveyed into an apparatus where each atom is subjected to the action of gases under pressure, whereby the whole of the sulphur and other materials which render the ore refractory are separated. The ore is then conveyed into a vessel containing an absorbing fluid metal, so constructed that every particle of the ore is brought into contact with the metal. For the production of the reducing gases, steam and air are passed through highly heated materials having an affinity for oxygen, and the gases so produced are utilised for raising the ore to a high temperature. By this means the sulphur and other metalloids and base metals are volatilised and eliminated, and the gold in the ore is then in such a condition as to alloy itself or become amalgamated with the fluid metal with which it is brought into close contact; the tailings passing off worthless, are conveyed to the dump.

The steam, in combination with the due proportion of atmospheric air, is first superheated in passing through the hearth or bed on which the fire is supported. The superheated steam and air under pressure are then forced through the fire, which is automatically maintained at a considerable depth, by which means the products of combustion are mainly hydrogen and carbonic oxide. These

gases are then conveyed by means of main and branch-pipes to a cylindrical apparatus, into which the ore to be acted upon is driven under pressure by means of the gases, which, being united, raise the ore to a high temperature. The ore is maintained in a state of violent agitation; each particle, being kept separate from its fellows, is consequently very rapidly acted upon by the gases. The ore, freed from its refractory constituents, is then fed into a vessel containing the fluid metal, in which each particle of ore is separated from the others, and being acted upon by the fluid metal, is absorbed into it, the tailings and refuse passing off, freed from any gold which may have been in the ore. Quantities of refractory ores treated by this process are said to have demonstrated that most of the gold in the ore is extracted. The successful outcome of these trials is stated to have resulted in the Anglo-French Exploration Company acquiring the right to work the process on the various goldfields of South Africa.

It will have been seen that the peculiar and essential features of the invention consist in subjecting every particle of the ore under treatment to the process in all its stages, instead of in bulk, thereby insuring that no portion shall escape being acted upon by the gases and the absorbing metal. This is done automatically and in a very rapid manner. It is stated that this method of treatment is applicable to all ores.—*Mining and Scientific Press.*

A NEW GOLD-EXTRACTING PROCESS.

A large number of gentlemen went to the floors of the De Beers Company at Bultfontein, for the purpose of witnessing an exhibition of a new gold-extracting process by chlorination, which has recently been patented by Messrs Lowndes and Koller, of Beaconsfield. About 700lb. of pyritic ore from the May Deep-level Gold-mining Company was operated upon, and the greater part of the day was spent in the process, those present taking a great interest in the proceedings. The patentees have carried on the work on behalf of a syndicate of local gentlemen. During the afternoon, Mr. Koller addressed the company, describing the process, and the following is the substance of his remarks:—

The patentees contend that there are several reasons why a loss of gold occurs, and is daily being found in the tailings of various companies now at work, particularly in South Africa. 1. Water is known to contain a varying percentage of impurities, the carbonic-acid gas of which renders the ordinary amalgamated copper-plates useless, by forming a slimy coating of carbonate of copper over the surface, and prevents all the gold from adhering to the mercury. 2. The plates being flat, and on an incline, the least access or rush of water washes away all lighter particles, or float-gold. 3. What little gold that chances to remain on the plates is too exposed, and easily removed by pilferers; losses of amalgam occurring daily to the companies in this way.

The advantages of the Lowndes-Koller extracting process are set forth by the patentees as follows: 1. Previous roasting of any ore is not required. 2. No amalgamated copper-plates are used. 3. By this process the gold is rendered purer and of greater commercial value. 4. Any water can be used without having a deleterious effect on any part of the machine. 5. The collection and amalgamation of the gold or silver is conducted within a revolving cylinder, the exit holes of which are locked, and it is impossible for any one to have access to the amalgam without authority to do so. 6. The cost of treatment is about 5s. per ton, thus taking about 1½dwt. of gold to cover working-expenses, which is far less than any other process now in vogue. 7. The machine extracts 98 per cent. of gold from refractory ore, and wins every grain of free or float-gold as well. 8. Each machine of five-stamp capacity is capable of treating ten tons of ore per day. 9. The machine, working automatically, both fills and empties itself without any special attention. One white man and one Kaffir can easily attend a set of three machines of five-stamp capacity each, equalling fifteen stamps. 10. The working parts of the machine, being made of the very best material, are most durable, and not easily put out of order. 11. As electricity is largely used in this process, electric lamps can be used without much extra cost for night working, thus providing a strong and brilliant light.

The following is a description of the machine: The machine consists essentially of four parts, each of which can be replaced separately at a minimum cost. 1. The apparatus, consisting of specially designed electro-magnets for removing particles of metallic iron (from the stamps) from the ore before being treated. If this iron is not removed it uses up the chemicals, and is also liable to go into the amalgam. 2. The automatic chlorinating cylinder, in which the ore is chemically treated under pressure and continuously. 3. The diffusion-box, in which the excess of chlorine gas is got rid of, in order that a loss of quicksilver may not be occasioned thereby. 4. The revolving electric amalgamator, where the gold is amalgamated by mercury in bulk.

The process may briefly be described as follows: The crushed ore, direct from the stamps, passes over the magnets to get rid of the iron, and thence into two hoppers fixed on cylinders. At the end of the chlorinator, plungers of steel force the mixture of ore, water, and chemical into the chlorinator under considerable pressure, where a powerful but harmless current of electricity produces a supply of chlorine gas, which attacks the pyrites, and sets free the gold or silver. After being thoroughly chlorinated, the ore passes through an exit-valve into the diffusion-box, where it meets a stream of air which carries away all excess of chlorine gas. The ore, being free from chlorine, then flows direct into the amalgamator, where in its sinuous course through the mass of quicksilver all the precious metals are abstracted, and obtained by retorting in the usual manner. It is impossible for float-gold to pass through the amalgamator; it must be taken up by the quicksilver and retained. The patentees specially recommend the electric amalgamator and the magnets to those companies possessing free ores rather difficult of amalgamation. The magnets remove all the metallic-iron from the ore, which, otherwise, would go into the amalgam, and render the gold of less value. The great advantage of the electric amalgamator is, that it can be easily attached to any stamp-battery, and will itself, without plates being used, collect all free and float-gold from the ore, at the same time rendering the amalgam perfectly secure against theft, as it is placed under

DREDGER FOR THE EXCAVATION OF GOLD-BEARING RIVER BEDS.

Fig 1

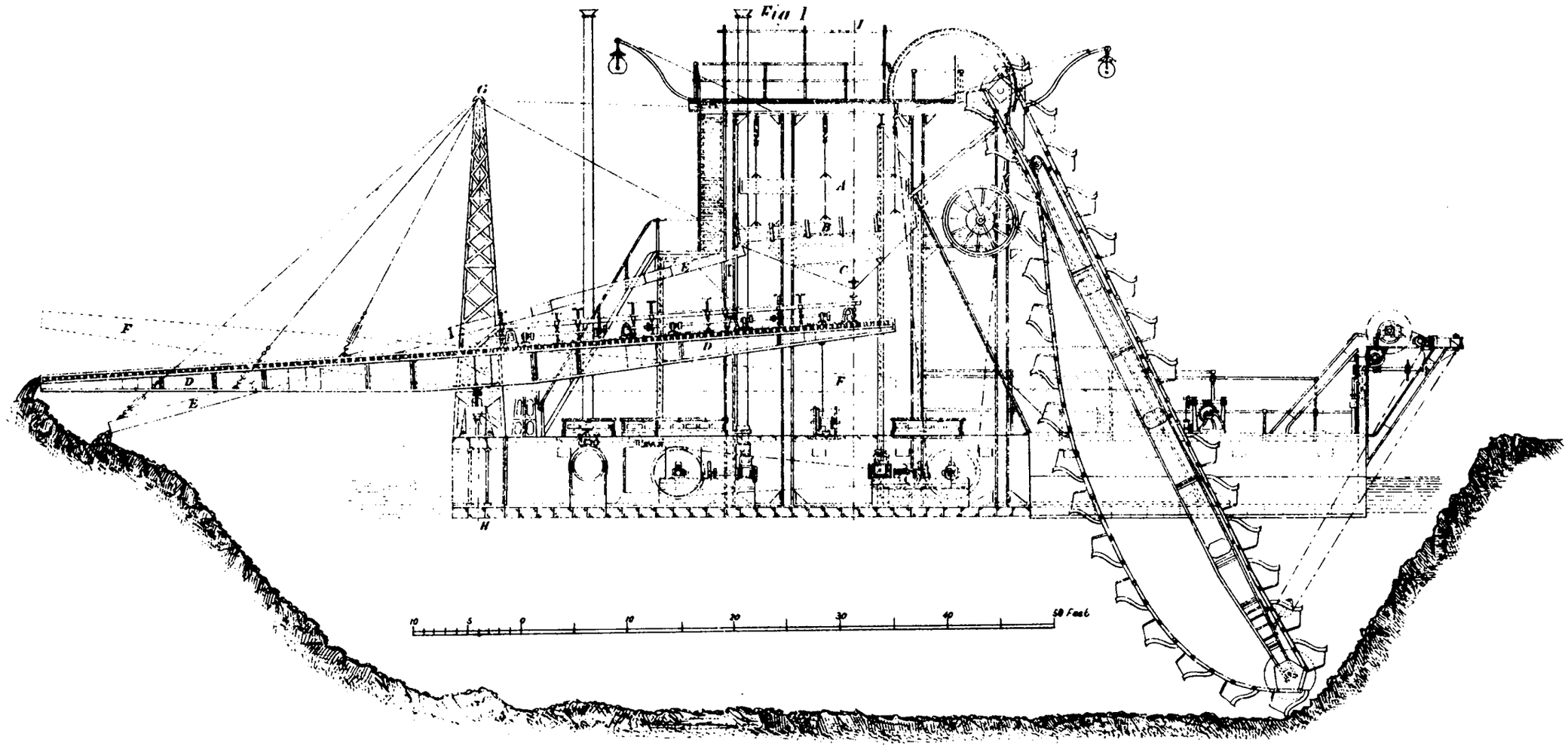


Fig.2

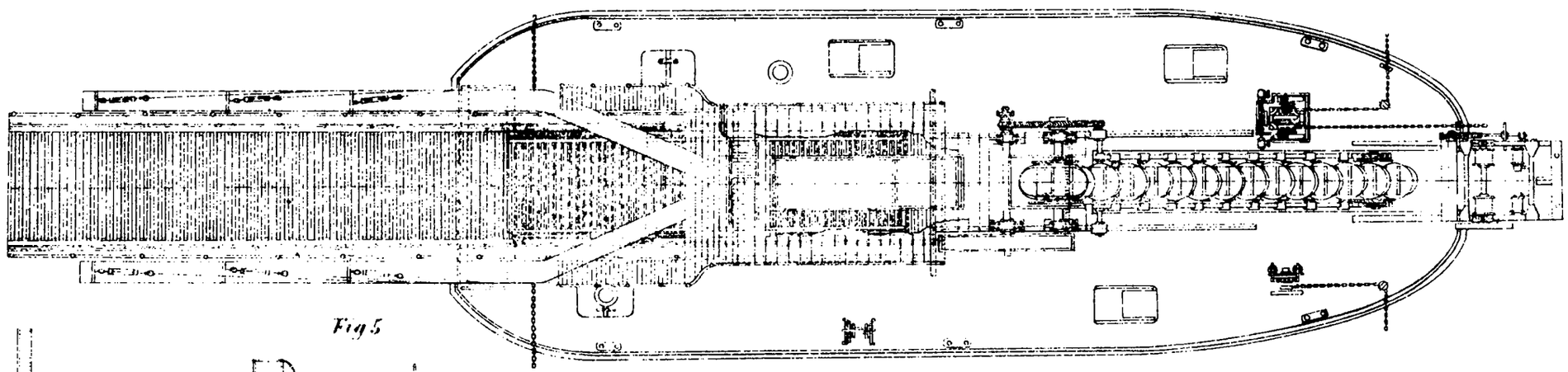


Fig.4

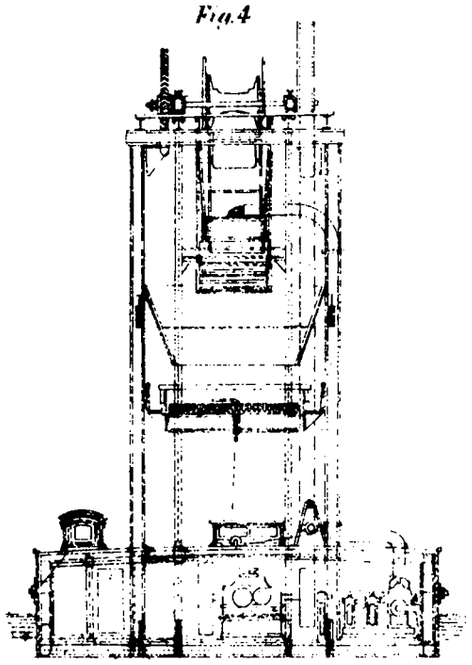


Fig.5

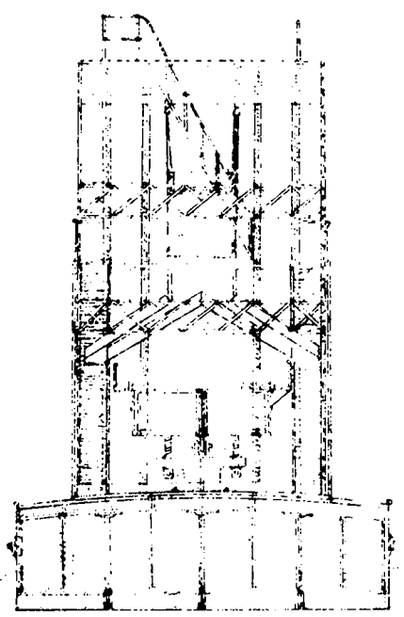
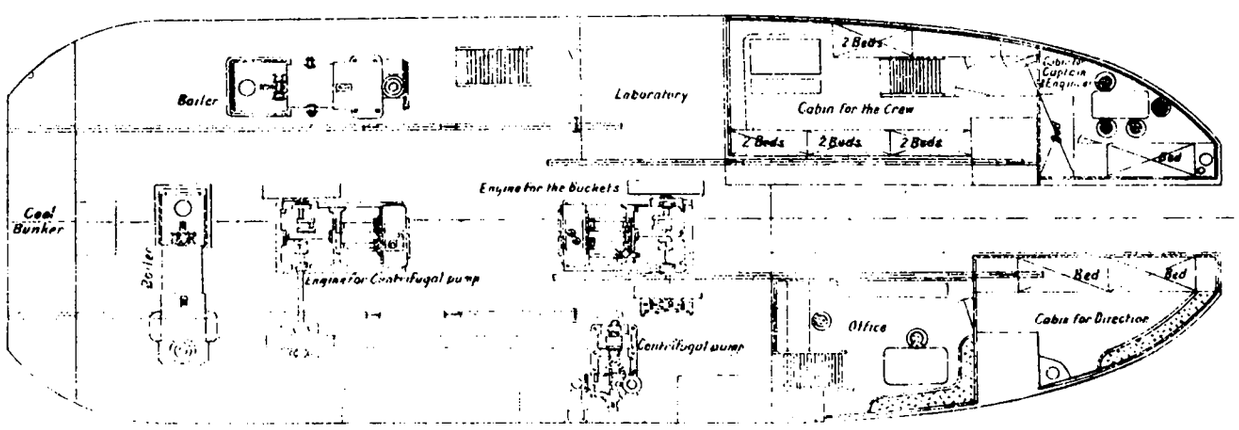
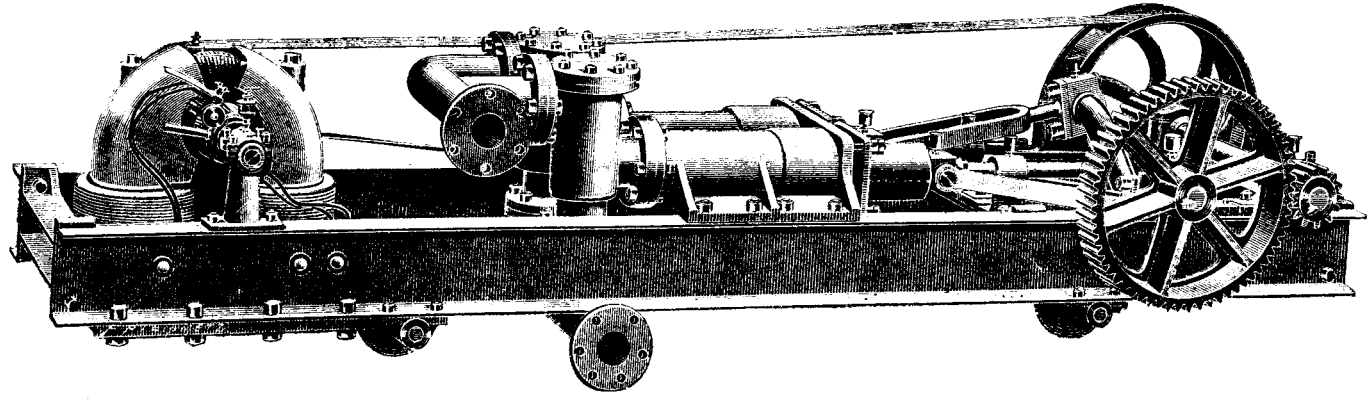


Fig.3



ELECTRIC PUMPING PLANT AT NEWTON COLLIERY.



lock and key, and access can only be had to it in the presence of two authorised persons possessing each a different key.

The patentees estimate the approximate cost of working per month, with one set of three machines, 15 stamps capacity, all told, as follows:—Steam-power, chemicals, labour, depreciation of machinery, and incidental expenses, £180. They then gave me the following estimates:—

Assay-value of ore equally, 1oz. per ton; quantity of ore treated, 720 tons; cost of treatment, 5s. per ton.

Quantity of gold extracted by the Lowndes-Koller process, being 98 per cent. = 705 oz.—

	£	s.	d.
Bank value, £3 10s. per oz.	2,467	10	0
Less working expenses	180	0	0
	2,287	10	0
Mining and crushing 720 tons, at 15s. per ton	540	0	0
	£1,747	10	0

Quantity of gold extracted by ordinary amalgamation, being 55 per cent. = 396oz.—

	£	s.	d.
Bank value, £3 10s. per oz.	1,386	0	0
Less working expenses	150	0	0
	1,236	0	0
Mining and crushing 720 tons, at 15s. per ton	540	0	0
	£696	0	0

Thus showing a balance in favour of the Lowndes-Koller process of £1,051 10s. per month.

Immediately after Mr. Koller's address, the engine was stopped, the amalgamator unlocked, the amalgam taken out and retorted, with the result that a bead of gold was produced, weighing 16dwt. 6gr. This result is considered highly satisfactory. The process is to be known in future as "The Reliance Gold Extractor." It has been patented all over South Africa, and in England.—*Engineering and Mining Journal.*

THE LOCKWOOD-CHAPPEL PROCESS.—SUCCESSFUL APPLICATION OF THE TREATMENT.

An experiment, the importance of which to the mining industry can hardly be over-estimated, has just been successfully carried out at the Sir Walter Scott Gold-mine, Cangai, New South Wales, by the Rev. Joseph Campbell, M.A., F.G.S., F.C.S. It will be remembered by many that last year this gentleman took a very active interest in the development of the Lockwood-Chappel process for the treatment of refractory gold-ores, and a thorough examination of its principles convinced him that it was admirably adapted to the extraction of gold from pyritic and other refractory ores. At the request of the patentees, Messrs. Lockwood and Chappel, Mr. Campbell selected an appropriate name for the treatment, and he chose the term "Hyperphoric" as being the most suitable. The term is from a Greek word, and, as applied to rocks and mineral masses, signifies the change which they undergo as the result of the elimination of one or more of their constituent elements; but it also has another signification—viz., that of bearing the pre-eminence. The term is, therefore, in the opinion of Mr. Campbell, the best that could be selected, inasmuch as it accurately describes the action of the Lockwood-Chappel treatment, which is the elimination of the base constituents of auriferous ore, and also asserts the position which the treatment is destined to hold among the various processes which have been suggested for the extraction of gold from base ores. After many successful experiments in Sydney, Mr. Campbell was invited by the Hon. John See to go up to Cangai, in the Clarence River district, and examine the Sir Walter Scott Gold-mine, from which the ordinary battery treatment failed to extract more than 14dwt. of gold, owing to the highly-mineralised character of the stone. The inspection of the mine was followed by careful experiments with the stone, and it was quite evident that the treatment was the best that could be applied. It was therefore decided that a complete plant should be erected, and, as it was the first plant of the kind erected, and the issues to the mining world generally were of the greatest importance, Mr. Campbell undertook to superintend the whole business.

Mr. Campbell left Sydney near the end of October last, and has spent nearly four months in the daily superintendence of the erection and subsequent working of the plant, and the development of the mine, which was in a sadly neglected condition. He was accompanied by Mr. Alf. A. Lockwood, one of the patentees, and the inventor of the process, to whom much of the practical work was entrusted; and Mr. Geo. Massey, of Post-office Chambers, Sydney, was engaged as consulting engineer. Owing to the heavy rains and the bad roads and flooded rivers the speedy accomplishment of the work was an impossibility, and it was not until a few weeks ago that the plant was ready for work. All difficulties are, however, now at an end, and the undertaking has been crowned with pronounced success, both as to the working of the plant and the yield of the mine. The old battery site was selected as the scene of operations, and a nest of six air-tight retorts was erected by Mr. Francis Peplow. These retorts are built after the fashion of the gas-works retorts; but above the six fire-clay retorts are two immense cast-iron retorts, which are used for the production of the gas required in the treatment. Connected with these is a steam-pipe from the boiler. They are charged with charcoal, and are kept at a temperature of 1,500deg. Fahrenheit. On coming in contact with this white-hot charcoal the steam undergoes decomposition, and forms hydrogen gas and carbon monoxide. These gases, to which the name of water-gas has been given, pass into the fire-clay retorts, which are charged with 5cwt. to 6cwt. of ore, broken by means of a No. 2 Dodge stone-breaker to about the size of hazel-nuts. Under the influence of the high

temperature—viz., 1,200deg. Fah., the gases seize upon the sulphur and arsenic of the ore, and, carrying them away, effect a sweet roast within eight hours. On being drawn, the ore is cooled with water, and is conveyed across the floor to the amalgamating-pans, which are the Lockwood-Nicholson patent, another invention of Mr. A. A. Lockwood's. These pans are grinding and amalgamating continuation-pans, and are described as being the most perfect of their kind. Their capacity is 3½ tons to 4 tons a day each, and at the end of the week's run it is found that, as the result of the complete arrangements for discharge, the concentrates from two pans and a settler only amount to 1cwt. The furnace is kept going continually, and during the week treats nearly 40 tons. This quantity, with fair running, is put through the two pans and settler in six days.

The workings of the Sir Walter Scott Mine consist of two shafts, a low-level drive 100ft. long at a depth of 130ft., an intermediate level at a depth of 75ft., and another at a depth of 110ft. going north. The ground between these levels and the surface both north and south has been completely honeycombed, only the ore which was supposed to be useless being left. At the low-level the stone averages 3½oz., but it is so highly mineralised that only 11dwt. can be extracted by battery. Owing to water, the stone can only be broken out by putting in a drive 300ft. long, which work will presently be commenced. Mr. Campbell's operations have, therefore, been restricted to the stone from the upper level, which varies considerably in richness, but averages, taking 100 tons as a basis, from 1½oz. to 2oz. to the ton, of which less than one-fourth is free gold. The stone contains 16 per cent. of sulphur and arsenic, and, when treated for eight hours, analyses showed ⅝ per cent. of sulphur, and only a trace of arsenic. The tailings from this ore assayed only 1dwt. 13gr. of gold, and the yield of smelted gold was nearly 1¾oz. per ton, or about 95 per cent. of the assay-value. Mr. Campbell describes his experiments as being of the most interesting character. When the ore was treated for only six hours, or when the men neglected to stir the ore as frequently as directed, the amount of sulphur left in the ore was from 1 to 2 per cent., and when this was the case the loss of gold was from 3dwt. to 6dwt. to the ton. When treated for four hours, the loss was 15dwt. to the ton; and when not treated at all, the tailings from half a ton of mineralised ore assayed 1dwt. less than before the stone went into the pans, thus clearly proving that without the treatment scarcely any gold can be saved, even with the most perfect pan-amalgamation. The treatment, when once the supply of gas is adjusted—itself a simple matter—is simplicity itself, and can be performed by any man accustomed to furnace-work. When the retorts are charged, it is only necessary to open them and stir the ore by means of a light hoe once every forty or fifty minutes. The furnace burns less than a cord of wood per day of twenty-four hours, and for the supply of gas during this time about 70lb. of charcoal are required. The weight of ore treated during twenty-four hours is about 6 tons, and the labour required in connection with the treatment of this quantity is one man or lad at the stone-breaker for one shift of eight hours, and to make himself generally useful; and three shifts of one man each at the furnace. It will be seen from this that the cost of treatment is very low, or between 8s. and 9s. per ton. Wood is plentiful in the neighbourhood, and is supplied at a cost of 12s. per cord. It is estimated that even with the present somewhat expensive method of working the mine—viz., by hauling the stone up the shaft and sending it down shoots 700ft. long—all of which can be obviated by a tunnel—the cost of raising, treating, and amalgamating is under 40s. per ton, and when Mr. Campbell's plans have been carried out this will be reduced by nearly 50 per cent. Owing to the hyperphoric treatment, the mine, which was virtually abandoned, has become a most valuable property, and Mr. Campbell declares that he has no hesitation in saying that at a cost of £2,000 a similar plant can be erected on any mine in the colony, and that, however refractory the ore, fully 90 per cent. of the assay-value will be won. With the valuable assistance of Mr. Lockwood, Mr. Campbell got everything in good going order, and handed over the management to Mr. J. F. Heighway, a gentleman of some scientific as well as great practical attainments in mining matters, and excellent results may now be looked for from the Sir Walter Scott Mine. Mr. Campbell desires us to say that he will gladly give information concerning the process. His address is "The Vicarage, Coogee, Sydney."—*Mining Standard.*

JORDAN'S PATENT CENTRIFUGAL GOLD PROCESS.

For the saving of their fine gold, the Faulkner G.M. Company, Pambula, New South Wales, have just had erected the plant required for Jordan's process of treating auriferous ores; and it is hoped that, by this method of treatment, much of the precious metal which has hitherto passed away with the water will be retained. The Jordan process is one of the many specially intended for the saving of very fine or refractory gold, and it is claimed that this end can be attained in a simple, satisfactory and economical way.

Milling.

"The plant employed is remarkable for its simplicity, and but little description is necessary. The usual stone-breaker begins the process. This is followed by a revolving pan set at an angle, and carrying three massive balls of white iron, which work in a suitably-shaped bed, also of white iron, around the greatest circumference of the pan. The ore and water are fed automatically into the bed of the pan, and by the rotary motion of the latter are conveyed under the rapidly revolving balls, whereby the comminution of the ore is effected. The inner half of the floor of the pan rises as a shallow dome surrounding the centre shaft, and is fitted with movable frames carrying wire-screens of any required mesh. The feeds of ore and water, and the inclination of the screens, are so adjusted that, as the ore is reduced to a sufficient degree of fineness, it is washed over the screens and passed away into a launder for conveyance to the amalgamator.

"A comparison of this machine with the most approved form of stamp battery reveals some highly important facts, which may be summarised thus: Cost.—A Jordan pan, equal in efficiency to a 10-stamp battery, is considerably less in first cost. To this saving must be added the greatly-reduced

cost of transport to the mine, as the pan weighs less than half that of a battery. A third economy effected is in the erection: Eminently simple and expeditious in the case of the pan, but a long and expensive operation with stamps. Generally it may be stated that the total cost of plant erected at the mines will not exceed one-half of that of a stamp battery. Efficiency.—The simple principle of the stamp battery (that of a falling hammer), which proves such an attraction to its advocates, carries with it several disadvantages. Not the least is its intermittent action: The time during which actual work is being done bears but a small proportion to the time the battery is in motion. Each hammer must be lifted to a greater or less height, and though the fall produces an effective blow, it is only at the moment of impact between stamp and ore that work is really done. Jordan's plan, on the other hand, has a continuous action on an evenly distributed and constantly changing layer of ore, and thus gets through a much greater amount of work. In fact, it disposes of a rapid feed at an astonishing rate. Trials with various ores showed a power of reducing 20 tons to 25 tons per twenty-four hours. Now, few 10-stamp batteries can do more than from 15 tons to 20 tons, even when the mesh of the screens is as low as 30. This one of the great faults of the stamp battery: Fine grinding is impossible at anything like a reasonable rate and cost. The outlet for the stamped stuff is so limited, and so ill-adapted, that it takes almost as long to pass pulp through a battery as to crush coarse stuff and pass it through. With Jordan's pan this is obviated; the screen area of which is much greater in proportion, and the screens are set at a very low angle.

"These features, combined with the wash produced by the rotation of the mill, and the inclination of the jet of feed-water, increase the facilities of outlet in a most remarkable degree. Another advantage which, in many cases, would be of primary importance, is that the consumption of water is only about half that required in the battery. In a crushing of 'Edwin Bray' ore which I witnessed, the water-feed was only a 1-inch pipe (where a 10-stamp battery would have had a 3-inch), and the ore, fed from a stone-breaker, was passed through an eighty-mesh screen at a surprising rate, not less than 20 tons per twenty-four hours. Such a result speaks for itself. Moreover, the power required to effect this is about half that needed with stamps, while the labour is virtually *nil*. With automatic feeds one man could watch a dozen pans, and the prodigal use of mercury, so common in batteries, is dispensed with. Wear and Repairs.—Here again Jordan's pan has advantages over the battery. There are only two wearing parts in the pan, *i.e.*, the balls and their bed. An examination of the latter, after six months' intermittent use, shows that the two surfaces wear in such a way as to maintain their proper relation to each other. When worn too thin, the bed can be removed and replaced with a new one with very little trouble. The screens are much less exposed to injury and wear, and are readily detached and renewed, any desired mesh being adopted. The frequent minor stoppages inherent to stamps with their numerons working parts are quite avoided.

Amalgamation.

"The only other apparatus employed is a novel form of of amalgamator. The stream or pulp, without any addition of water, flows into the hopper of the amalgamator. This machine consists of a series of shallow dishes attached one below another to a central revolving shaft, and enclosed in a fixed circular casing, which can be kept under lock and key. Secured to the inner side of the casing, and alternating with the dishes, are slightly-inclined shelves, also amalgamated. The pulp fed into the amalgamator enters the first dish, in which it is revolved until impelled by the centrifugal motion over the edge of the dish. It then falls on one of the shelves, and is thus conveyed to the centre of the second dish, there to undergo similar treatment. This is repeated to the end of the series, where the tailings escape. The free gold and silver contained in the pulp are completely arrested by the amalgamated dishes and shelves.

"The very high efficiency of Jordan's amalgamator is apparently due to several causes. In the first place the ore is reduced in the pan to such a degree of fineness that all precious metal not chemically combined is set free. Then the shape of the dishes and the manner and speed of rotation all tend to insure intimate frictional contract between the precious metals and the amalgamated plates, so that the finest particles of float-gold are retained, and the gentle attrition of the flowing pulp maintains the amalgamated surfaces in a constantly bright and favourable condition. Any amalgam which may become detached is caught in a well at the bottom of the machine, together with such mercury as may have escaped from the dishes when it is thought desirable to employ it. To such a high degree of perfection is amalgamation carried in this apparatus that it is capable of extracting nearly all the gold from most pyritic ores without calcination or any other treatment. In making such a statement I expect to incur the condemnation of theorists; but a study of the table of actual results achieved will substantiate my opinion. And a more startling piece of evidence, which may be deduced from the said table of results, is that in some cases the process is cheaper and more advantageous than chlorination itself; for whereas chlorination alone costs between £2 and £4 per ton, and seldom less than £3 for a return of 90 to 94 per cent. of the assay-value, the total cost by Jordan's process is only about 5s. to 10s. per ton, and the yield is often equal and sometimes superior to that from chlorination."—Extract from report by Mr. C. G. Warnford Lock, in the *Mining Standard*.

VARIATIONS IN THE MILLING OF OF GOLD ORES, OTAGO.

By T. A. Rickard.

The Province of Otago, in the South Island, was the first gold-mining district opened up in New Zealand. Its history dates from the discovery in June, 1861, of the golden gravel which made Gabriel's Gully a household word in the colonies. It has ever since continued to be more of a rich and extensive alluvial field than a quartz-mining country, but the last few years has seen considerable progress in the development of the quartz-lodes, whose importance is becoming better recognised. Up to March, 1892, Otago, which has an area of 20,000 square miles, has produced 4,889,563oz. of

gold, having a value of £19,310,707 or $96,553,535. For the year ended March 31, 1892, the yield amounted to 105,531oz., worth £423,527, or $2,117,635.

The milling practice has largely followed that of the older mining centres of Victoria, but altered conditions have induced some variations, which have given it certain characteristics which merit our attention. The three mills whose figures are given in the comparative table which follows are fairly typical. The Phœnix Battery at Skippers is one of the best known in New Zealand, and nestles at the feet of the snowy ranges of the Southern Alps. The Premier, at Macetown, is an old mill shortly to be replaced by a larger plant. The last on the list is a mill at Nenthorn, a mining camp which, though of comparatively recent origin, has already passed through many vicissitudes of alternating failure and prosperity.

Comparative Table.

Name of Mill.	Stamps.	Weight.	Drops per Min.	Height.	Depth of discharge.	Capacity of Stamp.	Capacity of Mill.	Grating.	Holes per Square Inch.	Concentrates.	Bullion.	Retort.	Wear of Gratings.	Loss of Mercury per Ton of Ore.	Consumption of Water.
		Lb.		In.	In.	Tons.	Tons.		Holes.	Per Cent.	Per 1,000.	Per Cent.	Days.	Dwt.	Gal.
Phœnix ...	30	800	78	7½	3½	1·4	40	Steel cloth	140	Not saved.	930	45	6	8·4	4
Premier ...	10	750	77	7	6½	1·2	12	*	180	Not saved.	949	34	8	7	3½
Reliance ...	10	850	75	7½	2½	2·0	20	*	200	Not saved.	850	35	12	5	5

* Round punched Russian iron.

The Phœnix Mill, at the head of the Shotover River, was one of the pioneers in the utilisation of electricity for the transmission of power. The plant was erected in 1884, and consists of two Pelton wheels under a head of 180ft., which drive two Brush dynamos, connected by two No. 8 B.W.G. copper-wires, nearly three miles long, to a Victoria motor, which in turn supplies the power to run thirty stamps, together with a rock-breaker, and to light the buildings.

Each stamp complete weighs 800lb. The speed varies from seventy-five to eighty drops per minute. The height of the drop is from 7in. to 8in. The depth of the discharge is variable. At the commencement of the month, and immediately after the clean-up, it is 2½in. The maximum distance from the bottom of the grating or screen to the die or false bottom is reached when the dies are worn down, and it is then 4½in. The average is therefore 3½in. The mill crushes 460 tons per fortnight of twelve working days, or at the rate of a little under 1½ tons per stamp per twenty-four hours. Two kinds of gratings or screens are in use. Wire-cloth is chiefly employed, but when the supply runs short the ordinary round-punched Russia iron is substituted. The holes in the two cases are of similar size, but the number of them per square inch is 324 in the one case and only 140 in the other. The pyrites which the ore contains has been proved to be of very low grade, and no after concentration is therefore attempted. The bullion is 930 fine. The last two shipments previous to my visit were: 922½ fine, worth £3 18s. 3d., and 933 fine, worth £3 18s. 3d. The loss or consumption of mercury was 90lb. avoirdupois during the crushing of 3,107 tons of ore, being at the rate of 8·4dwt. troy.

The gold-saving is done by the mortar-box and by blanket-tables, the residues from the one and the washings from the other both undergoing supplementary treatment in an amalgamating barrel. The method of milling is particularly simple. The ore passes through a rock-breaker and is fed by an automatic arrangement into the battery. The feeder, though a very elementary contrivance, does very good work, and is worthy of description. When there is insufficient ore on the die the tappet strikes the head of an iron rod whose lower end is fastened to a shoot leading to the ore bin. The bottom of the shoot passes upward under the ore, and the shock communicated by the stamp through the tappet to the ore causes it to move downwards into the free-hole of the battery. This is the idea which underlies most of the more complicated machines which are used for the same purpose.

The mortar-box has a depth from the lip or level of discharge of 9½in., distributed as follows: Distance from bottom of grating to top of die, 2½in.; thickness of die, 4in.; false bottom, 3in. The false bottom consists of two sets of four bars, which are placed under the dies and are packed in between with sand. Each of these bars is 3in. square and has a length of 2ft. 5in. The space between each bar and the distance of the outer ones from the side of the coffer or mortar-box is in each case 3½in.; the interior width of the coffer being 15½in. The whole arrangement is simply an expedient for surmounting the difficulties presented by a mortar whose shape is unsuited to the nature of the milling required by the ore. Before starting the mill, the coarse sand from the previous clean-up is packed between and around the dies. The order of the drop of the stamp is 3, 5, 1, 4, 2. No mercury is added to the ore when in the mortar-box, the gold being arrested by the action of gravity alone.

On leaving the mortar-box the pulp has three drops, making 18in. in all, before it reaches the uppermost blanket. This fall serves the purpose only of spreading the material. There are no amalgamating tables, and the pulp passes immediately over the blanket-strakes. These last have a length of 18ft. and a width of 6ft., subdivided into four partitions. The gradient is ⅞in. per foot. The quantity of water used amounts to about four American gallons per stamp per minute, and is supplied to each fifteen stamps by two 1½-in. pipes under a head of 25ft. The blankets are freed

from the gold and heavy sand which they collect by being washed in a tub of water. A vigorous movement through the water is given to them. The top row (there are four rows) of blankets is washed every hour, and the lower ones at longer intervals, depending very much upon the richness of the ore.

The blanketings, or residues from the washing, are removed from the tub when a certain amount has been accumulated, and are conveyed in buckets to a barrel, 5ft. by 4ft., having a capacity of 120 gallons, equal to about one ton of blanket residues. In running twenty-five to thirty stamps with the average grade of ore, 15dwt. to the ton, the supply for a barrel is obtained each day. Warm water is not used, nor are pieces of iron introduced as is often done in California, with the idea of assisting the grinding, but with the result of flouring the mercury. Experiments are being made with the use of bluestone. A full bottle of mercury is added. The barrel turns at a speed of twenty revolutions per minute.

When the amalgamation is considered to be completed, usually after twenty-four hours, the material is emptied into a vat underneath, from which it is slowly fed by a running stream of water to a shaking-table of the Rettinger type, and having dimensions of 8ft. length by 2ft. width. Below the table there are a few pieces of copper-plate, which, however, serve but little purpose. The collection of the amalgam from the contents of the barrel by the shaking-table occupies from 2½ to 4 hours, depending on the rate of feeding, which again varies directly with the heaviness of the pulp. The material—amalgam, pyrites, heavy sand, &c.—thus roughly concentrated is placed in enamelled iron buckets, to be further washed by hand in a "dish" or pan. This latter utensil has the shape of the ordinary friend of the prospector, but it is of copper, and, its surface having been amalgamated by frequent use, it readily collects the amalgam.

On examining the tailings below the shaking-table the writer found that they contained a large amount of floured quicksilver. It will be noticed by reference to the comparative table that a loss of 8·4dwt. of mercury per ton of ore crushed is there shown. This is more than the average, and is due undoubtedly to the excessive speed of the amalgamating barrel, whose 20 revolutions per minute should be diminished to about 14. At Clunes, in Victoria, the speed is 16 revolutions with a much smaller barrel. At the monthly clean-up the battery residues are roughly screened on a riddle, and the larger bits of quartz removed, previous to adding the remainder to the blanket-washings, to share with them the treatment in the barrel.

Before entering into a discussion as to the effectiveness of the milling, the following additional details will be of value. Two kinds of screens or gratings are used, wire-cloth and round-punched Russia iron. The friable quartzose character of the mill-stuff makes the former preferable. It is easier placed in position upon the screen frame, it has a somewhat longer time of wear, and a much greater area of discharge. The punched iron gives a finer crushing at first, before the burr is worn off, but afterwards becomes easily choked up. The short life of the grating, a week for the wire, and slightly less for the punched iron, is not due to anything in the ore itself, which is a comparatively clean quartz, but to the fragments of wood (from mine timbers), which to a more than usual extent find their way into the mill-stuff. They choke up the gratings, which, by reason of the pressure of the water and pulp, thus held back, are caused to burst. This is notably the case with the punched iron, which discloses lines of weakness along the vertical divisions made by the press employed in their manufacture.

The wire-cloth, No. 18 mesh, costs 9s. per yard. It is sold in pieces 30 yards long by 2 yards wide. The grating cut out of this is 2ft. 6in. by 10in. On the other hand, 120-punched Russia iron grating costs £17, or 2s. 10d. apiece, as against 2s. 2d. for the wire-cloth. The expenditure under this head amounts to £5 per month for the thirty stamps.

In the place of blankets green baize is used; it costs 3s. per yard, and has a time of service varying from three to four months. The expenditure per month is equal to £7 for the entire mill. Those which are least worn are always placed in the first row. The washing of the blanket is done by boys, the wages being 7s. 6d. per shift. One stout lad will do the work demanded by three batteries, but cannot manage the washing of the blankets belonging to four batteries, or 20 heads.

The treatment of the ore as carried out by this mill is interesting on account of its simplicity. Before questioning whether it be correct in principle, we must examine the ore. This is essentially of the free-milling type, and is broken from a large quartz-lode traversing schists. The quartz often has a laminated or ribbon structure which renders it readily broken. Inclusions of country rock are common. Pyrites or other sulphide minerals are present in very small proportion, from about ½ to ¾ per cent. only. Concentrating tests have shown that the best product will contain only 10dwt. of gold, giving a value too low for treatment in this particular locality, and on the same scale required by the necessities of the case. The gold occurs free. Ore containing more than the usual percentage of pyrites is generally below the average grade. The gold is not therefore notably associated with pyrites. It is usually coarse and often visible. Quartz in the stopes which does not, on examination, show occasionally specks of gold, is generally of low tenor. On being crushed, the matrix of quartz readily separates from the particles of gold. In the mill it would be expected that the coarsest gold would be found to remain in the mortar-box, and that obtained from the first row of blankets would be less fine than that washed from the bottom row. Such is the case; that found in the batteries on cleaning up is very coarse indeed, pieces weighing 5dwt. to 8dwt. being occasionally obtained.

The mill is illuminated at night by electricity, and on examining the blanket-strakes by the aid of the powerful arc light, the yellow particles of gold can be distinctly seen scattered over the green baize. The clean-up indicates the distribution of the gold-saving: 230 tons yielded 691oz. of amalgam. Of these 691oz., 270 came from the blanket-washings and 421 from the residues in the mortar-box. Thus about 61 per cent. remained in the battery. On retorting, 313oz. of bullion resulted; and upon melting, this was reduced to 301oz. 4dwt., worth £3 19s. 3d. per ounce.

The two most striking features of the method of treatment are, first, that no mercury is used in the mortar-box, or, indeed, in the mill proper, its use being confined to after treatment; and,

secondly, that the gold-saving is effected by gravity only. This system is borrowed for the most part from the mills of Clunes, Victoria, and was by them in turn derived from those of Nagyag and Verospotak, in Hungary. It will be allowed that the more simple a mill treatment is the better, because it is also usually cheaper. Another milling axiom is that the treatment should vary according to the nature of the ore. Here, if the methods employed are elementary, the character of the mill-stuff is no less strikingly simple. Whether the mill succeeds in the extraction of a proper percentage of the value in the ore is, then, the question? In this case the repeated assays of the tailings from the Phœnix Mill prove that excellent work is being done. The composition and character of the ore justify the entire replacement of the ordinary copper-plates by blankets; and the successful extraction confirm this.

In milling, as in mining, we are apt to generalise somewhat hastily, and the good work done by this mill has made the manager of the Phœnix—to whom I am indebted for courtesies received—an enthusiastic advocate of blankets, and an equally pronounced enemy of amalgamating-plates. He communicated to me the following result of an experiment carried out at his mill. Two five-stamp batteries were supplied with 80 tons each of the same kind of ore. No. 1 battery was provided with mercury inside the mortar-box, with copper amalgamating-tables outside, with mercury-wells, and, finally, two rows of blankets. No. 2 battery was supplied with no mercury, and was supplemented by blankets alone. The result of the test showed that 8oz., or 2dwt. per ton, more was obtained by No. 2 than by No. 1.

In condemning copper-plates, the manager equally objects to the use of mercury in the rest of the mill, and would confine its employment to the final collection of gold in the blanket washings. As a case in point, and to confirm the correctness of his ideas, he instanced the Invincible Mill, on the other side of the range of mountains, where the gold-saving was done by the mercury in the battery itself by wells, by amalgamating-tables, and lastly by blankets. On ceasing to add mercury to the ore in the mortar-box, it was found that more gold was saved.

The two instances at the Phœnix Mill and at the Invincible merit careful examination. Take the second case first. It so happened that I had visited the Invincible Mill, though it was then idle. It seems no wonder to me that the addition of mercury to the ore when in the mortar-box did not improve the gold-saving; that it indeed caused a loss, for the mortar-boxes were merely square iron boxes, in no way modified to do the particular work required of them. The explanation of the results above quoted appear to be sound, in the fact that the mortars were not designed of a shape adapting them for amalgamation inside, and there is no opportunity given to amalgam to collect out of reach of the falling stamps: but, on the contrary, the quicksilver added was subjected to a violent agitation, which caused it to be floured; that is, broken up into a myriad of small globules. These last are readily borne away by the water, and, escaping with the tailings, also take with them a certain amount of the gold with which they may have come in contact.

At the Phœnix Mill the experiment quoted is vitiated in a similar way. You cannot make a mortar-box a successful amalgamating machine by the non-addition of quicksilver. The batteries of this mill are rectangular in section, with vertical ends and sides, and are in no way adapted for inside amalgamation. To make a fair comparison between the effectiveness of amalgamation as against blanket saving, it is necessary to have the two types of batteries, one roomy and of particular shape, the other narrow and severely rectangular, whose constructors has kept in view their suitability to the two modes of milling.

But there is no suggestion intended to be made that blankets could be advantageously replaced at the Phœnix Mill by amalgamating-plates. Different ores require different kinds of treatment. Generalisations are always dangerous. Now, if blankets will arrest your gold, it is obviously not advisable to use an expensive chemical like quicksilver, or to employ an apparatus so troublesome as copper amalgamating-plates. Here at the Phœnix the mode of milling is of unusual simplicity, but it is suited to the ore whose gold contents it is intended to extract; and in saying that, one has made the best commendation of any particular system of treatment.

Passing on to another mill, the Premier, at Macetown, is a much smaller plant, but is engaged in the treatment of a somewhat similar ore by slightly modified methods. The mill consists of ten heads weighing 750lb. each. The speed varies from seventy-five to eighty drops per minute. The height of the drop has a maximum of 9in. and a minimum of 6in., according to the hardness of the mill-stuff. The issue or depth of discharge averages 6½in., from 6in. when the dies are new, to 7in. when they become worn down. The depth is regulated by the insertion of a blind or blank piece of sheet-iron inside the screen frame, which increases the issue at the start when fresh dies have been placed in position. As the dies wear down, a smaller similar piece is inserted, and finally the full depth of the screen is utilised. The capacity of the mill is 65 tons to 70 tons per week of six working-days. The grating or screen is of round punched Russia iron, having 180 holes per square inch. The bullion is 949 fine, and the amalgam yields on retorting 30 to 38 per cent.

The gold-saving is done by the mortar-box, to which mercury is added, by the copper-plates on the tables outside, by wells, and finally by blankets, supplemented by a berdan pan.

There is no rock-breaker in use; the feeding of the batteries is done by hand. The mortars of the two five-head batteries are of different patterns. One is more roomy than the other, and therefore discharges the pulp more slowly. Seeing that amalgamation inside the mortar-box is desired, the mill-man is right in preferring the wider coffer, since it gives more shelter to the particles of gold and mercury, and thereby better favours the amalgamation. On examination I found, as was to be expected, that the pulp issuing from the wider mortar was finer than that of the other, though the same kind of screen was used in both.

Contrary to the usual practice, the blankets precede the copper-plates. On being discharged from the battery, the pulp has a drop of 22in. before it falls upon the first row of blankets. This drop serves no purpose, except that of spreading the material over the surface of the blanket-tables. These last are 12ft. long and 4ft. 3in. wide, divided into three longitudinal partitions. They slope

1½in. per foot. The blankets succeed each other in three equal lengths. The first, or top, row is washed every hour, the second every alternate, and the third every third hour. Then follow the copper-plate amalgamating tables, 9ft. long by 4ft. wide. The total length is subdivided by five wells, one each at the top and bottom, and three others at equal distances between. Of the five, three only are supplied with mercury. They are 3in. wide, and only ½in. deep.

The residues from the blankets are shovelled from one tub into a second, from which they are fed by a running stream of water into a berdan pan of 4ft. diameter. Instead of the ordinary ball, a suspended muller, called the "drag," placed at one side of the pan, does the grinding. This modification keeps the grinding and amalgamation separate, thereby preventing unnecessary flouring of the mercury.

A copper-plate, 4ft. 8in. by 2ft., is placed below the berdan with the view of arresting any amalgam escaping in the slimes. At the lower end of the plate there is also a mercury-well. The berdan makes one revolution for every three drops of a stamp; that is, twenty-five revolutions per minute, when the average speed of seventy-five drops per minute is being maintained.

Of the total amount of amalgam obtained, 60 per cent. is found inside the mortar and 33 per cent. in the blanket washings. The copper tables save the remaining 7 per cent. It was found that by using copper-plates below the blankets, as against a fourth row of blankets, about 5 per cent. more amalgam was obtained. This last observation is of interest, as proving what might otherwise be inferred, namely, that blankets are particularly suited to the saving of coarse gold, just as plates are particularly adapted to the arresting of fine gold. The third mill on the list is a comparatively new machine, and is of American design. It is to be regretted that the irregular yield of the Nenthorn mines has prevented any reliable tests being made with the view of comparing it with the older plants.

It will be noticed that at none of these mills is there any attempt to concentrate the sulphide minerals. As a rule, the Phœnix being a notable exception, the pyrites of the Otago lodes yield a very good grade of concentrates. There is, however, no chlorination or smelting plant in the province, and any concentrates obtained have to be shipped to Australia for treatment at a cost and delay proportionate to the distance. That fact goes far to explain the neglect of this part of the milling.

Before concluding, it will be well to glance briefly once more at the two older mills. Both the Phœnix and Premier lodes carry ore the gold of which is coarse and free. This explains the comparatively crude and very simple method of treatment. Under such favourable conditions blankets are very effectual contrivances for arresting the gold. This system of gold-saving is of very early origin. It was used in America before the discovery of gold in California. The mining districts of the Sierra Nevada borrowed it from the miners of Georgia, and they in turn owed it to those of Verospotak and Nagyag, in Hungary. It came back eastward when the discovery of the Gregory diggings started the mining industry of Colorado. It was derived by the mill-man of Otago from the mills of Clunes, in Victoria, which, like those of the United States, borrowed it from Europe.

Blankets mark the infancy of milling, and belong to the gossan stage of mining. They can only survive those changes in the ore which accompany the increased depth of the mines when that ore remains, as rarely happens, unaccompanied by much pyrites, and that pyrites not too closely associated with the gold. It will be noted that the Premier Mill uses less water than the Phœnix, due to the fact that the blankets of the latter have a less gradient and a larger surface. At the Premier mercury is added to the ore in the battery, while at the Phœnix this is not done. The latter is probably the more correct practice. The gold is coarse and free, and, other things being equal, when a large percentage can be arrested by the blankets it is probable that the still coarser particles which remain inside the battery would be caught there by reason of their own gravity, and without the aid of mercury. In both mills the final extraction of the gold from the blanket washings is roundabout and clumsy. It should be possible to treat the residues without so much manipulation.

In conclusion, while it may appear that the mills of Otago have but little that can be advantageously imitated by those of Colorado or California, for the sufficient reason that they are adapted to the treatment of an ore of a very simple character, yet the examination of their modes of working can be of value to the American mill-man in causing him to ponder over the why and wherefore of many parts of his own practice whose advantage he is too ready to accept without previous questioning or consideration.—*Engineering and Mining Journal.*

THE PRESENT STATUS OF STAMP MILLING.

During the past year the stamp-mill has contributed its customary share of the gold and silver extracted from the ores of the mines. The number of additional new mills erected has been considerable, and up to the general average. In Colorado, particularly, the opening up of new goldfields during the year has stimulated the demand for this type of reduction-works. In California, the addition to the number of stamps at work has been relatively small; while in Dakota, Montana, and Arizona the stamp-mill has held its own.

Owing to various causes, the deadness of the mining share-markets and the uncertainty in the statutes of white metal, there has been no unwonted activity in this or any other branch of mill building. This is partly due to the great care and judgment now exercised in these matters. The time has gone by, it may be hoped, when millings were put up in a hurry and allowed to rust in idleness and decay at leisure. The amount of money wasted in the erection of costly plants, where there was no mine capable of giving the necessary ore-supply, or in the building of reduction-works totally unsuited to the end in view, would if added up form a startling sum and compare well with the total dividends paid by the mines of the West. People are more careful now, more sane and

business-like, and, while the machinery business may be less lively, the mining industry cannot but gain by the change.

The mortality among new processes is proverbially great, yet the past year has brought forth more than its usual quota of new methods for the extracting of the precious metals from their ores. Many of these processes have died young, others look decidedly unhealthy, but it must be allowed that something serious and valuable has been done in this direction. The cyanide process has of late been the theme of much discussion, the result of its comparatively recent introduction into this country. It is, to many, a thing either to swear by or to anathematize, to be called the "Ultima Thule" of simple metallurgical treatment, or to be scouted as impossible and impracticable. It is still in embryo, crude and dangerous in the hands of the unlearned, and a puzzle to the most experienced. Though the knowledge extant upon the workings of this process would even if concentrated form but a weak solution, it is safe to say that it will in certain districts and with certain ores prove a most valuable aid to the miner.

New processes have been many, not only for the extraction of the gold and silver, but also for the preparatory crushing and pulverisation of the ores. Mechanical devices of all kinds, and nearly all very ingenious, have been invented and patented, each time directing attention to the fact that the stamp-mill is at the very best only a very unsatisfactory machine. It is clumsy to erect and regulate, it consumes an excess of power in proportion to the work done, and, while a simple pulveriser, it has the serious defect of sliming the ore. It is generally allowed that for preparing the mill-stuff for a wet concentration process stamps are defective, in that the pulp when sufficiently pulverised is not immediately discharged through the screen, but remains long after it is of a fineness admitting of its exit through the screen openings. This produces an excess of slimes. Further, for leaching processes dry-crushing is preferable, because it is easier for the solvent solution to replace air between the particles of the pulp than water. The stamp-mill is, as a dry-crushing machine, very inefficient, and has always been largely replaced by other appliances.

At present the stamp-mill has the one overpowering argument in its favour that it is a simple and thoroughly tried machine, that a man knows what he can do with it, and that while able to treat a great variety of ores it does not require the services of a scientific engineer nor the adjunct of a laboratory. This is true, but the times are near at hand when this feature will diminish in importance, when milling will come into line with modern tendencies and be as systematically managed and as scientifically worked as any other, as the more complicated fire-reduction processes. The result will be to discredit the rule-of-thumb methods now so generally in vogue, and to further encourage the inventive genius of the age in the production of a machine which will be free from the radical defects of the stamp-battery.

In the meantime no one who has been through the chief gold-mining districts existing to-day can have avoided noting the fact that a model stamp-mill, fully equipped with improved labour-saving appliances, and arranged so as to give the maximum of efficiency and economy, is as uncommon, as it is where found successful and satisfactory. There is more difference in the work done by, and the results obtained from, a badly constructed and carelessly arranged stamp and mill and a model battery than there is between the latter and some other, perhaps better, type of reduction process. The moral is that we may recognise the stamp-mill to be defective, and may foresee the approach of a time when it will give place to a better machine, yet, in the meantime, where we do use it let it be properly arranged and fully supplied with modern improvements, thereby making the best of existing methods until such time as newer methods shall have been demonstrated better than the old.—*Engineering and Mining Journal.*

DIFFERENT METHODS OF EXTRACTING GOLD FROM ORES.

GOLD AMALGAMATION METHODS.

It is said that on an average there is one patent per day issued, somewhere in the world, to a new amalgamating machine for saving gold. Of mills and pulverisers, too, there are many born each year.

These facts are evidence of the common and universal belief that the present and old methods of amalgamation are faulty, and capable of being improved. Probably the only men who do not share in this belief are the mill-men. They contemptuously stigmatize the inventions as "new-fangled things," and their dictum is supposed to settle the merits of the question. The common herd of humanity says at once "they have had experience, and therefore their judgment should settle it." And the common herd of humanity, as usual, are wrong, just as the mill-men are.

That the mill-men are generally right in their condemnation of new machines of that character, goes without saying. Their error lies in sweeping condemnation of everything new; their unwillingness to believe that there can be any improvement over old methods and ways of treatment, and their close adherence to the rule-of-thumb style they have adopted. They continue to carry the grist to mill in one end of the sack, balanced with a stone in the other, because they were taught to do so. Of course all mill-men are not as described, but the majority are.

If there is any one thing that science has taught very clearly, it is that different ores require different treatment in amalgamating mills. The mill-man, however, is slow to learn that. In the early days in Colorado, they came from California and tried to treat our ores as they had been accustomed to treat ores on the Coast, nor would they listen to the possibility of there being any better method, or any value in its modification. They failed. What is now known as the Colorado method, which is certainly better adapted to the ores in our great, and then only, gold camp, was evolved from years of experiment, every step of which was opposed by the mill-men from the Coast.

Thirty years have since elapsed, and the Colorado mill-man, educated in the Colorado method, is where the California man was in those early days. He carries his system to Arizona, Mexico, San Juan, and Cripple Creek, in blissful ignorance of the fact that the ores of each region may require different methods of treatment.

The average mill-man never tests his work accurately and scientifically. He scarcely ever carefully samples the tailings which run into the creek, and ascertains their value. And, stranger yet than that, when someone else does ascertain facts which show that only a small percentage of the total value of the ore is saved, he insists that the assays are wrong. Like the Frenchman, when told that the facts contradicted his theories, he answers, "So much the worse, then, for the poor facts."

Here are a few things which science has demonstrated over and over again, which the average mill-man denies, or, if he half admits them, rejects the philosophy based upon them.

1. Some ores require finer stamping, and finer screens than others. These differences require a change in weight of stamps, speed and height of drop, height of discharge, and width of mortar.

2. If there are pyrites in the ore undergoing decomposition, giving acidity to the water, a chemical problem is combined with the mechanical, and any number of modifications of methods of treatment may be tried te overcome the resulting troubles, some of which are pretty sure to have value.

3. The existence of some mineral, generally silver in some form, may make it advisable to stop and clean plates much oftener than would otherwise be necessary.

4. The gold may be coated with silica or rust, requiring a modification of methods.

5. Metallic iron may interfere very materially with amalgamation.

6. A galvanic current may benefit or be injurious to amalgamation, or have no effect upon it, according to the ore treated.

7. The gold may occur with hydrated oxide of iron, free from sulphides, in which heating is not only beneficial, but actually necessary to secure even fair results.

8. More important, perhaps, than any other thing mentioned, is the fact that the gold may be so fine, that a decided modification of the method used may be desirable.

The last-mentioned point is the most common one which meets mill-men, and based upon tests and experience in Australia, India, and the Black Hills, one might be pardoned for believing that the Colorado mill is decidedly imperfect. In Australia, in many of the mills the amalgamated plates are arranged in steps, so that the pulp, in passing from one to the other, falls from 7in. to 12in. In India, the same plan is reported, and in all cases the result is said to be good.

Dr. W. P. Headden, Professor of Chemistry in the School of Mines, at Rapid City, South Dakota, gives the only rational explanation we have heard of why this plan gives good results, which he says it does give. He believes that the force of the fall of the fine particles of gold or floured quicksilver—the impact—is what causes the amalgamation of particles which would otherwise escape in the tailings. It is, perhaps, for this same reason that so large a percentage of the amalgamation takes place on the plates in the battery, which are universally used in Colorado. The pulp is dashed by the falling stamps upon these plates, very much with the same force that it receives when falling from one plate to the other.

At the Homestake Mill, in the Black Hills, this modification, we believe, has been adopted, coupled with an electric charge upon the plates, and a considerably higher saving is said to be the result.

An illustration of the necessity of changing amalgamating methods to fit ore, is seen at Cripple Creek. The methods adopted in Gilpin County long ago were adopted there. Mill-men claim that they save 75 to 90 per cent. of the value in the ore. As we have not yet seen one who carefully sampled the waste run into the creek, and as we have, in four different tests, sampled it and found that the saving was less than 40 per cent. we are inclined to think that the claim made is not well-founded, and that a modification of milling methods in use is necessary to get as good results as possible. In one case we found a hydrated oxide of iron in the porphyritic ore, and the saving was about 14 per cent. The ore was heated, after which it readily yielded 75 per cent. of its gold by amalgamation. The ore, however, contained no sulphides. The same method, it is reported, is soon to be adopted on an ore which contains considerable iron pyrites. Heating will decompose these sulphides, and form soluble sulphates, giving an acid water. Whether the effect of the acid will be an injury to offset the benefit derived from dehydrating the oxide of iron, is a question yet to be determined. It, however, opens an interesting field for experiment, which will certainly result in giving information of value in the way of improving present amalgamating methods.—*Mining Industry and Tradesman.*

GOLD AMALGAMATION.

By C. G. Warnford Lock.

The following interesting paper on "Gold Amalgamation" (taken from the London *Mining Journal*) was read by Mr. C. G. Warnford Lock at the third ordinary meeting of the second session of the Institution of Mining and Metallurgy, held in London on the 21st December last.

Mr. Lock said: The natural affinity which exists between gold and mercury, and the ease with which their combination can be broken up again without appreciable loss of either metal, led in very early times to the adoption of mercurial amalgamation as a means of recovering gold from auriferous mineral; and, notwithstanding the introduction in recent years of many other processes for extracting gold from so-called "refractory ores," it is probably no exaggeration to say that nine-tenths of the gold now being won is obtained by amalgamation. The subject would, therefore, appear still to be worthy of some attention. At the outset, we come to the question of the state in which gold occurs in nature. On this point there is some diversity of opinion, apparently due to different experimenters working on different ores. But if we admit that in some cases the gold is

in chemical combination with tellurium, and, perhaps, also with antimony, and that in other cases it may exist as a sulphide soluble in another sulphide (on the authority of Professor Roberts-Austen), whilst in a third case it may be present as a chloride associated with silver chloride, yet the sum of all these cases will give but a very small figure in comparison with the enormous number of instances in which it is only mechanically associated with the other ingredients of the mineral. It is in this predominating case of the gold being in a metallic state that the amalgamation process is applicable.

Difficulties of Amalgamation.

Before amalgamation can take place, the mineral, or that portion of it which contains the gold, must be reduced to a size proportionate to the dimensions of the gold particles. This is a self-evident proposition, but is worth mentioning because it is not always sufficiently recognised. When the gold occurs in relatively coarse grains, associated only with quartz or other equally innocuous materials, then the conditions render amalgamation a comparatively simple and easy proceeding. But, as a rule, this is not the case; and it more often happens that the gold, though in actual metallic grains, is in such an exceedingly fine state of subdivision that it is necessary to reduce the mineral to a practically impalpable pulp, in order to liberate the metal, while the presence of matters other than gold and rock helps to complicate the process of amalgamation. It would seem almost superfluous to insist that in all cases amalgamation is a very delicate metallurgical operation, demanding *absolute contact* between the gold and mercury, and that failure is mainly attributable to imperfection of contact caused by the interposition of some other body. So delicate is it that the grease which may be imparted to the surface of a sovereign by mere handling in the fingers will act as a deterrent.

The chief hindrances to amalgamation having their origin in the ore are: (1.) When the gold particles have been beaten so as to render them very dense and compact. (2.) When their surfaces have become studded with barren rock. (3.) When they have been flattened so as to render them abnormally buoyant. (4.) When they are so minute as to remain long suspended in flowing water. (5.) When they are coated with a film, usually of some metallic salt. (6.) When sulphurets present in the mineral have commenced to undergo decomposition, whereby sulphates are liberated. The first two evils are entirely due to faults in the reducing machinery, and the remedy can only be applied there. Probably their occurrence is too rare to be an important matter.

Concerning "Float" Gold.

The risk of "float" gold (by which is meant gold that remains long in suspension in water) arising from the causes named in (3) and (4), is much more real, though some authorities affect to disbelieve in its existence. In my experience, it is a potent factor of loss in amalgamation; and while there can be no doubt that flattening does, in some instances, take place in the stamp-battery, I am convinced that the microscopic fineness of the gold particles is much more often a natural feature than one created by over-stamping. It is a source of waste which is very generally neglected, partly because considerable care and skill are required to determine its extent, and partly because, with ordinary appliances, it is almost impossible of prevention. Therefore, where paying returns are got from the coarse gold saved, no trouble is taken to reduce this evil, and hence few mill-managers have given that attention to the subject which it deserves. It is only where there is no coarse gold, and where success consequently depends upon saving the fine gold, that the question assumes such importance as to command study. Quite recently I have seen properties in America where, despite the fact that nearly the whole of the gold is free, yet the amalgamation mills built to deal with the mineral have failed, owing, it is said, to the fineness of the gold, and chlorination mills have been erected in their stead. This you may consider to be an extreme case, but Cosmo Newbery found gold at the rate of 42oz. per ton in some slimes that only coloured the water, from a New Zealand ore, and in another instance at the rate of 20oz. per ton in slimes escaping from Frue-vanners. Therefore, I repeat that the "float" gold difficulty is an actuality, and not to be lightly dismissed as imaginery.

And to go a step further, I contend that with many ores the gold is so fine that the creation of slimes, may be an absolute desideratum, and that to stop short of it may mean leaving gold imprisoned in the grains of mineral. For the advocate of the amalgamation to cry out against slimes, is simply to admit his inability to grapple with the question. Either he must find a means of dealing with exceedingly fine and "float" gold, or he must retire in favour of chlorination or some other solution process. I believe, however, that amalgamation can be made to do the task efficiently and cheaply, though not on the lines in vogue now. "Coated" gold is not uncommon. In some cases the term "rusty" is well applied, the native gold particles being shielded by a film of iron oxide. In other instances the gold is rendered black by a jacket of manganic oxide of iron; or the envelope may consist of silica or a silicate of iron; while in the Transvaal it has been asserted that mineral oil, permeating the formation, has proved a serious obstacle to amalgamation. Even ores which have been roasted to drive off sulphur, arsenic, &c., are not always free from the same drawback, as imperfect roasting may result in the gold being concentrated in melted mono-sulphide of iron, or coated with a skin of magnetic oxide. So pernicious is the coating of the gold that, even when the coat is thin enough to be transparent, the gold will resist amalgamation after weeks of immersion in mercury. The presence of only clean sulphurets, especially the common cubical iron pyrites, does not materially interfere with amalgamation. But it is rare to find auriferous mineral which does not contain a larger or smaller percentage of the readily decomposed cupreous, or arsenical, or antimonial sulphides, which, on decomposition, seriously affect the usefulness of the mercury, apparently by forming sub-sulphates with it and adhering to its surface. They thus lead to a double loss—of mercury, which is sulphated and washed away, and of gold, which cannot reach the mercury through the film of sulphate.

Pure Mercury a Desideratum.

It may appear to be unnecessary to lay stress upon the urgency of starting with clean and pure mercury, yet that is a point often overlooked. Moreover, on exposure to the air the surface of the mercury will become oxidized sufficiently to hinder actual contact with the gold. Another important consideration which is apt to be lost sight of is the value of having a good body and a large surface of mercury. When mercury is broken up into a number of tiny atoms the oxidation of the multiplied surfaces must be enormously hastened, and the efficiency thereby reduced. When the particles become very fine they are rendered actually valueless as amalgamators, and finally disappear in the tailings, especially in the presence of even small proportions of sulphides undergoing decomposition. Amalgamation is essentially a wet operation, and cannot be satisfactorily accomplished except in the presence of water. Hence it is of importance to secure water which is free from salts in solution and solids in suspension. Mine waters are especially bad on this account. In a low temperature amalgamation is sluggish, and, therefore, it is customary to supply heat in cold weather; but summer water is often much less pure than winter water, and decomposition of the sulphurets is more rapid in the presence of heat, so that these two conditions may combine to more than counteract the advantages of a genial climate.

Amalgamation as now Practised.

Now, as to prevailing methods of effecting amalgamation. And here I venture to put forward the contentions that they are imperfect; that they are wrong in principle, and, therefore, cannot be perfected; and that improvement must be sought in other directions.

To commence with battery amalgamation. I cannot find a single argument in its favour, and I maintain that such amalgamation as does undoubtedly take place when mercury is fed into the mortar, happens in spite of, rather than by reason of, the conditions presented, and always at the cost of efficiency in reduction, which is the prime and only real duty of the battery. You cannot get two distinct and antagonistic operations out of one machine without detriment to both. That is surely a simple axiom. The effective capacity of the battery is curtailed to a most important extent by the discharge being retarded in order to give time for amalgamation, and by amalgamated plates occupying a portion of the never-too-abundant space which legitimately belongs to the screens. These evils will be the greater according as the reduction needs to be carried to a finer point; so that it becomes greatest in those cases where the reduction process is most prolonged and most costly. Then there is the drawback that the mercury, instead of being presented in a clean, substantial, and constant state, is broken up into the most minute particles, many of which must become inoperative, while all are exposed in a maximum degree to the injurious effects of decomposing sulphurets and other sources of contamination in the water. Unless the supply of mercury is much in excess of what the ore requires, amalgamation can only be very partial; if an excess is provided, the waste must be all the greater. During milling operations the amalgamation is quite beyond control, and must proceed haphazard. Another drawback which has not been estimated is the evil influence of the metallic iron worn from the shoes and dies. The inconsistency of putting mercury into the battery is obvious. We lament the smallness of the gold particles, and the difficulty attendant on collecting them from the mass of pulp in which they are buried, and forthwith we take pains to smash up the mercury into tiny atoms also, ignoring the fact that in proportion as the globules of mercury becomes smaller its efficacy is diminished, and the risk of its escaping with any gold it may have picked up is increased. To sum up the case of battery amalgamation, I submit that it must be condemned from both scientific and economic points of view.

The Amalgamated Copper-plate Table.

Now for the amalgamated copper-plate table. That such a cumbersome and imperfect apparatus should have come to be regarded as indispensable is sufficient evidence that a little study may yet be profitably devoted to the problem of amalgamation. Assuming that the difficulties attendant on getting the plates properly annealed and dressed are satisfactorily disposed of, the next consideration is to determine at what inclination they shall be set. A very great deal depends upon the grade being properly adapted to the ore, at the same time that it is practically impossible to insure the exact attainment of this end, because the plates once fixed their angle must remain the same, while the conditions which govern what it should be are subject to constant variation. Amalgamating the surface is a long and troublesome process, and it often requires weeks to get a new plate into condition, after which unremitting attention is necessary to keep it so. When it is in perfect condition, and the gold is coarse and free, we can count on catching 80 per cent. of it in this way. But for close work on fine gold the fixed plate is a failure, no matter how great an area is exposed. Suspending the plate and giving it a slight oscillating motion is a step forward, but it does not go far enough, and I believe from experiment that a rotary motion is the only one likely to lead to the attainment of satisfactory work. The centrifugal action spreads the mineral in such a way that an exceedingly thin film can be secured, in addition to which the particles are quite prevented from assuming stratification, and the friction engendered between the ore and the plate helps to secure the maintenance of a bright surface on the latter. The arrangement of a series of revolving dishes superposed on a vertical spindle provides an enormous area of amalgamating surface within a very small space, and is easy of access and control. Some three years ago I made a number of successful trials of a machine constructed on this principle, and expressed myself accordingly in its favour. Recent reports from Montana, where the machine has been in operation for some time on tailings from the mills of the Montana and other companies, more than confirm my opinion. The saving of 80 cents a ton, which is effected on the Drumlummon tailings, means an addition of £14,000 a year to the income of that mill. This result is achieved on the tailings as discharged, not on old tailings which have undergone more or less decomposition; and the mill in question has the reputation of being equipped with every approved device for the

amalgamation of the float or greasy gold contained in the ores which it is treating. Hence it is a crucial test of the centrifugal system, and an indubitable evidence of its value.

While on the subject of plates, I may mention one or two departures from the stereotyped form which have come under my notice. The first consists in studding the surface of the plate with a number of little circular depressions in which mercury and amalgam can collect; its claim to novelty may be good, but the drop is too shallow to produce immersion of the ore, and I do not see what advantage it possesses over the ordinary mercury trough at the foot of the plate, even if it can be considered equal to the older method. Another apparatus was inspired in the brain of its inventor by the fact that a drop of dirty water falling upon a smooth surface has a strong tendency to free itself from the dirt at the moment of impact, and from this it is deduced that if a mixture of mercury and ore-pulp be made to fall in drops upon an amalgamated plate, the mercury and gold will separate themselves from the sludge. Personally, I do not quite see the parallel, though I am willing to admit that forcible contact may favour amalgamation by momentarily cleansing the opposing surfaces. The machine made on these principles provides for thorough comminution of the mercury and its complete admixture with the pulp, the two then dropping in intimate association through numerous small holes so as to resemble a shower of rain. The fall is arrested by angular and flat amalgamated plates, provided at intervals with gutters, the mercury being supplied always in abundant excess, and returned again and again as it flows off. The machine is simple, inexpensive, and automatic, and it is reported that the amalgamating surface is always kept bright by the friction induced. It is said to have done good work on tailings and slimes with very small loss of mercury. The claim is rather vague, but I can quite conceive that with a properly adjusted feed it is capable of doing better work than the ordinary fixed plate. The third novelty to be described has very modest aims, and is simplicity itself. It consists in making the plate corrugated instead of flat, and supplying it at intervals with a corrugated lid, so that the pulp passes between two amalgamated surfaces. The whole is set at such an angle that packing is impossible, and the surfaces are electroplated to withstand the wear. Mercury is furnished occasionally, and occupies the depressions, being, however, at the same time forced to travel partially up the ridges by the flow of pulp. The only merit claimed for the apparatus is that it will catch float-gold; and certainly for this purpose it is well designed, and has the advantages of requiring no power whatever, and next to no attention. Placed in tailings-gutters where there was a loss of float-gold, it has effected a notable saving. In my opinion, mercury troughs are capable of doing much better service than ordinary amalgamated plates, besides being more compact, occupying far less room, and giving less trouble. As it is, they are regarded as a necessary adjunct to plates, saving gold, amalgam, and mercury, which would otherwise be lost. They can be arranged so that the pulp shall drop into a succession of them, and undergo actual immersion in the mercury in each, which is much more effective than merely floating over a more or less imperfectly amalgamated surface.

The Mercury Bath.

A development of the mercury-bath principle is to be found in the multifarious forms of "pan," from their prototype, the *arrastra*, down to the most complicated and "improved" modification, as well as in many other specially-contrived machines. They may be classed in two distinct groups, viz., those which aim simply at effecting an intimate commingling of the ore with the mercury, and those which at the same time grind the ore to a finer condition. It cannot be claimed that very striking results have been obtained from any of them. Nor is this surprising. They are employed almost exclusively on pyrites and tailings, where the conditions encountered are most unfavourable, and they endeavour to accomplish by rough and ready methods that which is a delicate operation at all times, and which, in their case, is rendered more difficult by the increased formation of sulphates from the ore. Those machines which combine grinding with amalgamation merit the same condemnation—only more severely—as the practice of putting mercury into the stamp-battery, and for the same reasons. Where iron is used in the frictional surfaces of the machines, the results are least satisfactory. In every case the loss of gold and mercury by flouring and sickening is great, and the capacity of the plant is very low, which means that pans cannot be worked on poor material. The general backwardness of amalgamation methods may be largely accounted for by undue attention having been given to the mechanical aspects of the problem, and neglect of the chemical questions involved. It is true that the preparation of the ore and the manner of introducing it to the mercury are essentially matters for the mechanical engineer; but the actual amalgamation is a chemical operation, and must be dealt with from a chemical standpoint. This is emphasized tenfold in the case of pyritic ores. As they are in very many instances the most highly auriferous, and are always the most tenacious of their riches, the chemical aspect of the undertaking forces itself upon our attention, and it is undoubtedly in this direction that we must seek to extend and apply our knowledge. The little we do know on the subject would seem to indicate that sulphuric acid, in the form of sulphates of the base metals, is the chief chemical agency in hindering amalgamation. An obvious remedy is to provide an alkaline base which will absorb the acid with avidity. Hence the addition of a small quantity of lime to the pyrites heap, and leaving it for twenty-four hours to react on the acid formed, is often attended with good results But as it is the mercury that requires protection, there would seem to be promise of better results if the alkali were furnished continuously and freshly to the mercury bath; and the facility for doing this which is presented by the mercury-trough arrangement is, in my estimation, an additional point wherein the mercury trough surpasses the amalgamated plate.

The Ideal Amalgamator.

The ideal amalgamator should provide a constantly clean and bright mercurial surface, coupled with mechanical means of forcing each gold particle into contact with that surface. The chemical agent used must be cheaply and easily procured all over the world. The power required must be

very little, and the capacity must be large. This brings me to a consideration of what has been done to practically carry out the theories and apply the principles I have laid down. Only one such machine has come within my knowledge. Its object is two-fold. By means of electro-chemical action, produced in a very simple manner, the mercury in an unbroken body is permeated by constant streams of hydrogen and sodium, the effect of which is to prevent or remedy any flouring or sickening, and to increase the absorptive or occluding energy of the mercury. Further, by a simple mechanical contrivance, every particle of the mineral under treatment is rolled on the surface of the mercury-bath, and kept in contact with it for a period of a quarter to half a minute. The machine consists essentially of a circular pan or dish, about 3ft. 4in. across, usually made of cast-iron, for portability, though a cement-lined concrete structure would probably be an improvement where the apparatus is intended to be a fixture. The centre of the pan is occupied by a topless and bottomless ebonite box, called the anode-box, formed by two cylinders, one within the other, and held together by cross-pieces; the sides reach about 4in. high, and the whole is pressed down so that the lower edge is immersed about ¼in. in the mercury, which thus forms the bottom of the box. The anode consists of a bar of lead, which in use soon becomes coated with peroxide. The anode-box is partially filled with an alkaline solution, which generally takes the form of carbonate of soda, a sufficiently cheap and available article. In this aqueous electrolyte rests the lead anode, which is connected by insulated wire with the positive pole of a battery or dynamo. That portion of the pan not occupied by the anode-box contains mercury, which is in uninterrupted communication with the mercury lying at the bottom of the anode-box, and presents a circular channel about 1ft. wide. This circular bath of mercury constitutes the cathode, being connected by another insulated wire with the negative pole of the dynamo, thus completing the circuit. Immediately over the surface of the mercury in the outer channel rotates a wooden disc, so arranged that while its inner edge rises free above the mercury, its outer edge just touches the surface of the mercury. The auriferous mineral, in a state of thin pulp, is fed continuously on to the surface of the mercury in the outer channel, at a point close to the anode-box, so that it immediately passes beneath the inner edge of the disc, and is thereby rubbed and rolled over and over in a constantly-increasing circle on the top of the mercury, and is finally immersed in it for a few seconds, before it escapes over the outer rim. In the matters of speed and the space between the mercury and the disc, the latter can be adjusted to suit the requirements of the ore. When the electric current is turned on, it passes from the positive pole of the dynamo to the lead anode in the anode-chamber. Thence, in order to reach the mercury, it has to pass through the electrolyte, lying between the anode and the mercury which closes the bottom of the anode-box. This it can only do by decomposing the solution, say of carbonate of soda, with the result that oxygen is given off at the anode and forms a coating of peroxide of lead, carbonic acid gas escapes into the air, and hydrogen and sodium are liberated on the mercury. As fast as the hydrogen and sodium are set free, they are occluded by the mercury, and spread throughout the body of mercury lying outside the anode-box, constantly tending towards the surface. When the rising sodium comes into contact with the water which accompanies the ore-pulp, it decomposes a portion of the water, combining with the liberated oxygen, while nascent hydrogen is evolved in considerable volume from the surface of the mercury. Now, in the presence of nascent hydrogen, the mercury cannot "sicken," cannot become oxidized or sulphated, and, as a consequence, its surface is maintained in a constantly bright and "quick" condition. Further, the hydrogen exercises a strong cleansing action on the particles of metals presented for amalgamation. The sodium also tends to free the metallic particles from impurities, and, even after its combination with the oxygen of the decomposed water, it performs a useful office in destroying any greasy substance which may by any chance have found its way in with the pulp.

In its ordinary form the machine weighs about 4cwt., and its capacity is 10 tons to 20 tons a day (twenty-four hours), according to the character of the ore and the length of the contact required. It takes the pulp direct from the reducer (stamps or otherwise), and dispenses with plates, blankets, &c. The maximum speed of the disc must not exceed 16 revolutions a minute, or mercury may be thrown out. Fine crushing is essential—the finer the better. The full charge of mercury is 270lb., none of which is lost. The dynamo should give about 15 amperes of current and 5 volts of force. The power required for each machine is under ½-horse power. One skilled workman can easily superintend five or six machines. The only chemical used—*i.e.*, the carbonate of soda—is consumed in very small quantity, so that its cost is covered by a halfpenny per twenty-four hours. In its earlier form this machine was a failure. It was found that in proportion as its action was prolonged so was the result less satisfactory. The fault was at last traced to the use of sulphate of soda as an electrolyte, the liberated sulphuric acid having a most injurious effect upon the mercury. On replacing the sulphate by the carbonate of soda, this difficulty disappeared, and success followed. Recent trials on "rusty" gold, or auriferous magnetic oxide of iron, on iron, copper, and arsenical pyrites, and on sulphide of antimony in Africa, America, and Australia, have shown that the machine is capable of exhausting the gold from all these ores in a raw state to a degree hitherto not attained, and this without loss of mercury and at a cost of about 3d. per ton for power, electrical energy, and chemicals. Professor Ricketts, of New York, succeeded with it in extracting 2½dwt. of gold per ton from some pyrites containing rusty gold, which yielded nothing at all to other amalgamating appliances. In a second case he gained an increase of 62 per cent. in the value of the return; and in a third case, of mixed iron and copper pyrites, he got 9dwt. as against 1dwt. At the Providence Mine, Nevada, one of these machines placed in the tailings gutter, after plates, blankets, and vanners, took out 1dwt. of the 1½dwt. per ton going to waste. Turning now to African mines: at Salisbury, where the blanket assays about 18dwt., carrying 5 per cent. of pyrites, and creating much greasy slimes, the extraction was 78¾ per cent., as against 60 per cent. by other methods; and the gold in the residue was not attacked by chlorine water until after roasting, showing that it was presumably not present in the metallic state. On the Murchison

Range, in the North Transvaal, ores containing antimony, arsenic, and sulphur, which yielded only 20 per cent. to 30 per cent. of their gold by other amalgamation methods, gave 72 per cent. to 77 per cent. by this process.

SOME POINTS IN SILVER-MINING BY AMALGAMATION.

By C. H. Aaron.

The present low and prospective lower price of silver makes a close study of the methods of its extraction more than ever necessary, and I offer a few points from my experience with some, though faint, hope that others may do likewise, which would surely inure to the benefit of the industry.

Silver-milling differs from gold-milling in that it is more of a chemical and less a merely mechanical operation, in so far as amalgamation is concerned. The gold which may be collected by means of quicksilver is already in the metallic state, and, while chemical considerations are not foreign to the subject, yet the main problem is the mechanical one of forcing the gold to intimate contact with the mercury, after freeing it from its rocky envelope. Silver, in ores, is almost invariably in some form of chemical combination, from which it must be released by chemical action before it can be united with mercury as an amalgam.

Silver exists in ores in many different combinations, and these compounds are often chemically combined or intimately mixed with base metal compounds, which complicate the process of extracting the precious metal.

An example of the mixture of a silver compound with a base metal compound is seen in some argentiferous galenas, which, when triturated with moist sodium disulphate (sodium hydrogen sulphate), yield hydrogen sulphide, lead sulphate, and silver sulphide, the latter not being acted on by the re-agent; in jasparite, on the other hand, it is probable that the silver and copper exist as a double sulphide.

Among the native compounds of silver, the chloride, bromide, and iodide are perhaps the only ones which can be metallized by simple contact with iron in the presence of water, and even with these the effect is promoted by an addition of salt and the application of heat. According to some authorities, silver glance (silver sulphide) yields the metal under the electro-chemical action of iron and quicksilver in the presence of hot brine, but it does so better if bluestone is also added to form cupric chloride by the aid of the salt. Other compounds generally necessitate the use of bluestone and salt, and even native metallic silver is much more readily recovered with than without such aid.

The copper chlorides, cuprous and cupric, and salt, are the only "chemicals" that are of general practical utility in the amalgamation of silver, and, in order that they may be effective, the ore, in the state of fine powder, must be exposed to their action in hot solution for a certain length of time, depending on the character of the ore and the degree of comminution. Whether or not some of the silver-ores, under these conditions, yield silver chloride, which dissolves in the brine, is a disputed point which need not be discussed here; what we know is, that the silver compounds yield the silver in a free state on contact with relatively positive metal, as zinc, iron, lead, copper, or even quicksilver alone, the latter being at once the most expensive and the slowest, and it is only used in that way, intentionally, in the *patio* process.

In order that the bluestone may be effective, either the ore must contain no substance, except the silver compounds, which can decompose cupric sulphate or chloride, or such substance must be saturated. This may be done by using a sufficiency of bluestone, or, in some cases, by the cheaper sulphate of iron, or by sulphuric acid, sulphurous acid, sodium disulphate, &c. Thus, if earthy carbonate, lead carbonate, or manganous oxides cause the trouble, either of the above substances will answer, some bluestone being also added, unless the ore contains copper oxide or carbonate, in which case bluestone may not be required; but if the difficulty is caused by zinc-blende, galena, or other sulphurets having the property of decomposing the copper chlorides, it is doubtful if you will not have to use an abundance of bluestone or give up its use entirely. Some ores contain so much of such substances that it will not pay to saturate them; and if they cannot be worked satisfactorily without, the best thing to do is to roast them with an admixture of pyritous ore and salt. There is, however, one case among those in which it may be feasible to treat the ore in the raw state—that is, when the only injurious substance present is calcium carbonate (or, probably, other earthy carbonates). Sterry Hunt states that cuprous chloride is not decomposed by carbonate of lime, and, if this is correct, cuprous chloride might be readily made and used in place of bluestone, salt being added to dissolve it.

But it is not alone the composition of the ore that must be considered in this connection. The iron of the amalgamating-pan is constantly destroying the copper chlorides by precipitating the copper, which goes into the amalgam and produces ferrous chloride, which is of little use in the operation; hence it is desirable to retard this action as much as possible, which end is promoted by crushing the ore as finely as may be needful in the battery and working the pan with muller raised just enough to avoid grinding. If this be done, the entire iron surface soon acquires a coating of amalgam of silver, copper, and perhaps lead, which diminishes the chemical activity of the iron. On the other hand, if the muller is allowed to grind the ore, the surfaces of the shoes and dies are kept free. Nor is this all. The pulp is pervaded by particles of iron ground off from the shoes and dies, and all soluble salts of copper are quickly decomposed.

In working roasted (chloridized) ore, it is not usually necessary to use any chemicals; yet, i the ore contains copper or lead, it is best to grind only so much as may be necessary to crush any lumps which may have been formed in the furnace; thus equally good results can be obtained as by grinding, and the bullion will be of a better quality. In regard to using an alkali in the pan when working roasted ore containing copper or lead, with a view to making finer bullion, by precipitating those base metals as oxides, it must be done with caution; if enough of alkali be used to completely precipitate the copper and lead as oxides, and to keep them in that state, notwithstanding the

constant tendency of ferrous chloride, produced by the decomposition of silver chloride, to cause their resolution, fine bullion will certainly be got, but there will be a larger loss of silver in the tailings.

Possibly carbonate of lime may not have this effect; I suggest its trial. My experience is to keep adding a little alkali, but never enough to quite prevent the staining of a knife-blade by the hot pulp.

The foregoing explains why it is that a roasted ore which forms a pulp with alkaline reaction, though yielding fine bullion, despite the presence of lead or copper in the ore, yet does does not give so satisfactory results as an "acid roast." This forms the exception to the rule that roasted ore requires no chemicals in the pan, for, if it can be done with economy, it will be advantageous to add sulphate of iron, or acid, to such a pulp. However, it generally requires too much to counteract the alkalinity, and all that may be used will be wasted unless that result be attained.

One reason why an alkaline pulp makes richer tailings is that, in roasted ore, a part of the silver is usually combined otherwise than as chloride, and, although iron reduces the chloride to metal in the presence of alkali, it does not reduce some of the other compounds under such conditions. Some of these compounds seem to be double or multiple sulphates. Another probable reason is that, in an alkaline pulp, the iron surfaces remain free from any coating of quicksilver or amalgam, a state of things which is very disadvantageous for the collection of the silver.

When an alkaline ore containing a haloid salt of silver (chloride, bromide or iodide) is to be treated, surfaces of copper are much better than of iron, for the reason that they retain a coating of quicksilver; this applies to raw and roasted ores alike. The philosophy of the matter is this: If the silver is reduced to the metallic state in the absence of quicksilver, that is, out of contact with the mercury, it becomes so mixed with the muddy pulp, and possibly rendered insensitive to amalgamation by superficial chemical action, that its collection is extremely difficult—in some cases impossible. Hunting for a needle in a haystack is hardly more futile than chasing those infinitesimal particles of silver through tons of mud. On the other hand, if the silver is born, so to speak, in contact with quicksilver, it amalgamates in the act. Iron in an acid pulp, or copper in either an acid or alkaline menstruum, forms with mercury an electro-chemical couple in which the iron, or the copper, plays the positive role, and it is known that, in such a case, the positive element of the electrolyte tends toward the negative element of the couple; in this case, the silver-salt is the electrolyte, and the silver is its positive element. In an alkaline liquid, iron is far less positive than in an acid, and though it remains positive to silver, and perhaps to mercury also, yet, as these metals do not adhere to it, even though mercury may be present, a large proportion of the silver-chloride must be metallized by the side or wings of the pan, the surface of the muller-plate, &c., out of the immediate proximity of quicksilver, and is thus liable to escape amalgamation.

I once had occasion to treat an ore in which the main part of the silver was in the form of pellets of chloride and chlorobromide in cavities of the gangue. The gangue contained a large proportion of calcspar and manganous oxide, which made the use of bluestone and salt impracticable; the manganous oxide also forbids the application of cuprous chloride. Certainly, these things were not necessary for the reduction of the silver to the metallic state, for which the iron pan was sufficient in the presence of salt; but the work was begun with the pans that were well lined with coppery amalgam from the previous treatment of a roasted coppery ore, and it was observed that, as soon as that lining had worn off, the tailings were richer than before, the bullion being quite fine. Experiment showed that it would require a barrel of sulphate of iron to a charge of ore to neutralise the pulp, so that bluestone could "live" long enough to coat the iron with copper amalgam, which, in this case, would be the only object in using it. I, therefore, made cement copper from bluestone in a tub, and added a quantity of that to each charge of ore in the pans. The result was a slightly coppery bullion, but considerably better yield. Had it been possible to treat that ore with metallic copper in a wooden vessel, the extraction would have been still better, not, as in the Aaron process, because of the reproduction of the cuprous chloride, which would have been useless, but because all of the haloid-silver would have been metallized in actual contact with quicksilver.

Although the copper chlorides with salt are the best agents, in general, for the treatment of raw ores of silver (even for metallic silver the cupric chloride is useful, because it produces a film of silver chloride on the particles, which dissolves in the salt pulp and is recovered by precipitation, leaving the surface of the particle sensitive to quicksilver), yet there are cases in which the copper cholorides are inapplicable, and other agents may be used to advantage. One such I have mentioned, and I have now to write of another.

The ore contained a large proportion of zinc-blende and galena, also pyrites and calcspar, but about 75 or 80 per cent. of the silver was in the metallic state. I made a number of experiments on the ore, on concentrates of two grades, and on tailings, in an experimental pan, taking a charge of 200lb.; very fair results were obtained, at a cost of 90 cents per ton, by the use of dilute nitric acid. In this method salt must be rigidly excluded, else the mercury will be badly granulated; even without salt I had, at first, some trouble with the quicksilver, but that was overcome by using sodium thiosulphate in the settler. The effect of the acid was to clean and sensitize the surfaces of the silver particles before it could be destroyed by the zinc-blende, &c. Nitric acid may sometimes be used with a quartz ore carrying a small percentage of pyrites.

Failure, as well as success, may be instructive; it at least teaches us what not to do, and, if its cause is ascertained, it may point the road to success.

I was once called on to work, without roasting, an ore which I thought should be roasted. For reasons which I do not remember, I crushed rather coarsely, then ground in Wheeler pans with bluestone and salt, but not quicksilver, and tried to amalgamate in Wakelee pans. The result was a low grade of amalgam and little of it, in fact a failure. I explain this on the theory that the silver mineral was metallized in the first pan, and, being mixed with the pulp, could not be successfully collected by quicksilver in the other pan, the more so as that other pan was of the slow-moving

class. This view is sustained by the fact that the next man who tried got better results by amalgamating, as well as grinding, in the first pan. His results, however, were not satisfactory. I did not fail to work that ore, for it was then that I discovered the Aaron process, which was not worked in pans. I bought some of the coarsely-crushed ore from the company, and taking it to where I could treat it in a barrel, extracted a high percentage in very fine bullion.

In those days it was considered necessary to grind in the pan; I had long before proved that grinding was not necessary for roasted ore, but had not applied the idea in raw working. The proper way to work that ore in pans would have been to crush it as finely as necessary by the stamps (or otherwise), and then work it in pans with bluestone and salt, keeping the muller raised just enough to avoid grinding, and with enough of quicksilver from the first to wet, so to speak, the silver at the instant of its birth *(in statu nascendi)*.

The lesson to be drawn from the failure of my experiment is, to avoid reducing the silver to the metallic state in the entire absence of quicksilver; my successor's partial failure was due to the rapid decomposition of the copper chloride, formed by bluestone and salt, by the clean iron surface and the iron powder resulting from grinding.

It may be objected that the universal practice, whether in the Freiburg barrel or the pan, is, and always has been, to reserve the mercury until the pulp has been worked for some time in contact with iron. As a matter of fact, however, a barrel or pan that has been used always retains a quantity of quicksilver and amalgam, and a new pan or barrel should not be charged without some quicksilver.

The practice of reserving the quicksilver seems to be an heirloom from Freiburg. The Freiburg process was devised by a chemist, and his object in delaying the addition of quicksilver was to allow time for the scrap-iron to reduce the ferric and cupric salts in the roasted ore to ferrous and cuprous salts, which are innocuous to the mercury. The chemical action is much less rapid in the barrel than in the modern pan, and a period of two hours was not very dangerous even if no quicksilver at all had been present, especially as the pulp was not heated by steam, but only gradually, by the chemical action. In fact, however, there can be but little, if any, ferric or cupric salt in roasted ore, and I doubt much if the whole of the required mercury might not just as well, or better, be added with the charge of ore in either barrel or pan. The older metallurgists sometimes provided against dangers which had no real existence. For instance, in the Plattner process we are directed to roast the ore "dead," because ferrous sulphate precipitates gold from its chloride; but experience has proved that dead roasting is neither necessary nor desirable, as the ore often works better without it, to say nothing of the saving of time and fuel, which fully offsets the greater consumption of chlorine to convert the injurious ferrous salt to the harmless ferric.

Again, at Freiburg, it was considered indispensable (at least the books so state) that a silver ore for roasting should yield 30 per cent. of iron and copper matte in an assay for matte. Every smelter and mill-man will admit the desirability of having a uniform grade and quality of ore to work, and this advantage the Freiburg metallurgists were able to command by mixing different ores, and by rejecting any that were unfit for roasting, and sending them to the smelting department, &c. But in this country we have not had those advantages, and we have found that we can sometimes do very good work with ores that would have been condemned as quite unsuitable for the process which alone we could command. In other cases, we have done the best we could. Pupils naturally tend to follow the instructions of their teachers, and servile imitation without proper regard to conditions too often results.

In working raw ore with bluestone and salt we do have cupric chlorides at first, and cupric chloride can act on mercury, producing calomel; but the cupric salt does not last long; it is quickly reduced to cuprous chloride by various causes, and, as there is certainly danger of a loss of silver if that is metallized out of contact with mercury, it seems better to take some risk of adding the quicksilver a little too soon than to run the greater risk of adding it too late. If, however, there should be any fear that the quicksilver may not have been added soon enough, the error may be remedied by using some more bluestone; the cupric chloride thus produced will reconvert the particles of silver in the pulp to chloride, at least superficially, and thus facilitate their amalgamation. After all, it is doubtful if calomel can be formed in presence of the soluble chlorides and metallic iron or copper.

The Aaron process is less rapid than the pan process, yet it requires but little power and possesses certain advantages. By this method it is always possible to produce fine bullion, and the consumption of bluestone is reduced to a minimum because the chemical action works in a circle, constantly reproducing cuprous chloride to act on the silver compounds in the ore. Experiments made many years ago proved that the ores of the Comstock Lode yielded readily to this treatment, and many millions of dollars would have been saved to the stockholders had it been adopted. The absurd method which has been used in treating the tailings from those mines, and the learned fuss and bother about the base bullion obtained, are enough to excite the laughter, or disgust, of those who know what might have been done. But those mines have been in the hands of sharpers and "muscular amalgamators" to such an extent that it has never been possible for any "outsider" to get recognition. Results have been tolerated there that would not have been tolerated in any other camp on the coast, and the sickening part of it is the eulogistic descriptions of the wasteful and stupid methods used, which have been published from time to time.

Also, it is well known to the older metallurgists, though not to the ordinary "chump mill-man"—probably not to the new generation of American operators turned out by scores by our colleges—that fine bullion can be got from any roasted silver-ore, no matter what its constituents, though possibly not always in the iron pans which have come to be regarded as a *sine quâ non* in amalgamation by a nervous, restless, hurrying people who are never satisfied unless they see something "going like hell beating tanbark," and who are paying now the penalty of haste and greed by seeing a noble series of mines worked out and half wasted, while one of the great products of the country

nas fallen more than one-third in value; for it is absurd to pretend that the change in relative values is due to a rise in gold and not to a decline in silver.

The fact is, that both gold and silver have fallen in value in the last forty years, owing to a vastly-increased production. The proof of this is in the higher rates of wages all over the world, even in Asia. If certain or all classes of products are cheaper, that is because of improved means of production and distribution. The value of silver has declined more than that of gold, simply or mainly because its rate of production has increased more than that of gold has, as the records prove, while, at the same time, the cost of its production has decreased. There are but two ways in which the old relation of the two metals, misleadingly called "parity of value," can be restored: The one is, to diminish the output of silver; the other, to increase the production of gold. To coin silver extensively would raise its price a little, no doubt; but coined silver still exists. It is not consumed in the coining, and such a course cannot restore "parity" so long as the present relative rates of production shall continue. Still less would the issuance of paper-money, backed by silver bullion, raise the price, for that silver would absolutely be there at all times; it would not even suffer the consumption due to abrasion, as coin in circulation would; nor would the glut find occasional vent in the loss of a shipload of it by wreckage or other accident to which gold is constantly exposed. Of course, an increased *consumption* of silver, by which it should be taken out of the market, as wheat disappears, would answer the same purpose as a diminished output; but I refer above to practical means. It is not likely that anybody will buy up silver and dump it into the Atlantic Ocean. But this is a digression; yet I would advise miners not to count on a much higher price for silver than the present value—rather, they should be prepared for a further decline.

If the ore contains gold as well as silver, and if the gold is not satisfactorily saved in the treatment for silver, it is advisable to make the pulp alkaline by means of lime, lye, or ashes, and work a couple of hours longer. At this time grinding may be necessary, though if that can be avoided it will be better for the next charge, because then the faces of the shoes and dies will retain a coat of amalgam. A little potassium cyanide may be beneficial, or, better, a little red oxide of mercury, or other salt of mercury, dissolved in potassium-cyanide solution, but not enough to saturate. To see if the liquid is right, put a drop on a gold coin and warm it. It should make a white spot on the coin; if it does not, add more cyanide.

Some ores require to be concentrated before amalgamation to separate sulphurets, which would destroy the bluestone, or would not yield their silver (or gold); the concentrates will require special treatment, generally roasting. The tailings from the concentrators must be run into vats and settled, to remove superflous water, then treated in the pans, unless the Boss process is used, when pointed boxes may be employed to feed the pans.

I think concentrators will pay for themselves in any silver-amalgamating mill, being used below the settlers. They will save a portion of quicksilver and amalgam, which is inevitably lost by settlers, and will also recover some valuable sand which may be again treated. For saving quicksilver and amalgam the Hendy concentrator is good, especially if lined with copper and amalgamated. For sand matter, undecomposed sulphurets, &c., the vanners are better. Some arrangement is required to deliver the tailings to the concentrator in a constant and nearly equal stream, which the settlers cannot do. Here, again, pointed boxes are useful, as it is an advantage to get rid of the muddy water, which usually contains nothing of consequence, coming from the settlers, and use clean water on the concentrators if the supply is abundant.

Sometimes a calcareous ore which contains too much lime for successful roasting, can be rendered fit by a partial concentration, which removes the excess of calcite with little loss of value. I have known a case in which very good concentration was effected by simply sifting the rather coarsely crushed ore: the portion which passed the sieve contained 200 dollars per ton, while that which refused had only 20 dollars per ton, which, under the circumstances of time and place, would not pay for working. This method of concentration is of wider applicability than is generally known, and might be still more so if conjoined with special methods of crushing.

As I am not pretending to exhaust my subject, nor wishing to repeat much that may be found in the standard works, but rather to offer a few pointers which cannot be found in books, I will say no more about concentration, itself a large subject, and will only make a few remarks on pans, settlers, amalgam, and furnaces.

The now almost universally-used combination pan is a good machine for its purpose. The wooden staves should be protected to a height of 8in. or 10in. either by a high inside flange on the iron bottom or by a special cast-iron ring, to prevent the cutting of the wood by the sand, which is thrown forcibly outward by the muller. In default of such protection, wooden staves, an inch thick and six or eight inches long, may be tacked around, forming a zone, and renewed when necessary.

The settlers, as now made, with plate mullers like the pan, are not very bad, though not what I should like. I sometimes alter the arrangement of the wooden shoes. The older form of settler, with arms furnished with ploughshares, rakes, and cultivators, was a wretched affair, fit only, like its prototype, the Mexican *lavadero*, to treat the impalpable pulp from the *patio;* but this kind, even, may be made to work as well as any by removing the ploughs and cultivators, and substituting pieces of scantling, extending from the outer end of one arm to the inner end of the next, in such fashion with regard to the direction of revolution, as to throw the pulp outward. These shoes should not reach very near to the side of the settler, but the speed of revolution should be sufficient to prevent any accumulation of heavy sand there. When I build a settler, I provide a groove about 4in. to 6in. wide and 3in. deep, surrounding a false bottom. In this groove not even coarse sand can accumulate, because of the strong current produced by the revolving muller, or stirrer; but any considerable object, such as a lump of rock, a cold chisel, &c., which may find its way into the machine, is at once swept into the groove, and there remains, disturbing nothing, until a convenient occasion for its removal. The sand and globules of mercury rise towards the surface, pass near to the centre, and there fall, to be again swept outward and lifted by the current. In this way, with a plentiful supply of water, the globules of quicksilver are gradually united into masses, which, too

heavy to be lifted by the current, fall into the groove and rest in peace until drawn out in the usual manner. Such a settler is described and illustrated in a little book on "Testing and Working Silver Ores," published in 1876, and still on sale.

The settler, as now generally constructed and operated, has the defect of allowing a gradual accumulation of the coarser and heavier part of the tailings, as well as permitting a stone, hammer-head, or any such matter, to cause considerable trouble if dropped in by any means, as will sometimes occur. As to the coarse sand, the practice is to remove it from time to time by hand, and, as it is mixed with amalgam and quicksilver, it must be ground in a pan in order to separate those and wash the sand away. I have found a way in which to wash coarse sand out of the settler while retaining the quicksilver and amalgam. The method has been published already, and I need not repeat the description of it here.

I have heard many stories about "iron amalgam," and the trouble it gave in the melting of the bullion. Were I to confine myself strictly to my own experience, I could say but little about iron amalgam, as I have never made it in such proportion as to give trouble, nor have I been able to find out all of the causes of its production. I think a good mill-man need not make it. Iron is not susceptible to amalgamation unless by the aid of sodium or potassium; but apparent amalgamation may arise from the coating of ferruginous particles by lead or copper, to which quicksilver adheres and envelopes the particle, which then enters the amalgam. Such ferruginous particles may be due to abrasion of the shoes and dies when the ore is ground in the pan, or to imperfect roasting of the ore by which a peculiar iron oxide is formed, which has the property of precipitating copper, and probably lead, from reducible salts of those metals.

When the amalgam is thus contaminated, the proper treatment is to work it thoroughly in the "clean-up pan," which is found in every well-equipped silver-mill, first with water and lye, which is better if warm, and then under a flow of clean water. In this way the amalgam is rubbed off from the iron particles and they are washed away. All dirty amalgam and hard scale from the pans is similarly treated, fresh quicksilver being added if necessary. I once got a 400dol. bar out of a pile of pan scale which I found on the ground outside of a mill, where it had been thrown by some "muscular amalgamator."

If amalgam containing much iron is retorted, it is hard or impossible to melt; the remedy then is to add sulphur, which combines with the iron, forming a fusible sulphide floating on the silver. As the requisite quantity of sulphur cannot be certainly applied, it is necessary to put some pieces of iron in a pot to reduce any silver sulphide which may be formed. Copper, if present, will also combine with sulphur, and then some loss of silver is inevitable, and the matte must be saved for further treatment.

When coppery amalgam is retorted, the copper and silver separate to some extent. Contrary to my expectation, experiment showed that the separation is more nearly complete when the retort is heated quickly. I have often taken red copper and snow-white silver from the same retorted, spongy mass, but there were also intermediate grades. If the retort is opened while still very hot, as is often though very improperly done, the copper may become oxidized, and may then cause trouble in the melting. I have seen an inexperienced melter in great difficulty from this cause. He had a mess like a potpie in his pot—liquid silver with great lumps of infusible matter in it, which consisted of copper-oxide mixed with silver, and just so plastic that no amount of borax could liquefy the copper oxide. The man called that iron-amalgam; perhaps others may have made a similar mistake. In the next smelting I caused charcoal to be mingled with the metallic sponge in the pot; then covering and heating, the oxide was reduced to metal, and the copper-silver alloy melted readily, after which borax was added to slag the impurities. Copper may be removed from silver by means of sulphur, but the matte retains much silver, despite the presence of metallic iron, and the silver is liable to retain sulphur.

Very leady amalgam may be strained through flannel bags under hot water; that which remains in the bags is enriched, while that which passes through them is comparatively poor in silver, and may be strained, when cool, through canvas as usual; the quicksilver which passes through still retains lead and a little silver.

When it becomes necessary to retort a large quantity of quicksilver to purify it, I proceed as follows: Into the upper side of the retort I tap a half or three-quarter inch pipe, passing through the brick arches above, which is bent as an S-tube, and is surmounted by a funnel. The interior of the retort is painted with a paste of clay and ashes mixed with water, and the closure is luted with similar material, in which the clay and ashes are so proportioned, by trial, as neither to crack nor peel off in drying; a little salt may be added with advantage. The retort is then dried and warmed by a small fire, after which several flasks of the quicksilver are poured in through the S-pipe, in the bend of which some remains, forming a valve, which prevents the escape of vapour. The heat is then increased until the quicksilver begins to distil, when that temperature is maintained steadily. As the metal comes over it is replaced, flask by flask, by means of the pipe, until all is finished, and, when cold, the retort is opened and a cake of lead is found. I am told that, in order that the distilled quicksilver may be quite clean, some powdered charcoal should be put into the retort before closing it; a little lime is also beneficial.

The life of a retort depends greatly on the care used in raising the heat slowly to the degree at which the mercury begins to distil, and then keeping as nearly as possible uniform temperature until the discharge slackens, when the heat must be again raised to dull redness and so maintained until no more quicksilver comes over, and the pipe is readily cooled by throwing water on it near to the body of the retort. With a properly-mounted retort, as most are in these days, a good guide to the final temperature is that the end of a pine-stick rubbed on the front end of the retort is charred, and the streak of carbon left by it sparkles a little and burns off.

It is dangerous to open the retort while it is still hot, though that is often done; there is always some fume which is likely to injure the workman. With much lead in the amalgam, melting of the metal cannot be avoided, and the result is a solid slab, which, however, is easily cut to pieces on

the blacksmith's anvil; but fine silver, or silver and copper, should never be melted in the retort; it should remain as the spongy mass, easily broken by means of a hammer for the crucible. The end of the pipe should never dip in water; a cloth wrapped around it should connect the pipe with the water in the vessel which receives the mercury, the pipe being kept cool by some kind of water-jacket. If the end of the pipe be submerged, a slight cooling of the retort causes the water to back into it, when an explosion occurs. This warning will not be needed by any experienced mill-man, but may be useful to some of our "new chums."

In regard to crushing appliances, much might be said depending on different conditions; I prefer to say nothing rather than too little. As to furnaces and roasting, also, I must plead the statute of limitation, indulging in only one remark. Where the inclined-cylinder furnace is used, I look on an auxiliary fire as a nuisance, and a needless waste of fuel. I must prefer Thompson's dust-returning apparatus, and, though I was never so fortunate as to have it, I satisfied myself of its utility by the aid of a couple of boys in Honduras. As, however, boys in Honduras, as elsewhere, object to being half-roasted and suffocated, I adopted another plan, which suited me better than an auxiliary fire which I could not get properly attended to, and which largely increased my fuel consumption. When the flues were cleaned, I piled the imperfectly-roasted stuff on the ore-floor and, stopping the battery, passed the dust into the furnace by means of the screw-feeder. To my gratification and slight surprise, it passed through very well, not much more than the usual proportion going again to the dust chambers. It is a curious fact that, in roasting with these furnaces, while 15 per cent. or 20 per cent. of the ore may go to the dust chambers, that same "dust," if collected and passed in, will go through with about the same proportional loss. On the other hand, the ore which has passed through with a loss of 15 per cent. or more in the dust chambers, will, if passed in again on account of imperfect roasting, lose nearly as much as it did before.

I will now conclude for the present, hoping these notes may be useful, and desiring, while frequent disappointment in similar cases almost forbids hope, that others may be stimulated to give us the benefit of their experience to some extent. As to my few remarks on the great question of the silver market, while I freely acknowledge the right of every person to have and to express his views, I decline in advance to enter into any controversy. I have given my idea; let others do the same if they so choose.

NOTE.—The operation of the Boss process may be thought to contradict my idea in one respect. In this process the ore-pulp passes continuously through a series of pans and settlers. The first two pans are intended to grind the ore, and no quicksilver is put in them. No doubt the silver is, more or less, metallised in the grinding-pans, and yet the process is very successful.

Two facts must be considered in this connection: Firstly, a portion of quicksilver finds its way from the amalgamating-pans to the grinding-pans, by regurgitation or counter-currents in the connecting channels; probably, however, this is not sufficient to amalgamate all of the reduced silver, though the fact that, in working the chloride ores of the Calico District, nearly all of the silver is collected in the first amalgamator of the set, may throw a doubt on this. Secondly, bluestone as well as salt is always used in the amalgators, even in working ores which would not seem to require it if treated in single pans as usual; the chemicals are dropped in at brief intervals by automatic apparatus. The cupric chloride thus formed converts the metallic silver to chloride, which is again metallised by the iron pan, and amalgamated in the act.

I know an operator in Calico who claims to work closer than others, though getting more coppery bullion, because he uses more bluestone than others, preferring to make poorer tailings, even though the bullion may be of rather lower grade, because the greater part of the copper added in the form of bluestone must ultimately find its way into the amalgam, so long as iron amalgamators are employed.

Thus, when all of the facts are taken into account, my theory is sustained rather than opposed by the action of the Boss process, if that can be called a theory which is the result of repeated experience and observation.—*Mining and Engineering Journal.*

AUSTIN'S PATENT AMALGAMATOR.

A new invention, patented throughout the world by the inventor, Mr. T. R. L. Austin, of Talbot, Victoria, promises to perform what the numerous prior inventions have tried to do—namely, save all free gold (especially float- and flour-gold) from battery tailings, puddling-machine slimes, alluvial tailings, surfacing and other auriferous material. The invention consists virtually of one part, but for convenience it is divided into a column or chute and a quicksilver cell. The machine is automatic in working, and, as all the parts are fixtures, there is no danger of anything getting out of order. The amalgamator is built over a furnace, and is so constructed that the heat passes under the silver, through it by means of tubes, like a multitubular boiler, and over the top of the silver, whereby the quicksilver in the cell is kept at a sufficiently high temperature to more readily amalgamate with the gold. For feeding the machine, the detritus passes into the vertical column, and by the force of gravitation is carried through the warm quicksilver (downwards) for 3in., through it longitudinally for 18in., and, finally, up through 3in. before it discharges itself. The construction of the cell is of such a nature that all material must pass through the silver, and in a distributed state; so that there is no possibility of any free gold escaping. The capacity of the amalgamators that are already made is about one ton an hour, but they can be made to take a much larger quantity of stuff in that time. The machines can be put on a dray, carted to a tailings- or slum-heap, and erected ready for work in eight hours. For live battery-sand or slum running from puddling-machines, Mr. Austin claims the saving of copper-plates and blankets (a considerable item in expenses). One man can supervise ten machines of the capacity of one ton an hour, which is at once an important saving in labour alone. The expense of the patent amalgamator is a royalty of £1 for machines of one-ton-an-hour capacity; and the inventor asserts that *débris* containing 1dwt. to the ton will pay well. For the present-sized machines there must

be at least a 2in. pipe to supply water, if working on a dead sand or slum-heap, but on a battery or puddling-machine constantly at work there would be sufficient water coming with the *débris*. The following trials have been made, which show its efficiency for saving all gold that escapes from batteries or puddling-machines.

No. 1 trial: Parker's United Quartz-mining Company, Gordons, after passing over Chinese tables, the return was 12dwt. for sixteen hours' work. No. 2 trial: At Egerton's Quartz-mining Company, Egerton, the return was 27dwt. for thirty-five hours from the sand heap. No. 3 trial: At Talbot, 5 tons of slum gave a return of 7½dwt. No. 4 trial: At Talbot, 10 tons of sluice tailings gave 7½dwt. of gold. (The mine was so poor that work was stopped the following week.)

At the Golden Mountain Gold-mining Company, Bonnie Doon, last January, Mr. Austin competed with the Wheeler's pans. First trial: Nine tons and a half through Wheeler's pans gave a return of 17dwt. smelted gold. Nine tons from the same hopper and at the same time, passed through the Austin amalgamator, gave a return of 22dwt. smelted gold. Second trial: Wheeler's pans, 20 tons cleaned up for 9dwt. of smelted gold. Austin's machine, from the same hopper and at the same time, put through 20 tons for a return of 1oz. 2dwt.

The directors of this company have commissioned Mr. Austin to supply them with the requisite number of his amalgamators, in preference to the many other gold-saving appliances brought under their notice.

Mr. Austin asserts (and he has every reason to be confident from the trials made) that with his amalgamator, miners suffering from old age and miner's complaint can be able to earn a good living with little labour by putting through the millions of tons of auriferous tailings and slimes that are now lying in all the gold-mining districts throughout the world; and mining companies, by saving the fine gold they are known to lose at the present time, will be almost able to pay working expenses of the whole mine from the amalgamators alone.—*Australian Mining Standard.*

FINE-GOLD EXTRACTION BY READING AND RIGBY'S PATENT AMALGAMATOR.

The Ballarat School of Mines, after recent experiments upon samples of stone from the United Bluey Gold-mining Company (Limited), recommend that ores containing very fine or float-gold should be treated by the so-called dry-amalgamation process. Acting upon this suggestion, the directors of the United Bluey Company forwarded two tons of their ore for treatment at Messrs. Parke and Lacy's works, Pyrmont, by Reading and Rigby's patent amalgamator, a process described in the *Mining Standard* of June 4th last. The results obtained have demonstrated the correctness of this mode of treatment, as 80 per cent. of smelted gold was extracted (40 to 50 per cent. was the average at the mine), which by addition of the gold remaining in the pyrites is nearly the same result as that obtained by the Ballarat School of Mines—namely, 92 per cent. of assay. This machine will treat 7 tons to 9 tons of ore per day. Captain Hosking, who watched the treatment of this parcel of ore, has made the following report: "Having carefully watched the process of treating two parcels of stone from the United Bluey Mine by Reading and Rigby's mixing and amalgamating pan, I have much pleasure in stating that the results—namely 80 per cent. of the assay-value of bullion contained—were highly satisfactory. This machine is undoubtedly a perfect amalgamator, as the whole of the pulp must come in contact with the quicksilver; and the system of amalgamating in charges renders it impossible for any free gold or quicksilver to get away, no matter how fine the gold may be. In my opinion the gold-bearing material should be crushed dry, and passed through the finest screens possible, so as to liberate all the free gold, which when liberated cannot possibly escape from the amalgamating-pan, as the rapid rotary motion throws the large quantity of silver used up the sides of the pan, bringing it into contact with the arms or mixers, which disseminate it in fine particles through the whole of the pulp. After being thoroughly mixed, clean water is introduced, and while the machine is in slow motion all the amalgam and fine particles settle at the bottom and the whole of the pulp is flushed off; but no silver or amalgam can possibly get away, as the flushing is done in comparatively still water. Neither can float-gold escape, as there is no current to carry it away, and should any particles happen to get over, the using of the same water again will give it time to settle, consequently no gold can be lost. If the ore contains any pyritous matter the pulp can be passed over vanners and concentrated, and this concentration would be perfect with the one process, owing to the even fineness of the pulp treated. The capacity of this machine I estimate from 7 tons to 8 tons in twenty-four hours, as charges of 5cwt. can be thoroughly mixed, amalgamated, and flushed off in about three-quarters of an hour; the work being automatically done, there is no delay between charges. The machine can be cheaply and profitably worked, as it requires less than one-horse power per machine, and its automatic action enables one man to look after two or more machines.—*Mining Standard.*

CHEMISTRY AND USE OF THE CYANIDE PROCESS.

The following description of the chemistry of this process was written by Messrs. Charles Butters, Ph.B., and John Edward Clinnell, B.Sc., for the *Engineering and Mining Journal*, of New York, from which it is taken:—

Solubility of Gold in Potassium-Cyanide.—That metallic gold is soluble in cyanide of potassium has long been known as a scientific fact. Faraday pointed out that gold-leaf immersed in a solution became so thin that it transmitted a green light. Prince Bagration observed (I. pr. Chem., xxxi., 367) that very finely divided gold, obtained by precipitating a solution of the chloride with ferrous sulphate, may be dissolved by this reagent. Elsner showed, however (I. pr. Chem., xxxvii., 333), that the presence of oxygen is required for the solution of gold. A solution is obtained which, on evaporation, yields colourless octahedral crystals of the composition $KAuCy_2$—auro-potassic cyanide, which may be looked on as a double cyanide of gold and potassium—KCy. AuCy. The action which occurs may, therefore, probably be represented by the following equation:—

$$2\,Au + 4\,KCy + O + H_2O = 2\,KAuCy_2 + 2\,KHO.$$

There are two interesting points indicated by the above equation which it is well to bear in mind, in conjunction with the application of potassium-cyanide as a solvent for gold on a commercial scale.

(1.) That the quantity of cyanide theoretically necessary to dissolve a given weight of gold is infinitesimal in comparison with the weight actually required in practice. Taking Au 196·8, K 39·09, and Cy 25·98, we see that 130·04 parts by weight of potassium-cyanide should be capable of dissolving 196·8 parts of gold, or, approximately, two parts of cyanide should dissolve three parts of gold. The minimum actual consumption in treating free-milling ore, assaying, let us say, 10dwt. of gold to the ton, is about 3lb. per ounce of gold recovered; roughly, 40 parts by weight of cyanide for one part of gold. In the leaching-tanks alone, 1lb. of cyanide is generally consumed per ton of material treated.

(2.) That an extremely small quantity of oxygen is sufficient to bring about the solution of gold, 15·96 parts being required for 396·6 parts of gold, or one part for nearly 25 parts of gold. The quantity present in the porous mass of tailings, to say nothing of that dissolved in the water used in making up the solution, would be considerably in excess of that actually required for the reaction.

Decomposition of the Cyanide.—How, then, does it happen that such an enormous consumption of cyanide occurs? In the first place we must bear in mind the great instability of the simple cyanides. Hydrocyanic acid is, from a chemical point of view, perhaps the weakest acid known. It is liberated from its salts by all mineral acids, by carbonic acid, and by all organic acids of common occurrence. Then, the atmospheric carbonic acid is accountable for a certain amount of decomposition, in which a constant evolution of hydrocyanic acid takes place after reaction:—

$$2\,KCy + CO_2 + H_2O = 2\,HCy + K_2CO_3.$$

Then, again, we must consider the proneness to oxidation which cyanides exhibit, and which, in fact, lies at the base of most of their technical applications. Potassium-cyanide readily changes into cyanate, and ultimately into carbonate. The presence of alkalies, which always occur in commercial cyanide, tends to induce that peculiar and little-understood decomposition termed "hydrolysis." In this reaction the alkali appears to determine a chemical change, in which water plays a part, while the alkali itself is not the least affected when hydrocyanic acid is treated with concentrated mineral acids, or with boiling alkalis. The reaction is as follows:—

$$HCN + 2H_2O = HCO_2\,(NH_4),$$

ammonium formate being produced.

The hydrolysis of potassium-cyanide, which undoubtedly occurs to a considerable extent when excess of alkali is present in the solution, or has been added to the tailings before treatment with cyanide, gives rise to ammonia and potassium formate:—

$$KCN + 2H_2O = NH_3\,HCO_2K.$$

The smell of hydrocyanic acid, generally noticeable in the neighbourhood of the cyanide tanks, is partly accounted for by the decomposition due to atmospheric carbonic acid, previously alluded to. But there are grounds for supposing that in dilute solutions a dissociation of the cyanide takes place, so that what we term a weak solution of potassium-cyanide is in reality a mixed solution of potassium hydrate and hydrocyanic acid:—

$$H_2O + KCy = HCy + KHO.$$

The truth of this theory is supported by the extraordinary fact that a distillation of hydrocyanic acid takes place when a current of neutral gas (*e.g.*, nitrogen) is passed through a cold solution of cyanide. This being the case, it is evident that hydrocyanic acid, which is an extremely volatile body, must be constantly disengaged from all vessels in which weak cyanide solutions are freely exposed to the air. Where agitation or circulation systems are adopted the consumption must be still greater, since these methods involve a constant exposure of fresh surface.

The tendency of the simple cyanides to form double salts with each other, or with other metallic compounds, must likewise be taken into account. Salts of iron, and, to a lesser extent, salts of aluminium, magnesium, calcium, and the alkali metals, are liable to occur in the tailings, especially such as have been long exposed to atmospheric influences.

We have said enough to show that, even under the most advantageous circumstances, an enormous waste of cyanide must take place. Some of these losses are, doubtless, preventible; the use of closed tanks, and careful attention to the purity, both of the cyanide itself and the water used for dissolving it, would reduce the extent of the decomposition in a very marked degree.

Action of Cyanide on Pyritic Material.—Let us now consider what additional decomposition occurs when cyanide is applied to the treatment of pyritic ores or tailings. To understand the action of cyanide on these ores, or the products derived from them, we must briefly describe their composition, and the chemical changes to which they are liable. The surface ores, found on blanket formation, consist almost exclusively of silica and oxide of iron. These occur in the form of rounded quartz pebbles, embedded in a softer matrix, highly charged with ferric oxide, which imparts its characteristic reddish tinge. The gold is found in this matrix associated with the oxide of iron, or sometimes in small scales on the surface of the pebbles—the pebbles themselves carry little or none. At a lower level this free-milling ore passes into an ore precisely similar in structure, but much harder, and containing the iron in the form of sulphide instead of oxide, which gives it a peculiar bluish tint.

There can be but little doubt that free-milling ores have been formed by gradual oxidation of the pyrites through the influence of air and moisture during a long period of time, and, in fact, we see the same change in progress wherever pyritic material has been exposed to the action of the atmosphere. The first effect observed is the conversion of ferric sulphide into a double sulphate, free sulphuric acid being simultaneously produced:—

$$FeS_2 + H_20 + 70 = FeSO_4 + H_2SO_4.$$

Certain insoluble basic sulphates, of variable and somewhat complex composition, are gradually formed by the action of the air on the ferrous sulphate :—

$$2\ FeSO_4 + O = Fe_2O_3 . 2\ SO_3 \text{ (Wittstein).}$$

A certain amount of ferric sulphate is likely to be produced at the same time :—

$$10\ FeSO_4 + 5O = \underset{\text{(Basic sulphate, insoluble.)}}{2\ Fe_2O_3SO_3} + \underset{\text{(Ferric sulphate, soluble.)}}{3\ Fe_2\ (SO_4)_3} \text{ (Berzelius).}$$

The pyritic ores likewise contain small quantities of arsenic, copper, and sometimes cobalt and nickel, but the amount of these foreign metals has so far been so small that they have not practically interfered in the cyanide treatment. We may here note, as a fact observed in the treatment at the Robinson Chlorination Works of pyritic concentrates purchased from various gold-mining companies, that copper and arsenic seem to occur in gradually increasing quantities with the increasing depth of the workings. These elements may in future be a source of serious trouble in the application of the cyanide process.

Suppose now we attempt to treat a charge of partially-oxidized pyritic tailings directly with a cyanide solution. The moisture in the tailings has a distinct acid reaction, chiefly due to the presence of free sulphuric acid. This, of course, liberates hydrocyanic acid. Ferrous sulphate reacts upon the cyanide, with formation of ferrous cyanide, a yellowish-red flocculent precipitate :—

$$FeSO_4 + 2\ KCy = FeCy_2 + K_2SO_4.$$

This, however, is, under ordinary circumstances, slowly converted into potassium ferro-cyanide by the excess of the cyanide present :—

$$FeCy_2 + 4\ KCy = K_4\ FeCy_6.$$

If sufficient acid be present, the ferro-cyanide reacts upon an additional quantity of the ferrous salt, ultimately giving rise to a blue precipitate or coloration of Prussian blue :—

$$3K_4\ FeCy_6 + 6\ FeSO_4 + 3O = Fe_2O_3 + 6\ K_2SO_4 + Fe_7Cy\ 18.$$

The appearance of a blue coloration on the surface of the tailings, or in the solution, is a sure indication that acid iron salts are present, and that an enormous waste of cyanide has taken place. Ferric salts, when present unmixed with any ferrous compounds, decompose cyanide solution with evolution of hydrocyanic acid and precipitation of ferric hydrate :—

$$Fe_2(SO_4)_3 + 6\ KCy + 6\ H_2O = Fe_2(OH)_6 + 6\ HCy + 3\ K_2SO_4.$$

This reaction takes place in two stages, the first being the formation of a soluble but very unstable ferric cyanide, giving a brown solution :—

$$Fe_2(SO_4)_3 + 6\ KCy = Fe_2Cy_6 + 3\ K_2SO_4.$$

This decomposes as follows :—

$$Fe_2\ Cy_6 + 6\ H_2O = Fe_2\ (OH)_6 + 6\ HCy.,$$

giving rise to ferric hydrate, part of which is in a finely-divided colloidal condition, and is with difficulty removed by filtration, as it chokes the pores of the filter.

A mixture of ferrous and ferric sulphates, such as is probably always present in partially-oxidized pyritic tailings, causes the appearance of a blue colour on addition of cyanide, after the free alkali of the commercial product has been neutralised, Prussian blue—ferric ferro-cyanide—being produced when the ferric salt is in excess—

$$18\ KCy + 3\ FeO_4 + 2\ Fe_2\ (SO_4)_3 = 9\ K_2\ SO_4 + Fe_4\ (FeCy_6)_3$$

—and Turnbull's blue—ferrous ferric-cyanide—when ferrous salt is in excess :

$$12\ KCy + 3\ Fe\ SO_4 + Fe_2\ (SO_4)_3 = 6\ K_2SO_4 + Fe_3\ (FeCy_6)_2.$$

Preparatory Treatment of Pyritic Material.—Before attempting to treat such ores or products with cyanide, it is therefore necessary to get rid of the free sulphuric acid and soluble iron-compounds. This is generally done by giving a leaching with water until the liquid running off the tank no longer shows a coloration with ammonium sulphide. After the treatment, however, there still remain the insoluble basic sulphates, which are gradually decomposed by water, and would act upon the cyanide solution. A washing is accordingly given with caustic soda or lime-water, which converts the basic salts into ferric hydrate, and sodium or calcium sulphates :—

$$Fe_2O_3SO_3 + 2\ NaOH + 2\ H_2O = Fe_2(OH)_6 + Na_2SO_4$$
$$Fe_2O_3\ 2\ SO_3 + 4\ NaOH + H_2O = Fe_2(OH)_6 + 2\ Na_2SO_4$$

But the preliminary water-wash may be omitted with advantage in cases where the quantity of free acid and iron salts is comparatively small. Lime, in the dry state, is sometimes mixed with the tailings before the cyanide treatment commences. When this method is adopted, the iron is precipitated as a mixture of ferrous and ferric hydrates.

After the washing with alkali is complete, the tanks are allowed to drain, and "strong cyanide solution" (about 6 per cent.) is pumped on. Even after this treatment, the consumption of cyanide, with moderately pyritic tailings which have been partly decomposed by exposure, is found to be four times that which occurs with free-milling material. The presence of a large excess of alkali in the solution brings about various secondary reactions which lead to a loss of cyanide, such as the hydrolysis before alluded to, and a peculiar action of the zinc-box, which will be discussed later.

Lime, although slower in its action, is preferable to caustic soda as a neutralising agent, as it is equally effective in decomposing the iron salts, less active in bringing about secondary reactions on the cyanide, and also less energetic in attacking the zinc in the precipitating-boxes.

Ferric hydrate does not appear to be acted upon by potassium cyanide, but ferrous hydrate, which is formed in the neutralisation of the iron salts by alkalies, reacts on the excess of cyanide, with formation of ferro-cyanide of potassium :—

$$Fe(OH)_2 + 6\ KCy = K_4FeCy_6 + 2\ KOH.$$

Deposition of Gold from Cyanide Solutions.—Under certain conditions, such as the absence of sufficient oxygen in the solution, a partial precipitation of the previously-dissolved gold appears to occur. If by any chance the solution should become acid, there is a decomposition of the double cyanide of gold and potassium, in which the gold is generally supposed to be thrown down as (insoluble) aurous cyanide, *e.g.* :—

$$KAuCy_2 + HCl = KCl + HCy + AuCy.$$

In working on the circulation and transfer system, we find that where pyritic material is under treatment, it is not safe to transfer a solution already rich in gold to a fresh lot of tailings, as the extensive decomposition of the solution which takes place may lead to a final loss of gold.

Selective Action of Cyanide.—It is claimed by the promoters of the McArthur-Forrest process, that in a mixture containing metallic gold, silver, copper, and base metals, cyanide of potassium exerts a selective action, dissolving first the gold, then the silver, and afterward attacking the copper and base metals. The process, however, does not appear to have been successfully applied to ores such as those met with in California and Australia, which contain considerable quantities of foreign metals. Ores containing sulphide of silver and sulphide of copper produce considerable decomposition of cyanide, the copper being partially dissolved as sub-sulpho-cyanide, the silver, however, remaining unattacked. In two experiments carried out by Mr. William Bettel, chief chemist of the Robinson Gold-mining Company, who has kindly given us valuable assistance in the compilation of this paper, on ore from the Albert Silver-mine containing 30oz. of silver and 10 per cent. of copper, it was found that no extraction of silver occurred, this metal being present as sulphide.

Action of the Zinc Shavings on the Solution.—We must now pass on to consider the action of the zinc on the gold-cyanide solution. Theoretically a simple substitution of zinc for gold occurs in accordance with the following equation :—

$$2\ KAuCy_2 + Zn = K_2ZnCy_4 + 2\ Au.$$

Taking Zn = 65·1, Au = 196·8, it follows that 65·1 parts by weight of zinc should be sufficient to precipitate 393·6 parts of gold, or 1lb. of zinc should precipitate about 6lb. of gold. The actual consumption is about 1lb. of zinc per ounce (Troy) of gold recovered. It is evident, then, that zinc is consumed in some other way than in mere substitution for gold.

During the passage of the solution through the zinc boxes we notice a constant and vigorous evolution of small bubbles, which prove to consist principally of hydrogen gas. The outflowing liquid is found to possess a greater degree of alkalinity than it had on entering at the top of the box, and a smell of hydrocyanic acid, and sometimes of ammonia, is constantly observed in the neighbourhood of the zinc boxes. It is clear, then, that a decomposition of the potassium-cyanide solution itself by the zinc is in progress ; and this is not to be wondered at when we consider the powerfuf electro-chemical effect which must be produced by the contact of such a highly positive metal as zinc with a strongly negative metal such as gold. Ordinary commercial zinc loses weight when immersed for some time in cyanide solution, but the action is slow. It is doubtful whether pure potassium cyanide would have any action at all on chemically-pure zinc. It is well known that the " copper-zinc couple " produced by immersing zinc in a solution of a copper salt decomposes water.

An analogous reaction of the gold-zinc couple accounts for the evolution of hydrogen which we have mentioned :—

$$Zn + 2\ H_2O = 2\ H + Zn\ (OH)_2.$$

The hydrate of zinc is at once dissolved in the excess of cyanide—

$$Zn\ (OH)_2 + 4\ KCy = K_2ZnCy_4 + 2\ KOH,$$

which reaction explains the increase in the alkalinity of the solution.

There are reasons for believing that the black deposit formed on the zinc shavings is an actual chemical compound of gold and zinc, which acts as the negative element in the electric couple, the undecomposed zinc forming the positive element.

When strong solutions of caustic soda have been used for neutralising the acid salts of the ore a white deposit is frequently observed on the zinc. The alkali first attacks the metal to form a zinc-sodium oxide :—

$$Zn + 2\ NaOH = Zn\ (ONa)_2 + 2\ H.$$

This then reacts on the double cyanide of zinc and potassium always present in the solution, and precipitates the white insoluble simple cyanide of zinc :—

$$2\ H_2O + Zn\ (ONa)_2 + K\ ZnCy_4 = 2\ ZnCy_2 + 2\ NaOH + 2\ KOH.$$

This reaction is of some importance as affording one means by which the excessive accumulations of zinc in the solutions is avoided.

Affinity of Zinc for Cyanogen.—Potassium auro-cyanide ($KAuCy_2$) appears to be one of the most stable of the salts of gold, but the reaction in the zinc-boxes shows that the affinity of zinc together with potassium for cyanogen is greater than that of gold with potassium for the same radical. Hence a solution of potassium cyanide cannot dissolve gold which is in contact with zinc ; neither can gold replace zinc in a solution of the double cyanide of zinc and potassium. So long as any zinc is present, therefore, we need not fear that the precipitated gold will redissolve in the excess of potassium cyanide flowing through the boxes.

It is evident that the cyanogen contained in the double cyanide of zinc and potassium is not available for dissolving gold, and when a solution charged with zinc is employed in the treatment of a fresh lot of tailings it is only effective so far as it contains a certain quantity of simple cyanide of potassium or other alkaline cyanide.

New Methods of Precipitation.—The cyanides of sodium and ammonium, and those of the alkaline earth metals (calcium, barium, &c.), will dissolve gold, as well as potassium cyanide.

Sodium cyanide is more difficult to manufacture than the potassium compound, but a given weight of it should be more effective than the same weight of potassium cyanide, since forty-nine parts of the former are equivalent to sixty-five parts of the latter.

The advantage of Molloy's process and others which employ sodium or potassium amalgam was pointed out in our previous paper. The alkali metal is obtained by the electrolysis of the carbonate between electrodes of lead and mercury :—

$$Na_2CO_3 = Na_2 + CO_2 + O.$$

The sodium forms an amalgam with the mercury. Sodium amalgam may also be manufactured direct from its elements. It is claimed for this method of precipitation that the whole of the cyanogen is restored to a condition in which it is available for dissolving gold, as shown by the reaction :—

$$Na + KAuCy_2 = Au + KCy + NaCy.$$

Composition of the Zinc Slimes.—Any base metals which happen to be in solution in the cyanide liquor are liable to be precipitated by the zinc along with the gold. Hence the "zinc slimes" are found to contain a certain percentage of copper as well as traces of arsenic and antimony. Moreover, any impurities in the zinc will also find their way into the slimes, as zinc will be dissolved by the cyanide in preference to any less oxidizable metals (*e.g.*, tin and lead).

Silver is dissolved by cyanide and reprecipitated by zinc by a set of reactions precisely analogous to those of gold :—

$$2\,Ag + 4\,KCy + O + HO = 2\,KAgCy_2 + 2\,KOH,$$
$$2\,KAgCy_2 + Zn = K_2ZnCy_4 + 2\,Ag.$$

It has been observed that the proportion of silver to gold is greater in the "cyanide bullion" than in the gold from the batteries, and this is explained by supposing that the loss of silver in amalgamation is greater than that of gold.

Treatment of the Zinc Slimes.—The removal of the zinc is a troublesome operation, and is only very partially carried out in smelting the dried slimes. The admixture of sand is made for the purpose of forming a fusible silicate of zinc. A portion of the zinc is volatilised, and burns at the mouth of the crucible with a greenish flame, producing the white oxide, ZnO, which is found incrusting the flues, and doubtless carries with it no inconsiderable quantity of gold and silver. The most promising method of treating these slimes appears to be that suggested by Mr. Bettel, of fluxing with acid sulphate of soda and fluor-spar.

Attempts to remove the zinc prior to smelting have been only partially successful, as all such methods involve the filtration of a slimy mass which retains soluble salts with great tenacity.

The slags from the fusion of the zinc-slimes contain a considerable amount of gold, some of which is in the form of round shots, and may be removed by pounding up the slag, passing through a coarse sieve, and "panning off." The residue from the first fusion should always be fused again, with addition of lead, to form an alloy with the gold. The same lead bars may be used for a number of successive fusions of the slag, and when sufficiently enriched the gold may be recovered from them by cupellation.

Testing of Cyanide Solutions.—It is a matter of importance to determine exactly what strength of cyanide solution is used in treatment of tailings. The ordinary method of testing depends on the fact that silver cyanide is soluble in excess of potassium cyanide, with formation of a double cyanide of silver and potassium :—

$$KCy + AgNO_3 = AgCy + KNO_3$$
$$AgCy + KCy = KAgCy_2.$$

When silver-nitrate solution is added drop by drop from a burette to a solution of cyanide a white precipitate is formed, which quickly redissolves. At a certain stage the precipitate becomes permanent, when, in fact, the whole of the cyanide has been converted into a soluble silver salt, and an additional drop of silver nitrate produces a permanent precipitate of the insoluble simple cyanide of silver :—

$$KAgCy_2 + AgNO_3 = KNO_3 + AgCy.$$

From these reactions 107·66 parts by weight of silver are equivalent to 130·04 parts of potassium cyanide. A convenient standard silver solution is one of such a strength that every c., added to 10c. of the solution to be tested corresponds to 1 per cent. pure KCy.

This method gives good results when pure cyanide solutions are under examination, but when we come to test solutions containing zinc, it is difficult, if not impossible, to determine the end of the reaction. A white flocculent precipitate occurs at a certain stage, probably consisting of simple (insoluble) cyanide of zinc, formed by decomposition of the soluble double cyanide :—

$$K_2\,ZnCy_4 + AgNO_3 = KAgCy_2 + ZnCy_2 + KNO_3.$$

This precipitation occurs long before the whole amount of potassium cyanide has been converted into the soluble double salt of silver ($KAg\,Cy_2$), for the solution, after the appearance of the flocculent precipitate, still gives the Prussian-blue reaction, with acidulated ferrous sulphate. A standard solution of iodine in potassium iodide may be used with great accuracy for determining the total amount of cyanogen in a solution, whether in combination with zinc or not, making use of the reaction :—

$$KCy + I_2 = KI + ICy$$

The colour of the iodine is discharged so long as an excess of cyanide is present. The sharpness of the end reaction may be increased by adding a small quantity of starch to the solution under examination, which gives a permanent blue colour as soon as an excess of iodine has been added.

What is most needed, however, is a rapid method of determining the amount of cyanide *available for dissolving gold*, for, as we pointed out above, the cyanide in combination with the zinc is not available for that purpose.

The method of testing solutions containing zinc for "available cyanide," which was introduced by Mr. Bettel at the Robinson General Mining Company's works is as follows: Two perfectly-clean flasks of equal size are taken. To each of these is added a considerable bulk, say, 50cc. of the solution to be tested, and 50cc. of water. The liquid in both flasks will probably appear slightly turbid, but the degree of turbidity will be the same in each. Standard silver nitrate solution is run into one flask until the slightest possible increase in turbidity is observed on comparison with the liquid in the other flask. This point is taken as indicating the conversion of the whole of the free potassium cyanide into the soluble silver salt, and, therefore, as determining the amount of available cyanide present in the solution.

The amount of gold in the solution is generally found by evaporating a known bulk with litharge, fluxing the residue, and cupelling the resulting lead button. Evaporation on lead foil may likewise be employed.

Poisonous Properties of Cyanide.—A few words may not be out of place as to the poisonous action of cyanide of potassium. Although one of the most rapid and deadly of known poisons when taken internally, its action as a blood poison is much less violent. Nevertheless, when introduced into cuts it produces very painful sores. The men employed in the "clean-up," and in melting the slimes, are subject to a peculiar eruption, especially on the arms, and complain of headache, giddiness, and general depression. Ferro-cyanide of potassium has been recommended as a remedy for the eruption; it may be taken internally, and also applied as a lotion. Considering the dangerous nature of the substance, it is remarkable how few fatal accidents have occurred through the use of cyanide on a large scale. In cases of poisoning, precipitated carbonate of iron, obtained by mixing solutions of sodium carbonate and ferrous sulphate, may be used as an antidote. This forms internally an insoluble blue compound with the cyanide.

Hydrocyanic acid acts directly on the nervous system, causing instant paralysis; hence any treatment which will excite the action of the nerves, such as application of cold water to the spine, inhalation of ammonia, &c., may be tried in cases of faintness produced by breathing the vapour of the acid.

The disposal of waste cyanide liquors is a matter for very serious consideration. Solutions containing 1 or 2 per cent. of potassium cyanide must occasionally be discharged, and are likely to contaminate the water of the dams or streams which receive them to a dangerous extent. If some effective means of precipitating the zinc, or, better still, of dispensing with the use of zinc altogether, could be devised there would never be any necessity for allowing cyanide liquors to leave the building.

THE CYANIDE PROCESS IN SOUTH AFRICA.

It has long been known (writes Messrs. Chas. Butters, Ph.B., and John Edward Clennell, B.Sc., in the *Engineering and Mining Journal*) that the extraction of gold from its ores by amalgamation is imperfect. The only method which has hitherto proved successful in working the tailings from that process on the South African goldfields is that known as the cyanide process. The adoption of this process has been rapid, and the success attending its operation most striking. It is all so beautifully simple on paper that we might well suppose the "Ultima Thule" of metallurgical research has been reached.

But the working metallurgist who attempts to carry out this process on a large scale soon finds himself confronted with difficulties, and is forced to the conclusion that even the cyanide process is open to improvement. These difficulties arise from the nature of the material under treatment, and from the manipulations necessary in applying the process to large bulks of material. Neither the solution of the gold in the ore under treatment, nor the precipitation of this gold, nor the conversion of this precipitate into a marketable commodity is perfect, from a theoretical or practical point of view. Losses occur in each of these operations. Moreover, the consumption, both of cyanide and zinc, is enormously in excess of that which is indicated by the various chemical reactions involved.

We propose in this paper to shortly describe the process as it is carried on at the present day in South Africa, indicating the various improvements which have been introduced for the purpose of overcoming the drawbacks pointed out above, with special reference to the methods in use at the large works belonging to the Robinson Gold-mining Company.

In subsequent papers the details of the process from a metallurgical and from a commercial point of view will be more fully dealt with. It will be sufficient to state at the outset that hitherto the process has only been successfully applied to those ores or tailings usually described as "free-milling," *i.e.*, such as are capable of yielding the greater part of their gold in the ordinary amalgamation process. Although it is quite possible to extract a high percentage of gold from pyritic and other refractory ores by means of potassium cyanide, it remains to be seen whether this operation may be profitably conducted on a commercial scale.

The promoters of the McArthur-Forrest process have been singularly fortunate in the nature of the material they have had to deal with on these fields. The ores forming the upper portion of the main reef series, extending to a depth of 10ft. to 150ft. or 200ft. (as on the Robinson property), consist almost exclusively of silica and oxide of iron. They contain practically no substances except gold and silver which the cyanide is capable of attacking. The serious difficulties of the process begin when we come to deal with ores or products containing sulphides of iron, especially when these are partially oxidized to sulphates, and those containing compounds of the base metals, lead, zinc, &c.

The cyanide process, as applied to free-milling ores or tailings, comprises three distinct operations: (1.) Solution of the gold in potassium cyanide. (2.) Precipitation of the dissolved gold by some suitable reagent. (3.) Conversion of the precipitated gold into bullion.

We shall consider each of these operations separately, noting the various methods in use, the difficulties to be overcome, and the plans which have been tried or suggested for surmounting them.

Solution of the Gold.—When the cyanide process was first introduced about two years ago, it was thought necessary to agitate the material under treatment with cyanide solution in order to

obtain a satisfactory extraction of gold. It was soon found, however, that the powers required for the agitation and the rapid decomposition of the solution were sources of expense which more than compensated for the greater percentage of precious metal extracted in comparison with the method of simple lixiviation. At the present day the "percolation" system is almost invariably adopted. The operation is carried out by the African Gold Recovery Company, who represented the patentees in South Africa, as follows: The damp tailings, taken from the tailings-pits, are charged into wooden vats of a capacity of 35 to 50 tons; these vats are usually square. The best works are now building circular tanks.

The round vats in use at the Robinson Works have a capacity of 75 tons; those now in use at the Langlaagte Estate have a capacity of about 400 tons, and still larger vats are being constructed for the cyanide works at the New Primrose Mine. The vats are filled to within a few inches of the top, and the surface of the tailings levelled. Cyanide solution 0·6 to 0·8 per cent. strength is then allowed to flow into the tank until it is completely filled. The ore settles from 3in. to a foot below the rim of the tank (the amount of shrinkage depending on the depth of the vat). This solution is allowed to remain undisturbed, in contact with the ore, for twelve hours. Each vat is provided with a false bottom—usually a wooden framework covered with cocoanut-matting. Below this is a layer of coarse sand and pebbles through which the solution percolates. An iron pipe communicates with the vat below the false bottom, and conveys the filtered solution to the "zinc-boxes," where precipitation takes place. After twelve hours' contact with the ore, the solution is allowed to drain out of the tank by opening a cock.

It may be interesting to remark here that the dilute cyanide solution does not attack a wooden vat, nor does it corrode the iron-piping to any appreciable extent. As to wear and tear of apparatus, the use of cyanide offers decided advantage over chlorine or chlorine-water, which otherwise might be applied quite as cheaply to the treatment of those oxidized surface ores. Brass plungers and valves, such as are in use in ordinary pumps, are attacked, but not very rapidly. The pumps at the Robinson Works were in use for four months with comparatively little wear, but iron is, of course, preferable for all pump-fittings where cyanide solution is used. As the liquor is drawn off during the leaching process it is replaced by fresh solution. This operation is continued for a longer or shorter period, depending on the value of the tailings (about six to twelve hours).

At the end of this period, which is known as the "strong solution leaching," a weaker solution (containing 0·2 to 0·4 per cent. of cyanide) is turned on, and allowed to filter through the ore for about eight to ten hours. This "weak solution" is then drawn off through another zinc-box (known as the "weak zinc-box"). Finally a quantity of water is run into the tank, more or less, equivalent to the amount of moisture which the ore contained when the tank was filled. This last water-washing displaces the weak cyanide solution, so that the volume of cyanide in use remains unchanged. The "weak solution" is, in fact, the liquor which has previously passed through the zinc-boxes into the receiving-tanks or "sumps," and has been pumped again to the leaching-tanks. The cyanide is usually supplied in cases, containing 190 to 195lb. of crude cyanide, contaminated with carbonaceous matter and iron, but containing 72 to 78 per cent. of pure potassium cyanide.

This cyanide is usually dissolved in a small volume of water, to form a highly concentrated solution, a special small tank being employed for this purpose. The solution of required strength is obtained by adding this concentrated cyanide to the dilute liquor in the sumps. By this means a dilute solution of given strength is more accurately arrived at than would be the case if the cakes of cyanide were dissolved directly in the required volume of water, since the percentage of cyanide can be more accurately determined in a strong solution than in a weak one. The actual amount of cyanide used in this method of working is about half a ton of strong (0·6 to 0·8 per cent.) solution and half a ton of weak (0·2 to 0·4 per cent.) solution for every ton of ore treated. As the amount of cyanide actually entering into combination with gold and silver is almost infinitesimal in comparison with the quantity consumed in the different stages of the process, it will be obvious that there is still considerable scope for inventive genius in determining the conditions of economical working. When the final water-wash has been added, and has displaced the weak solution, the exhausted "tailings" or "residues" are discharged, usually by the somewhat tedious process of shovelling out over the side. A truck-line runs across the top, or by the side of the tank, to receive the discharged tailings, which are then removed and dumped outside the works. The tank is then ready for a fresh charge.

The "percolation system" described has been modified in various ways. One of the first difficulties in the application of this process arose when tailings were treated containing a small percentage of pyrites, which, by exposure to the air, had become partially converted into sulphate of iron and free sulphuric acid. These substances gave rise, as will be explained in a later paper, to a considerable decomposition of the cyanide solution, a decomposition which could only be prevented by special treatment, adding greatly to the cost of the operation. The trouble could be minimised by treating tailings direct from the battery, in which there had been no time for the oxidation of the pyrites; but where old tailings, which had been exposed for many months to the action of the atmosphere, were to be extracted, it was found necessary to give a preliminary washing, first with water and then with some alkaline solution, such as lime or caustic soda. At the Robinson Works lime was found to be in every way preferable to the stronger alkali, as it is less active in inducing the decomposition of the cyanide solution in the tanks, and in attacking the zinc used in the subsequent precipitation. Endless complicated reactions occur when substances are present in the ore capable of decomposing the cyanide solution, and in some cases the gold already dissolved may be re-precipitated and deposited in the gelatinous mass formed on the surface of the tank, especially when the "circulation" method is employed.

It has been stated that in the usual method of working about a ton of solution is employed in the treatment of a ton of ore. Since, with free-milling ore, a much smaller quantity is sufficient to dissolve the same percentage of gold, it was suggested that the solution from one tank might be transferred to a second, and be made to dissolve an additional quantity of gold before being

passed through the zinc-box. For example, at the Robinson Works it was found that 20 tons of solution were amply sufficient to extract 40oz. of gold from 75 tons of tailings in one tank. It was found that 20 tons of solution sufficed to fill a tank holding the usual charge of 75 tons of tailings, covering the charge to a depth of three or four inches. Instead of replacing this 20 tons of solution by fresh cyanide, the solution filtering through was continually pumped back again into the same tank for about thirty-six hours, and then passed through the zinc-box. The extraction of gold by this circulation-system was equal to that obtained by the ordinary method, and the consumption of cyanide was much less, since a much smaller quantity of solution was exposed to the action of the zinc. A further modification suggested itself—namely, the transference of the solution charged with gold from one tank to a second and third, in order that it might take up an additional quantity of gold from fresh tailings before passing into the zinc-boxes. The advantages of this method are that the solutions from which the precipitate is obtained are much richer in gold, giving a cleaner deposit on the zinc, with much less consumption of cyanide.

The usual practice, as we have pointed out, is to dissolve the cyanide in a special tank set apart for that purpose. At the Robinson Works a different procedure is adopted. The strength of the cyanide solution is kept up by adding cyanide in lumps, dissolving it under the steam from the pump. By this method a cyanide solution of required strength is formed in the leaching-tank itself, and not in the pump. This simplifies the operation, and diminishes the number of tanks required in the treatment. It also gives us an easy means of getting rid of the insoluble impurities of the cyanide (the so-called carbide of iron), which would otherwise accumulate as a black slimy deposit in the concentrated solution-tank. This insoluble residue is, of course, discharged with the tailings when the tanks are emptied.

Another difficulty frequently encountered in the application of the cyanide process is the treatment of "battery slimes," *i.e.*, the very finely-divided material produced during the crushing, and which has a tendency to accumulate in pasty masses. These either resist the penetrating action of the cyanide, or retain the dissolved gold during the leaching operation. No satisfactory method of breaking such material has yet been devised—the evil may be lessened by mixing the slimy tailings with clean coarse sand.

A trial is now being made by the African Gold Recovery Company on the direct treatment of ore from the battery. Ore from the May Consolidated Mine (averaging about 2oz. to the ton) is being crushed with cyanide solution, instead of water, and is then led into the tanks without passing over amalgamated plates. The operations so far do not appear to have been very successful. Coarse gold, which is easily caught on the plates, is very slowly dissolved by cyanide, and this is probably a very serious source of loss in all such attempts at direct treatment. Experiments are also on foot at the Langlaagte Estate and many other places on the treatment of pyritic concentrates, with or without agitation, by the cyanide process. Although an extraction of over 90 per cent. has been obtained, it appears that the consumption of cyanide is enormous. The results obtained by the agitation-method in the treatment of concentrates have been so unsatisfactory that it is now abandoned by its originators. The results of both experiments will be awaited with great interest, as they have an important bearing on the future of the gold-mining industry, and will give us some indication as to whether the cyanide process can successfully compete with amalgamation and chlorination.

Various improvements have been introduced in the mechanical details of construction. The large leaching-vats of the Robinson Company are rapidly and conveniently discharged by means of a trap-door placed in the centre of the tank bottom, and which may be hermetically closed by a patent screw fastening. The enormous underground vats of the Langlaagte Estate Company are discharged by means of a dredge, which appears to give perfect satisfaction.

Precipitation of the Gold.

Having obtained a solution of gold in cyanide of potassium, the next step is to recover it. Various precipitants have been suggested, but the only one which has been practically successful on a large scale is metallic zinc, in the form of freshly-turned shavings. Zinc in sheets offers too little surface for the deposition. The same is true of granulated zinc. When once the surface has become coated with an extremely fine layer of gold, the action ceases, or becomes so slow that the precipitant cannot be practically applied in this form. Zinc dust and zinc amalgam have also been tried, and are effective in so far as they present a large surface for deposition, but are found to clog if the continued flow of liquid through them is interrupted. Sodium or potassium amalgam has been used with success on a small scale, as in the Molloy process, now about to be tried with a 500-ton plant at the Pioneer Gold-mining Company; but the difficulty so far has been to manufacture these substances cheaply and in sufficient quantity.

The zinc-shavings now in use are prepared by turning thin sheets of zinc on a lathe. This produces a light spongy mass, which readily allows the solution to filter through, and exposes a large surface for the precipitation of the gold. These shavings are placed in wooden troughs, commonly known as "zinc-boxes," and the solution from the leaching-vats is allowed to flow slowly through them, depositing the gold as a finely-divided black slime on the surface of the zinc, while the zinc gradually dissolves in the liquid. After passing the zinc-box, the "exhausted solution," which should not contain more than ½dwt. of gold to the ton, flows into a storage tank or "sump," whence it may be pumped back to the leaching-tanks, when a fresh charge has to be treated. But the simple replacement of gold by zinc is not the only reaction which occurs in the zinc-box; we find that a notable falling off in the strength of the cyanide occurs, due to secondary reactions caused by the gold-zinc couple.

Various slight modifications have been introduced in the construction of the zinc-boxes. They are usually divided into several compartments, so arranged that the liquid flows alternately upward and downward through the shavings. The shavings are placed in a tray, the bottom of which is an iron-wire screen of about four holes to the inch. This is supported a few inches from the bottom

of the zinc-box. The fine "gold slimes" fall through this screen, and may thus be separated from the undecomposed zinc when the "clean up" takes place.

The zinc-boxes in use at the Robinson Works are about 20ft. long, 2ft. wide and 2ft. deep, with inclined bottoms. They are divided into compartments of about 20in. in length. Each compartment holds about a bushel of shavings, weighing perhaps 40lb. Seven compartments in each zinc-box are filled with shavings; a single compartment at the head is left empty to receive any sand that may be carried through the filters by the solution from the tanks. A double compartment at the foot is also left empty to allow any gold that may be carried away by the stream of liquid to deposit before the solution flows into the sump. About 60 tons of solution, which is the quantity required for treating the ordinary daily charge of 225 tons of tailings, are allowed to run off through two zinc-boxes in about nine hours. This solution may carry from 1oz. to 3oz. of gold per ton of liquid; after passing through the zinc-boxes it rarely contains more than 2dwt., and should not contain more than ½dwt. if the precipitation has been properly carried out.

There are two sets of zinc-boxes, one to receive the "strong solutions" (0·6 to 0·8 per cent. cyanide), and one for the "weak solutions" (0·2 to 0·4 per cent). The slimes formed in the weak boxes are as a rule much poorer than those in the strong boxes, and less consumption of zinc takes place in them.

The total amount of zinc consumed amounts to about 100lb. a day. Two men are constantly employed at the lathes, so that the turning is an arduous and somewhat costly operation. It is desirable to use freshly-turned zinc, as the surface rapidly oxidizes and becomes much less active in precipitating the gold.

The most vigorous action, of course, takes place in the compartments which first receive the solution from the tanks. It is here that the zinc dissolves most rapidly, and is accordingly replaced by shavings from the lower compartments, while fresh zinc is continually added as the last compartment becomes empty.

The clean-up takes place once or twice a month. The screens containing the undissolved shavings are lifted from the zinc-boxes. The boxes are then left undisturbed for an hour so as to allow the zinc-gold slime to settle at the bottom. The liquid is then drawn off by a siphon until very little is left above the slimes. The box is then cleaned out, and the slimes and muddy water allowed to drain through a screen of 40 meshes to the inch. The mass, consisting of water, finely-divided gold and very fine zinc, is rubbed through this screen by means of a short stick, 5in. or 6in. in length, to the end of which is affixed a piece of indiarubber.

The stuff remaining on the screen consists almost entirely of unconsumed zinc, fine enough to pass through a screen of twelve meshes to the linear inch. This is replaced in the first divisions of the zinc-boxes over a fresh lot of shavings.

The slime, consisting of finely-divided gold and silver, with a large proportion of zinc and lead, and a certain quantity of tin, antimony, organic matter and other accidental impurities, is allowed to settle in a small tank placed beneath the 40-mesh screen, and is now ready to undergo the drying and smelting operations necessary for its conversion into bullion.

In the Molloy process, to which we have alluded above, the use of zinc is dispensed with altogether. The solution passes through a shallow trough containing mercury, in which is an inner cylindrical vessel filled with solution of carbonate of soda; the edges of the cylinder just dip beneath the mercury, so that its contents are entirely cut off from the outer portion of the vessel. A rod of lead dips into the soda solution; the lead and the mercury are connected with opposite poles of the battery, and the solution is electrolyzed by the passage of a current. The sodium combines with the mercury to form sodium amalgam, which at once decomposes the gold cyanide solution with formation of ordinary gold amalgam, sodium.cyanide being simultaneously produced. It is claimed that much less decomposition of the cyanide takes place than with zinc, and, moreover, that the outflowing solution is better adapted for dissolving fresh quantities of gold. It is obvious that in the ordinary method a large accumulation of zinc in the solutions must take place, which, in time, would render them valueless for gold extraction, whereas sodium-cyanide is just as effective as the potassium compound. It must be added that the validity of the Molloy patent is at present under dispute; still, if this method of precipitating should prove successful on a large scale, a great improvement will have been effected.

Production of Bullion.

The third stage of the cyanide process consists in converting the precipitated gold into a marketable commodity.

The slimes are now transferred to enamelled-iron pans, and carefully dried over a small furnace. This is a tedious operation and requires considerable time. The richness of the dried slimes will depend on the percentage of gold present in the cyanide liquors passed through the zinc-boxes. The pans in use at the Robinson Works contain about five or six gallons of dried precipitate. This may contain as much as 150oz., or as little as 20oz. of gold.

The precipitate, when nearly dry, is mixed with sand, borax, and bicarbonate of soda, and melted in a No. 60 crucible at a fairly high temperature. The material melts very easily, forming a very liquid slag, which, however, rapidly corrodes the pots, so that a good 60 crucible rarely lasts for more than eight meltings. The charge is not added all at once, but as each portion melts and sinks down, fresh quantities of the mixture are added. When the pot is full of liquid slag it may contain from 100oz. to 150oz. of bullion. Large quantities of oxide of zinc are given off during the melting, which carry off a very appreciable amount of gold. The zinc fumes, together with the products formed by the decomposition of the cyanide salts, render the operation anything but healthy.

The bullion produced is whitish in appearance, and about 650 fine. It is very hard and brittle, and the bars are by no means uniform, so that it is difficult to obtain an accurate assay. In addition to zinc, they contain silver, lead, and sometimes a little copper. Several ways have been suggested

for obtaining a purer bullion. One method consists in partial roasting of the slimes in a muffle furnace, whereby a portion of the zinc is oxidized and volatilised, leaving a much smaller mass for the subsequent smelting. By this treatment bullion of 800 fine may be obtained. Another method is to first carefully wash out the soluble cyanide salts, and then to treat with dilute sulphuric acid, which dissolves the zinc. The objection to this process is that the slimy mass is very difficult to filter, and retains the soluble zinc salts even after prolonged washing. The same trouble is encountered when the zinc is dissolved in hydrochloric acid.

Some difficulty is also experienced in washing out the soluble cyanide salts. It is possible that the use of filter presses might to some extent solve the problem of purifying the zinc slimes. The use of acid sodium-sulphate as a solvent for zinc also appears to promise good results.

But what would strike an American engineer as curious is that as a rule, on these fields, no attempt is made to refine the product, because to melt straight away into bars of bullion yields more "ounces," and in Africa it is "ounces per month," and not value in "pounds sterling" or in "dollars" that one looks to.

Scope of the Process.

In general we find that on the large scale the extraction of gold by cyanide amounts to 70 or 80 deg.; tailings assaying 8dwt. to 10dwt. will give residues assaying 2dwt. to 5½dwt. A much higher extraction is obtainable on a small scale, with the same strength of solution, when relatively large quantities of solution are allowed to pass through the material under treatment. In its present phase the limitations of the cyanide process appear to be: (1.) That it is only completely successful with free-milling ores. Pyritic ores may be treated, but at a greatly increased cost. (2.) That it is not applicable to ores containing a considerable percentage of coarse gold. (3.) That it cannot be economically applied to rich material. If we can afford to lose 2dwt. in 8dwt.-ore, we cannot afford to lose 2oz. in 8-oz. ore.

On the other hand, the cyanide process is admirably adapted for recovering the so-called "float gold," *i.e.*, gold in an extremely fine state of division, which remains suspended in the water for several hours and cannot be obtained by any process of amalgamation or concentration. That the cyanide process is well adapted for the treatment of Rand ores is shown by the fact that although the system has been in use little more than two years, over 40,000 tons of tailings are now being treated per month. The process is only in its infancy; the varied and complex problems to which it has given rise are mostly unsolved; its limits are yet undefined, and he would be rash indeed who should dare to forecast its future.

MOLLOY'S NEW CYANIDE PROCESS.

The *South African Mining Journal* gives a preliminary account of a new cyanide process for the extraction of gold from tailings, invented by Mr. B. C. Molloy, of Johannesberg. The improvement consists in the abolition of zinc as a precipitator of the gold, and in the revivification of the cyanide of potassium solution. In the new process the tailings are treated with cyanide of potassium solution as usual, and the resulting liquors are passed through a patent "Molloy separator." This separator consists of some sort of an amalgamator, through which a weak current of electricity is sent. When the solution containing the double cyanide of potassium and gold is sent through the separator, metallic potassium is released on the mercury, and this potassium immediately replaces the gold in the cyanide. The gold is thus amalgamated, and the liquors pass out as revivified cyanide of potassium.

One advantage claimed for this process is the possibility of obtaining the gold in the form of an amalgam and thus avoiding the loss inseparable from the treatment of gold-zinc slimes. The retorting of the gold amalgam, also, does not require the skilled labour which is necessary for the reduction of such slimes. The most important advantage, however, is the regeneration of the cyanide of potassium after the precipitation of the gold. The chief cost of the cyanide process as hitherto worked has been due to the entire loss of the cyanide of potassium. Its economical recovery by any process must necessarily result in a great reduction of working expenses.

Several trials of the process have been made by Dr. Simon, an eminent authority in Johannesberg. One solution whose original contents were 2oz. 18dwt. of gold per ton, was found to contain only 1½dwt. after it had passed the extractor. Further trials are now being made, and if they establish the process as a commercial possibility, Mr. Molloy will give full details of his invention. Experiments in this country with the use of mercury as a precipitating agent have not proved a success, and we have reason to doubt the claims for this process, particularly those for the regeneration of the solutions.

THE CYANIDE PATENTS.

The Attorney-General of the Transvaal has decided that the McArthur-Forrest Company is not entitled to a monopoly of the use of cyanide in South Africa, as the company had claimed. He gave his opinion, moreover, that no process in which cyanide is used in a different manner is an infringement on the McArthur-Forrest patent. This decision was reached in an attempt by the McArthur-Forrest Company to restrain the Cyanide Gold Recovery Syndicate from using the Malloy process. This process differs from the McArthur-Forrest only in the method of precipitation. Instead of the fine zinc shavings, or filiform zinc, as Messrs. McArthur-Forrest prefer to call it, sodium amalgam is used. This amalgam is formed electrolytically from a solution of carbonate of soda in contact with a bath of mercury. In precipitation the sodium combines with the cyanogen atoms of the molecule of auric cyanide, forming sodium cyanide, while the gold is instantly amalgamated. This auriferous amalgam is then strained, retorted, and melted as in an amalgamation mill.

While we have no late information as to the efficiency of the process, on its face it would seem to have many advantages over the method of precipitating on finely divided zinc, as no prejudicial

elements absorbing cyanogen are introduced into the solution, and the ultimate product is far easier to treat without loss. We understand that the company owning the Malloy patent is confident of a favourable decision in the English suit brought against it by the McArthur-Forrest people. They claim that the McArthur-Forrest patents are invalid, and that they have the fullest testimony to that effect.

This coincides with the opinion we have so often expressed that the McArthur-Forrest patents were untenable, and could never live through the Courts. The American purchasers of the McArthur-Forrest patents have stated that they will bring a suit promptly against anyone using a cyanide process without authorisation from them; but so far this announced intention has not been put into effect, although there is at least one mine at which cyanide is being used and no royalty is being paid. The McArthur-Forrest people are undoubtedly aware of this instance of infringement if their patents are valid, but are doubtless reluctant to have a case brought to trial, as what we have long stated, that the process is unpatentable, would be clearly proved, and other companies which are now paying them $1 a ton royalty would then stop doing so.—*Mining and Engineering Journal.*

IMPROVEMENTS IN THE CYANIDE PROCESS.

After a certain amount of experience with any process, its weak points are seen, and opportunities for improvements present themselves. To this rule the cyanide process is no exception. One of the great difficulties experienced in this process, or indeed in any lixiviation process, is the treatment of the slimes of an ore otherwise well-suited to reduction by the method. They pack upon the filter, forming beds impermeable to the solution, and even if mixed with large quantities of coarser material are rarely attacked, although laboratory experiments will show that their precious metal contents are extremely soluble. Of such material, the Robinson Gold-mining Company, of South Africa, operating one of the largest cyanide plants on the Transvaal, has accumulated 60,000 tons, and the management has long despaired of treating it successfully, as the gold would not amalgamate, nor would the cyanide permeate the mass if it were charged into vats. The average assay-value was between $7 and $8 a ton, but the fineness, it is estimated, is such that it would pass a 225 mesh screen.

Mr. W. Bettel, the chemist of the company, has been experimenting with these slimes for some time past, and has devised a plan which, it is claimed, will solve the difficulty. The process consists in mixing a mass of the slimes with 50 per cent. of its weight of the double cyanide of manganese and potassium ($K_6Mn_2C_{12}$) mixed with ordinary cyanide solution.

The fine slimes are thoroughly mixed with the solution, and, while in a state of suspension, are pumped into a Johnson filter-press under a pressure of 100 pounds to the square inch. Charging the press occupies about twenty minutes. At the end of this period, the charging of slimes is shut off and water is forced through the press, which, it is said, thoroughly washes out the gold cyanide solutions. Forcing water through the slimes is continued, until the escaping fluid does not show an alkaline reaction. The gold in the solutions which flow off is precipitated preferably by the Molloy process. Slimes at the Robinson Works, which contained originally $7 to the ton, showed but 12 cents to 16 cents after treatment by this method.

In various experiments, 97·6 per cent. to 98·2 per cent. was obtained, and from fine ground concentrates 96·85 per cent. was extracted. When, however, it was attempted to treat coarse sands by this method, an absolute failure was made, showing that the ore must be in an extremely fine state of division to be successfully treated by Mr. Bettel's process. When tailings and slimes are treated direct from the mill, the use of classifying spitzlutten is proposed.

While the application of the filter-press to the treatment of ores by the cyanide process is undoubtedly new, yet such a procedure has been proposed for the hyposulphite lixiviation process by the late E. N. Riotte; a description of it will be found in the *Engineering and Mining Journal*, of March 31st., 1888.—*Engineering and Mining Journal.*

IMPROVEMENTS IN THE EXTRACTION OF GOLD AND SILVER FROM ORES OR COMPOUNDS CONTAINING THE SAME.

Specification.

"I, John Cunninghame Montgomerie, of the 'Water of Ayr,' and 'Tam O'Shanter' Hone Works, Dalmore, Stair, in the County of Ayr, Scotland, manufacturer, do hereby declare the nature of my invention for 'Improvements in the extraction of gold and silver from ores or compounds containing the same,' and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

"This invention relates to the treatment of auriferous and argentiferous ores or compounds for the purpose of separating and collecting the gold and silver contained therein, by means of solvent agents—as, for example, cyanide of potassium.

"According to a method commonly employed in the recovery of gold and silver by means of cyanide of potassium, the ore or other material, having been reduced to a finely triturated state, is placed along with the solvent in a barrel or other vessel, and is there subjected to agitation. After the lapse of a few hours, the contents of the barrel are removed to a filter, where the liquid portion of the charge (containing the precious metals in solution) is separated from the ore. The latter is further washed for the removal of any gold or silver remaining in solution therewith. The cyanide solution of gold and silver, as also the wash-water, is then treated for the recovery of the precious metals by precipitation in a zinc filter or percolator.

"Where, in a process of the kind above referred to, cyanide of potassium is employed as the solvent agent, it is necessary for the ore to be neutralised before treatment; and, in some cases it is advantageons to render it more or less alkaline, according to the nature of the ore, especially so where its treatment is effected in the presence of oxyden under pressure. With this object, sodium-oxide (NaO_2) or caustic soda (NaOH) may be added, either before or with the solvent agent; the quantity best suited to the character of the ore being determined by experiment.

"Instead, however, of treating the mixture of ore, cyanide solution, and sodium-oxide in the presence of oxygen under pressure, I have found that equally satisfactory results may be obtained with atmospheric air instead of oxygen, if sodium dioxide (Na_2O_2) be added to the mixture of ore and cyanide solution. In carrying out this operation, I take of cyanide of potassium a quantity proportionate to the ore to be treated, and dissolve the same in a little water. I then take a small quantity of sodium-oxide or caustic soda (say three-fourths by weight of the cyanide), and, having dissolved this also in a little water, I add the two solutions to the quantity of water appropriate for the charge of ore about to be treated. Before adding the ore to the mixture, I mix with the former the required quantity of sodium dioxide. This may be one-third by weight of the sodium-oxide. The compound is then added to the mixture before referred to, and subjected to agitation, preferably in a closed vessel, in which case the oxygen gas evolved generates pressure. Additional air may be forced in. By way of illustration, an ore containing, say 4oz. of gold and 12oz. of silver to the ton, may be treated with 12lb. of cyanide, 3lb. of sodium dioxide, and 9lb. of sodium-oxide.

"I find that by adding a certain proportion of sodium-oxide or caustic soda to the cyanide, prior to the ore being added, the proportion of cyanide or other solvent, as also that of the sodium dioxide to be subsequently added, may be largely economized. In this way, moreover, I am enabled to mix the sodim dioxide with the ore, and, without any violent action taking place, it gradually becomes dissolved as the ore gets saturated with the water. I do not, however, confine myself to the precise sequence of operations, or to the particular proportions hereinbefore mentioned, as these may be varied to a considerable extent for different kinds of ores, and will be best determined by experiment. For dioxide of sodium, dioxide of potash or equivalent alkali may be substituted; the same being applied under pressure of air or of oxygen if preferred.

"When sodium dioxide is employed in the manner hereinbefore described, the mixture of ore and cyanide solution is not only rendered alkaline, but, by reason of the action of the dioxide upon the base metals and other impurities, a larger proportion of the cyanide is left free to act on the gold and silver, considerable economy resulting.

"Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, and observing that the present application for letters patent is made within the term of priority of twelve months prescribed by section 106 of "The Patents, Designs, and Trade-marks Act, 1889," of the General Assembly of New Zealand, a British patent for the invention having been applied for on the 21st September, 1892, No. 16894, I declare that what I claim is:—

"1. In the extraction of the precious metals by a solvent process of the kind herein referred to, the employment of dioxide of sodium (potash, or equivalent) as an oxidizing and alkaline agent, substantially as herein described.

"2. In the extraction of the precious metals by a solvent process of the kind herein referred to, the employment of dioxide of sodium (potash, or equivalent) in the presence of oxygen, or atmospheric air, under pressure, substantially as and for the purposes set forth.

"Dated this 10th day of March, 1893.

JOHN CUNNINGHAME MONTGOMERIE.

"Certified to be a true copy.—HENRY HUGHES."

IMPROVEMENTS IN THE EXTRACTION OF GOLD AND SILVER FROM ORES OR COMPOUNDS CONTAINING THE SAME, AND IN APPARATUS APPLICABLE FOR USE IN THE TREATMENT OF SUCH MATERIALS BY MEANS OF SOLVENTS.

SPECIFICATION.

"I, John Cunninghame Montgomerie, of the 'Water of Ayr' and 'Tam O'Shanter' Hone Works, Dalmore, Stair, in the County of Ayr, Scotland, manufacturer, do hereby declare the nature of my invention for 'Improvements in the extraction of gold and silver from ores or compounds containing the same, and in apparatus applicable for use in the treatment of such materials by means of solvents,' and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

"This invention relates to the treatment of auriferous ores or compounds for the purpose of separating and collecting the gold and silver contained therein by means of solvent agents—as, for example, cyanide of potassium—and to apparatus applicable for use in processes of this description.

"According to a method commonly employed in the recovery of gold and silver by means of cyanide of potassium, the ore and other material having been reduced to a finely triturated state, is placed, along with the solvent, in a barrel or other vessel, and is there subjected to agitation. After the lapse of a few hours, the contents of the barrel are removed to a filter, where the liquid portion of the charge (containing the precious metals in solution) is separated from the ore. The latter is further washed for the removal of any gold or silver remaining in solution therewith. The cyanide solution of gold and silver, as also the wash-water, is then treated for the recovery of the precious metals by precipitation in a zinc filter or percolator.

"When a cyanide solvent is employed as hereinbefore described, a certain portion thereof is taken up by base metals and other impurities invariably present in greater or less proportions in the ore. The solvent is also contaminated by the zinc dissolved, while the mixture of ore and solvent matter is under treatment in the zinc percolator; both of these cases resulting in a considerable waste of the cyanide, and in its contamination with deleterious matter.

"My improvement in the process of extraction by means of the kind hereinbefore referred to consists in adding sodium-oxide (caustic soda), or other suitable oxide of the alkalies to the cyanide solution before (or whilst) mixing the same with the ore, thereupon agitating or otherwise treating the resultant mass for the time requisite for enabling the gold and silver to be dissolved by such a solution, then discharging the same into a filter, and drawing off the original quantity of water employed, the same being highly charged with the unconsumed cyanide and sodium-oxide, and with the precious metals in solution.

"By the employment of sodium-oxide in the manner hereinbefore described, particularly where the alkali is in excess, I have found that the proportion of cyanide or other solvent may be considerably reduced, and an important economy in the cost of working effected.

"In carrying out this stage of the process, a sufficient quantity of water is added to the surface of the ore in the filter, as soon as it becomes dry, the added water displacing the liquid remaining in the ore, and permitting the latter to be discharged. The liquid obtained is then tested for cyanide of potassium and sodium-oxide, and the deficiency supplied by the addition of the necessary quantity of these agents, so as to restore the solvent solution to its original character and strength. This solution is now applied to a fresh charge of ore, and the same operation is repeated with successive charges till it is found necessary to discharge the solution, with a view to precipitating the gold and silver in the usual manner. Experiment alone can determine the quantity of solvent and of sodium-oxide appropriate, and the period of time requisite to insure the greatest extraction of the precious metals and the least consumption of the solvent, as these will vary according to the nature of the ore operated upon. (It may be mentioned, by way of illustration, that for an ore containing about 4oz. of gold and 12oz. of silver per ton, 12lb. of cyanide of potassium and 3lb. of sodium-oxide would be suitable.) The tailings are then further washed to remove the last trace of gold and silver remaining in solution, and the resultant wash-water is treated in the usual way for the recovery of the precious metals contained therein. By this mode of procedure, the quantity of liquid subjected to treatment for the recovery of gold and silver by precipitation is greatly reduced.

"My invention relates, secondly, to the construction of the barrel or other vessel in which the ore is subjected to the action of the solvent.

"If this barrel or vessel be formed of metal, its internal surface is rapidly acted upon by cyanide of potassium or other solvent of the precious metals; and if a lining of wood or similar material be employed, the latter is incapable of withstanding the chemical action of the solvent and the abrasive action of the ore for any length of time.

"With a view to overcoming these difficulties, I line the barrel or vessel with tiles or segments composed of glass or glazed porcelain—or similar solvent and acid-resisting material—the same being set in cement adapted to withstand the chemical action of the cyanide or other solvent employed.

"My invention relates, thirdly, to the construction of the filter or leaching-vat, employed for separating the ore from the cyanide or other solution of gold and silver, or from the wash-water.

"Apparatus constructed according to my invention is illustrated in the accompanying drawings, whereof Figure 1 is a vertical section, and Figure 2 is a plan. The apparatus comprises an upper vessel, *A*, for the reception of the mixture of ore and solvent, and a lower vessel, *B*, in which the solution is received after passing through the filter-bed. The latter is formed of filter-cloth, *C*, carried on wire gauze, *D*, coated with an acid-proof enamel and supported on wooden laths F^1 on the top of the vessel *B*. The vessel *A* is attached to the vessel *B* by means of bolts *F* and nuts F^1, and is so arranged that its bottom edge rests upon the circular margin of the filter cloth *C*, which it presses against the bottom of a recess or socket formed in the upper edge of the vessel *B*, thereby securing a water-tight joint between the two vessels, and at the same time holding the filter-cloth securely in position. *G* is a draw-off cock; *H* being the exhaust cock.

"For protecting the filter or leaching-vat against the action of the solvent, I line the same with segments or tiles *K*, composed of glass or glazed porcelain or similar solvent and acid-resisting material; the same being set in cement adapted to withstand the chemical action of the cyanide or other solvent employed. When a barrel is used it may be lined with segments or tiles set in a similar manner.

"Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

"1. The improved process of extracting gold and silver from ores or compounds containing the same, substantially as herein described, the same consisting in mixing the ore with a solution of cyanide of potassium or other cyanide solvent, rendered alkaline by the addition of sodium-oxide, or an equivalent alkaline oxide, filtering or otherwise separating the liquid (containing the gold and silver in solution) from the ore, and treating the former by precipitation or other known mode for the recovery of the precious metals.

"2. In the extraction of the precious metals by a solvent process of the general character herein referred to, applying the solvent solution, after separation from the first charge of ore, to a subsequent charge, or successively to subsequent charges of fresh ore, the solution being fortified at each operation by the addition of a suitable quantity of the chemical agents employed, and ultimately treating the liquid (consisting of a more or less saturated solution of gold and silver) by any known means for the separation and recovery of the precious metals.

MONTGOMERIE'S PROCESS FOR EXTRACTION OF PRECIOUS METALS FROM ORES.

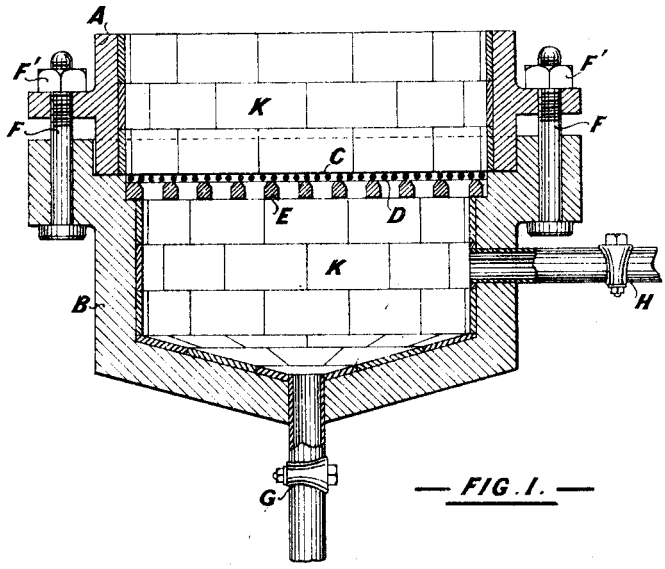


FIG. 1.

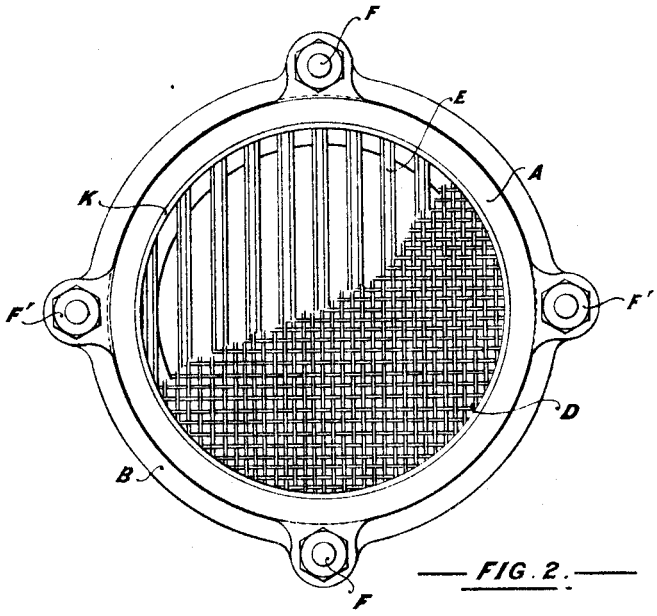


FIG. 2.

"3. In the process of extracting gold and silver by means of cyanide of potassium or other cyanide solvent, the addition of sodium-oxide or other suitable alkaline oxide to the solvent, either prior to or during its admixture with the ore, for the purpose of economising the solvent and expediting its action.

"4. In the extraction of the precious metals by a solvent process of the general character herein referred to, discharging the solvent remaining with the ore after filtration by adding water to the surface of the ore, and thereby displacing the solvent containing the precious metals in solution, substantially as herein described.

"5. In apparatus adapted for use in the treatment of ores or compounds containing gold or silver, a barrel, filter, or leaching vessel, such as *A* or *B*, lined with tiles, *K*, set in an acid or solvent resisting cement, substantially as herein described.

"6. The herein-described apparatus, for use in the treatment of ores or compounds containing gold and silver by means of solvents, the same comprising an upper vessel, *A*, for the reception of ore and solvent; a lower vessel, *B*, in which the solution is received; a filter-cloth, *C*, held between the lower part of the vessel, *A*, and a socket in the upper part of the vessel, *B*; wire-gauze, *D*, on which the filter-cloth lies; and bars, *E*, for supporting the wire-gauze.

"7. The herein-described apparatus, for use in the treatment of ores or compounds containing gold and silver by means of solvents, the same comprising an upper vessel, *A*, lined with tiles, *K*; a lower vessel, *B*, also lined with tiles, *Ka*; a filter-cloth, *C*, held between the vessels *A* and *B*; wire-gauze, *D*, under the filter-cloth; bars, *E*, for supporting the wire-gauze; a draw-off cock, *G*, and an exhaust-cock, *H*.

"Dated this 24th day of March, A.D. 1893.

"JOHN CUNNINGHAME MONTGOMERIE."

COAL-MINING.

WHANGAREI.

During the last year an important discovery was made in this district in finding semi-bituminous coal within twelve miles of Whangarei, and about six miles up the Ngunguru River. It was known that coal existed in this locality for a considerable time, as it crops out in several places, but as these outcrops were on Native land, and the land not dealt with by the Native Land Court, negotiations with the Natives for a lease of this land were going on for about six years. As soon as the land was dealt with, a lease of 1,100 acres was secured, in two blocks, one of which is known as the Kiripaka Block. The lease is held by a local syndicate, who commenced boring to test the coal in July last year. After putting down six bores, and satisfying themselves that there was a good area of coal, they commenced operations to open out the mine and connect it with a point in the Ngunguru River, where vessels drawing from 6ft. to 7ft. of water can get to load the coals. The coal will be worked from an adit-level constructed into the face of the hill about 250ft. above the level of the river, and connected by a horse-tramway of 9 chains from the mine to top of the incline, and thence it is led down an incline of 10 chains in length, constructed on a gradient of about 1 in 3, the boxes or skips being lowered down by a steel wire-rope, 2¼in. in circumference, from a drum which is worked by a brake. There is a double line of rails on the incline, so that the full skips going down brings up the empty ones, each skip having a carrying-capacity of about 8cwt. of coal. From the bottom of the incline the tramway is constructed along on the flat at the foot of the terrace leading down the valley of the Nunguru River, having several embankments in the mangrove swamps, and having cuttings round the points of the terraces, which were necessary to get a sufficient radius of curve. The length of the tramway on the flat is about 1 mile 21 chains. It terminates at a point in the river where a wharf has been constructed, with two hoppers which are capable of holding about 50 tons of coal. The tramway is constructed with 40lb. iron rails laid to a 2ft. gauge, and all ballasted and fit for horse-traffic. The manner in which this tramway and incline is constructed and laid reflects credit on those who designed its construction. There are some small defects which could be pointed out, such as the wooden rollers with small iron spindles running in a hole through an angle-iron bar. When the coal begins to be sent down the incline the life of these rollers will be very short. The points and crossings are also very primitive; but all these will be very soon put in order when they commence to send down the coal, when their deficiencies will be found out.

The coal-hoppers are five miles up the river from the Heads. The syndicate have a steam launch for towing up and down vessels from the wharf to the Heads, and have everything almost complete ready to send coal away to the market. They were only beginning to send coal down the incline at the time of my visit on the 22nd April last, and had about 10 tons or so in the hoppers at the wharf. Any one seeing the large amount of work that has been done in the erection of buildings and tramway, with wharf and hoppers, and the heavy cuttings that have been made, must acknowledge that the syndicate has carried on these works with considerable energy, and got them constructed extremely cheap. The whole works, including boring, and payment of sixpence per ton royalty to the Natives in advance on 21,000 tons—£525—has only been £3,600, and beyond that they have no liability.

The syndicate were at the time of my visit commencing to open up the mine by constructing a main heading, and also a back heading, leaving a pillar of 18ft. between the two. The headings are going up on an incline, and the syndicate state that the seam has been proved by bores to have a rise of 22ft. in 10 chains. This is equal to 1 in 30, and from this main heading levels will be constructed on each side, from which bords will be opened. The heading at the time of my visit was only constructed for a distance of 30ft., and the coal was only from 4ft. to 4ft. 6in. in thickness; but, by the bores which were put down, the coal gradually increases in thickness as it goes into the hill.

At 10 chains in from the mouth of the heading, the bore shows the coal to be 8ft. in thickness. The coal near the mouth of the adit is of good quality, but rather soft; but, as it goes into the hill, with more cover on it, there is no doubt it will increase in hardness. There is a considerable quantity of resin in the coal, such as that found in the coal at Hikurangi and Kawakawa, but it is slightly more of a bituminous character than the Kawakawa. According to an analysis made at the Colonial Laboratory of two samples forwarded from this field, the result was as follows:—

	No. 1 Sample.	No. 2 Sample.
Fixed carbon	61·61	59·82
Hydro-carbon	32·81	35·08
Water	4·76	4·19
Ash	0·82	0·91

The evaporative power of the first sample would be 8·00, and of the second sample 7·77—that is, by adopting the standard for New Zealand coals; or, if the coëfficient were used that Professor Liversidge of New South Wales adopts in comparing the value of coal, the evaporative power would be 13·55 and 13·15 respectively, which would make it compare favourably with any coal from Newcastle, in New South Wales, and only very little less value than the coal on the west coast of the Middle Island. However, as stated previously, it requires to be of a harder character before it would bear even a slight comparison with the bituminous coal in Buller and Grey Districts.

It is, however, an important discovery in this part of the North Island, and if it can be landed in Auckland at the price quoted to me—14s. or 15s. per ton, there is no doubt a good market will be found. The greatest difficulty that this syndicate will have to contend with is getting suitable vessels to take it away; vessels having a large carrying capacity, and not drawing more than 7ft. of water, are not easily procured, unless specially built for the purpose. There is also another element which enters into the question, which, if not carefully dealt with when the coal is first put on the market, may have a serious effect on its introduction—that is, the amount of mundic that some of it contains. Pieces containing much mundic should be picked out and thrown away, so as to keep it as clear as possible of any sulphur.

On the other side of the river there is a block of Crown land, but it has not been tested to see whether the coal is on the north side of the river or not. The shallow water in the river will always be a great drawback to getting coal away from this place, but, being only a short distance from Auckland, it may be found that its superiority as local coal will cause it to be largely used, if a proper class of vessels can be procured to carry it from the mine.

THE CONTINENTAL METHOD OF MAKING COKE.*

As coke enters to a considerable extent into the cost price of pig-iron, it may be said to be a raw material of the highest importance in the iron manufacture, for which it is now almost exclusively used, there being only a few countries, like Sweden and Austria, where the abundance of timber or certain special methods of manufacture, warrant the retention of old methods. Gas-coke has in some exceptional cases been used in conjunction with matallurgical coke, in the proportion of 30 per cent., and even 50 per cent. While coke has been made in England for several centuries, it has only been made in France for about eighty years, the consumption of which country exceeds 2,200,000 tons, part being imported from Belgium, especially Germany; and the French imports in 1890 amounted to 1,500,000 tons. The production, which is constantly increasing, was 790,000 tons in the Nord and Pas-de-Calais district in 1889, the whole production of the country in that year having amounted to 1,190,000 tons.

Physical Properties of Coke.—When coke was substituted for charcoal in small blast-furnaces, working with cold blast or one only slightly heated, efforts were made to obtain a light porous coke, the physical qualities of which should not differ greatly from those of charcoal, a too dense coke having, in such furnaces, the disadvantage of burning, or transforming the carbonic acid into carbonic oxide too slowly. With modern blast-furnaces, however, of great capacity, blown with a blast of 700deg. to 800deg. Cent., and at great pressure, efforts were chiefly directed to obtain a dense coke, and especially one of great resistance to crushing stress. Combustion always takes place with sufficient ease, the great point being that the pieces of coke do not break, but divide the charge so as to form a mass permeable to the gases, even in the zone of highest temperature. When the coke is crushed it forms, with the slag, and the matters more easily reduced, compact refractory masses, which do not allow the hot gases to pass, in which case choking is unavoidable.

Resistance to Crushing Strain.—The strength of coke is due to two elements: (1) The nature of the coal, and (2) the method of coking. (1.) As a rule, dry flaming coals—that is to say, those containing more than 40 per cent. of volatile matters, or coals not sufficiently bituminous, having less then 19 per cent. of volatile matters, are not suitable for yielding a coke of great resistance, the best coke being obtained from coals containing from 20 to 30 per cent. of volatile matters. (2.) The form and dimensions of the oven, and also its temperature, exert great influence, and should be carefully studied for such classes of fuel. The second element, however, is less important than the first—in this sense: that, if inferior coke can be made from good coal in a bad oven, it is impossible to make good coke from bad coal, however perfect may be the method of coking, while with good coal excellent results may be obtained in ovens of very various types.

Cohesion and Tests.—The best method for ascertaining the cohesion of a sample of coke is to use the revolving drum of a metre diameter that serves for testing the cohesion of briquettes, which drum has three projecting feathers inside, 22cm. (9in.) in the direction of the radius. A quantity of 50 kilogs (110lb.) of coke, in pieces as they leave the oven, is introduced into the drum, which is turned at 25 revolutions per minute, as for briquettes. The cohesion is ascertained by the proportion of coke

*Abstract of a communication to the Société Minérale Saint-Etienne, by M. Rossigneux, Ing. Civ. Min.

remaining, after the operation, on a sieve with square meshes 4cm. (1⅝in.) wide. While the operation only lasts two minutes for briquettes, it is continued for six minutes in the case of coke, which, under these conditions, should show a cohesion of 70 per cent. Coke not coming up to this figure is liable to rejection, so that the coals should be mixed, in order that the cohesion of their coke shall never fall below 70 per cent. This method, which is used at the Creusot Works, permits of taking into consideration all the elements which may exert an influence on the physical qualities of the coke. For instance, if the size of the pieces or their hardness diminishes, and if the quality is lowered, either owing to the nature of the coals employed, or a too hot or too cold working of the ovens, this is immediately detected, and its importance measured by the cohesion test. In the case of coke to be used in high-blast furnaces, crushing or cohesion tests have a capital defect—that is, of being carried out at the surrounding temperature instead of at the high temperatures to which coke is subjected in the blast-furnace. Sir Lowthian Bell's experiments at the Clarence Ironworks are mentioned; and regret is expressed that no more perfect tests for coke exist. The author asks if the resistance of this substance when hot, is in all cases, and for all kinds of coke, proportional to the resistance cold, and expresses the hope that some blast-furnace managers will take up this question.

Density.—A very dense coke has the advantage of diminishing the volume of the charge, and thus increasing the useful capacity of the furnace. If, for instance, the coke constitutes half the charge in volume, an increase of 20 per cent. in density is equal to an increase of 10 per cent. in the capacity of the furnace. The coke used in foundry cupolas should not be too dense nor too hard, founders generally seeking a coke containing from 6 to 8 per cent. of ash, and of an apparent density not exceeding 90 per cent. The relative space occupied by the cells in blast-furnace coke varies between 0·256, obtained for a coke with a density of 0·92, and that of 0·432 for coke of 0·71 density. The quantity of water, therefore, which a coal may absorb varies between 23 per cent. and 31 per cent. of its weight. Coke is less hygrometric than charcoal, but it rarely contains less than 2 per cent. of water, even when quenched, or rather stifled, without water. When quenched in the ordinary manner, coke often contains from 3 to 5 per cent. of water; and the managers of ironworks, when buying their coke, generally stipulate that the humidity shall remain between these two figures, a percentage being deducted if the higher figure is exceeded.

Contents in Ash.—Unwashed blast-furnace coke generally contains from 12 to 15 per cent. of ash, and washed coke from 6 to 9 per cent.; but these expressions are only commercial terms, as coal which yields coke with 12 per cent. of ash is often subjected to, at any rate, a partial washing, while, on the other hand, coke with 8 per cent. of ash may be made with a coal, from specially-favoured mines, just as it leaves the pit.

Sulphur.—All cokes contain a larger or smaller proportion of sulphur, which, for making pig-iron, is not a great drawback, unless the ore or the flux should also contain a large quantity. And this substance is easily got rid of with a calcareous slag and a high temperature. The following are a few examples of cokes, with their contents in ash and sulphur:—

	Ash Per cent.	Sulphur Per cent.
Firminy gas coke ...	12	0·4 to 0·44
Roche-la-Moliere ...	13	0·3 to 0·4
Saint-Etienne Collieries	13	0·3 to 0·405
Montcel, Saint-Etienne	11	0·27 to 0·4
Montmartre, "	11	1·37
Tilleur, Belgium ...	12	0·05
Marihaye ...	6	0·46
Donetz, Russia ...	6	0·27
Anzin (North of France)	11·5	0·25
Besseges (Lalle) ...	12	1·15
Creusot ...	10	0·83
Grand'Combe ...	10·8	1·26
Blanzy	10·8	0·60
Graissessac ...	11·88	1·04
Carmaux, Grillatie	6·53	2·03
" Saint Roch	9·5	0·74
Decazeville, Valserie	13·8	1·92
" Lagrange	8·1	1·41

Coke generally contains less sulphur than the coal from which it is made, although there is no relation between the two contents, the elimination of sulphur being effected in variable proportion, larger in gas coals, and especially cannel-coal, although a few rare samples of coke show more sulphur than that originally contained in the coal. Pyrites is found in all descriptions of coal, whether poor or bituminous, in the form of thin scales in the cleavage planes, being specially found in the state of bisulphate; and the pyrites heated with an excess of coal gives up half its sulphur, a eaction which must take place almost completely during the operation of coking. A magnetic pyrites has been found in coke, which shows that it does not always lose half its sulphur. Some coals contain appreciable quantities of arsenic, which is probably present in the pyrites in the state of arsenic sulphate. The mineral, of chrystalline form, when calcined out of contact with the air, loses its arsenic, which is sublimed in the state of sulphate, so that the greater portion of the arsenic must be volatilised during carbonisation.

Nitrogen.—Part of the nitrogen contained in the coal remains in the coke in combination with the carbon, which is not yet well defined. According to the analyses of M. Marsilly and M. Scheurer-Kestner, the proportion of nitrogen is slight in the semi-bituminous coals, and especially in the poor coals of the Franco-Belgian coalfield, in which coals this substance is only present to the amount of 0·7 per cent., and even sometimes 0·4 per cent., while certain poor coal in

South Staffordshire contains 1·84 per cent. Nitrogen has no other disadvantage but that of diminishing its calorific power, being generally found in a proportion of less than 0·5 per cent.

Phosphorus.—The phosphorus of the coke passes almost entirely into the pig, as does that of the ore, so that the purity of coke has great importance when making pig intended for treatment in the acid Bessemer converter. The content in phosphorus varies greatly in different coals. M. Carnot has sought to establish a relation between the content in phosphorus and the nature of the plants from which the coal has been formed, and has found that coals containing a large number of spores, such as cannel-coal, are very rich in phosphorus. Practically, the quantity of phosphorus contained in the coal of a given seam is sensibly proportional to its content in ash. This metalloid is present, in the state of phosphate, in the ash, in which it persists, there being no elimination during carbonisation.

The following are the contents in ash and phosphorus of some coals, several of which are the same as those mentioned above as regards their content in sulphur:—

	Ash Per cent.	Phosphorus Per cent.
Anzin coke	10	0·0885
Ruhr „	10	0·186
Douchy „	10	0·027
Aniche „	10	0·070
Grand Bouillon, Belgium, coke	10	0·022
Aubin coke	10	0·020
Firminy coke...	12	0·016
Roche-la-Moliére coke...	13	0·015
Saint-Etienne Collieries coke	13	0·023
Montcel, Saint-Etienne, coke	10	0·080

Sulphur and phosphorus are the two principal elements which claim the attention of metallurgists, being found in the coal in sufficiently high proportion to exert considerable influence on the quality of the products. Other substances, however, exist in coal and persist in the coke, although in but slight proportions, including iron, manganese, zinc, lead, and copper. M. Daubrée has found traces of arsenic and antimony in Newcastle coal; and the late Dr. Percy, galena in Scotch coal. As these various substances remain in the coke, they might exert an injurious influence on the quality of the iron; but fortunately their quantity is too slight, being quite insignificant in the presence of sulphur and phosphorus.

Various Classes of Coal.—The following descriptions of coal may all be used, either pure or mixed, for making coke. Coals are called semi-bituminous (*demi-gras*), when they contain 35 per cent. of volatile matters, in the Decazeville basin; 19 per cent. in that of the Loire; and 14 per cent. in the north of France; although the quantities of these three coals are quite different. The following six classes of coal are distinguished by the author.

1. *Houilles sèches à longue flamme*, or dry coals, burning with a long flame, yield a pulverulent coke in the retort or crucible, and contain from 75 to 80 per cent. of carbon, 5 to 5½ per cent. of hydrogen, and 15 to 20 per cent. of oxygen and nitrogen. When distilled in a small retort they yield 55 to 62 per cent of coke, 10 per cent of tar, 5 to 10 per cent of ammoniacal liquor, and 15 to 20 per cent. of a gas less illuminating than that yielded by the second class. These coals, which show on fracture a compact structure and a dull lustre, make a brownish dust; they are hard and give but little small, while their specific gravity is 1·25 to 1·28. They are met with in considerable quantity near Glasgow, and are also found in Blanzy in France.

2. *Houilles grasses à longue flamme*, or bituminous coals, burning with a long flame, yield a coke which forms into large pieces, being very much puffed out. They contain from 80 to 85 per cent. of carbon, 5 to 5½ of hydrogen, and 10 to 15 of oxygen, yielding on distillation 62 to 70 per cent. of coke, 8 to 10 per cent. of tar, 6 to 8 per cent. of ammoniacal liquor, and 18 to 19 per cent. of a highly illuminating gas. These coals, which in Belgium bear the name of Flénus—from the name of a concession in the Mons basin, where they are found in abundance—are specially suitable for gas-making, and may also be used for producing blast-furnace coke; but the yield is very slight and the coke is not so hard as in the following classes:—

3. *Houilles grasses maréchales*, or bituminous smith's coal, contain from 85 to 90 per cent. of carbon, 5 to 5½ per cent. of hydrogen, and 5 to 10 per cent. of oxygen, yielding on distillation 70 to 76 per cent. of coke, 6 to 8 per cent. of tar, 4 to 6 per cent. of ammoniacal liquor, and 15 per cent. of a gas slightly less illuminating than that from long-flame coals. They make a good coke, but in a slightly smaller quantity, are less hard, more friable, and of a more schistose character than the preceeding, showing a bright lustre. They are specially suitable for the forge, owing to the intense heat which they give out, and their property of agglomerating and forming a bridge over the articles to be heated.

4. *Houilles grasses à courte flamme*, or bituminous coal burning with a short flame, containing from 90 to 91 per cent. of carbon, 5 per cent. of hydrogen, and 4½ per cent. of oxygen, yield on distillation 74 to 81 per cent. of coke, 4 to 7 per cent. of tar, and 5 to 6 per cent. of ammoniacal liquor. These are coking coals *par excellence*, producing a large proportion of hard, strong, sonorous coke. The more bituminous qualities are suitable for coking in the forty-eight hour ovens, which yield large pieces; while the less bituminous should be coked in twenty-four hours, and shortly after their extraction from the colliery, because, by their alteration when exposed to the atmosphere, they lose the capability of yielding a cohesive coke.

5. *Houilles demi-grasses*, or semi-bituminous coals, yield a coke which is simply fritted; they possess very little resistance, and cannot be used alone for coke-making. Their production has greatly increased during the last twenty years in the Franco-Belgian coalfield, and they are admirably fitted for firing steam-boilers, burning freely and without smoke. They occur in the Cardiff district, which is so closely identified with steam navigation. These coals generally contain from

4 to 5 per cent. of hydrogen, and a very variable quantity (from 2 to 11 per cent.) of oxygen, but on an average they contain a little less oxygen than the bituminous short-flame coals. They yield from 82 to 86 per cent. of coke, and at this last percentage the coke is partially pulverulent. On distillation they produce from 1 to 2 per cent. of tar and a little ammoniacal liquor, while their gas has but slight illuminating power, and is to a large extent composed of hydrogen. Coals of this class are not capable of yielding coke by themselves; but they are much used in Belgium and the north of France, mixed with more bituminous coals.

6. Lastly, the *houilles maigres* (poor coals) or anthracites, contain from 92 to 95 per cent. of carbon, 2·5 to 4 per cent. of hydrogen, and 2·5 to 3 per cent. of oxygen, their density varying from 1·31 to 1·35 per cent. They do not yield any tar whatever, and very little ammoniacal liquor. They preserve their form and brilliant appearance after calcination; and there is no trace of agglomeration in the pieces, they being often very friable and produce a large amount of slack. Some qualities of anthracite sputter in the fire, and burn with difficulty. They are used at the Creusot Works, in the Franco-Belgian coalfields, and in Germany, mixed with bituminous coals for coke-making; and, treated in this manner, they yield from 88 to 95 per cent. of dense, ill-looking coke, but one which may prove very useful.

Calorific Power of Coals and Cokes.—The author opens this portion of the subject by observing that it is sufficiently difficult to give the precise calorific power for each one of the six classes mentioned above, there being no well-determined relation between the elementary composition of a coal, its yield in coke, and its calorific power. He cites the researches of M. Gruner, M. Scheurer-Kestner, the Société Industrielle de Mulhouse, resumed by M. Mène and M. Cornut; but those made by M. P. Mahler, for the Société d'Encouragement, which treat the question in a thoroughly exhaustive manner, had not then been published.

Theory of Carbonisation.—For a coke to be capable of yielding coke from dust, it must be softened by the action of heat so as to form an adhesive paste; this is what happens to a bituminous coal at about 350° Cent., at which temperature the various pieces unite to form a swollen or puffed-out substance. As the temperature increases, the gas is driven off; and it is only after exposure of the whole mass at a temperature corresponding with red, that distillation is complete and the coke begins to form. Coal-dust is a very bad conductor of heat, as also is coal in the state of hot paste; it follows that the conduction of heat only takes place very slowly. In the case of a coke-oven of the baker's type in which the height of the charge is half a metre and the cooking is effected in forty-eight hours, the whole of this period is required for the heat to be transmitted to the bottom of the charge, so that that the speed of conduction is only 1cm. ($\frac{1}{3}\frac{3}{2}$in.) per hour. If the batch be drawn after twenty-four hours, a layer 25cm. (10in.) thick of incandescent coke would be found at the top, and then a thin layer, under 1in. thick, of hot coal in the state of paste, and below that an unaltered mass of small coal perfectly cold and pulverulent. This speed of conduction is not uniform, being greater at the beginning than at the end, decreasing as the layer of coke across which the heat has to be conducted becomes gradually thicker. The same is the case in a furnace with heated sides. In a Belgium oven, for instance, the conversion of coal into coke takes place by very thin zones, parallel with the walls. Towards the end of the operation there only remains a very thin plate, as it were, of coal in the middle; and this is often noticed when the ovens are drawn a little too soon. The formation of coke is accompanied by a very considerable contraction, on account of which the first crust of coke which is formed along the walls, must necessarily break, because, if it remained in a single piece, this would only be accompanied by its exerting a considerable pressure on the mass not carbonised, and subjecting it to a diminution of volume corresponding with the shrinkage. As the strength of the crust of coke is not sufficient for this, it breaks into pieces, each of which becomes, as it were, a centre of aggregation, if not of crystallisation; and, when the burning is finished, a series of pieces are obtained, limited by fractures at right angles to the successive zones of transformation, and terminating in the central plane. The pieces of coke are, therefore, when the the operation goes on well—as should be the rule—about half the width of the oven long. When the oven in not sufficiently hot, or the mixture is too poor, there are formed to the right and left of the central plane of separation secondary planes, owing to the fact that the aggregation has not been regular, but that, at a given moment, there has been either a slipping or a separation of the coke already formed, the coal in a finely-divided state remaining in the centre. In that case, the pieces of coke show cuts (*coupures*) or cracks, which have the disadvantage of diminishing the size of the pieces, while in the neighbourhood of the cuts the coke is badly formed, and more or less pulverulent, not possessing the resistance of well-made coke. In the 24-hour furnaces, the speed of heat conduction is about the same as in those of the baker's type; but in the 48-hour furnaces the speed is less, so that this period in not suitable for coals which become impaired by the action of heat and which should be coked rapidly. It is often noticed that on the surface of pieces of coke, and especially near the walls, there are deposits of pure carbon in the form of pearls, filaments, or tufts, of hair fineness, due to the decomposition of the hydrocarbons. There is no doubt that the tar and the bicarbonate of hydrogen, disengaged from the central mass, are partially decomposed by the heat, and form a deposit which increases the density of the coke already made: but the importance of this phenomenon must not exaggerated. Even in the ovens where it is most manifest, tar is still disengaged, so that decomposition is not complete; and if it were so, inasmuch as tar only yields, at the outside, 20 per cent. of coke, the increase of yield on this account would only be from 1 per cent. to 2 per cent., at the very outside. As regards the great contraction which accompanies the transformation of coal into coke, it is chiefly by their action on the contraction that the various circumstances of humidity, of conglomeration, and of the form of the oven, act on the product favourably or unfavourably. The influence of these various circumstances will now be considered.

Weight of a given Volume of Coal.—For the same class of coal the weight varies considerably with the size and form of the pieces. It is much lighter when the pieces are of nearly equal size, with no smaller fragments to fill up the interstices. Some experiments made in this direction,

made with various samples of Anzin coal, showed clearly the influence of the form of the pieces. With an equal content of ash, pea coal (*grenus*) of uniform size weighs less than the slack (*fines brutes*), which contains pieces of variable size. The latter weigh less than the washed small coal (*fines lavees*), first on account of their lower content in ash, and, secondly, because a considerable portion of the fine dust is separated by the washing. This latter, which is deposited in decantation-tanks, forming mud (*schlamm*), acquires, through a silting action, a remarkable degree of density, 1·41 being found for coaldust (a very high figure), showing that no traces of air remained in the interstices between the fragments, and that this dust is denser than compact pieces of large size, the specific gravity of which does not much exceed 1·31. This *schlamm* always yields coke of excellent appearance, even when the proportion of ash is high; and this is due to the fact that the shale is not noticed, as everything is ground fine, and also to the density of the charges, which exerts a beneficial influence on the coke's density. On the other hand, bad coke is obtained with nuts (*gailletteries*), and all the sizes with a too exact classification, even when they are very bituminous and pure. When it is necessary to use these raw materials, they must be ground. It will be understood that there is a certain advantage in charging into the oven a sufficiently dense substance, especially in the case of pure coals, in which case, if the substance be not sufficiently pressed together, the carbonisation will be well effected in the first moments, when the oven is well filled and the disengagement of gas increases the compression; but when half the charge is turned into coke, with a reduction of 40 or 45 per cent. in volume, the coal in the centre will be no longer kept in place by the walls of coke, but will run together of itself through its own weight, or, attaching itself partially to the coke already formed, it will give rise to cracks and hollows, which would not be formed, or not to the same extent, if the original density had been greater. To obtain a dense mixture, the coal must first be brought into a suitable condition—that is to say, it must be ground, unless it already contains a sufficient proportion of dust. Ovens of suitable form are also necessary; and humidity exercises a decided influence on the weight of a given volume.

Influence of Water contained in the Coal.—This influence makes itself felt in two ways—namely, by varying the density of the charge, and by its own physical or chemical action. It might be thought that, by wetting small coal, the weight of a given volume would be increased; the contrary, however, is the case, at any rate, up to a certain limit. Taking two samples wetted—(1.) Bituminous coal, containing 24 per cent. of volatile matters, mixed with 20 per cent. of poor coal containing 10 per cent. of volatile matters. The whole was ground fine in a Carr disintegrator, of 1m. in diameter, making 400 revolutions per minute. The measure was weighed after being filled, care being taken to shovel the coal in from a constant height of 1·3m. (4ft. 4in.) Coal is, in fact, very compressible; and the weight of a hectolitre (3½ cubic feet) varies, within wide limits, with the degree of closeness imparted to it, owing to the height from which it is allowed to fall when charged. (2.) Poor coal, containing 10 per cent. of volatile matters, passed through a 2mm. screen, was discharged from a height of 20cm. (8in.)

In the first case, if the weight of coal be taken with the water deducted, the minimum will correspond with 8½ per cent.; and it is only from 37 per cent. upwards that the presence of water increases the density. As regards the second sample, the minimum corresponds with 8½ per cent. for the wet coal, and 11 per cent. for the coal with water abstracted, while 19 per cent. and 33 per cent., respectively, must be exceeded for the water to increase the weight of a given volume. Dampness is therefore a factor, first, because too slight a density tends to lower the quality of the coke, and next, because it entails a diminution of production, a striking example of which (not reproduced) is given by the author. The presence of water has a tendency to cool down the oven and slacken the burning, which takes place when the proportion attains, for instance, 20 per cent. In that case the mass, especially if it be ground fine, is an absolute mud. When the coal is bituminous, no other difficulty is experienced, as there is plenty of heat in excess to drive off the water, and produce, with this coal-dust mud, a dense coke of good appearance. The same is not the case, however, with mixtures of poor coal. In the Appolt oven, with poor coals, and especially with the dry long-flame coals bordering on the limit, it has been noticed that dampness was injurious. Above 5 per cent. it prevents the coke from adhering, and produces a less resisting sample. In this case water exerts an injurious effect, both in cooling down the oven and in diminishing the density of the charge.

The Effect of Grinding.—As observed above, it is necessary to grind coal which does not contain sufficient dust to fill the interstices between the pieces. It would also be disadvantageous to admit too large pieces, which might contain portions impregnated with shale, or of different composition from the rest, that would subsequently form a cleavage plane in the coke. Lastly, heat is not transmitted with the same speed in a large lump, and in the fine dust which surrounds it, a more uniform sample being obtained with fine or small coal. Coke is seldom made with unscreened coal, the round coal being generally sold at a better price in its natural state; and it is also rarely made with larger pieces than those which will pass through a 3 to 4cm. (about 1½in.) screen. With this reduced size, and even in the case of a homogeneous bituminous coal, it would be worth while to grind the product so as not to have pieces larger than 1cm. (0·4in.). With mixtures, either of bituminous and poor coal, or of semi-bituminous and poor coal, the grinding must be carried to a greater extent. Some Belgian engineers considered that coal is deteriorated by grinding, and that some classes of coal, but little bituminous, should be coked—first, as soon as possible after they have been brought to day, and secondly, without being ground at all. Even supposing that there exist coals which become so quickly deteriorated that grinding them would be injurious, the author is of opinion that this is an exceptional case that must not constitute a rule for all coals which just come within the coking limit. The investigations into the deterioration of coal by the atmosphere, made by M. Fayol, general manager of the Commentry Company, led him to the conclusion that this deterioration takes place by the disengagement of certain gases (firedamp, nitrogen and carbonic acid), and the simultaneous absorption of oxygen from the air. Slack may absorb as much as 5 per cent. its weight of oxygen, while at the same time losing, to a considerable

extent, its capability of yielding coke; but this deterioration only takes place under the action of heat, in coal collected in stock, generally requiring several days. Isolated fragments of coal have not undergone any change, physical or chemical, when kept for several years at the ordinary temperature surrounding them, and free from the action of heating; while slack deteriorated very rapidly when placed in an oven. Now, grinding as practised at Anzin, for instance, cannot cause heating. If a calculation be made of the increased temperature resulting from the transformation into heat of a work of 27-horse power applied to a mass of 25 tons of coal, it will be found that this increase is only from 2deg. to 3deg. Cent., and therefore quite insignificant. The author is of opinion that if, in some cases, grinding has been found disadvantageous, it is because this operation diminishes the density; at Anzin, when screened coal, not ground, up to a size of 40mm. (1·6in.) weighs 850kilog. per cubic metre, the same coal, passed through a Carr disintegrator, only weighs 720kilog. per cubic metre. It will be understood that so great a diminution of density may be disadvantageous in some cases; but this influence sinks into complete insignificance when coals of different nature are mixed, in presence of the great advantage of grinding, which permits of the bituminous coal to surround and envelope more completely each fragment of pure coal, and, in the case of a mixture with semi-bituminous, insures a more complete fusion of the two classes of coals during the period when they are in a soft state. To obtain a uniform and homogenous mixture, grinding alone is not sufficient; it is necessary that the different kinds of coal be constantly proportioned by means of suitable apparatus, so that the proportion be the same not only in each oven but even in all parts of the same oven. This point is very important, especially when mixtures are treated which are just on the limit of being cokable.

Influence of the Form of Oven.—Coke-ovens may be divided into two classes,—those in which the coking is effected in twenty-four hours and those in forty-eight hours. The first should only be adopted if the coal be just on the limit of cokability; and the 48-hour ovens produce coke, when the coal is suitable, in larger, denser, and more solid pieces than the 24-hour ovens. The choice lying between these two classes, there remain the type and form of oven to be chosen. In the case of 24-hour ovens, the types which secure a complete carbonisation of the charge, within the time and at a sufficiently high temperature, all turn out a good sample. The carbonisation depends upon the hardness of firing, which, in turn, depends on the temperature and the ratio between the outer surface of the compartment and its capacity. Belgian ovens, high and narrow, are just as suitable as the Appolt ovens for mixtures with slight adhesion. It is true that, in both these types of oven, a slight difference is noticed in the density of the coke taken from the top and bottom of the batch, but this difference is not very great. The coal is presssed together in the ovens, not only under the static action of the load, but also owing to the fall into the oven and the action of the rake. In the Appolt oven the compression cannot be carried to a great degree, for, if a certain limit be exceeded, the oven sides would be put out of shape, as they are subject to great strain when the gases are first given off. The temperature exerts great influence on the quality of a coke. It is not sufficient that the charge be carbonised in the assigned period, but it must also be treated at a suitable temperature. Coke obtained at a dark-red heat is black and friable without cohesion, while contraction and density appear to be so much greater as the temperature is higher. In good ovens the temperature maintained in the flues is generally from 1,000deg. to 1,200deg. Cent. Nor must there be an excess of temperature, especially at the commencement of the operation, for in that case the coke turns out fragile and in very small pieces. To obtain large pieces, especially in 48-hour ovens, the walls must be very dark at the time of charging; and it is no disadvantage if from that period the temperature rise and be kept very high until the batch is drawn. It is the temperature at the commencement of the operation which determines the system of "fissuration" of the first crust of coke formed, and consequently the ultimate size of the blocks.

Influence of Compresssion.—Why has oven-coke greater density and resistance than gas-coke? It is not on account of the slow coking, because, in experiments made at a low temperature in the crucible, the heating is less intense than in an oven; and yet the resulting coke is light and non-adherent. The density of blast-furnace coke is solely due to compression of the coal. While the coal is being transformed into coke, in ovens of the baker's or of the Belgian type, a layer from 4cm. to 6cm. (about 2in.) thick, of very light coke, more puffed out even than gas-coke, is formed all over the whole upper surface of the batch; and it is only after the formation of this first crust that the coke begins to acquire any degree of density, preventing, as it does, the swelling of the pasty mass when giving off gas. When the crust attains a thickness of 4cm. (1·3in.) in Belgian ovens, for instance, it would exert a very considerable pressure if it did not break under the influence of contraction, and, indeed, on account of this strain. This first crust of coke greatly opposes the disengagement of gas, and prevents the pasty mass from swelling; and it is much more on account of this opposition than static compression, due to the height of load or head, that the coke acquires its density and resistance. When there only remains a little coal to be transformed into coke, this coal finds by its side a vacant space, resulting from the contraction of the coal already formed; and it is not so strongly compressed as at first—indeed, it is not compressed at all. Moreover, the coke is always less dense in the centre of the oven; and in the Appolt ovens this diminution of density amounts to one-half with the dry coals of Aubin. To a certain extent a strong initial compression counteracts the disastrous influence of the contraction on the quality of the last coke formed; but, in an oven of large dimensions, the effect of contraction cannot be completely annihilated. If, for instance, the contraction is 40 per cent., an initial compression of more than 50 kilogs. per square centimetre (711lb. per square inch) would be required to diminish by 40 per cent. the original volume, and therefore to suppress the contraction; but ovens as actually built are far from being able to stand such pressure. Attempts have been made in the Lürmann oven to exert a continuous mechanical action, during carbonisation, for compressing the coal in its pasty state. The principle is excellent; but this action is only exerted in the Lürmann oven by breaking the pieces already formed. To completely succeed in this direction, the pressure should be exerted in the same direction as the conduction of heat; as the oven is of prismatic form and heated on its long

surfaces, the latter should be made movable, so as to exert a compressive action on the charge. The same result would be obtained, much more simply and without any mechanical action, by adopting cylindrical retorts, in which the coal might be slightly pressed together, such retorts being of too slight a diameter for the annular crust of coke, which first forms against the walls, from breaking, and which, tightening round the rest of the charge, as in a ring, should compress it by the mere force of contraction, when a compact block would be obtained. M. de Marsilly formerly tried, at Anzin, retort-ovens based on this principle, which yielded, with tolerably poor mixtures, a coke that was much esteemed. The density of coke yielded by a mixture of bituminous coal and anthracite in the Lürmann oven attains 1·5. Is so great a density really advantageous to the blast-furnace? No doubt an increase of density is equivalent to an increased furnace capacity; but, on the other hand, Sir Lowthian Bell explains the better yield per unit of capacity obtained with charcoal, as compared with that which is obtained with coke, by the consideration that charcoal, being much less dense, occupies in the charge a more considerable fraction of the whole volume, and that the pieces of ore, being surrounded on all sides by the fuel, are in a much better condition for being rapidly reduced. If this explanation be correct, certain disadvantages may be foreseen, theoretically, in the use of a too dense coke; but actual experience can alone settle this question definitely. This influence of initial compression would appear to be greater on poor or semi-bituminous coals than on mixtures of bituminous and anthracite; and experiments on a small scale have not shown so great a difference, in the case of this mixture, between coal, pressed together or not, as with the semi-bituminous. A table [not reproduced here] is given of the results of experiments, made at Anzin, in compressing dry slack in a cast-iron pipe. With coal containing 9 per cent. of water the coke was not quite so good; and the crucible was heated in a coke-oven. The effect of the initial compression was only marked in the case of a mixture containing 40 per cent. of poor coal, having 10 per cent. of volatile matter, the bituminous containing 26 per cent.; but in the other cases it was insignificant. In the experiments on the scale of actual working in the ovens, good coke was only obtained when the proportion of poor coal did not exceed 30 per cent.; but at the Creusot works 40 and 45 per cent. of poor coal is used. The discrepancy in the results arises from differences in the nature of bituminous coal, which, in the Creusot case, is of a much more coking description.

Quaglio Apparatus.—Initial compression is employed in Silesia, in a certain number of Belgian ovens charged with long-flame coals; and these ovens are provided with the Quaglio apparatus, a notice of which is given in the *Journal* of the Iron and Steel Institute for 1890. After describing the apparatus and process, the author observes that this system, notwithstanding its complication, appears to give good results.

Coke from Anthracite.—So early as 1825 a certain proportion of anthracite was mixed with bituminous coal, coked in batch at the Creusot Works. Several inventors have taken up the problem, and have sought to increase the proportion of anthracite, either by the use of special ovens or by means of great attention to the mixture, or again by the addition of bituminous substances, such as pitch and tar. In 1855 M. Grosrenaud called attention to the importance exerted by an intimate mixture of the substances, of a constantly uniform proportion, and of a sufficient degree of grinding. In the experiments he carried out at Sotteville, in ovens of the baker's type belonging to the Compagnie du Chemin de Fer de l'Ouest, coke suitable for firing locomotives was obtained with two-thirds of Welsh anthracite and one third bituminous coal, and also a coke suitable for house purposes with two-thirds of sawdust and one third of bituminous coal. In 1857 a high proportion of anthracite, 40 to 50 per cent., was adopted at the Creusot Works, the mixture of poor and bituminous coals being ground in a Carr disintegrator, and coked in 24-hour Belgian ovens 48 cm. (1ft. 7in.) wide. The proportion of anthracite chiefly depends upon the nature of the bituminous coal which serves as an agglutinant, it not having been found possible to exceed the proportion of 30 per cent. of poor coal at Anzin, in ovens much narrower and hotter than those of Creusot. Some Lürmann ovens work with as much as 50 per cent. of poor coal; but, as this oven is one of high temperature, a large proportion of the coke drawn is found in the state of dust when the mixture is too poor. In fine, the oven would appear to exert less influence on the quality of the coke in mixtures of poor and bituminous coal than in those in bituminous and semi-bituminous. A 24-hour oven will stand a much larger proportion of poor coal than a 48-hour oven; but all the 24-hour ovens properly built and heated give very similar results as compared one with the other. The use of a mixture of bituminous coal was patented in France by M. De Chavignè, and in England about 1872 by Richard A. Penrose, of Swansea; and at Landore in the same year coke was made from Welsh anthracite with the addition of pitch, but without bituminous coal. In 1878 experiments were made in America for the utilisation of Pennsylvanian anthracite dust, when, with 50 per cent. of anthracite, 30 per cent. of bituminous coal, and 20 per cent. of gas-tar, coked in four hours, a strong coke was obtained, but yet not sufficiently strong for blast-furnace use—which is not to be wondered at, considering the method of carbonisation employed. In crucible experiments at a white heat, 75 to 78 per cent. of hard coke was obtained from 65 anthracite 25 bituminous coal and 10 tar. This substance is inferior to pitch as an agglutinant, yielding only from 18 to 22 per cent. of coke, so that at least double the quantity is required, and, as its cost is about the same as that of pitch, there is nothing to recommend its use. The anthracite used for coke behaves like an inert substance, the grains preserving their form and aspect; and the coke yielded by the bituminous coal must surround and unite the fragments of anthracite. In order to economize the bituminous coal, it is necessary on the one hand that the interstices between the grains of pure coal be as small as possible, which would lead to a restriction in the extent to which grinding was carried (for the weight of a given volume of coal is generally greater when the grains are of variable size, so that the smaller fill the space between the larger, than in a fine mixture obtained by uniform grinding), while, on the other hand, too large pieces should not be left for favouring the contraction of juxtaposed matters and for preventing the pieces of anthracite from cracking and sputtering. The report on the first trials of the Appolt ovens states that coke was obtained with only 25 per cent. of bituminous coal, and poor

coal, free from dust, in uniform pieces of about 3mm. Investigations might be made into the degree of fineness to which both the bituminous and the poor coal should be brought.

Accessory Appliances.—The author devotes considerable space to a description of appliances for proportioning the mixture and grinding the materials, and also to drawing apparatus and the question of chimneys, observing that the short chimneys to each oven are now replaced by those of sufficient height and diameter to serve twenty or twenty-five ovens, and sometimes more, after which he comes to the important questions of—

Quenching.—Twenty years ago coke was often stifled in Knab and several Belgian ovens. The batch of coke was forced between walls arranged in continuation of the side walls of the oven, and was covered with ashes for preventing contact with the atmosphere. After from twelve to twenty-four hours the temperature became low enough for the mass to be loaded up. This method, however, is no longer used, and everywhere the coke is quenched with the hose. Stifling had the advantage of turning out a perfectly dry coke, with metallic lustre and bright colour. With quenching, the same result is only obtained in hot and dry weather, and, even then, there are always some pieces which receive too much water and show a black appearance. It is difficult to have less than 2½ per cent. of water in quenched coke, and the proportion soon increases to 4 and 5 per cent. in wet weather. The method generally adopted in Belgian ovens is to arrange a series of water-cocks in line, 6m. or 8m. apart, on the charging-floor. These cocks are fitted with unions, which receive the leather or indiarubber hose-pipes, from 4cm. to 5cm. (1¾in. to 2in.) inside diameter, terminating in a nozzle of 25mm. to 30mm. diameter, the quenching being effected by two hose-pipes at a time. The quantity of water required is 40 per cent. of the weight of the coke; but 50 per cent is generally allowed for in estimates. The water must have a pressure due to at least 8m. (26ft.) of head; and the nozzles must be so calculated that they deliver sufficient water to quench the coke in half the time required for drawing the batch. A description is then given of the coke-ovens at Méons, near Saint-Etienne, provided with a special system of quenching, which economizes hand-labour, and leaves the coke with a good appearance, although the system has been abandoned on account of deterioration in the plant. The author then treats of the charging and drawing floors, the arrangement of which, however, must vary with local circumstances; and, in dealing with the first lighting up of the ovens, he confines his attention to the Belgian type as being that most generally employed.

Utilisation of Waste Heat.—The paper concludes with this important subject. So soon as ovens of the baker's type were used, an attempt was made to utilise the waste heat either for burning lime or for firing boilers; in some installations large chambers were constructed for collecting the lamp-black produced by the incomplete combustion of the gases of distillation. The most convenient manner in which to utilise the waste heat is in firing boilers. There are few batches of Belgian ovens which do not fire the boilers, although no attempt is made in almost all cases to utilise all the waste heat, as the heating-surface is generally insufficient. He then refers to the utilisation of waste heat at Méons and at Anzin, with data, as to which latter he gives the calorific results of the operation, observing that each kilogramme of fuel burnt has a calorific power of 11,200 calories, which is equal to 20,160 British thermal units per pound. If this figure be compared with that of the coal usually employed for firing boilers, there is no reason to be astonished, says M. Rossigneux, at the generation of steam by the waste heat. In existing coke-ovens only a small portion of the waste heat is utilised, one-tenth at the outside. The ovens are generally situated on the collieries, where but little attention is paid to economy, the waste heat being only used to generate the steam necessary for washing, grinding, and discharging, while a considerable proportion of heat is wasted which might be utilised without in any way interfering with the working of the ovens or impairing the quality of the coke. The practice, generally adopted at ironworks, of buying coke instead of making it, leads to great waste. It may be laid down as a general principle, says M. Rossigneux, that all works consisting of blast-furnaces and puddling-furnaces or steel-works should begin by the production of coke. The hot-hair stoves, and the boilers of the blowing and other engines, should be fired by the coke-ovens; and the gases of the blast furnaces should be used for re-heating and puddling, when, in many cases, the buying of coal for being burnt raw may be avoided. Great pains are taken to collect and retain the blast-furnace gases; and the quantity of heat lost in coke-ovens is just the same as that formerly lost with open-topped furnaces. As mentioned above, out of the 8,200 calories given out by a kilogramme (14,760 British thermal units per pound) of coal, 2,800 calories per kilogramme (5,040 British thermal units per pound) are given out in the coke-oven, while 5,400 calories per kilogramme (9,720 British thermal units per pound) remain available in the coke obtained. Now, it is generally admitted that, in hot-blast furnaces, the escaping gases carry away a little more than half the heat that may be got out of the coke, that is to say, 2,800 calories per kilogramme (5,040 British thermal units per pound) of the coal used to make the coke. The saving effected by complete utilisation of the waste heat from coke-ovens would, therefore, be of just the same order as that utilised by utilising the blast-furnace gases. Particulars are given of the Turenne coke-ovens owned by the Anzin Company, and also of the Givors and Boucan coke-ovens of the Aciéries de la Marine, in all of which the waste heat is utilised. The last-named ovens are grouped in twenties, each group, which fires a boiler, having two chimneys, one square, 8m. high and of one metre side, for carrying off the flames and gases when the boiler is not at work, and another, round, of plate-iron, 25m. high and of 1·1m. diameter, which is only used when the boiler is fired. The hot gases arrive by four openings in the same horizontal plane that may be closed by fireclay slabs. When the boiler is working, a plate-iron damper prevents the flames from passing up by the 8m. chimney; while, to fire the boiler, this damper is raised and the four fireclay slabs are brought into the position of "closed." The temperature of the gases at the base of the 25m. chimney is 300degs. Cent. The ovens are drawn in groups of five, as regularly as possible, so as to equalise the disengagement of the gases and the generation of steam. While discharging, steam is generated in each boiler at the rate of 2,750 to 3,000 kilogs. per hour; but, immediately after drawing, it falls to 2,050 kilogs. per hour.

Taking a mean of 2,300 kilogs., or 55,000 kilogs. in the five hours, represents 9·2 kilogs. of steam per kilogramme of fuel burnt, supposing the latter to constitute 22 per cent. of the weight of coal charged into the oven. This result is very remarkable, and has not been obtained in any other coke-oven plant; while it gives evidence of the advantage which may be derived from associating with coke-ovens boilers having sufficient heating-surface, and showing the economy which may follow from this practice.—*Colliery Guardian.*

PRODUCTION OF COKE IN NEW SOUTH WALES.

The following report has been presented to the Under-Secretary for Mines for New South Wales by the Government Geologist:—

"Sir,—With the object of obtaining as much information as possible in reference to the coke at present being made in the colony, I have inspected the following coke-works, viz.: (1) The Newcastle-Wallsend Colliery coke-ovens at Wallsend; (2) the Singleton Colliery coke-ovens at Rix's Creek; (3) the Vale Colliery coke-ovens near Lithgow; and (4) the Bulli Colliery coke-ovens at Bulli. I have also obtained samples of the washed and unwashed coal from which coke is at present being prepared, and also representative samples of the coke made at the above-mentioned coke-ovens. These samples were collected by the inspectors of collieries and myself, and were analysed by Mr. Mingaye, F.C.S., analyst to this department. At my request, Mr. Mingaye also subjected each sample of coal to a careful washing in the laboratory, and it may, I think, be assumed that the results obtained by this washing are about equal to the results obtainable by the best washing appliances used on the large scale at the present day in Europe. The accompanying table (A) of coal analysys shows the constituents of such coals before and after being subjected to the process of washing by hand in the laboratory, and it will be observed that in the two instances where the coal had been previously washed by machinery at the works (viz., the Newcastle-Wallsend Colliery and the Singleton Colliery) a still further reduction of the percentage of ash, amounting to 0·55 in the one case, and 2·75 in the other, was effected by the laboratory treatment.

"In a sample from the Co-operative Colliery, the coal, which had not been previously washed by machinery, was treated in the laboratory, with the result that the percentage of ash was reduced from 6·85 to 3·85 and a firm coke obtained, containing 6·30 per cent. of ash. In another sample from the Mount Pleasant Colliery the percentage of ash in the coal was reduced (by washing in the laboratory) from 10·65 to 4·70, and a firm and lustrous coke was obtained which contained 6·42 per cent of ash.

"The system of washing the coal before introducing it into the coke-ovens is only adopted at four collieries—viz.: (1) The Singleton Colliery; (2) the Newcastle-Wallsend Colliery; (3) the Vale Colliery; and (4) the Bulli Colliery. At the Singleton Colliery the washing process is of the simplest kind; the coal after coming from the tunnel is thrown upon screens of $\frac{3}{4}$in. mesh, and the smalls thus separated are carried in trucks to a hopper, whence they are fed into wooden sluice-boxes, having a maximum fall of about 1 in 36, and the coal is separated from the shale and brass by running water. The clean coal is then further separated by screens into blacksmiths' nuts and fine coal, which is converted into coke in ordinary beehive ovens. The method of washing here adopted is crude, and, as already stated, it was found by experiment in the laboratory that the percentage of ash in the coal after washing at the works could be further reduced by about 2·75 per cent.

"The Newcastle Wallsend Company have a much more extensive coal-washing plant, which, I understand, was designed by Mr. Taylor, the manager. The coal is delivered into a hopper, whence it is carried by an elevator to a pair of rolls. After being crushed, it is carried by another elevator to distributing-troughs, which divide it amongst three pulsating washing-machines. The shale and brass fall through a grating and are carried away by a sluice, while the cleaned coal is carried forward by the water on the screens of $\frac{3}{4}$in. mesh, which separate it into blacksmiths' nuts and fine coal; the latter is carried downwards in a sluice with a perforated bottom, and thus reaches the next pair of rolls in a sufficiently dry condition. After being crushed fine between these rolls it is elevated to trucks, whence it is charged into beehive ovens. The method of washing, as practised at these works, is quite automatic, and is perfect as far as it goes, but there is, I think, little doubt that it could be improved by the addition of another pulsating washer provided with a layer of felspar above the sieve. After the second crushing the small particles of shale or dirt which it liberates from the coal could be separated therefrom by a second washing in a machine such as I have referred to. As before stated, the percentage of ash in the coal which had passed through this washing-plant was reduced by hand-washing in the laboratory from 5·20 to 4·65.

"At the Vale Colliery, near Lithgow, a small coal-washing machine of American manufacture, and known as Diescher's coal and ore-washing plant, is employed. The coal is first thrown on screens of about 1in. mesh, and the smalls from these screens are then crushed between rolls with spiral corrugations. The crushed coal passes thence into a pulsating washing-machine; the small dirt passes through a fine wire-sieve, with apertures of $\frac{1}{16}$in. to $\frac{1}{32}$in., the sieve having a slight inclination from back to front. The clean coal is washed over a lip in the front, and the pieces of shale or dirt which are too large to fall through the sieve escape by a $\frac{3}{4}$in. aperture under the lip. The washed coal contains a good deal of dirt, and a considerable amount of coal is necessarily lost with the larger pieces of shale which escape through the $\frac{3}{4}$in. aperture. The Western coal contains a large amount of dirt intimately mixed with it, and it is questionable whether it is of sufficiently good quality to warrant the expenditure of such a sum as would be required for the erection of a washing-plant capable of thoroughly cleaning it.

"At the Bulli Mine a Sheppard coal-washing plant has been erected. The small coal is raised by an elevator, and is then fed into a large pulsating washing-machine; the clean coal is carried forward by the water and is washed over a lip, while the dirt and brass escape by an aperture which can be regulated by a valve. The cleaned coal is carried by a screw to an elevator furnished

with a perforated bottom, and is delivered in a sufficiently dry condition to the rolls, where it is crushed, and again elevated to trucks which convey it to the coke-ovens. In this plant, as in the Newcastle-Wallsend, there is no provision for a second washing after the coal has passed through the rolls, and consequently none of the dirt, which may be liberated by the fine crushing, is separated from the coal before charging into the ovens. It is in this respect, I am of opinion, that the principal improvement can be made in the coal-washing plants of the colony. The New South Wales coals are inferior to the British only by reason of the fact that they contain a larger percentage of dirt intermixed with the coal. There is no doubt that the most perfect washing appliance in the world will not reduce the percentage of ash in coal below a certain limit, so thoroughly is a part of it incorporated with the fuel. At the same time much of the dirt, besides that occurring in bands, can be removed by alternative crushing, sizing, and washing; and the superiority of the modern coal-washing plants, such as the Lührig, consists in this, and in the final treatment of the finely-powdered coal, which is washed in pulsating machines provided with a layer of felspar—a mineral intermediate in specific gravity between the coal and the dirt. With such improved coal-washing plants there appears to be no reason why colonial coke should not be made of a quality (so far as the percentage of ash is concerned) suitable for any smelting operations it may be required for, and if the more modern ovens of a rectangular form were adopted, a saving of time and a corresponding reduction in the cost of manufacture would probably result.

"The Bulli Company use a rectangular oven, which is a modification of the Copéé coke-oven, and produces a dense coke capable of bearing a heavy furnace burden; but unfortunately the coal is very dirty, and the coke is subsequently high in percentage of ash. The period required for making coke in these furnaces is considerably shorter than with the beehive ovens which are used at all the other works visited by me. The charge of coke is removed by a hydraulic ram, and is quenched in the open air by spraying water upon it. The gases of combustion are caused to traverse flues built in the sides and floor of the oven, so that a minimum amount of the heat is lost, and altogether there is no doubt that these ovens are more economical than the beehives.

"With the object of comparing the imported cokes in actual use at Broken Hill with those now manufactured in the colony, samples were at my request taken from the coke-stacks at the Broken Hill Smelting-works by Mr. Geological Surveyor Jaquet, and were analysed by Mr. Mingaye.

"The three samples taken were: (1) Hood's (Welsh) coke, taken from Broken Hill Proprietary Company's Smelting-works; (2) Brancepeth (Welsh) coke, taken from the Proprietary Company's works; and (3) Hood's (Welsh) coke, from the Central Broken Hill Company's works. The first of these contained only 4·75 per cent. of ash, but the second and third contained 7·80 and 9·70 per cent. respectively. These percentages appeared to be so high compared with the composition claimed for the imported coke, that I determined to check the results by an examination of the foreign cokes as they arrive at Port Pirie. With this object in view, six samples were taken for me at Port Pirie by Mr. Hebbard, Inspector of Mines. The samples were analysed by Mr. Mingaye, and the results were as follows: (1) Westport (New Zealand) coke, containing 7·15 per cent. of ash; (2) Hamburg (German) coke, containing 9·20 per cent. of ash; (3) Shamrock (German) coke, containing 7·30 per cent. of ash; (4) Brancepeth (Welsh) coke, containing 5·50 per cent. of ash; (5) Hood's (Welsh) coke, containing 8·20 per cent. of ash; and (6) Hood's No. 2 (Welsh) coke, containing 5·85 per cent. of ash.

"The annexed table (B) shows the proximate analyses of the nine samples of foreign coke taken at Broken Hill and Port Pirie, together with that of thirteen samples of coke made in different parts of New South Wales. It will be observed that some of the Welsh coke used at Broken Hill contains a higher percentage of ash than the colonial coke made by either the Newcastle-Wallsend or the Singleton Colliery Companies; also that the average percentage of ash, calculated from the nine samples of foreign cokes in use at, or in transport to Broken Hill, amounts to 7·26, which is only 0·6 per cent. lower than is contained by the coke made at the Newcastle-Wallsend Colliery. Also, having in view the improvements that are possible in the manufacture of colonial coke by the adoption of more complete washing-plants, it will be seen, in reference to table A, that two samples of coke, containing less than 6½ per cent. of ash, were made in the laboratory from hand-washed coal, from the Co-operative (Newcastle) and Mount Pleasant (Southern) Collieries, while a coke has been made from the Newcastle-Wallsend coal, closely approximating, in the percentage of ash it contains (7·51) to the average of the coke used at Broken Hill.

"With regard to the strength of coke, or its capacity for resisting the crushing-weight of the ore burden in the furnace, it has been asserted that the colonial-made article is much inferior to the imported. It was proposed that a practical test of the relative merits in this respect of the colonial and foreign cokes should be made in the furnaces of the Clyde Smelting-works. It appeared to me, however, that to make such a test satisfactorily would be both difficult and expensive. The furnace would have to be run for several weeks with the same ore in order to ascertain the strength of each sample of coke to be tested; and I therefore decided to adopt a simpler method of testing, which though not absolutely free from objections, may, I think, be taken as fairly conclusive in regard to the relative strength of the different cokes tested. I had cubes of some sixteen varieties of foreign and colonial cokes carefully cut on an emery-wheel, and these were then forwarded to the University, where their crushing strength was ascertained in the testing-machine. Professor Warren was good enough to devote a great amount of care to these tests, and the results, which are appended in table C, are somewhat surprising. Four of the samples tried with foreign cokes, and twelve were of New South Wales manufacture; and the latter, with one exception, exhibited better pressure-resisting qualities than any of the foreign samples. The reason why only four of the foreign cokes were tried was that the balance of the other samples collected for me at Port Pirie were too small to allow of cubes being cut from them.

"Without placing too much importance upon the results of these tests, I think they demonstrate beyond doubt that the average strength of the cokes made in this colony is much superior to some (at any rate) of the imported cokes used in the smelting-works of Broken Hill

"It will also be noticed that the Bulli coke, which is the only one made in rectangular ovens, is superior in strength to all the other cokes which are manufactured in beehive ovens.

"In regard to freight rates, there appears to be no doubt that the coke manufacturers of New South Wales labour under a disadvantage, so far as the Broken-Hill trade is concerned, compared with the manufacturers of British and German cokes. I have made inquiries from several shipping firms, and am informed that while the freight from British and German ports to Port Pirie is now about 16s. per ton, it has been as low as 9s. On the other hand, the cost of freight on coke from Newcastle to Port Pirie varies from 15s. to 18s. per ton.

"The conclusion which I have arrived at may be summarised as follows: (1.) That there is room for improvement in the manufacture of colonial coke, both in the direction of reducing the ash and increasing the density or capacity for resisting pressure, and these improvements can best be achieved by a more perfect system of coal washing, and by the use of a more modern type of coke oven. (2.) That some of the cokes at present manufactured in New South Wales are nearly equal (as regards ash) to the average of the imported cokes in use at the Broken Hill smelting-works. (3.) That several of the cokes at present manufactured in New South Wales are superior (as regards percentage of ash) to some of the imported cokes in use at Broken Hill. (4.) That, in regard to strength, or capacity for resisting pressure, the cokes manufactured in New South Wales are superior to some of the imported cokes at present in use at Broken Hill.

"I have, &c.,

"EDWARD F. PITTMAN, A.R.S.M., Government Geologist.

"The Under-Secretary for Mines.

Table A.—Showing Analysis of Washed and Unwashed Samples of New South Wales Coals.

Description of Coal.	Analysis of Coals as received.						Analysis of Coal after being Washed in the Laboratory.					
	Moisture at 100deg. C.	Volatile Hydro-Carbons.	Fixed Carbon.	Ash in Coal.	Percentage of Coke.	Ash in Coke.	Moisture at 100deg. C.	Volatile Hydro-Carbons.	Fixed Carbon.	Ash in Coal.	Percentage of Coke.	Ash in Coke.*
Unwashed coal from the Co-operative Colliery's coke-ovens	2·85	34·70	55·60	6·85	62·45	10·96	1·60	37·35	57·20	3·85	61·05	6·30
Unwashed screened coal from Mount Pleasant Colliery	0·95	24·90	63·50	10·65	74·15	14·36	0·65	26·20	68·45	4·70	73·15	6·42
Washed coal from Newcastle Purified Coke and Coal Company's coke-ovens	2·50	35·90	56·40	5·20	61·60	8·44	1·35	36·80	57·20	4·65	61·85	7·51
Washed coal from Singleton Colliery coke-ovens	3·05	35·85	53·35	7·75	61·10	12·68	1·65	36·70	56·50	5·05	61·65	8·19
Unwashed unscreened coal from Mount Pleasant Colliery	0·85	23·85	64·85	10·45	75·30	13·87	0·75	26·10	67·15	6·00	73·15	8·20
Unwashed crushed slack from Unanderra Coke-works, Wollongong	1·15	24·40	64·40	10·05	74·45	13·49	0·55	25·90	67·25	6·30	73·55	8·56
Unwashed coal from Brown's Minmi Colliery	2·55	34·15	53·35	9·95	63·30	15·71	2·10	37·80	54·95	5·15	60·10	8·56
Unwashed small coal from Singleton Colliery coke-ovens	3·40	32·60	48·60	15·40	64·00	24·06	2·20	36·80	55·45	5·55	61·00	9·09

* This represents the percentage of ash in the coke made by hand-washed coal. It is probable that better results could be obtained if the coke were made on the large scale in rectangular coke-ovens.

Table B.—Analysis of Foreign and New South Wales Cokes.

Description of Cokes.	Hygroscopic Moisture.	Volatile Hydro-carbons.	Fixed Carbon.	Ash.	Sulphur.
A.—FOREIGN COKES.					
Hood's (Welsh) coke, from Broken Hill Proprietary Smelting-works	0·70	1·00	92·71	4·75	0·84
Brancepeth (Welsh) coke, from Port Pirie	0·80	0·85	91·93	5·50	0·92
Hood's (Welsh) coke No. 1, taken from Port Pirie ...	0·20	0·30	92·71	5·85	0·94
Westport (New Zealand) coke, taken from Port Pirie ...	0·85	1·05	89·53	7·15	1·42
Shamrock, Westphalia (German) coke, taken from Port Pirie	0·35	0·15	89·69	7·30	2·51
Brancepeth (Welsh) coke, from Broken Hill Proprietary Smelting-works	0·62	1·63	89·20	7·80	0·75
Hood's (Welsh) coke, sample No. 2, taken from Port Pirie	1·30	1·00	88·19	8·20	1·31
Hamburg (German) coke, taken from Port Pirie ...	0·35	0·55	88·58	9·20	1·32
Hood's (Welsh) coke, from the Central Broken Hill Smelting-works	0·36	0·37	88·86	9·70	0·71

Table B.—Analysis of Foreign and New South Wales Cokes—continued.

Description of Cokes.	Hygroscopic Moisture.	Volatile Hydrocarbons.	Fixed Carbon.	Ash.	Sulphur.
B.—Colonial Cokes.					
Purified Coke and Coal Co., sample No. 1, made from washed coal	0·40	0·02	91·33	7·82	0·43
Purified Coke and Coal Co., sample No. 2, made from washed coal	0·41	0·51	90·54	8·01	0·53
Purified Coke and Coal Co., sample No. 3, made from washed coal	0·42	0·00	90·79	8·38	0·41
Singleton Colliery coke, Rix Creek, made from washed coal	0·67	0·11	89·02	9·67	0.53
Co-operative Colliery coke, sample No. 1, made from unwashed coal	1·87	0·27	87·77	10·45	0·64
Unanderra (Wollongong) coke, made from unwashed crushed slack	0·29	0·15	87·55	11·56	0·45
Co-operative Colliery coke, sample No. 2, made from unwashed coal	0·22	0·34	86·71	12·06	0·67
Brown's Minmi Colliery coke, made from unwashed coal	0·62	0·32	85·65	12·62	0·79
Bulli Colliery coke, made from washed coal	1·15	0·90	83·98	13·40	0·57
Mount Pleasant coke, No. 1, made from unwashed screened coal	0·67	0·18	84·40	14·11	0·64
Mount Pleasant coke, No. 2, made from unwashed screened coal	0·75	0·26	84·41	14·15	0·43
Mount Pleasant coke, No. 3, made from unwashed unscreened coal	1·07	0·31	83·78	14·45	0·39
Vale Colliery (Lithgow) coke, made from washed coal ...	1·08	0·12	82·74	15·47	0·59
Mount Pleasant coke, No. 4, made from unwashed screened coal.	0·90	9·18	83·01	15·66	0·25

TABLE C.—Crushing Strength of Coke Samples tested by Professor Warren, M.I.C.E.

No. of Sample.	Description of Coke.	Size of Cube in Inches.	Total Crushing-force in Pounds.	Crushing Strength per Square Inch.	Remarks.
1	Hood's (Welsh) coke No. 2, taken from Port Pirie	1·045	800	765	Sound specimen.
2	Brancepeth (Welsh) coke, taken from Port Pirie	1·035	570	551	Cracked.
3	Shamrock, Westphalia (German) coke, taken from Port Pirie	1·045	500	478	Sound specimen, cracked at 250lb.
4	Westport (New Zealand) coke, taken from Port Pirie	1·010	755	747	Sound specimen.
5	Purified Coke and Coal Co.'s coke	1·038	1,700	1,368	Slight crack at base.
6	" " "	1·290	2,450	1,899	Slightly cracked all over.
7	" " "	2·030	3,500	1,724	Cracked across base.
8	" " "	1·060	3,955	2,383	" "
9	Co-operative Colliery (Newcastle) [coke	1·010	625	619	" "
10	" " ...	1·295	1,500	1,158	" "
11	" " ...	1·154	1,550	1,343	" "
12	Singleton Colliery (Rix's Creek) [coke	1·275	2,350	1,843	" "
13	" " " ...	1·039	1,155	1,112	" "
14	" " " ...	1·740	3,500	2,011	" "
15	Bulli Colliery coke	1·276	3,155	2,473	Sound specimen.
16	"	1·040	3,250	3,125	"

MINE-MANAGERS' EXAMINATIONS.

Up to the present time there has been 41 gentlemen who have successfully passed an examination, and have obtained first-class certificates under the Mining Acts of 1886 and 1891. There are also 125 first-class service certificates issued to gentlemen who have been managers of mining companies prior to the passing of "The Mining Act, 1886;" and 122 second-class service certificates issued to gentlemen who produced satisfactory certificates to the Board of Examiners within six months after the passing of "The Mining Act, 1891." There are 6 gentlemen who have passed an examination, and hold first-class certificates under the Coal-mines Acts of 1886 and 1891; also 4

who have received second-class certificates under the same Acts; and 66 first-class certificates have been issued to those who were managers of mines prior to certified managers being required; and 25 second-class service certificates have been issued to persons who could produce evidence, to the satisfaction of the Board of Examiners, that they had been either managers of mines or deputies for a prescribed term. There were also 64 service certificates issued to engine-drivers, and 4 after examination.

There seems to be an impression that if a young man is capable of passing an examination that he can get a certificate as manager; but this is not the case. Indeed, it would be a pernicious system if this could be done, as there are many at the present day with a good technical education who could easily pass an examination, and yet are totally ignorant of the practical working of a mine. Every candidate for a mine-manager's certificate must first satisfy the Board of Examiners that he has been at least three years continually employed in the underground workings of a mine under the Mining Act, and at least five years actually employed in the underground workings of a coal-mine, before he is allowed to come up for examination for his certificate. The miners acknowledge the advantage of mine-managers having a good technical education, and many of them are now improving their technical knowledge and studying subjects that a few years ago were almost looked on by them as useless. There is no doubt that some men may hold certificates who will never attain eminence in their profession, but the same can be said of holders of certificates in all professions. At the same time, capable men will always come to the front. The principle of having mine-managers with a fair technical knowledge, in addition to their practical knowledge, must be acknowledged as a great desideratum.

Mine-managers' and Engine-drivers' Examinations.

The following are the questions which were used at the last examinations for mine-managers' certificates under "The Mining Act, 1891," and under "The Coal-mines Act, 1891;" also for certificates as engine-drivers working winding-machinery, under the same Acts, held in January, 1893:—

UNDER "THE MINING ACT, 1891."

First Day.—Time: 9 a.m. to 12 Noon.

SUBJECT A.

The Laying-out and Construction of Shafts, Chambers, Main Drives or Levels, Uprises, and Stopes.

1. In commencing to sink a shaft to a depth of 400ft., describe how you would proceed: (*a*) what arrangements would you make before actual sinking was commenced; (*b*) how far would you sink in ordinary gravel-wash drift before you commenced to timber the shaft?

2. Describe how you would open out a chamber from the shaft: (*a*) what provision would you make before commencing to open out if water had to be bailed; (*b*) how would you secure the timber in the shaft at the opening; (*c*) what size of chamber would you construct to provide for forty men being employed on a shift if all material required were landed in this chamber?

3. Describe how you would construct an uprise vertical shaft, 6ft. by 3ft. in the clear, through ordinary gravel-drift, if it had to go up a distance of 150ft., so as to insure the safety of the workmen employed.

4. If a lode was found to be dipping at an angle to the westward of 72° from the horizontal, and a vertical shaft had to be sunk at 600ft. to the westward of the lode, at what depth would the shaft cut the lode? Also, if the shaft was sunk on the footwall of the lode at the surface to a depth of 525ft., and a drive put in to the westward from the bottom of the shaft, at what distance would the drive cut the lode?

5. If a lode was 6ft. in thickness, how far apart would you construct the passes? Give dimensions of passes, and why they are required at the distance you mention.

SUBJECT B.

On the Timbering of Shafts, Adits, Main Drives or Levels, Passes, Stopes, and generally on the Systems of timbering Mines, and also in filling up Old Workings.

1. If you were working a quartz lode in heavy ground, and the main level had to be constructed for a double line of rails, give the dimensions you would construct it in the clear, and also the dimensions of timber you would use.

2. Show by sketch how you would fit the timber for a main level, such as mentioned in the preceding question.

3. Give the dimensions of timber you would use in timbering a shaft (*a*) if planking alone was used, and (*b*) if frames and planking were used. Show by sketch how you would divide the shaft into compartments to allow of winding with double cages, and to have provisions for pumps being placed in the shaft; and also how you would fit the timber at the corners.

4. If you were sinking a shaft where a pump had to be placed, the pipes being 18in. in diameter, how far apart would you place the bearers in the shaft? and give the dimensions of the bearers in the shaft, if they had to be 9ft. in length in the clear.

5. In constructing a drive through broken ground, describe how you would timber it, and what provision you would make to insure the drive not collapsing if a cap-piece were to break at any part in the drive.

6. Give the breaking-load of a cap of red-pine timber 7ft. long between the props and 12in. in diameter; also give the crushing-weight on a prop of red-pine timber 8in. in diameter and 6ft. long, and state what the safe load on the cap-piece and prop would be. Show by calculation.

7. Show by sketch how you would timber stopes and passes, supposing the lode was 8ft. wide and dipping at an angle of 60° from the horizon.

FIRST DAY.—TIME: 2 P.M. TO 5 P.M.

SUBJECT C.

On the Drainage of Mines, and Pumping Appliances.

No. 1. Describe briefly the various systems of drainage as applied to mines.

No. 2. Describe in detail and mention all the parts of a pump capable of raising water to a height of 860ft.

No. 3. What limits the height to which water can be forced?

No. 4. From what depth will an ordinary pump draw water? Give your reason.

No. 5. How many tons of water would a pump lift in twenty-four hours, making 12 strokes per minute, single acting; diameter of pump, 16in.; stroke, 9ft.; pump $\frac{3}{4}$ full each stroke?

No. 6. What horse-power would be required in Question No. 5, the water to be raised 860ft.?

No. 7. What thickness of cast-iron pipe would be required for the bottom length in Question No. 6?

No. 8. Explain the use of the siphon and its application underground.

No. 9. To transmit power by electricity what is required?

No. 10. What is a dynamo, and what is a motor?

SUBJECT F.

Tapping Water in Mines, and the Mode of constructing Dams in Underground Workings to keep the Water back.

1. If you were constructing a drive to tap a lodgment of water, the face of the drive being 6ft. high and 4ft. wide, and the water standing to a height of 200ft. above the level of the drive, show by calculation the pressure in pounds on the face of this drive when it was close up to the water.

2. If you were driving through alluvial drift to tap a lodgment of water, state what precautions you would adopt when you were getting close to the water, and how you would secure the drive.

3. Show by sketch how you would construct a dam in a main level when the rock was solid—(*a*) if the dam were required to only keep back the water for a depth of 6ft.; (*b*) if the dam had to be constructed so that the water might rise to a height of 240ft.; (*c*) if the dam were of brick or concrete, and constructed in a main level 7ft. wide and 7ft. high, show thickness of dam capable of resisting a pressure 130lb. per square inch on the face.

4. What precautions are you required to take on approaching a body of water under "The Mining Act, 1891"?

SECOND DAY.—TIME: 9 A.M. TO 12 NOON.

SUBJECT D.

On the Haulage in Shafts, and on Underground-planes, also Strength of Hauling-ropes and Chains.

No. 1. What are the provisions in the Mines Act as to inspection of machinery, ropes, and cages?

No. 2. Describe the method of attaching a safety-catch to a cage, also its action in the event of the rope breaking.

No. 3. What appliances are used to prevent over-winding?

No. 4. What are the regulations as to signalling in shafts?

No. 5. How many different appliances are used for signalling?

No. 6. What, in your opinion, is the safest and best appliance for signalling, and give your reasons?

No. 7. What is the safe working-load on a 1-inch close-link chain?

No. 8. What is the safe working-load on a 4-inch round steel-rope?

No. 9. To raise 200 tons quartz in six hours, from a depth of 680ft., what size of coupled engines would you require? Give diameter of cylinders, stroke, and boiler pressure.

No. 10. What size of boiler or boilers would be required for engines in Question No. 9? Give sizes and type you would recommend.

SUBJECT G.

On Blasting and the Use of Explosives.

1. Give the relative strengths of dynamite, gelatine, gelignite, and rackarock, taking gunpowder as unity.

2. What explosives are you acquainted with that are affected by frost, and at what temperature do they get in a frozen condition? and when in such a condition can proper combustion be effected?

3. What is the composition of dynamite? What effect would be produced by applying a lighted taper to a plug of dynamite or gun-cotton in the open air?

4. In stoping a hard, compact quartz lode, if you were to drill a hole horizontally 2in. in diameter 2ft. above the top of the lower stope, and to have the hole 3ft. deep, show by calculation the quantity of dynamite required to be used to produce an effective result in blasting.

5. Give the weight of dynamite sufficient to fill a hole 2in. in diameter and 5in. deep.

SECOND DAY.—TIME: 2 P.M. TO 5 P.M.

SUBJECT E.

On the Ventilation of Mines.

1. Give the gases found in metalliferous workings, with their composition.

2. How do you ascertain or detect the presence of gases in a mine?

3. What effect has carbonic-acid gas on the workman? and what percentage of this gas in a mine would be dangerous to the lives of the men employed therein?

4. If an air-course was 6ft. by 6ft. and 1,000ft. in length, and passing 10,000 cubic feet of air per minute, and if this quantity were split into three divisions, namely,—first one, 6ft. by 4ft., 1,500ft. long; second one, 6ft. by 3ft., 1,200ft. long; and third one, 5ft. by 4ft., 800ft. long; show by calculation the quantity of air passing through each.

5. If there were two air-courses, each 1,000ft. long, one of which is 8ft. by 2ft. and the other is 4ft. square, if it required a pressure of 3lb. per square foot to force a given quantity of air through the 4ft.-square air-course, what pressure would it require to force an equal quantity through the 8ft. by 2ft. air-course?

SUBJECT H.

The Effect that Faults, Slides, and Mullock Bars have on Lodes, and how to ascertain the Direction of Slides and Heavals.

Give six diagrams, with verbal explanations, to illustrate the effect that is exercised on mineral lodes by faults, slides, and mullock bars; and describe instances from personal observation.

THIRD DAY.—TIME: 9 A.M. TO 12 NOON.

SUBJECT I.

A Knowledge of Underground Surveying, and of making Plans for the Workings, &c.

(*a.*) The candidate must produce a plan, showing the surface boundaries of a mining-claim of at least twenty acres in extent, and also show (in different coloured ink) the underground workings, so as to illustrate the relation these latter bear to the surface boundaries of the claim. All the traverse lines, measurements, and bearings should be shown on the plan, both of surface claim and underground workings, so as to illustrate the method adopted in the survey; such plan and survey to be the actual work of the candidate himself. State if the bearings are taken by compass or by theodolite, and, if the latter, describe how the meridian was obtained.

(*b.*) Produce the original field-notes of the survey, and, if possible, let all the traverses be calculated, and have the latitude and departure of each peg shown in a table. (A great number of marks will be secured by any candidate who calculates his traverses.)

(*c.*) Draw a rough diagram, and describe in writing how the surface survey was connected with the underground survey; also fully describe the apparatus used.

(*d.*) From the two points which are nearest to the boundaries of the claim in the underground survey, give the nearest distance to such boundaries in a horizontal direction; also from the centre of the shaft, or adit entrance, show the shortest distance to the end of the most distant working: furnish this distance in feet or links, and describe how you obtained it.

(*e.*) Give a written description of the method used in the survey, from first to last, naming the instruments used for measuring both angles and distances, and describe how you obtained the horizontal measurements.

THIRD DAY.—TIME: 2 P.M. TO 5 P.M.

SUBJECT I—*continued.*

(*f.*) State what means you took to insure the correct length of your chain, tape, or whatever else was used.

(*g.*) If the survey is a compass one, state what the variation is, and how you obtained it.

(*h.*) In your opinion, will the compass give reliable results in underground surveys, and state what you base your opinion on?

(*i.*) Describe the adjustments of a theodolite, also of a miner's dial, in writing. (The candidate will be examined in the use and adjustments of these instruments.)

(*j.*) Describe the most correct way of obtaining the correspondence of the surface and underground meridians: (1) if there is only one shaft or adit; (2) if there are two shafts or adits.

(*k.*) Describe how the plan has been plotted from the field-notes.

(*l.*) What is the area in square feet of a figure which is 2,000ft. long, 150ft. wide at one end, and 260ft. wide at the other, measured at right angles to the first line.

(*m.*) What is the area of a triangle 1,800ft. in the base, and 400ft. in the perpendicular?

FOURTH DAY.—TIME: 9 A.M. TO 12 NOON.

SUBJECT J.

A Knowledge of the different Rocks where Gold, Silver, Tin, Copper, Zinc, Lead, and Antimony are found, and on the Formation of Lodes and Leads.

1. What metallic ores are usually associated with killas slate, propolyte, serpentine, and limestone respectively?

2. What is the composition of the chief ores of silver, lead, tin, antimony, copper, and zinc?

SUBJECT K.

A Knowledge of Arithmetic and of the Method of keeping Accounts.

1. Give the quantity of superficial feet there is in a balk of timber 2ft. 7½in. by 1ft. 10¾in. and 20ft. long.

2. If a contract was let to take out a block of quartz 44ft. 6in. long, 3ft. 3in. wide, and 97ft. 2in. high, at 3d. per cubic foot, required the total amount of the contract.

3. A piece of work cost £126 12s. 6d. for labour; there were six men and two boys employed on it; the men were paid 9s. per day and the boys 5s. per day of eight hours; a boy could only do two-thirds as much work as a man: how many days were they employed on the work?

4. Find the $\sqrt{\cdot 02469}$ and the $\sqrt[3]{0\cdot 6843674}$, and the value of $\cdot 006243^3$.

5. If a ton of ore contained, according to assay, 4oz. 13dwt. 12gr. of gold and 23oz. 3dwt. 4gr. of silver, and 65 per cent. of the gold and 49 per cent. of the silver was saved, what would be the value of the bullion saved, taking the value of gold to be £3 17s. 6d. per ounce and silver 3s. 2d. per ounce?

6. Calculate the following:—

167lb. of dynamite, at 1s. 9¼d. per pound.
394lb. of candles, at 9⅛d. per pound.
7 shovels, at 54s. 4d. per dozen.
34 men for 3 weeks and 3 hours, at 48s. each per week of 48 hours.

UNDER "THE COAL-MINES ACT, 1891."

FIRST DAY.—TIME: 9 A.M. TO 12 NOON.

SUBJECT I.—*On the Sinking of Shafts and Construction of Main Roadways, Opening-out a Mine, and the Division of a Mine into Districts.*

1. What arrangement would you make for the proper fitting of your curb-joints in sinking a circular shaft? Give sketch.
2. What considerations would guide you in fixing the position of a shaft to open up a coalfield?
3. Describe fully all your operations in sinking to the stone head. Assume conditions.
4. What thickness would you leave the rib of coal, which surrounds the different districts, in (1) a 20ft. seam? (2) in a 6ft. seam?
5. Explain fully the natural conditions in which it would be preferable (1) to sink, (2) to drive, in opening up a seam; and give a case where the methods would be equally suitable.

SUBJECT II.—*The various Methods adopted in Securing Shafts and Workings in a Mine, showing the relative Advantage and Efficiency of each Class of Material used.*

1. In a cap 10in. deep by 8in. broad, what reason is there for the extra depth? Would you adopt that form, and, if so, in what circumstances?
2. What thickness of cast-iron tubbing would you use for a shaft 15ft. diameter and 30 fathoms deep?
3. Sketch how you would support the lining at the bottom of a rectangular shaft.
4. What are the chief disadvantages of the circular form in shafts?
5. How would you control the pressure and support the roof in working by longwall?

FIRST DAY.—TIME 2 P.M. TO 5 P.M.

SUBJECT III.—*The various Methods of Hewing and Cutting Coal of Different Classes to Advantage, and Securing the Ground whilst so engaged.*

1. Enumerate the various conditions in which the longwall-system of working is superior to bord and pillar.
2. If you had an area of 30 acres in pillars, and the roof was not standing well, describe your method of working it. Thickness, 10ft.
3. Give sketch showing how you would lay off a longwall working and guide the air therein, with the workings shown a considerable distance from the shaft.
4. In working out 18ft. of coal, and leaving coal roof, what method would you adopt to work the upper part of the 18ft.; and how prevent accidents from falls of the roof thereafter?
5. State your arrangements fully, in driving through very soft and wet measures, to open up a coal-seam to the dip.

SUBJECT IV.—*The various Methods of Ventilation, and the Construction of Airways so as to produce a Good Circulation of Fresh Air in any part of a Mine.*

1. What is meant by an open running fan, and what are its advantages?
2. Give a sketch-plan of bord-and-pillar workings, showing intakes, returns, air-crossings, regulators, bratticing, doors and stoppings, where they are required.
3. Give sketch in section of a good air-crossing.
4. Why is the dynamo specially suitable for driving fans?
5. If the volume of air be trebled, how much will the friction be increased?
6. Explain fully how you would put up your brattice-cloth.

SECOND DAY.—TIME: 9 A.M. TO 12 NOON.

SUBJECT V.—*On the Areas of Airways, the Velocity and Divisions of Currents, and the Deductions to be made for Friction.*

1. Is anything else than an increased current gained by splitting the air?
2. An air-way passing 40,000 cubic feet of air per minute is split in two, measuring $6' \times 5' \times 1{,}500'$ and $10' \times 6' \times 2{,}400'$: how much does each split pass?
3. You have an upcast 100ft., and chimney an additional 40ft., circulating 10,000 cubic feet of air per minute. What volume would circulate if the chimney were blown down; and would the mine's atmosphere be explosive if there had been 1½ per cent. of fire-damp in the first instance?
4. You have an air-course $20' \times 10'$ which must be allowed to close. What size must two smaller air-ways of equal area be to give the same volume of air?
5. Would you unite all your return air-currents as soon after passing the men as possible, in an extensive mine free from gas?

SUBJECT VI.—*On the Nature and Composition of Explosive and Dangerous Gases occurring in Coal-mines, and on Spontaneous Combustion.*

1. Describe the different properties of carbonic acid gas.
2. State what you know of the influence of the temperature of a mine's atmosphere in regard to the origin of spontaneous combustion.
3. In what circumstances would you require to guard against black-damp; and what would you do?
4. What proportions of fire-damp and air cease to be explosive?
5. In working with electric lights, how would you detect fire-damp and black-damp?
6. What is the composition of after-damp?

SECOND DAY.—TIME: 2 P.M. TO 5 P.M.

SUBJECT VII.—*On the Drainage of Mines, and Pumping Appliances.*

1. In a shaft 390ft. deep, state your arrangements for pumping very heavy feeders of water.
2. What diameter of plunger would you require to pump 1,000 gallons of water per minute, with a 5ft. stroke and 10 strokes per minute?
3. Explain the meaning of the constant number 0·034 in the formula used in finding the diameter of a plunger to pump a given quantity.
4. What is the greatest depth for a single lift, and what causes limit this?
5. Is there more wear and tear with a forcing or lifting pump? Explain why.
6. Sketch the arrangements at the junction of a plunger and lifting-set.

SUBJECT VIII.—*The Haulage on Planes and in Shafts, also the Different Systems of Underground Haulage, with Horse-power required to do the Work.*

1. If an engine can draw 100 tons per hour on the level by the endless-rope system of haulage, what could it draw with the same conditions upon an incline of 1 in 8? Assume weight of rope and co-efficient of friction.
2. What is the limit to the length of one section of endless rope? Give an example.
3. Give sketch and describe your arrangements in the tail-rope system of haulage, for working, a branch where the tail-rope does not need to be used.
4. Give sketch in plan of self-acting incline, where the roof is so bad that you cannot have a double line of rails except at the middle, and describe your arrangements for the tubs passing.

THIRD DAY,—TIME: 9 A.M. TO 12 NOON.

SUBJECT IX.—*The Theoretical and Effective Power of Steam-engines and -boilers; also on the Strength of Hauling-ropes and Chains.*

1. What evaporating surface should boilers have for each horse-power?
2. How many Lancashire boilers would you require at a colliery to provide for engines of 500-horse power, and how do you arrive at the result?
3. With a mean pressure of 50lb., and 220ft. of travel per minute, what size of cylinder is required to give 76 indicated horse-power?
4. If you found your winding-engine had rather too much to do in starting the load, what arrangements would you make?
5. What is the breaking-strain of a steel wire-rope 3in. in circumference?

SUBJECT X.—*The Incrustations in Steam-boilers and Cause of same, and the Remedy therefor.*

1. Explain what you know of incrustations in boilers.
2. What is meant by "grooving" in a boiler, and how is it caused?
3. In a Cornish boiler, what area of fire-grate should there be for each horse-power?
4. What measures would you adopt if there were sedimentary, but not chemical, impurities in the feed-water for your boilers?

THIRD DAY.—TIME: 2 P.M. TO 5 P.M.

SUBJECT XI.—*Tapping Water in Mines, and the mode of Constructing Dams in Underground Workings to keep Water back.*

1. Give a sketch in plan, with sizes marked, of the dam you would put in to guard against a heavy influx of water.
2. What arrangements would you make to prevent too great an outflow of water from the bore-hole in tapping a body of water under great pressure?
3. Are there any objections to the use of brick in underground dams? If so, specify them.

SUBJECT XII.—*Blasting and the Use of Explosives.*

1. What is the chief objection to the use of powder in mines?
2. What is the composition of dynamite, and how would you thaw it when frozen?
3. Why should another hole not be drilled near one in which any nitro-glycerine explosive has missed fire?
4. What are the preparations and conditions necessary for the efficient and safe firing of a shot with blasting-powder?

SUBJECT XIII.—*The Effect that Faults produce in Coal-seams, and How to Ascertain the Direction of a Coal-seam when severed by a Fault.*

1. In what circumstances would you look for a reversed fault?
2. What is meant by a "step" fault, and what does it indicate?
3. What reasons are there for coal being of inferior quality near faults?
4. What surface-indications would lead you to expect a fault; and are such customary?
5. What is a fault of erosion?

FOURTH DAY.—TIME: 9 A.M. TO 12 NOON.

SUBJECT XV.—*A knowledge of Surface and Underground Surveying, and of making Plans, showing System of Working, Inclination of Seam, Faults, and System of Ventilation.*

1. The candidate must produce a plan showing the style of workings in a colliery, with the surface taken up for at least 20 acres in the vicinity of the shaft, and the underground workings in different coloured ink. He must describe how he would connect them with the surface in the event of there being only one shaft. The levels and main heading must have assumed traverse calculated in detail, and showing latitude and departure for each bearing.
2. Which is the best of all ways of connecting the underground workings with the surface?
3. If the dip of a seam is due east at 45°, what will the inclination of a drawing-road be which you lay off bearing N. 70° E.?
4. Where two seams are worked at the same place, detail the advantages of showing them clearly distinguished from each other, and how you would do this on the plans.
5. Due N. from shaft for 250 links; thence 20°, 120 links; 96°, 90 links; 183°, 360 links: what distance would you have to drive to connect with the shaft, and on what bearing? Seam level.
6. What is meant by the term "fast needle dialling"?

FOURTH DAY.—TIME: 2 P.M. TO 5 P.M.

SUBJECT XIV.—*A knowledge of the Composition and Character of the Different Classes of Coal, and also of the Character of the Rocks and Formation of the Country where Coal is likely to be found.*

1. What is the composition of an average lignite?
2. If analysis showed a coal to be of excellent quality, could you certainly rely on this for its taking the market?
3. Explain the formation of country where you would be most likely to find coal, and the rock most characteristic of it in your district.
4. Explain the various reasons why an upper seam is sometimes of better quality than a lower one.
5. What are the conditions which have brought about the anthracite variety of coal?

SUBJECT XVI.—*A knowledge of Arithmetic, and the Method of Keeping Accounts.*

1. What is the sum of $1\frac{1}{3} + \frac{5}{8} + \frac{3}{7} + \frac{1}{6}$?
2. What is the $\sqrt{4,583,881}$, and the $\sqrt[3]{,741,632}$?
3. A brick-wall is 900 square feet, and one half-brick in thickness: how many bricks does it contain?
4. A pillar-waste measures 15 chains by 12: how many tons of coal does it contain if the seam is 8ft. thick, and 60 per cent. of the coal has been won?
5. The base of a right-angled triangle is 180 yards; another side is 80 yards: what is the third side?
6. What is the area of the triangle in the last question?
7. Smith took seven days to do a piece of work, which Jones could do in five days, and Brown could do in three: how long would it take if they were all put on together?
8. What weight of material would you have to wind in sinking a shaft 10ft. diameter a depth of 70ft.? Assume weight per cubic foot.

SUBJECT XVII.—*A knowledge of the Provisions of "The Coal-mines Act, 1891."*

UNDER "THE MINING ACT, 1891," AND "THE COAL-MINES ACT, 1891."

FIRST DAY.—TIME: 9 A.M. TO 12 NOON.

SUBJECT 1.

On the different Classes of Steam-engines used in Winding, and also all the Internal and Moving Parts.

No. 1. Describe briefly the different types of engines used for winding.
No. 2. How would you ascertain if your crank-shaft was in line?
No. 3. Describe a piston; mention all its parts, and their respective uses.
No. 4. Describe a feed-pump; mention all its parts, and for what purpose each is required.
No. 5. For what use is a fly-wheel on an engine; and in what class of engine can they be dispensed with?
No. 6. What speed per minute do you consider it safe to wind men up a shaft; and what speed material?
No. 7. What is a slide-valve; where placed, and for what purpose is it required?
No. 8. What position in a horizontal engine should the slide-valve be when the crank is on the outer centre?

SUBJECT 2.

On the different Appliances and Indicators used to show the Positionof Cage in Shaft, or Truck on Plane, in which Persons are conveyed; also the meaning of the different Signals used in Mines.

No. 1. How is the position of the cage in the shaft, or truck on plane, made known to the engine-driver?

No. 2. How many kinds of indicators comply with the above conditions?

No. 3. Describe the different methods of signalling from any part of the shaft to the engine-driver, and *vice versâ*.

No. 4. Describe the different methods of signalling from a plane to the engine-driver.

No. 5. What are the regulations under the Coal-mines Act when the cage is required to lift, stop, or lower, and if any difference when drawing men or material?

No. 6. Describe any other sets of signals you are acquainted with.

FIRST DAY.—TIME: 2 P.M. TO 5 P.M.

SUBJECT 3.

On the different kinds of Boilers used for Winding and their Connections; the effects of Impuirties in Water in Boilers, and the Remedies adopted to keep them clean.

No. 1. Describe a Lancashire boiler.

No. 2. Mention all the necessary mountings required for a Lancashire boiler.

No. 3. Give a description of a low-water alarm.

No. 4. If water became dangerously low in a boiler at work, what precaution would you adopt to prevent an explosion?

No. 5. If feed-pumps refused duty, what precautions would be necessary?

No. 6. What would be the effect on a Lancashire boiler if water was used coming over a limestone country?

No. 7. What parts of a Lancashire boiler would require special attention if limestone water was used?

No. 8. What ingredients would be required to remove the impurities in limestone water?

SUBJECT 4.

On the different Appliances used for Winding with Hydraulic Machinery, and the methods adopted for letting on and shutting off the water.

No. 1. In what respects does a reversing water-wheel differ from an ordinary wheel?

No. 2. Is a brake necessary on a reversing wheel; if so, where should it be placed?

No. 3. Can a "Pelton," or "Hurdy-gurdy," wheel be used for winding; if so, what gear, if any, is required for its adoption?

No. 4. Can a Turbine wheel be used for winding?

No. 5. What is a sluice-valve; where fitted, and for what purpose?

SECOND DAY.—TIME: 9 A.M. TO 12 NOON.

SUBJECT 5.

On the Power of Steam-engines and Hydraulic Machinery.

No. 1. What is a government-head of water?

No. 2. What height of water is equal to 95lb. per square inch?

No. 3. How many heads of water falling 60ft. would be equal to 20-horse power?

No. 4. Give the average efficiency of the "Pelton," the overshot, and the undershot wheels.

No. 5. What would be the total steam-pressure on a cylinder-cover: diameter of cylinder 16in., boiler-pressure 80lb. per square inch?

No. 6. A safety-valve 3in. diameter, lever 30in. long to the centre of weight, and 3in. from fulcrum to centre of valve; weight on end of lever, 65lb.: what would be the boiler-pressure per square inch (neglecting weight of lever and valve)?

No. 7. What direct weight would be required on a safety-valve 4in. diameter to give a pressure of 90lb. per square inch?

No. 8. What would be the indicated horse-power of an engine whose cylinder-diameter was 20in., piston-speed 450ft. per minute, mean pressure 40lb. per square inch?

ADDITIONAL QUESTIONS UNDER "THE COAL-MINES ACT, 1891."

SUBJECT 6.

On the Prevention of Priming in Boilers.

No. 1. What is meant by boilers "priming"?

No. 2. Is there any danger to boilers from priming?

No. 3. State what precautions are necessary with the machinery when boilers prime.

No. 4. Mention all the causes you know of conducive to priming.

No. 5. What remedies or precautions would you adopt to prevent boilers priming?

LIST OF MINE-MANAGERS AND ENGINE-DRIVERS WHO HAVE OBTAINED CERTIFICATES UNDER THE MINING AND COAL-MINES ACTS OF 1886 AND 1891.

As there have been several inquiries made as to the names of persons who hold certificates as mine-managers and engine-drivers, the annexed is a complete list of those holding certificates at the date of this report:—

THE MINING ACT.

First-class Service Certificates.

Issued under "The Mining Act, 1886," without Examination.

Adams, H. H., Waiorongomai.
Anderson, P., Thames.
Andrews, T., Thames.
Andrews, R., Coromandel.
Barclay, T. H., Thames.
Bennett, J., Alexandra.
Benney, J., Coromandel.
Black, T., Waiomai.
Bollersley, N., Boatman's.
Bradbury, M., Reefton.
Bray, John, Lyell.
Burch, W. H., Thames.
Byrne, J. F., Stafford.
Cameron, A., Macetown.
Cameron, E., Te Aroha.
Chapman, J. A., Dunedin.
Clarke, G. S., Thames.
Comer, R., Thames.
Conradson, M., Thames.
Corin, W., Thames.
Cornes, C. A., Karangahake
Coutts, J., Thames.
Crawford, T. H., Thames.
Crowley, C., Reefton.
Cummings, W., Reefton.
Davis, J. E., Queenstown.
Davey, C., Ross.
Donald, J., Cromwell.
Dryden, S., Thames.
Dunlop, T. A., Thames.
Edwards, J., Skippers'.
Elliott, J., Macetown.
Evans, F., Skippers'.
Evans, J. H., Skippers'.
Fitzmaurice, R., Reefton.
Frewen, J. B., Queenstown.
Gavin, T., Te Aroha.
Gilbert, J., Reefton.
Gilmour, T., Thames.
Giles, G. F., West Wanganui.
Glass, W. M., Naseby.
Goldsworthy, J., Waiorongomai.
Greenish, J., Reefton.
Greenville, W., Ohinemuri.
Hall, J. P., Thames.
Hansen, P. C., Thames.
Harris, J., Owen's Reefs.
Harrison, R. H., Coromandel.
Hicks, T. B., Thames.
Hilton, G. P., Bendigo.
Hodge, F., Coromandel.
Hollis, W., Thames.
Hunter, R., Thames.
James, F., Thames.
Jamieson, A., Coromandel.
Jenkins, M., Wakatipu.
Johnstone, H., Bluespur.
Julian, J., Boatman's.
Kelly, J., Lyell.
Kerr, J., Thames.
Lawn, E., Black's Point.
Lawn, H., Boatman's.
Lawn, J., Reefton.
Littlejohn, W., Karangahake.
Lowe, E. W., Thames.
Malfroy, J. M. C., Ross.
Martin, W. G., Thames.
McCullum, J., Reefton.
McCullough, R., Thames.
McGruer, N., Karangahake.
McIlhaney, J., Thames.
McIntosh, D., Bluespur.
McKay, J., Ross.
McKenney, J., Reefton.
McKenzie, W., Thames.
McLeod, G., Coromandel.
McLiver, F., Thames.
McLiver, H., Thames.
McMaster, J., Reefton.
Moore, H. W., Thames.
Moore, J. H., Thames.
Morgan, R., Otago.
Morrisby, A. A., Glenorchy.
Nasmyth, T., Reefton.
Newman, W., Naseby.
Northey, J., Thames.
O'Sullivan, D. E., Thames.
Polton, A., Karangahake.
Porter, J., Waipori.
Purvis, G., Ross.
Quinn, E., Te Aroha.
Radford, T., Thames.
Ralph, J. G., Thames.
Ranger, J., Reefton.
Rasmussen, C. L., Mokihinui.
Rasmussen, C. P., Mokihinui.
Reid, P., Coromandel.
Resta, L., Macetown.
Roberts, E., Ross.
Rooney, F., Reefton.
Scott, T., Waiorongomai.
Searight, A., Reefton.
Senior, J., Thames.
Smith, J. E., Thames.
Stone, F., Karangahake.
Steedman, J. B., Thames.
Sturm, A., Waipori.
Taylor, N., Thames.
Todd, C., Heriot.
Treloer, J. S., Reefton.
Tripp, R. S., Arrowtown.
Vivian, J. G., Thames.
Vivian, S., Reefton.
Waite, C. D., Thames.
Waite, E., Thames.
Walker, J. W., Thames.
Watson, T., Reefton.
Wearne, J. E., Endeavour Inlet.
Wilcox, J., Thames.
Williams, J., Skippers'.
Wright, G., Boatman's.
Wylie, W., Ross.
Young, G., Skippers'.

First-class Mine-managers' Certificates, issued after Examination, under "The Mining Act, 1886," and Amendment Acts.

Adams, B., Thames.
Baker, W., Thames.
Black, G., Reefton.
Caples, P. Q., Dunedin.
Carter, J., Thames.
Casley, G., Reefton.
Cochrane, D. L., Reefton.
Colebrook, J. D., Coromandel.
Coombe, J., Reefton.
Crawford, J. J., Thames.
Cummings, W., Reefton.
Donaldson, W., Otago.
Fleming, M., Thames.
Gardner, W. P., Reefton.
Harris, W., Thames.
Horn, G. W., Thames.
Horne, W., Coromandel.
Hornick, M., Thames.
Hosking, G. F., Auckland.
Kruizenza, W., Reefton.
Lawn, T., Reefton.
Logan, H. F., Wellington.
Mangan, T., Thames.
Mouat, W. G., Dunedin.
Truscott, G., Thames.
Watkins, C. E., Reefton.
Wilkie, J., Reefton.

First-class Mine-manager's Certificate issued on production of Foreign Certificate, under "The Mining Act, 1886."

Argall, W. H., Coromandel.

First-class Mine-manager's Certificate issued to Inspector of Mines by virtue of his office under "The Mining Act, 1886."

Binns, G. J., Dunedin.

First-class Mine-managers' Certificates, issued after Examination, under "The Mining Act, 1891."

Annear, William, Reefton.
Bray, E., Thames.
Bruce, Malcolm, Thames.
Fahey, P., Reefton.
Flannigan, Francis, Reefton.
Lawn, C. H., Capleston.
McDermott, J., Thames.
Paul, Matthew, Thames.
Paltridge, Henry, Thames.
Robertson, D. B., Stafford.
Steedman, J. G., Thames.
Sutherland, Benjamin, Reefton.
Warne, George, Thames.
Williams, C., Capleston.

Second-class Service Certificates as Mine-managers.

Issued under "The Mining Act, 1891."

Adams, W. J., Thames.
Allen, Richard, Reefton.
Argall, A. E., Coromandel.
Bennett, C. H., Coromandel.
Begley, Thomas, Reefton.
Beard, W. T., Reefton.
Bone, William, Reefton.
Bowler, John, Thames.
Blair, Thomas, Kuaotunu.
Bray, Edwin, Reefton.
Brownlee, Thomas James, Thames.
Brokenshire, James, Thames.
Bolitho, James, Reefton.
Brown, John, Macrae's.
Bremner, John, Coromandel.
Borlase, J. H., Capleston.
Bunny, Joseph, Thames.
Byrne, John, Karangahake.
Caird, Alexander McNeil, Reefton.
Campbell, J., Kuaotunu.
Climo, Noah, Coromandel.
Comer, George, Thames.
Cowan, Hugh, Kuaotunu.
Corbett, T., Paeroa.
Comer, W. W., Thames.
Crabb, Thomas, Reefton.
Daniel, P. F., Greymouth.
Dobson, John Allan, Kuaotunu.
Edwards, George, Westport.
Ellery, John, Reefton.
Flannigan, Francis, Reefton.
Foster, Thomas, Wellington.
Gale, C. W., Coromandel.
Gill, George, Thames.
Glasgow, T. M., Thames.
Goldsworthy, Henry, Thames.
Govan, Joseph, Thames.
Griffin, Patrick, Thames.
Grimmond, Joseph, Ross.
Goldsworthy, William, Mauku, Auckland.
Gemmings, Charles, Thames.
Gribble, James, Norsewood.
Guthrie, John, Wellington.
Guy, Robert, Kuaotunu.
Harris, Richard, Thames.
Harvey, William, Reefton.
Hardman, James Edward, Thames.
Hicks, William, Thames.
Hetherington, William, Thames.
Hill, Alex. Grey, Waikakaho.
Hore, John, Wellington.
Hollis, Fred. J., Waihi.
Hornibrook, H. P., Kuaotunu.
Jamieson, John, Reefton.
Johnstone, William, Collingwood.
Jobe, James, Thames.

SECOND-CLASS SERVICE CERTIFICATES OF MINE-MANAGERS—*continued.*

Johns, Thomas, Thames.
Kendall, Henry, Thames.
Kerr, George, Kamo.
Kirker, Thomas, Thames.
Laughlin, David, Thames.
Law, John, Thames.
Loughlin, S., Thames.
Lough, Henry, Thames.
McLean, James, Thames.
McLean, Alex., Coromandel.
McLean, Charles, Thames.
McCormick, Charles, Coromandel.
McQuillan, John, Reefton.
McNeill, Daniel, Thames.
McNeill, George, Upper Kuaotunu.
McCombie, John, Karangahake.
McEwen, James, Reefton.
McLoghry, Archibald, Karangahake.
Mackay, William, Nenthorn.
Martin, James, Reefton.
Meagher, John, Karangahake.
Mills, George, Thames.
Mayn, John, Coromandel.
Martin, David, Black's Point.
Morgan, William, Upper Thames.
Moorecroft, Thomas, Thames.
Milne, John, Thames.
Moyle, Thomas, Thames.
Naysmith, James, Reefton.
Newdick, Alfred, Thames.
Notman, Alexander, Reefton.
O'Keefe, M. W. D., Thames.
Page, John, Lyell.
Parkiss, Jos. W., Reefton.
Potts, W. H., Thames.
Primrose, J., Kuaotunu.
Pettigrew, Robert, Sydney.
Peebles, Alexander, Kuaotunu.
Pollock, John, Thames.
Phillips, William Henry, Thames.
Rabe, Henry, Thames.
Reid, Thomas Groat, Thames.
Rickard, John, Thames.
Rickards, A. H., Kuaotunu.
Radford, Thomas, Thames.
Rogers, Charles Henry, Reefton.
Rogers, William Henry, Kumara.
Ross, J., Thames.
Rowe, James, Thames.
Shaw, James, Karangahake.
Sligo, Alex., Nenthorn.
Thomas, James, Thames.
Thomas, A., Thames.
Thomson, John, Dunedin.
Tregellas, James, Reefton.
Tregoweth, William, Thames.
Wells, Charles Lewis, Thames.
Willets, Henry, Thames.
Williams, James, Thames.
Williams, John, Thames.
Whisker, Charles, Thames.
White, John S., Karangahake.
Wilson, James R. S., Kuaotunu.
Wilson, J. G., Thames.
Woodcock, James, Thames.
Worth, Robert, Waihi.

ENGINE-DRIVERS' SERVICE CERTIFICATES.

Issued under "The Mining Act, 1891."

Audley, F., Coromandel.
Battens, H., Coromandel.
Black, C., Reefton.
Black, G. J., Reefton.
Bridson, Mat. J., Thames.
Casley, J., Thames.
Clerkin, F., Reefton.
Crabb, J., Reefton.
Crofts, J. W., Skippers.
Cook, W., Thames.
Craig, D., Thames.
Davies, D., Thames.
Dunstan, J., Thames.
Faithful, William, sen., Cromwell.
Faithful, William, jun., Cromwell.
FitzMaurice, Raymond, Reefton.
Grundy, T., Thames.
Harrison, R. H., Kuaotunu.
Hope, J. S., Waitekauri.
Hufton, George, Reefton.
Ivey, R., Thames.
Latimer, Alfred, Dunedin.
Lamberton, J., Reefton.
Lawn, E., Reefton.
McLean, J., Reefton.
Milne, S., Coromandel.
Murphy, A. R., Queenstown.
Morton, C., Thames.
Patterson, D., Reefton.
Patten, A. C., Reefton.
Phillips, W. H., Thames.
Ryan, J. P., Coromandel.
Roche, H., Thames.
Saunders, William, Reefton.
Smith, R., Thames.
Skilton, A. G., Westport.
Sullivan, W., Coromandel.
Titley, A. W., Black's Point.
Walding, J., sen., Coromandel.
Walding, J., jun., Coromandel.
Warne, G., Thames.
Wishart, R., Thames.
Wood, A., Thames.

Engine-drivers' Certificates issued after Examination under "The Mining Act, 1891."

Allen, A., Thames.
Auld, James, Reefton.
Blackadder, D., Reefton.
Daldy, E. A., Coromandel.
Dunstan, I., Waihi.
Elliston, A. J., Reefton.
Slowey, William, Reefton.
Wilson, F. H., Thames.

THE COAL-MINES ACT.

FIRST-CLASS MINE-MANAGERS' CERTIFICATES.

Issued under "The Coal-mines Act, 1886."

Aitken, T., Wendon.
Alexander, T., Brunnerton.
Austin, J., Sheffield.
Bishop, J., Brunnerton.
Brown, T., Westport.
Brown, T., Glentunnel.
Cameron, J., Denniston.
Campbell, J. C., Fairfield.
Collins, W., Taupiri.
Dando, M., Brunnerton.
Elliott, R., Wallsend.
Ferguson, A., Whitecliffs.
Freeman, J., Green Island.
Geary, J., Kamo.
Gray, J., Abbotsford.
Harrison, J., Brunnerton.
Irving, J., Kaitangata.
Jemison, W., Waimangaroa.
Kenyon, J., Shag Point.
Kerr, G., Kamo.
Lindop, A. B., Springfield.
Lindsay, W., Otago.
Lloyd, J., Invercargill.
Louden, J., Green Island.
Love, A., Whangarei.
Mason, J., Nightcaps.
May, J., Greymouth.
Moody, T. P., Kawakawa.
Moore, W. J., Springfield.
Nelson, J., Green Island.
Ord, J., Huntly.
Redshaw, W., Whangarei.
Reed, F., Westport.
Richardson, D., Abbotsford.
Shore, J., Kaitangata.
Shore, T., Orepuki.
Shore, W. M., Kaitangata.
Smart, W., Christchurch.
Smith, A. E., Nelson.
Smith, T. F., Nelson.
Sneddon, J., Mosgiel.
Swinbanks, J., Kawakawa.
Taylor, E. B., Huntly.
Thompson, A., Whitecliffs.
Walker, J., Collingwood.
Williams, W. H., Shag Point.

Certificates issued after Examination under "The Coal-mines Act, 1886."

First Class.	First Class.	Second Class.
Armitage, F. W., Auckland.	Green, J., Brunnerton.	Barclay, T., Kaitangata.
Gibson, John, Westport.	Hosking, G. F., Auckland.	Lindsay, J. B., Orepuki.
Green, E. R., Abbotsford.	Jebson, D., Canterbury.	Snow, T., Mercer.

First-class Mine-managers' Certificates issued on production of English Certificate, under "The Coal-mines Act, 1886."

Binns, G. J., Dunedin.
Black, T. H., Waipori.
Broome, G. H., Ngakawau.
Cater, T., Auckland.
Cochrane, N. D., Dunedin.
Garrett, J. H., Auckland.
Hayes, J., Kaitangata.
Hodgson, J. W., Ross.
Macalister, J., Invercargill.
Nimmo, J., Oamaru.
Straw, M., Westport.
Tattley, W., Auckland.

First-class Mine-managers' Certificates issued to Inspectors of Mines by virtue of office under, "The Mining Act, 1886," and "The Coal-mines Act, 1886."

Cochrane, N. D., Westport.
Gordon, H. A., Wellington.
Gow, J., Dunedin.
Wilson, G., Thames.

MINE-MANAGERS' SERVICE CERTIFICATES (FOREIGN).

Issued under "The Coal-mines Act, 1886."

Irvine, James, Dunedin.
Jrodan, R. S., Kaitangata.
Lewis, W., Blackball.
Proud, Joseph, Wanganui.

SECOND-CLASS MINE-MANAGERS' SERVICE CERTIFICATES.

Issued under "The Coal-mines Act, 1891."

Collier, Levi, Kamo.
Carson, M., Kaitangata.
Clarke, Edward, Shag Point.
Elliot, Joseph, Coal Creek.
Harris, John, Denniston.
Herd, Joseph, Brunnerton.
Howie, James, Kaitangata.
Leeming, William, Whitecliffs.
Lobb, Joseph, Mokau.
Love, Alexander, Orepuki.
McLaren, J. M., Thames.
McIntosh, Allan, Shag Point.
Marshall, J., Ngakawau.
Murray, Thomas, Denniston.
Nimmo, George Stewart, Ngapara.
Radcliffe, William, Reefton.
Roberts, John, Brunnerton.
Ross, John, Kawakawa.
Sara, James, Reefton.
Smith, Charles, Whangarei.
Thomas, James, Springfield.
Wallace, William, Huntly.
Willetts, John, Papakaio.
Willetts, John Morris, Papakaio.
Young, William, Waimangaroa.

ENGINE-DRIVERS' CERTIFICATES.

Issued under "The Coal-mines Act, 1886."

Bainbridge, William, Brunnerton.
Beirn, William H., Kaitangata.
Clark, A., Kaitangata.
Davidson, Robert, Walton Park.
Elliott, R., Denniston.
Eltringham, Stephen, Greymouth.
Foote, Thomas, Miranda.
Gall, Adam, Huntly.
Gill, Robert, Shag Point.
Gillies, D., Walton Park.
Girven, Adam, Kawakawa.
Grundy, Walter, Kamo.
Gibson, J., Denniston.
Gray, G. A., Kaitangata.
Harrison, C. F. R., Huntly.
Hazeldene, T., Denniston.
Hartley, H., Huntly.
Henderson, J., Huntly.
Hetherington, R., Huntly.
Howie, William, Walton Park.
Kelly Peter, Kaitangata.
Leisham, G., Denniston.
Marriott, T., Huntly.
Mason, J., Springfield.
Muir, T., Huntly.
Moore, Luke Martin, Brunnerton.
McFarlane, Henry, Miranda.
McGarry, James, Brunnerton.
McGregor, Duncan, Stirling.
McIntosh, Donald, Allandale.
McVie, John, Walton Park.
O'Neill, J., Denniston.
Porter, H. R., Huntly.
Ryan, T., Huntly.
Sampson, J., Huntly.
Saunders, J., Denniston.
Shore, Joseph, Kaitangata.
Skilton, F. G., Denniston.
Skellern, R., Huntly.
Smith, J., Denniston.
Southall, James, Brunnerton.
Thomas, William, Kamo.
Troughhear, Robert, Dobson.
Turner, Henry, Kawakawa.
Vincent, James, Miranda.
Wearn, Alfred, Boatmans.
Wearn, James, Wallsend.
Williams, Llewellyn, Kawakawa.
Woods, William, Kawakawa.
Williams, F. A., Shag Point.

Second-class Mine-manager's Certificate issued after Examination, under "The Coal-mines Act, 1891."

Dixon, W., jun., Kaitangata.

ENGINE-DRIVERS' SERVICE CERTIFICATES.

Issued under "The Coal-mines Act, 1891."

Archibald, W., Kaitangata.
Barlow, William John, Shag Point.
Boag, John, Shag Point.
Forrestor, Robert, Kaitangata.
Girvan, R., Kawakawa.
Greening, Luke, Springfield.
Johnstone, R. N., Kaitangata.
McVie, Gavin, Kaitangata.
Milburn, Edward, Westport.
Park, John A., Huntly.
Prentice, J., Shag Point.
Rixon, William E., Shag Point.
Todd, William, Dunedin.
Webb, Peter Oliver, Nightcaps.

Engine-drivers' Certificates issued after Examination, under "The Coal-mines Act, 1891."

Johnson, W. P., Kaitangata.
Marshall, D., Kaitangata.
Napier, A. T., Kaitangata.
Shearer, W., Huntly.

SUMMARY OF WORKS CONSTRUCTED.

The following statement shows the whole of the different classes of works constructed by the department, either by direct grants or by subsidies to local bodies, during the last eleven years (the votes for this purpose having been under the control of the Hon. the Minister of Mines, for the purpose of opening up the mineral belts throughout the colony, and also for the development of the mining industry:—

Nature of Work.	Total Cost of Construction, or Amount authorised to be expended.	Expenditure, by way of Subsidy or otherwise, by Mines Department.	Amount of Liability by Mines Department on Works in Progress.
UP TO YEARS 1882–83 AND 1883–84.	£ s. d.	£ s. d.	£ s. d.
Water-races	29,252 1 11	14,853 9 5	14,398 11 6
Roads on goldfields	21,437 11 2	13,089 16 0	8,347 15 2
Roads and tracks undertaken by County Councils, subsidised by Mines Department	52,841 17 0	21,844 16 7	10,207 15 9
Works undertaken by prospecting associations, subsidised by Mines Department	13,216 13 4	3,350 0 0	3,400 0 0
Construction of drainage- and sludge-channels, subsidised by Mines Department	5,750 0 0	2,468 15 4	781 4 8
	122,498 3 5	55,606 17 4	37,135 7 1
1884–85.			
Water-races	4,846 1 9	14,596 2 9	4,648 11 6
Roads on goldfields	13,667 10 1	9,630 9 6	12,384 15 9
Roads and tracks undertaken by County Councils, subsidised by Mines Department	13,566 14 1	6,293 16 6	12,739 17 6
Roads to mines, other than gold, subsidised by Mines Department	4,594 10 0	111 19 0	2,888 1 0
Works undertaken by prospecting associations, subsidised by Mines Department	850 0 0	108 0 0	3,692 0 0
Construction of drainage- and sludge-channels, subsidised by Mines Department	4,050 0 0	1,050 0 0	1,931 4 8
Diamond and other drills	3,600 0 0	1,858 0 0	..
	45,174 15 11	33,648 7 9	38,284 10 5

SUMMARY OF WORKS CONSTRUCTED—*continued.*

Nature of Work.	Total Cost of Construction, or Amount authorised to be expended.	Expenditure, by way of Subsidy or otherwise, by Mines Department.	Amount of Liability by Mines Department on Works in Progress.
1885–86.	£ s. d.	£ s. d.	£ s. d.
Water-races	3,660 4 9	6,063 2 3	6,964 4 4
Roads on goldfields	27,543 18 8	12,360 14 9	27,567 19 8
Roads undertaken by County Councils, subsidised by Mines Department	14,773 2 3	13,043 15 9	12,477 9 2
Roads to mines, other than gold, subsidised by Mines Department	1,551 19 10	4,327 0 10	490 12 8
Works undertaken by prospecting associations, subsidised by Mines Department	11,860 18 0	1,999 5 7	6,389 5 9
Construction of drainage- and sludge-channels, subsidised by Mines Department	10,051 14 9	3,994 16 6	6,995 9 9
Schools of Mines	2,160 9 7	1,260 9 7	900 0 0
	71,602 7 10	43,049 5 3	61,785 1 4
1886–87.			
Water-races	..	1,928 14 4	3,466 0 8
Roads on goldfields	12,453 3 5	22,229 16 1	17,791 7 0
Roads and tracks undertaken by County Councils, subsidised by Mines Department	12,613 4 8	7,415 19 6	10,455 1 5
Roads to mines, other than gold, subsidised by Mines Department	..	306 1 0	110 13 1
Works undertaken by prospecting associations and companies, subsidised by Mines Department	15,671 19 6	4,521 7 3	4,618 4 7
Construction of drainage- and sludge-channels, subsidised by Mines Department	5,549 14 6	6,207 18 0	672 6 10
Diamond and other drills	422 15 6	422 15 6	..
Schools of Mines	3,183 7 1	3,383 7 1	700 0 0
	49,894 4 8	46,415 18 9	37,813 13 7
1887–88.			
Water-races	6 6 6	6 6 6	..
Roads on goldfields	6,860 4 3	17,281 11 3	7,370 0 0
Roads and tracks undertaken by County Councils, subsidised by Mines Department	2,998 15 0	8,012 5 2	3,942 4 2
Roads to mines, other than gold, subsidised by Mines Department	..	14 5 4	..
Works undertaken by prospecting associations and companies, subsidised by Mines Department	6,456 8 0	2,703 19 3	924 8 0
Construction of drainage- and sludge-channels, subsidised by Mines Department	..	1,110 4 11	2,054 10 6
Schools of Mines	1,859 3 7	2,221 19 4	337 4 3
Aids to treatment of ores	1,200 0 0	390 18 3	209 1 9
	19,380 17 4	31,741 10 0	14,837 8 8
1888–89.			
Roads on goldfields	10,253 5 3	4,304 3 9	13,218 11 6
Roads and tracks undertaken by County Councils, subsidised by Mines Department	7,318 1 0	2,466 16 8	5,195 6 1
Works undertaken by prospecting associations and companies, subsidised by Mines Department	474 0 0	236 0 0	687 8 0
Construction of drainage- and sludge-channels, subsidised by Mines Department	..	54 10 6	..
Wharves, contributions by Mines Department	589 19 5	96 6 0	343 13 5
Aids to treatment of ores, subsidised	..	209 1 9	..
Schools of Mines	895 16 10	1,188 6 10	44 14 3
	19,531 2 6	8,555 5 6	19,489 13 3
1889–90.			
Roads on goldfields	3,834 9 7	9,148 5 9	8,005 5 4
Roads and tracks undertaken by County Councils, subsidised by Mines Department	8,507 15 8	3,451 17 11	5,928 1 3
Works undertaken by prospecting associations and companies, subsidised by Mines Department	..	..	663 0 0
Water-races	2,200 0 0	719 0 0	681 0 0
Wharves	..	150 0 0	193 13 5
Schools of Mines	1,040 0 8	1,034 0 11	50 14 0
Aids to treatment of ores	142 8 9	142 8 9	..
Tracks to open up mineral lands	1,000 0 0	207 3 6	792 16 6
Diamond drills	425 14 5	425 14 5	..
	17,150 9 1	15,278 11 3	16,314 10 6
1890–91.			
Roads on goldfields	8,811 14 4	10,815 14 8	5,201 5 0
Roads and tracks undertaken by County Councils, subsidised by Mines Department	2,703 5 0	2,252 5 5	5,027 8 4
Work undertaken by prospecting associations and companies, subsidised by Mines Department	..	..	663 0 0
Water-races	5,542 19 8	6,234 4 6	..
Wharves	..	39 9 9	..
Schools of Mines	3,847 10 0	3,898 4 0	..
Tracks to open up mineral lands	..	78 4 7	419 19 5
	20,905 9 0	23,319 2 11	11,311 12 9

SUMMARY OF WORKS CONSTRUCTED—*continued.*

Nature of Work.	Total Cost of Construction, or Amount authorised to be expended.	Expenditure, by way of Subsidy or otherwise, by Mines Department.	Amount of Liability by Mines Department on Works in Progress.
1891–92.	£ s. d.	£ s. d.	£ s. d.
Roads on goldfields	14,226 5 1	8,460 0 3	11,767 9 10
Roads and tracks undertaken by County Councils, subsidised by Mines Department	3,162 0 0	1,720 18 6	4,937 10 2
Work undertaken by prospecting associations and companies, subsidised by Mines Department	1,455 5 5	336 15 9	1,663 0 0
Water-races	2,256 13 6	2,256 13 6	..
Wharves	..	..	..
Schools of Mines	1,370 19 9	1,370 19 9	..
Tracks to open up mineral lands	40 0 0	41 16 0	418 3 7
	22,511 3 9	14,187 3 9	18,786 3 7
1892–93.			
Roads on goldfields	15,199 2 4	17,325 10 0	9,628 6 10
Roads and tracks undertaken by County Councils, subsidised by Mines Department	550 0 0	1,033 0 0	4,831 9 10
Works undertaken by prospecting associations and companies, subsidised by Mines Department	970 4 9	865 4 3	1,768 0 6
Water-races	3,811 1 10	3,811 1 10	..
Wharves	..	..	..
Schools of Mines	1,232 4 4	1,232 4 4	..
Tracks to open up mineral lands	..	..	419 19 5
Artesian well-boring, Maniototo Plains	550 0 0	281 3 6	268 16 6
	22,312 13 3	24,548 3 11	16,916 3 1
SUMMARY.			
Roads on goldfields	134,287 4 2	124,646 2 0	9,628 6 10
Subsidised roads and tracks	119,034 14 8	67,535 12 0	4,831 9 10
Subsidised roads and tracks other than on goldfields	6,146 9 10	4,759 6 2	..
Prospecting	50,906 13 0	14,121 12 9	1,768 0 6
Water-races	51,575 9 11	50,468 15 1	..
Wharves*	435 15 9	185 15 9	..
Schools of Mines	15,589 11 10	15,589 11 10	..
Drainage-channels	21,401 9 3	14,885 5 3	..
Diamond drills	4,448 9 11	2,706 9 11	..
Treatment of ores	1,342 8 9	742 8 9	..
Tracks to open up mineral lands†	745 7 6	325 8 1	419 19 5
Artesian well-boring, Maniototo Plains	550 0 0	281 3 6	268 16 6
	406,463 14 7	296,347 11 1	16,916 13 1

* £154 3s. 8d. deducted on wharves, which was included in previous statements, but since cancelled.
† £444 12s. 6d. included in previous statements for Port Pegasus track has been cancelled.

During last year works were authorised to the value of £22,312 13s. 3d., as against £22,511 3s. 9d. for the previous year; the actual payments having been £24,548 3s. 11d., as against £14,187 3s. 9d. for the former year. The principal increase in the expenditure was incurred in the construction of roads; the greater portion of which were authorised under direct grants, as but few of the Goldfields County Councils were able to undertake these works under subsidy. The total liabilities on departmental works at the end of March last amounted to £16,916 13s. 1d. The total value of works authorised since the votes for works were placed under the control of the Mines Department amounts to £406,463 14s. 7d., and the actual expenditure to £296,347 11s. 1d., while local bodies and prospecting associations have contributed towards these works to the extent of about £88,368, in cash and labour. At the present time there are outstanding liabilities, incurred by local bodies and prospecting associations, amounting to £4,831 9s. 10d., on works now in progress.

There is no better way of developing the mineral wealth of the colony than by opening the country up by roads and tracks so that men can get into it to prospect. It is said by a great many that there is not the same class of prospectors now in the colony as there were in the early days when gold was first discovered. This to a certain extent must be admitted; at the same time there are plenty of men who would be willing to go out prospecting for a few months, if they had the means to support themselves. It is well-known that gold is not so easily obtained as it was in the early days, when one could pick it up on and near the surface. This being the case, it costs so much more to obtain than it did in former years, and money is not nearly so plentiful as it was in the early days of the diggings. Accordingly, men have now to look carefully before they spend a pound to see where the next pound is to come from; and in embarking in prospecting works in rough bush country, where there are no roads and tracks to the localities, where prospectors may have to carry their tools, clothing, and provisions, on their backs for miles, very little actual prospecting work can be accomplished for the labour and money expended. Time, to the miner of the present day, means earning a livelihood, and unless he can get easily into the country there is very little chance of much prospecting work being done away from the well-known centres of population.

The Hauraki Peninsula shows in a remarkable manner the extent of country in which auriferous and argentiferous lodes exist, and some parts of this peninsula have as yet hardly been trodden by the foot of man. There is no reason whatever why another goldfield as large and lasting as the Thames should not be discovered; very little prospecting has been done, except within easy distances of goldfield centres, and very few men can afford either the time or the money to go out on chance expeditions. The introduction of mining companies with large nominal capitals, very little of which being even called up, has not been a real benefit to the mining industry. These companies have purchased the ground on which the individual miner used to spend his all upon;

and in cases where a venture turns out well the dividends are, in many instances, expended in other channels than mining. The price of shares is run up, and the miner, in order to have an interest in the company, pays far more than the intrinsic value of the share. In many instances he also loses the small amount of capital of which he is possessed. These mining companies do not employ labour to prospect outside their own property. The chance of finding rich lodes in another locality has no charms for them, as it has for the individual miner. To a certain extent this is not to be wondered at, seeing that the chance of securing a moderate area of ground as a claim is very small should a rich lode be discovered by a company. The scramble for the ground would be so great that companies would have to be contented with a double area of ground for the men they had employed in prospecting at the time the discovery was made.

The discovery made by Messrs. Lowrie Brothers last year, between Waitekauri and Maratoto, tends to prove that good lodes may yet be found in the back-country of the Hauraki Peninsula, and it holds out encouragement to others to follow their example. There are numbers of lodes between this locality and the East Coast cropping out here and there that have never yet been prospected, and if gold or silver were found in any of these lodes they could not be worked until roads or tracks were constructed. Although the expenditure which has already been incurred in the construction of roads near the present goldfield centres may seem large, a much larger sum will yet have to be expended before the country is properly opened up. In the Counties of Ohinemuri, Thames, and Coromandel a great deal remains to be done; roads and tracks must be constructed before much of the country can be settled on for any industrial pursuit. Unfortunately, however, a great portion of the land is not fit for anything but mining. The auriferous belt of country stretches from Waiorongomai to Cape Colville, and although at present the land is of very little value, the time may yet come when this portion of the colony will yield abundant riches.

The whole of the land on the west coast of the Middle Island is more or less auriferous. Not only are there rich auriferous lodes, but the large deposits of gold-bearing drifts will make what is familiarly known as "the Coast" a home for the miner for many generations to come. Little or nothing is at present known of the back-country and the mineral wealth of the mountain-ranges. In proof of this, a discovery made last year by Mr. A. M. McKay, the Mining Geologist, may be mentioned. This officer, when exploring the mountain-ranges up the Arahura River, came on a large belt of cupreous schist rock. Some of the samples which he brought away with him proved, by assay at the Colonial Laboratory, to contain 10 per cent. of copper. This discovery is a long distance up the Arahura River, and would be expensive to work unless a good road, fit for wheel-traffic, were constructed. This discovery is only cited as showing the large amount of wealth there is in the mountain-chain which at the present time is nothing but an unprofitable wilderness, of no value except for the timber growing thereon; and even this, under existing circumstances, cannot be utilised.

Again, the recent discoveries near Preservation Inlet go to show that there is a probability, in the near future, of a considerable number of persons being engaged in mining in that locality. This is without doubt a portion of the country on which, without the discovery of gold or other minerals, there will never be a settled population, very little of the land being suitable for either pasture or cultivation. The bold rugged mountain-peaks, the gorges, chasms, and cliffs present a charm to the tourist, but these would be a scene of desolation to any one who was compelled to settle there, unless the land contained mineral wealth.

The yield of gold from the different fields has not been so great for the past year as it was for the previous year; the value of the produce last year being £917,467, as against £1,107,177 for the year previous. But a portion of the latter amount properly belongs to the year prior to the abolition of the gold-duty in the Middle Island, when some of the gold was held by the banks. This was shown last year to be of a value of about £81,000. Thus, instead of the deficit in the yield being £189,710 it is really only about £108,710. But the value of the gold obtained last year was £232,146 more than the value for the year 1890–91, the value of the yield for that year being £685,321. Gold-mining forms one of the largest industries in the colony, as it may be said that one-tenth of the entire population of the colony is supported by it, and indirectly, therefore, it must contribute largely to the general revenue.

In conclusion, it may be observed that the mining industry compares favourably with any other industry in the colony, and the amount contributed by that portion of the community who are supported by gold-mining tends to show that mining is an industry which increases the revenue and prosperity of the colony generally. The mining community, therefore, may fairly expect assistance towards the development of the resources of the colony, in which they are immediately interested, by the construction of roads, tracks, and other works, which will also enhance the value of the Crown lands generally. Not only is the development of mining in the back-country a direct benefit to the colony, by settling a mining population on the land, but it also enhances the value of lands in the vicinity which may be suitable for agriculture, as the mining population furnishes a ready market for the produce of the farmer.

The mining industry may, to some extent, fluctuate from time to time, but it may be considered a certainty that gold-mining will continue to prove attractive to a large proportion of our population, and will be an industry which will assume extensive proportions in future years.

Improvements will be made in gold-saving appliances; and machinery will, in the future, be more extensively used for work which is now done by hand. This will not, however, interfere with the employment of men, who, with its aid, will be enabled to execute a great deal more work than they could by the old methods in use; and ground will yet be made to pay for working which at the present time is considered to be valueless. It may in short be accepted as a fact that as mining in the past has proved to be the leading industry in the colony, and taking into consideration the large areas of metalliferous and mineral lands, it is likely to continue to be so in the future.

I have, &c.,

HENRY A. GORDON, M.A., Inst.M.E.,
Inspecting Engineer.

LIST of WORKS on GOLDFIELDS undertaken wholly by the Mines Department, or by Subsidies to County Councils, Local Bodies, and Prospecting Associations, in Progress on the 31st March, 1893.

Locality and Nature of Works.	Total Cost, or Amount authorised.	Amount of Contribution paid by Mines Department.	Amount due by Mines Department on Works still in Progress.
NORTH ISLAND.			
ROADS (SUBSIDISED).			
Bay of Islands County.	£ s. d.	£ s. d.	£ s. d.
Road from Tuamarere Railway-station to Puhipuhi Township	482 0 0	146 0 0	95 0 0
Coromandel County.			
Mercury Bay Road	1,100 0 0	495 0 0	55 0 0
Sea-beach to Kuaotunu	1,450 0 0	700 0 0	450 0 0
Kuaotunu–Coromandel Road	300 0 0	..	150 0 0
Pumpkin Flat–Just in Time Road	300 0 0	120 0 0	30 0 0
Just in Time Road extension	300 0 0	75 0 0	75 0 0
	3,450 0 0	1,390 0 0	760 0 0
Thames County.			
Thames–Tapu Road	100 0 0	..	50 0 0
Upper Tararua Road to Sylvia Mine	750 0 0	342 3 6	32 16 6
Te Papa Gully Road	100 0 0	..	50 0 0
Thames to Hikutaia Road	52 4 10	..	26 2 5
Road to Puriri Battery	100 0 0	5 16 6	44 3 6
Upper Tararua Road to Vulcan's workings	300 0 0	..	150 0 0
Waiomo to Puhoi Creek	200 0 0	16 10 0	83 10 0
Tairua track	300 0 0	..	150 0 0
	1,902 4 10	364 10 0	586 12 5
Ohinemuri County.			
Bridge over Ohinemuri River at Karangahake	550 0 0	6 5 6	543 14 6
Waitekauri Lower Road	360 0 0	166 17 0	13 3 0
Karangahake Hill Track	200 0 0	43 12 0	56 8 0
Karangahake and Waihi Road	600 0 0	28 15 0	271 5 0
	1,710 0 0	245 9 6	884 10 6
MIDDLE ISLAND.			
ROADS (SUBSIDISED).			
Waimea County.			
Baton to Karamea	100 0 0	..	50 0 0
Inangahua County.			
Globe Hill to Merrijigs	1,560 0 0	698 13 0	81 7 0
Larry's Creek to Lyell	1,080 0 0	530 17 6	9 2 6
Mangles Valley to McGregor's	1,200 0 0	300 0 0	300 0 0
Horse Terrace to Hunter's	1,280 0 0	..	640 0 0
Golden Lead to Battery	300 0 0	..	150 0 0
Cumberland machine-site	400 0 0	..	200 0 0
Boatman's *viâ* Painkiller	100 0 0	..	50 0 0
Widening Larry's Creek Road	140 0 0	..	70 0 0
Road up Burke's Creek, Little Boatman's	200 0 0	..	100 0 0
	6,260 0 0	1,529 10 6	1,600 9 6
Buller County.			
Cedar Creek Road	100 0 0	..	50 0 0
Basin to Ballarat Creek	100 0 0	..	50 0 0
County road to United Alpine	100 0 0	..	50 0 0
Track, Fairdown from North Terrace	100 0 0	..	50 0 0
	400 0 0	..	200 0 0
Grey County.			
New Rush, Cape Terrace	200 0 0	..	100 0 0
Westland County.			
New Rush, south side of Hokitika River	100 0 0	18 19 3	31 0 9
Widening Seddon's Terrace Track	150 0 0	65 10 0	9 10 0
Hillside Track, Seven-mile Creek	50 0 0	..	25 0 0
	300 0 0	84 9 3	65 10 9
Tuapeka County.			
Track to Antimony Mine	100 0 0	..	50 0 0
Lake County.			
Pembroke Flat to Nursery	240 0 0	..	120 0 0
Taieri County.			
Nenthorn Road	600 0 0	..	300 0 0

LIST of WORKS on GOLDFIELDS, &c.—*continued.*

Locality and Nature of Works.	Total Cost, or Amount authorised.	Amount of Contribution paid by Mines Department.	Amount due by Mines Department on Works still in Progress.
Southland County.	£ s. d.	£ s. d.	£ s. d.
Repairing bridges	38 13 4	..	19 6 8
TRACKS TO OPEN UP MINERAL LANDS.			
Ngakawau Foot-bridge	500 0 0	80 0 7	419 19 5
ROADS CONSTRUCTED WHOLLY BY MINES DEPARTMENT.			
Dray-road, Devil's Creek to Big River	1,750 0 0	1,617 19 0	132 1 0
Road to Charles Russell (Painkiller)	100 0 0	..	100 0 0
Oparara, through Gorge to gold-workings	150 0 0	75 0 0	75 0 0
Okira Bridge at Dirty Mary's Creek	100 0 0	50 0 0	50 0 0
Track to Diggings, Cape Foulwind	400 0 0	150 0 0	250 0 0
Lagoon Bridge	100 0 0	..	100 0 0
Extending Horse-track to Blackball Creek	500 0 0	400 0 0	100 0 0
New piles, Nelson Creek Foot-bridge	100 0 0	..	100 0 0
Widening Cape Terrace Road	100 0 0	..	100 0 0
Cedar Creek Dray-road	500 0 0	466 11 2	41 14 10
Tucker's Flat Road	264 0 0	104 0 0	160 0 0
Track at Kanieri Lake, also at McIntosh's Falls, Lake Mahinapua	100 0 0	..	100 0 0
Dray-road, Dillman's to Larrikin's	130 0 0	..	130 0 0
Extension of road, Rimu to Shallow Rush	150 0 0	..	150 0 0
Gillam's Gully Track	150 0 0	..	150 0 0
Deviation, Pleasant Creek Track	130 0 0	..	130 0 0
McKay's Creek, Kokatahi, Track	100 0 0	..	100 0 0
Wakamarina Forks to Wairau Valley	150 0 0	..	150 0 0
Tereohanga Gorge to Puhipuhi	800 0 0	702 7 0	97 13 0
Cabbage Bay to Port Charles	360 0 0	200 0 0	160 0 0
Tiki to Mahikarau	250 0 0	210 0 0	40 0 0
Puriri to east side of range	300 0 0	..	300 0 0
Aorere Valley to Karamea and Mokihinui	29,620 17 3	28,202 5 11	1,760 0 0
Hampden to Horse Terrace	2,850 0 0	1,965 15 0	884 5 0
Repairs to Nile Bridge	800 0 0	701 12 0	98 8 0
Hatter's Terrace to Haupiri	800 0 0	600 0 0	200 0 0
Grey River to Moonlight	300 0 0	..	300 0 0
Black Ball Track	250 0 0	..	250 0 0
Great South Road	2,702 16 3	2,702 16 3	..
Cascade to Barn Bay Road	443 0 0	411 7 0	31 13 0
Piers, Victoria Bridge	725 0 0	..	362 10 0
Arrowtown to Macetown	450 0 0	300 0 0	150 0 0
Waiau to Preservation Inlet	3,726 9 1	2,126 9 1	1,600 0 0
Tracks to Western Sounds	4,171 16 8	3,618 18 8	552 18 0
Tracks to Stewart Island	200 0 0	37 16 0	162 4 0
Repairs to decking, Tapu Wharf	10 0 0	..	10 0 0
Mahakipawa to Waikakaho	150 0 0	..	150 0 0
Miller's Flat to Skipper's Road	400 0 0	..	400 0 0
	54,283 19 3	44,642 17 1	9,628 6 10
SCHOOLS OF MINES.			
Schools of Mines	11,839 11 10	11,839 11 10	..
School of Mines (Otago University)	3,750 0 0	3,750 0 0	..
	15,589 11 10	15,589 11 10	..
PROSPECTING SUBSIDIES.			
Kapanga Gold-mining Company (Limited)	20,000 0 0	337 0 0	663 0 0
Ohinemuri County	100 0 0	6 0 0	94 0 0
Westland County	89 5 1	89 5 1	..
Boy's Tunnel, Blue Spur	80 0 0	54 12 3	25 7 9
John Halligan and party	300 0 0	8 17 6	291 2 6
Due-north Tail-race	190 10 0	..	190 10 0
Frying-pan Tail-race	109 10 0	33 18 0	75 12 0
Totara Miners' Association Low-level Tunnel, Donnelly's Creek	300 0 0	137 2 6	162 17 6
Extension, Low-level Tunnel, Boatman's	150 0 0	137 7 11	12 12 1
Mr. Olderog, Arahura	4 19 0	4 19 0	..
Mr. G. Rebay, Arahura	13 17 6	13 17 6	..
Hyndman and party, Callaghan's Flat	141 5 0	141 5 0	..
Deep-level Prospecting Committee, Dillmanstown ..	274 14 11	274 14 11	..
Owharoa Tunnel	62 10 0	14 1 4	48 8 8
Gillam's Gully	69 10 0	15 0 0	54 10 0
Boatman's Tailing Company, to erect plant	150 0 0	..	150 0 0
	22,036 1 6	1,268 1 0	1,768 0 6
WATER-RACES.			
Waimea–Kumara Water-race	20,144 0 3	20,144 0 3	..
Mount Ida Water-race	5,649 19 6	5,649 19 6	..
Mikonui Water-race	14,279 16 4	14,279 16 4	..
Contingencies	659 12 8	659 12 8	..
	40,733 8 9	40,733 8 9	..
Artesian well-boring, Maniototo Plains	550 0 0	281 3 6	268 16 6

Summary of Works.

Locality and Nature of Works.	Total Cost, or Amount authorised.	Amount of Contribution paid by Mines Department.	Amount due by Mines Department on Works still in Progress.
Roads (subsidised)—	£ s. d.	£ s. d.	£ s. d.
Bay of Islands County	482 0 0	146 0 0	95 0 0
Coromandel County	3,450 0 0	1,390 0 0	760 0 0
Thames County	1,902 4 10	364 10 0	586 12 5
Ohinemuri County	1,710 0 0	245 9 6	884 10 6
Waimea County	100 0 0	..	50 0 0
Inangahua County	6,260 0 0	1,529 10 6	1,600 9 6
Buller County	400 0 0	..	200 0 0
Grey County	200 0 0	..	100 0 0
Westland County	300 0 0	84 9 3	65 10 9
Lake County	240 0 0	..	120 0 0
Tuapeka County	100 0 0	..	50 0 0
Taieri County	600 0 0	..	300 0 0
Southland County	38 13 4	..	19 6 8
	15,782 18 2	3,759 19 3	4,831 9 10
Roads constructed wholly by Mines Department	54,283 19 3	44,642 17 1	9,628 6 10
Schools of Mines	15,589 11 10	15,589 11 10	..
Prospecting subsidies	22,036 1 6	1,268 1 0	1,768 0 6
Tracks to open up mineral lands	500 0 0	80 0 7	419 19 5
Water-races	40,733 8 9	40,733 8 9	..
Artesian well-boring, Maniototo Plains	550 0 0	281 3 6	268 16 6
	149,475 19 6	106,355 2 0	16,916 13 1

LIST of WORKS on GOLDFIELDS constructed wholly by the Mines Department, or by Subsidies to County Councils, Local Bodies, and Prospecting Associations, and completed prior to the 31st March, 1893.

Locality and Nature of Works.	Total Cost.	Amount of Contribution paid by Mines Department.
NORTH ISLAND.		
ROADS (SUBSIDISED).		
Bay of Islands County.	£ s. d.	£ s. d.
Tiriwhanga Gorge to Galbraith's Road, Puhipuhi	237 0 0	118 10 0
Air-line Road to battery-site, Puhipuhi	73 0 0	36 10 0
	310 0 0	155 0 0
Coromandel County.		
Improving road to Iona and Just in Time Companies' Mines	200 0 0	133 6 8
Making and improving track from Tokatea towards Kennedy Bay	320 0 0	213 6 8
Golden Belt Track	100 0 0	50 0 0
Tokatea Road (repairs)	300 0 0	150 0 0
Making and improving track from Golden Belt to Tiki	239 3 3	159 8 10
Making road from Ring's Bridge to Kapanga Mine	150 0 0	100 0 0
Making road to Kapanga Mine	132 0 0	88 0 0
Temporary track from Tokatea Saddle to Waikoromiko	50 0 0	33 6 8
Continuation of track from Success Company's Mine to top of main range	80 0 0	53 6 8
Completion of road from Tokatea Saddle to Tokatea Battery	50 0 0	33 6 8
Widening road from Matawai to Vaughan's Claim	357 0 0	238 0 0
Improving track, Mercury Bay to Waitai	100 0 0	66 13 4
Continuation and improving Waikoromiko Track	150 0 0	100 0 0
Emily Battery to Rocky Creek	60 0 0	40 0 0
Track, Bismarck Battery to Kennedy Bay	200 0 0	133 6 8
Road up Manaia	675 10 6	450 7 0
Extension of Vaughan's and Vizard's Tracks	150 0 0	100 0 0
Vizard's towards Marebel	200 0 0	133 6 8
Extending and widening Waitaia Road	100 0 0	66 13 4
Makarau to Waiau	1,600 0 0	1,066 13 4
Waikawau to Tiki	500 0 0	333 6 8
Paul's Creek to Cabbage Bay	200 0 0	133 6 8
Waikawau Creek Track	100 0 0	50 0 0
McLaughlin's Road	100 0 0	50 0 0
Manaia to McGregor's new find	100 0 0	50 0 0
Manaia to Tiki	500 0 0	250 0 0
Old saw-mill towards Matawai	200 0 0	100 0 0
Extension of Paul's Creek Track	300 0 0	150 0 0
Matarangi Track	400 0 0	200 0 0
Thames–Coromandel Road, *viâ* Manaia	300 0 0	150 0 0
Harbour View extension	210 0 0	105 0 0
Kapanga to Paul's Creek	200 0 0	100 0 0
Mercury Bay to Kuaotunu	360 0 0	180 0 0
Wainara to Kuaotunu	450 0 0	225 0 0
	9,133 13 9	5,485 15 10

LIST of WORKS on GOLDFIELDS, &c.—*continued.*

Locality and Nature of Works.	Total Cost.	Amount of Contribution paid by Mines Department.
Thames County.	£ s. d.	£ s. d.
Making new road from Ohinemuri River to Karangahake Quartz-mine	650 0 0	433 6 8
Dray-road to connect Otanui Mines with crushing-battery at Maungawherawhera Creek	710 0 0	473 6 8
Improving roads from Waitekauri Road to Katikati Road	250 0 0	166 13 4
Improving road up Karaka Creek to Lucky Hit Company's Mine	263 1 0	175 7 4
Improving road to upper mines, Waitahi	258 18 10	172 12 7
Karangahake to battery	300 0 0	200 0 0
Ralph's Battery, Waitekauri	399 1 0	199 10 6
Otanui Road to mines	299 18 0	199 18 8
Road to Wick's Battery	70 0 0	46 13 4
Rocky Point Road, Tararu	300 0 0	200 0 0
Thames Borough boundary to hæmatite-mine	350 0 0	233 6 8
Widening road from bridge over Hape Creek to Otanui Mines	183 17 0	122 11 4
Track, Karangahake Goldfield	784 1 0	522 14 0
Kauaeranga Valley to Otanui	470 7 0	313 11 4
Tapu Road to mines	81 17 9	54 11 10
Tauranga Road to Karangahake Bridge-site	341 5 0	227 10 0
Karangahake Bridge	229 6 6	152 17 8
Track up Maungakerikeri Creek	93 4 4	62 2 11
Thames Borough boundary to Hape Creek No. 2	600 0 0	300 0 0
Upper Karaka Road	179 13 0	119 15 4
Repairing flood-damages, Waiotahi, Moanataiari, Karaka, and Collarbone Roads	350 0 0	175 0 0
Sea-beach to Waiomo	750 0 0	375 0 0
Te Papa Gully Road	75 0 0	37 10 0
New Find to Waiomo Battery	110 0 0	55 0 0
Rocky Point Road	429 11 10	214 15 11
Waiotahi towards Mercury Bay	522 11 0	261 5 6
Te Mata Road	178 17 6	89 8 9
Waiomo Creek to Tapu	1,499 0 0	749 10 0
Alabama Creek Track	100 0 0	50 0 0
Road from Prospectors' Mine, Puriri, to battery	50 0 0	25 0 0
Karaka Creek to Lucky Hit	365 0 0	182 10 0
Bullion Mine, Tapu, to battery	36 5 0	18 2 6
Track to Hikutaia Goldfield	147 15 2	73 17 7
	11,428 10 11	6,683 10 5
Ohinemuri County.		
Jubilee Mine Track	118 0 0	59 0 0
Track up Tui Creek	306 0 0	153 0 0
Prospecting-track, Whangamata and Waitekauri	200 0 0	166 13 4
Tramway, Karangahake to Railey's reduction-works	400 0 0	200 0 0
Strengthening bridges, Waihi Road	200 0 0	133 6 8
Paeroa to Hikutaia	400 0 0	200 0 0
Repairs, flood-damages	34 13 8	17 6 10
Hikutaia River to Maratoto Mine	180 15 0	90 7 6
Karangahake through Gorge (bridge and culverts)	200 0 0	100 0 0
	2,039 8 8	1,119 14 4
Piako County.		
Extension and completion of Te Aroha Tramway	18,000 0 0	12,000 0 0
Tramway to Fergusson's Battery, Waiorongomai	1,500 0 0	1,000 0 0
Road, Waiorongomai	497 17 0	331 18 0
Track to claims at Buck's Reef	55 5 6	36 17 0
Track, Fern Spur to Butler's Spur	231 17 9	154 11 10
Tracks up Stony Creek, Te Aroha Goldfield, &c.	54 0 0	36 0 0
	20,339 0 3	13,559 6 10
Hutt County.		
Road to connect Otorongo Bay with Albion Company's Battery, also to connect Terawhiti Quartz-mine with battery	509 16 6	210 17 0
Road, Makara Junction to Terawhiti	450 0 0	225 9 0
	959 16 6	435 17 0
SOUTH ISLAND.		
ROADS (SUBSIDISED).		
Marlborough County.		
Track, Deep Creek to Dead Horse Creek	68 0 0	45 6 8
Mouth of Gorge to Forks, Cullensville to Mahakipawa Diggings	450 0 0	225 0 0
Formation of road at Cullensville, Mahakipawa	217 4 0	108 12 0
	735 4 0	378 18 8
Waimea County.		
Road to open up Table Diggings	260 0 0	130 0 0
Punt over Motueka River	100 0 0	50 0 0
Repairing Baton to Table-land Track	40 0 0	20 0 0
Dove River to Baton Saddle, and from Rolling River to Wangapeka Saddle	120 0 0	60 0 0
	520 0 0	260 0 0

LIST of WORKS on GOLDFIELDS, &c.—*continued.*

Locality and Nature of Works.	Total Cost.	Amount of Contribution paid by Mines Department.
	£ s. d.	£ s. d.
Collingwood County.		
Road, West Wanganui	300 0 0	200 0 0
Bridge over Aorere River	173 14 0	115 16 0
Extending Anatoki Bridle-track	160 0 0	80 0 0
	633 14 0	395 16 0
Buller County.		
Deviation of road from Candlelight Flat to Deep Creek, Charleston	370 0 0	246 13 4
Road from Orowaiti Lagoon to North Terrace	256 18 6	171 5 8
Prospecting-track from Razorback to Paparoa Range	100 0 0	66 13 4
Track from Seatonville to Larrikin's	438 9 6	292 6 4
Waimangaroa to Denniston	787 0 0	393 10 0
Road to connect alluvial workings with Charleston Road	400 0 0	266 13 4
Track, Four-mile Creek towards Grey Valley	300 0 0	200 0 0
Road to connect alluvial diggings north of Deadman's Creek	278 0 0	185 6 8
Ngakawau to Mokihinui, *viâ* beaches	100 0 0	66 13 4
Road to connect Ngakawau Railway with Mokihinui Coal Company's workings	193 0 0	128 13 4
Lyell Bluff to Victor Emmanuel Claim	650 0 0	433 6 8
Beach, Little Wanganui to Mokihinui	300 0 0	100 0 0
Cape Foulwind Road	450 0 0	300 0 0
Road up Nile Valley	56 16 4	28 8 2
Denniston extension	850 0 0	425 0 0
Promised Land towards Motueka	380 0 0	190 0 0
Road over Gentle Annie	200 0 0	100 0 0
Extension, Lyell Creek to Low-level Tunnel	60 0 0	30 0 0
Extension of track 50 chains south of Brighton	140 0 0	70 0 0
Continuation of road, Deadman's Creek	437 17 0	218 18 6
Ngakawau Railway-station to Mokihinui	50 0 0	25 0 0
Addison's Flat towards ranges	20 0 0	10 0 0
North Terrace to Oparara Diggings	500 0 0	333 6 8
Extension of Croninville Road	100 0 0	50 0 0
Waimangaroa to sea-beach	80 0 0	40 0 0
Extension of track, Oparara to Fenian Creek	100 0 0	50 0 0
Con's Creek to Beaconsfield	80 0 0	40 0 0
Addison's Flat to Caroline Terrace	200 0 0	100 0 0
Waimangaroa to sea-beach extension	390 0 0	195 0 0
	8,268 1 4	4,756 15 4
Inangahua County.		
Dray-road from Soldier's Creek to Devil's Creek	647 0 0	431 6 8
Dray-road from Inangahua to Rainy Creek Battery	900 10 0	606 6 8
Dray-road from Capleston up Little Boatman's Creek	379 0 0	252 13 4
Dray-road from Capleston up Main Boatman's Creek	697 0 0	464 13 4
Dray-road from Westport Road to Inangahua River	224 5 0	149 10 0
Track from Devil's Creek to Big River	134 3 6	89 9 0
Track from Waitahu River to Capleston	358 0 0	238 13 4
Survey and expenses	250 0 0	166 13 4
Track from Cariboo to Big River	728 0 0	364 0 0
Dray-road up Murray Creek to United Inglewood Claim	3,472 0 0	2,314 17 4
Road from Reefton to Big River, *viâ* Devil's Creek	614 0 0	307 0 0
Road up Big River	922 19 0	615 6 0
Continuation of dray-road up Little Boatman's Creek	169 7 6	112 18 4
Road from Capleston to Larry's Creek	640 0 0	426 13 4
Track to connect Capleston with Lone Star	75 0 0	50 0 0
Crushington to Globe Company's workings	403 0 0	201 10 0
Snowy Creek Track	85 15 0	42 17 6
Reefton to Big River	1,792 0 0	1,194 13 4
Glenroy to Horse Terrace	254 0 0	122 10 0
Devil's Creek to Globe Hill	917 6 2	458 13 1
	13,672 6 2	8,610 4 7
Grey County.		
Road from Notown to Deep Creek	1,100 0 0	550 0 0
Road from Langdon's to Moonlight	1,600 0 0	800 0 0
Contribution from goldfields vote towards main road	2,296 6 6	2,296 6 6
Track, Waipuna to Clarke's River	1,200 0 0	800 0 0
Track, Cameron's to Cape Terrace	700 0 0	466 13 4
Road, Limestone to Maori Creek	800 0 0	533 6 8
Red Jack's to Nelson Creek	601 17 6	401 5 0
Barrytown to Deadman's	2,240 0 0	1,493 6 8
German Gully to Arnold's Flat	120 0 0	60 0 0
Baird's Terrace to Lake Brunner	400 0 0	200 0 0
Hatter's Terrace Road	1,000 0 0	500 0 0
Irishman's to Lake Brunner	2,400 0 0	1,200 0 0
Hatter's Terrace	600 0 0	400 0 0
Track, Baird's Terrace to Irishman's	250 0 0	125 0 0
Deep Creek to Bell Hill	1,331 0 0	665 10 0
Track to Blackball Diggings	790 0 0	395 0 0
	17,429 4 0	10,886 8 2

LIST of WORKS on GOLDFIELDS, &c.—*continued.*

Locality and Nature of Works.	Total Cost.	Amount of Contribution paid by Mines Department.
	£ s. d.	£ s. d.
Westland County.		
Improving track, Butcher's Creek to Gentle Annie Terrace	225 10 0	163 13 4
Bridle-track to Kanieri Lake	719 11 0	350 5 6
Bridle-track to Eel Creek	168 9 0	84 4 6
Tunnel-track, Galway Beach to Gillespie's Beach	437 5 0	218 12 6
Road from Duffer's Creek, Greenstone Road, to fifteen-mile peg, Christchurch Road	726 9 0	480 4 6
Continuation of track, Back Creek to Eel Creek	249 4 0	166 3 4
Bridle-track, Duffer's Creek, Bowen and Okarito Road, to sea-beach	333 18 0	222 12 0
Ross Borough boundary to Mount Greenland	1,280 15 0	853 16 8
Track, Kanieri Lake to Humphrey's Gully	279 2 0	186 1 4
Track, Larrikin's to Loop-line Dam	449 11 0	299 14 0
Rough Wainihinihini to Upper Dam	450 0 0	300 0 0
Browning's Pass to Reefs	3,311 6 0	2,207 10 8
Okarito Forks to Teal Creek	600 0 0	400 0 0
Road, Christchurch to Baldhill Range reefs	500 0 0	250 0 0
Extension of Tucker's Flat Road to New Rush	170 19 6	85 9 9
Hokitika Borough boundary (Reefton) to Shotover Rush	120 0 0	60 0 0
Track to New Rush, Back Creek	100 0 0	50 0 0
Repairing old track round Wataroa Bluff	50 0 0	25 0 0
	10,171 19 6	6,412 8 1
Taieri County.		
Mullocky Gully to Silver Peak	499 15 0	333 3 4
Lake County.		
Track, Skipper's to Phœnix and Scandinavian Reefs	292 2 3	194 14 10
Track to connect scheelite-mine with Lake Wakatipu	225 0 0	150 0 0
Arrowtown to Macetown, construction	225 0 0	150 0 0
Arrowtown to Macetown, maintenance	150 0 0	100 0 0
Invincible Quartz-reef Track, Rees River	300 0 0	200 0 0
Rees Valley to company's workings	61 7 6	30 13 9
Pack-track, Criffel Diggings	50 6 6	33 11 0
Left-hand Branch Road, Skipper's	63 9 10	31 14 11
Old Morven Ferry Road	289 0 0	144 10 0
	1,656 6 1	1,035 4 6
Tuapeka County.		
Making road from top of Terrace to Waipori Bush	300 0 0	200 0 0
Road, Beaumont to Remarkable Bush	300 0 0	200 0 0
Improving road from Waipori Township to antimony-mines, Lammerlaw Ranges	200 0 0	133 6 8
Waipori Township to Waipori Bush	200 0 0	133 6 8
Clutha River to Campbell's	76 9 0	50 19 4
Waitahuna to copper-mine	200 0 0	133 6 8
Road to open up quarry for Waitahuna Bridge	160 9 10	106 19 11
Waipori Road, *vid* Bungtown	566 8 10	283 4 5
	2,003 7 8	1,241 3 8
Wallace County.		
Track, Colac Bay to Round Hill	200 0 0	133 6 8
Pack-track to Round Hill, Colac, and Orepuki	1,050 0 0	500 0 0
	1,250 0 0	633 6 8
Maniototo County.		
Road to Serpentine Diggings	136 10 0	91 0 0
Pig and Whistle to Clarke's Diggings	200 0 0	133 6 8
Shepherd's Hut Flat to Vinegar Hill	100 0 0	66 13 4
Kyeburn Peninsula to main road	82 0 0	41 0 0
	518 10 0	332 0 0
Fiord County.		
Dusky Sound, tracks	300 0 0	200 0 0
Waitaki County.		
Road, Naseby to Livingstone	41 12 0	20 16 0
Southland County.		
Improving tracks from Mataura to Nokomai	75 0 0	50 0 0
Improving road, Waikaka to Leatham	150 0 0	100 0 0
Improving road from Waikaka Township to Leatham Creek	30 0 0	20 0 0
Improving road from Waikaka to Waikaka railway-siding	150 0 0	100 0 0
Widening and improving bush-track to Waikawa	150 0 0	100 0 0
Waikaia to Whitcombe	150 0 0	100 0 0
Waikaka to Switzer's	150 0 0	100 0 0
Road near Waikaka Township	150 0 0	100 0 0
Waikaia to Whitcombe	161 6 8	80 13 4
Waipapa to Six-mile Beach	175 0 0	87 10 0
	1,341 6 8	838 3 4

LIST of WORKS on GOLDFIELDS, &c.—*continued.*

Locality and Nature of Works.	Total Cost.	Amount of Contribution paid by Mines Department.
DIAMOND AND OTHER DRILLS.	£ s. d.	£ s. d.
Inangahua County Council (diamond)	2,000 0 0	1,000 0 0
Springfield Colliery Company (diamond)	1,250 0 0	625 0 0
Westland County Council (tiffin)	350 0 0	233 0 0
Diamond drills for prospecting purposes	848 9 11	848 9 11
	4,448 9 11	2,706 9 11
WHARVES.		
Repairs to wharf, Coromandel	300 0 0	150 0 0
Anikiwi Jetty, Marlborough	135 15 9	135 15 9
	435 15 9	285 15 9
AIDS TO PROSPECTING.		
Construction of low-level tunnel, Terawhiti	750 0 0	150 0 0
Queen of Beauty Company, prospecting deep levels	300 0 0	150 0 0
Caledonian Low-level Company, prospecting deep levels	300 0 0	150 0 0
Red Hill Gold-mining Company, prospecting deep levels	600 0 0	300 0 0
Caledonian Low-level Company, low-level tunnel	2,700 0 0	300 0 0
Lyell Creek Extended Company, low-level tunnel	300 0 0	150 0 0
New Cromwell Gold-mining Company	250 0 0	100 0 0
Deep-level Association, Waipori	450 0 0	300 0 0
Little Boatman's deep-level tunnel	600 0 0	300 0 0
Oterongia Prospecting Association	198 17 2	99 8 7
Vincent County	137 9 0	68 14 6
Tapanui Prospecting Association	25 0 0	12 10 0
Tuapeka County	12 0 0	6 0 0
Maniototo County	500 0 0	250 0 0
Pullar, Shelmerdine, and Basan	400 0 0	200 0 0
Royal Oak Association	300 0 0	150 0 0
Star of the East Quartz-mining Company	150 0 0	75 0 0
West Coast Prospecting Association	300 0 0	150 0 0
McBride and party	169 2 2	84 11 1
McLean and party	66 0 0	33 0 0
Deep-level Tunnel, Tokatea	700 0 0	350 0 0
Deep-level Tunnel, Owharoa	300 8 0	200 5 4
Deep-level Tunnel, Tapu	1,200 0 0	600 0 0
Deep-level Tunnel, Cedar Creek	1,207 10 0	603 15 0
Manuka Flat Prospecting Association	200 0 0	100 0 0
Red Hill Minerals Company	437 19 10	218 19 11
Tuapeka Prospecting Association	277 0 0	138 10 0
Cardrona Prospecting Association	800 0 0	400 0 0
Cromwell Prospecting Association	500 0 0	250 0 0
Coromandel County	550 0 0	275 0 0
Thames County	309 18 0	154 19 0
Thames Borough	200 0 0	100 0 0
Buller County	146 12 6	73 6 3
Inangahua County	488 7 0	244 3 6
Westland County	1,236 19 4	618 9 8
Grey County	871 15 2	435 17 7
Deep-level Prospecting Association, Waipori	432 9 8	216 4 10
Waipu Prospecting Association	180 0 0	90 0 0
Hokianga County	100 0 0	50 0 0
Vulcan Smelting Works, Onehunga	30 0 0	15 0 0
Ohinemuri County	100 0 0	50 0 0
Waitaki County	29 5 0	14 12 6
Waihemo County	85 9 0	42 14 6
William Fox and party	711 1 8	355 10 10
Kirk and party	176 0 10	88 4 11
Hodge and party	98 13 8	49 6 10
Carey and Hyndman	441 9 4	220 14 8
Don, Boyce, and party	107 16 0	53 18 0
Quentin McKinnon	58 10 0	29 5 0
Bullion Mine, Deep-level Tunnel	300 0 0	150 0 0
Sutherland and party	30 0 0	15 0 0
Inangahua Low-level Tunnel	6,966 0 0	3,000 0 0
Deep-level Tunnel, Manaia	451 4 0	225 12 0
Waimea Miners' Association, prospecting at Callaghan's	50 0 0	50 0 0
Totara Miners' Association, Ross	51 3 6	51 3 6
Antonio Zala	4 10 0	4 10 0
Ross, Cunningham, and another	9 0 0	9 0 0
Wm. Thompson, stores from Benmore Station	2 1 10	2 1 10
Totara Miners' Association, Ross	8 6 6	8 6 6
Harris, Davidson, and party	27 7 6	27 7 6
Contingencies	484 15 10	242 7 11
	28,870 11 6	12,853 11 9
WATER-RACES.		
Water-main, Bull's Battery	350 0 0	100 0 0
Round Hill Water-race	200 19 0	133 19 4
Tomkiss's Water-race	100 0 0	100 0 0
Cardrona Sludge-channel	100 0 0	50 0 0
New water-mains, Thames Water-race	1,479 10 4	739 15 2
Argyle Water-race	7,653 15 1	7,653 15 1
Nelson Creek	957 16 9	957 16 9
	10,842 1 2	9,735 6 4

LIST of WORKS on GOLDFIELDS, &c.—*continued.*

Locality and Nature of Works.	Total Cost.			Amount of Contribution paid by Mines Department.		
DRAINAGE- AND SLUDGE-CHANNELS.	£	s.	d.	£	s.	d.
Drainage-channel, Lawrence (total cost, approximate)	3,000	0	0	2,000	0	0
Subsidy towards purchase of Messrs. Laidlaw and Crawford's freehold in Spotti's Creek, to allow tailings to be deposited (Tinker's Diggings)	500	0	0	400	0	0
Damage by floods, Thames	1,000	0	0	500	0	0
Sludge-channel, Smith's Gully, Bannockburn	1,000	0	0	251	1	0
Round Hill Sludge-channel survey	52	19	7	52	19	7
Compensation to J. Costello, damage done by tailings	788	0	0	788	0	0
Long Gully Sludge-channel	150	0	0	100	0	0
New Pipeclay Gully Sludge-channel	1,547	18	0	773	19	0
Kumara Sludge-channel, No. 2	2,762	17	2	2,762	17	2
Ophir Tail-race	2,300	0	0	1,150	0	0
Lawrence Drainage-channel	1,150	0	0	956	14	0
Muddy Creek Channel	2,000	0	0	1,000	0	0
St. Bathan's Channel	2,000	0	0	1,000	0	0
Tailings-outlet, Maerewhenua	1,595	4	0	1,595	4	0
Ross Sludge- and Storm-water-channel	1,554	10	6	1,554	10	6
	21,401	9	3	14,885	5	3
AID TOWARDS THE TREATMENT OF ORES.						
Testing-plant, School of Mines, Thames	1,200	0	0	600	0	0
Testing minerals, Dunedin Exhibition	142	8	9	142	8	9
	1,342	8	9	742	8	9
ROADS WHOLLY CONSTRUCTED BY MINES DEPARTMENT.						
Construction of road, Arrowtown to Macetown	9,270	6	8	9,270	6	8
Road to open up Woodstock Goldfield	1,000	0	0	1,000	0	0
Ahaura to Amuri	2,504	19	7	2,504	19	7
Waikaia Bush Road	1,000	0	0	1,000	0	0
Waitahuna Bridge	750	0	0	750	0	0
Merrivale, tracks	500	0	0	500	0	0
Mokihinui to Specimen Creek	1,238	7	5	1,238	7	5
Wilberforce Quartz-reef Road	1,830	17	7	1,830	17	7
Opening Mokau River	552	8	0	552	8	0
Lyell to Mokihinui	5,098	8	6	5,098	8	6
Brighton to Seventeen-mile Beach	1,789	7	2	1,789	7	2
Whangapeka to Karamea	2,000	0	0	2,000	0	0
Hatter's Terrace to Bell Hill	500	0	0	500	0	0
Cedar Creek Road	3,000	0	0	3,000	0	0
Owen Valley Road	2,208	9	2	2,208	9	2
Cobden to Seventeen-mile Beach	3,036	1	4	3,036	1	4
Cedar Creek Road	1,500	0	0	1,500	0	0
Bridle-track to Upper Anatoki	722	8	0	722	8	0
Whangamata Road	141	10	6	141	10	6
Waikawau to Manaia	1,000	0	0	1,000	0	0
Karangahake through Gorge	1,000	0	0	1,000	0	0
Arthur's Point to Skipper's	12,167	4	1	12,167	4	1
Tracks to Coal Island	54	6	3	54	6	3
Grey Valley to Teremakau	900	0	0	900	0	0
Rimu to New Rush	829	17	9	829	17	9
Kuaotunu–Coromandel Road	500	0	0	500	0	0
Tapu to Waikawau	750	10	0	750	10	0
Puhipuhi Road	1,396	17	9	1,396	17	9
Jackson's Bay to Cascade and Gorge River district	5,310	10	11	5,310	10	11
Improving roads and tracks, Collingwood to Takaka and Motueka	10,905	8	11	10,905	8	11
Tramway from New Find to Waitekauri	100	0	0	100	0	0
Havelock-Mahakipawa Dray-road	1,311	9	0	1,311	9	0
Mokihinui to Wanganui	200	0	0	200	0	0
Burnett's Face to Coalbrookdale	200	0	0	200	0	0
Deadman's to Christmas Terrace	20	0	0	20	0	0
Low-level Alpine Claim, Lyell	80	0	0	80	0	0
Bowen Road to Salt-water Beach	60	0	0	60	0	0
Repairing damage done by floods, Westland County	100	0	0	100	0	0
Deviation of road at Kanieri Forks	140	0	0	140	0	0
Road up Dark River	200	0	0	200	0	0
Coromandel to Kuaotunu	200	0	0	200	0	0
Kuaotunu to Mercury Bay	350	0	0	350	0	0
Thames to Manaia	500	0	0	500	0	0
Cobden to Seventeen-mile Beach	400	0	0	400	0	0
Bridge over Mahinapua Creek	503	16	10	503	16	10
Garston to Nevis	1,565	17	2	1,565	17	2
Track up Waiho River	105	0	0	105	0	0
Haast Ferry to Glue-pot	126	0	0	126	0	0
Contingencies	383	2	4	383	2	4
	80,003	4	11	80,003	4	11

LIST of WORKS on GOLDFIELDS—*continued.*

Locality and Nature of Works.	Total Cost.	Amount of Contribution paid by Mines Department.
ROADS TO OPEN UP MINES OTHER THAN GOLD.	£ s. d.	£ s. d.
Aniseed Valley to Champion Copper-mine	4,963 10 6	4,116 10 6
Richmond Hill to copper-mine	315 16 0	209 4 0
Track, Ohinemuri Coal-seam	267 3 4	133 11 8
Road, Kanieri Coalfield	600 0 0	300 0 0
	6,146 9 10	4,759 6 2
TRACKS TO OPEN UP MINERAL LANDS.		
Glory Harbour to Kopack	50 0 0	50 0 0
Port Pegasus Track	155 7 6	155 7 6
Removing snags and felling timber, Mokau River	40 0 0	40 0 0
	245 7 6	245 7 6

Summary of Works.

	£ s. d.	£ s. d.
Roads (subsidised)—		
Bay of Islands County	310 0 0	155 0 0
Coromandel County	9,133 13 9	5,485 15 10
Thames County	11,428 10 11	6,683 10 5
Ohinemuri County	2,039 8 8	1,119 14 4
Piako County	20,339 0 3	13,559 6 10
Hutt County	959 16 6	435 17 0
Marlborough County	735 4 0	378 18 8
Waimea County	520 0 0	260 0 0
Collingwood County	633 14 0	395 16 0
Buller County	8,268 1 4	4,756 15 4
Inangahua County	13,672 6 2	8,610 4 7
Grey County	17,429 4 0	10,886 8 2
Westland County	10,171 19 6	6,412 8 1
Taieri County	499 15 0	333 3 4
Lake County	1,656 6 1	1,035 4 6
Tuapeka County	2,003 7 8	1,243 3 8
Wallace County	1,250 0 0	633 6 8
Maniototo County	518 10 0	332 0 0
Fiord County	300 0 0	200 0 0
Waitaki County	41 12 0	20 16 0
Southland County	1,341 6 8	838 3 4
	103,251 16 6	63,775 12 9
Diamond and other drills	4,448 9 11	2,706 9 11
Wharves	435 15 9	285 15 9
Aids to prospecting	28,870 11 6	12,853 11 9
Water-races	10,842 1 2	9,735 6 4
Drainage- and sludge-channels	21,401 9 3	14,885 5 3
Aid towards treatment of ores	1,342 8 9	742 8 9
Roads wholly constructed by Mines Department	80,003 4 11	80,003 4 11
Roads to open up mines other than gold	6,146 9 10	4,759 6 2
Tracks to open up mineral lands	245 7 6	245 7 6
	256,987 15 1	189,992 9 1

HENRY A. GORDON, M.A.Inst.M.E.,
Inspecting Engineer.

RETURN showing the VALUE of the SALES of WATER, and EXPENDITURE on, and COLLATERAL ADVANTAGES derived from, the Working of the WATER-RACES constructed and maintained by GOVERNMENT, during the Year ending 31st March, 1893.

Name of Water-race.	Value of Sales of Water and Channel-fees.	Expenditure on Maintenance.	Profit or Loss.	Cost of Construction.	Total Cost of Construction.	Percentage on Capital invested.	Average Number of Men employed.	Approximate Amount of Gold obtained.	Value of Gold obtained.	Average Weekly Earnings of Men after deducting Value of Sales of Water and Channel-fees.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.			Oz.	£ s. d.	£ s. d.
Waimea	1,015 12 3	858 0 4	157 11 11*	128,558 12 3		⅛	66	2,499	9,746 2 0	2 10 10
Kumara	5,789 0 9	1,782 11 0	4,006 9 9*	40,425 11 11	190,949 2 4	10	147	8,648	33,724 4 0	3 13 1
Kumara Sludge-channel	..	404 13 0	404 13 0†	21,964 18 2		..	..	..	..	..
Nelson Creek	213 0 0	292 6 6	79 6 6†	..	90,722 10 8	..	23	245	980 0 0	1 19 2
Argyle	..	..	..	..	..	..	..	..	..	..
Mikonui	..	..	..	..	25,927 4 6	..	..	..	..	..
Mount Ida	104 16 8	141 12 4	36 15 8†	67,006 9 7	67,006 9 7	..	130	342	1,316 14 0	1 17 5
Totals	7,122 9 8	3,479 3 2	3,643 6 6*	257,955 11 11	374,605 7 1	..	366	11,734	45,767 0 0	..

* Profit. † Loss.

HENRY A. GORDON, M.A.Inst.M.E., Inspecting Engineer.

APPENDICES.

APPENDIX I.

WARDEN REPORTS.

No. 1.

Mr. Warden RUSH, to the UNDER-SECRETARY of MINES, Wellington.

SIR,— Resident Magistrate's Office, Auckland, May 27rd, 1893.

I have the honor to report that little or no work of a practical nature has been done in the Puhipuhi Mining District during the last year. No fresh discoveries have been made. Most of the Mining Leases have been forfeited for non-payment of rent, and non-working of Mine. All the holdings are protected pending the arrival of an Expert to report on them, who it is said will reach the Colony in about two months' time.

Most of the leases are under offer to an English Syndicate, and all the holdings are protected pending the arrival of the Expert already referred to.

It is generally supposed that the probability of work being resumed in these holdings depends in a great measure upon the introduction of outside capital, as the original holders are not now in a position to incur further expenditure on them.

I trust I shall be in a position to report more favourably on this field at the end of the present financial year.

I have, &c.,

The Under-Secretary, Mines Department, Wellington. E. R. RUSH, Warden.

No. 2.

Mr. Warden NORTHCROFT to the UNDER-SECRETARY of MINES, Wellington.

SIR,— Warden's Office, Thames, 19th May, 1893.

I have the honor to forward herewith statistical returns for the Hauraki Mining District for the year ended 31st March last, and also the following report on the mining industry for the same period:—

Mining operations generally in this district have been of a discouraging nature, very few mines paying dividends, and by far the largest number being worked on calls; and were it not for the Ohinemuri (Waihi Karangahake Waitekauri) and Kuaotunu portions of the district mining might almost be said to be at a standstill. At the three first-named places, the English Companies who have Martha, Crown, and Komata Mines, with plenty of capital to develop them, are doing good work with fair prospects of ultimately enriching the owners. There are doubtless a great many other properties in this district whose futures would be as bright if the owners had the capital to systematically develop them, but unfortunately for the Colony and district they have not.

In the past, particularly at the Thames and Coromandel, all the gold was taken out of the surface and easily worked portions of the mines, and large dividends were paid. Afterwards the fortunate shareholders who had reaped the harvest sold to investors who had little if any more than enough capital to pay for their shares, and none to further develop the mine and prospect for fresh gold bearing country. And so many valuable properties are either abandoned, or next to useless work is done driving and cross-cutting to work for surface patches that are supposed to have been missed or not driven to in the earlier workings, to put up the scrip market for the benefit of the shareholders, and so allow some of them to make a rise or get out to the disadvantage of the less knowing of the public. Whereas, had proper provision been made and due care exercised, as in the Waiotahi and perhaps one or two other mines, there would have been ample funds at the command of the different Companies to work the deep levels and more difficult parts of these localities. It is deplorable that any mining community should have to acknowledge they have not sufficient capital to work lower than 400 feet when it is considered that the field has been in existence for upwards of 26 years, and the yield of gold has been nearly 2,000,000 oz., and that lodes are known to exist to the lowest depth we have ever sunk, viz.: 750ft., and at that depth were still in good channel of country. It is disappointing to admit that we should be unable to work known payable ground simply for want of capital to put up a pump of sufficient power to keep the water down. Yet such was the case in the Queen of Beauty Shaft, which had to be abandoned though the Company was then on a good reef with every indication of its going down. The policy of this part of the field has been to work out the payable patches or work in the floor that carries payable quartz, though experience has clearly shown that rich and poor floor of a country are met with in all mineral districts, and that by sinking we are still as likely to meet with deposits as rich as we have worked in the past. This was actually proved in the shaft before mentioned, and the well-known Geologist, Mr. S. H. Cox, gave it as his opinion that floors of rich and poor country would be found till the slate was reached. Yet with all this knowledge before us the Thames portion of the field is stagnating and mining at a standstill so far as deep levels are concerned, because we have not the necessary capital to prospect the deep country, though it is universally acknowledged that it bids fair to be as rich as the country we have worked. It is

difficult to say what would be the best way out of the difficulty, but one thing must be apparent to everyone, the deep levels are a dead letter to us without capital, and unfortunately, though clearly shown by the many localities gold has been found in, that this peninsula is intersected by numerous auriferous channels of country, hardly anything is known on many of them except when they touch the seaboard or valleys of the Thames and Ohinemuri Rivers, and so unreliant and unadventurous are nine-tenths of our young miners, that they never venture away from the well-known paths of the field, preferring to eke out a living by fossicking, tributing, gum-digging, or living on credit, to going unto unprospected parts of the district. Fortunately there are a few such men as the Lowries, McIsaacs, Blackmores, Wall, Davis, Tilsley, Burney, Liddle, W. White, and Kawhena, and a few others who do prospect occasionally, or we should still be confined to the well-known localities of 20 years' standing. No doubt the inaccessible nature of the ranges deters many that would try their luck if there were tracks cut enabling them to procure their "tucker" more easily. And it seems to me the only way this district will ever be thoroughly prospected unless we wait for another generation, is to make tracks at intervals where the country is accessible; but then comes the question, who is to do it? Certainly the County Councils cannot, for they have not sufficient revenue to keep their present roads in repair, and I do not suppose the Government could, unless the work was extended over a number of years.

Although, as I have before intimated, the mining industry in this district is not in the flourishing condition it ought to be, or as I should like to see it, yet there was an increase over last year of £13,323 0s. 11d, and if the plant that is now being erected at Karangahake by the Crown Company proves the success its owners anticipate, I think the return for 1894 will be considerably in excess of this year's. The Mining Inspector having in his report so fully entered into all details, processes, and progress of the various Companies and Mines, it would be mere repetition for me to more than allude generally to the different localities and the operations carried on in them.

Te Puia Mahakirau and Moewai.

A little mining has been done at Mahakirau, and some nice looking stone got out besides some very rich specimens, but the owners are not yet sufficiently satisfied with its permanency to warrant them in erecting a battery; but should it turn out so they have very great advantages in having plenty of mining timber and one of the finest rivers for motive power in the district. The country also is good, and appears to be in one of the gold bearing channels. I hope when it is more known to see it a thriving part of the district.

At Te Puia very little has been done further than prospecting. Some of the beach sand was taken away for trial, but was found not to be in sufficiently rich patches to pay.

Kuaotunu.

The majority of the Companies in this part of the district are trying or about to try what is known here as the Cassell Wet Process, which differs from the other inasmuch as ore is crushed wet which is far more easily done, and has besides the great advantage of avoiding the dust which is so troublesome in dry crushing. I have, however, very grave doubts as to its proving as potential as the dry process, owing to the fineness and lightness of the gold. I am afraid the loss will be considerable, far greater than the mine owners yet anticipate.

The Try Fluke, which has certainly been the best mine from the first, has treated a large quantity of tailings by the Cassell Process with, it is said, fairly good results; but when last at their battery the Manager could not give me the exact detail. As the tailings would be similar to dry ground ore it would not be any test as to whether the Cassell's Wet Process will be a success or the reverse at Kuaotunu.

The other mines are doing fairly well, but want of water power is the great drawback. Now each Company that can afford it has a little crushing mill of its own. Whereas one or two good large mills could do all the work, and so save what is now wasted energy and capital in management. Were there good water power, such as we have at the Thames or Karangahake, a great quantity of ore that will not pay with the present method of treatment would yield handsome results.

Kauri Timber Company's Land.

At Owera the Company erected a battery and crushed 1496 tons of ore for 1921 ozs., but now have had to shut down, having either worked out or lost the run of gold.

The battery and mine at Whangapoua, or more properly Opitamu, has been shut down for some months past, the Company finding it did not pay to treat the ore they had.

Waikoromiki and Cabbage Bay.

A good deal of prospecting has been done at Waikoromiki, and some nice stone found, but whether the find is of a continuous payable nature or of sufficient value to justify the erection of a battery has yet to be determined. Mr. James Vizard put up a small battery on his holding and worked for a time, but owing to the poorness of the stuff he was treating, and anxious enquiries being made about his financial position he left the district, and the property was sold under the 53 Section of "Mining Act 1891." There are one or two other claims there, but Vizard leaving has thrown everything back.

Coromandel.

The English Company that own the Kapanga Special Claim may truly be said to be the only mine or claim holders who are mining in this locality. It is true there are some parties on the Tokatea Range working in the Royal Oak and Tokatea, but they are only tributers chiefly working in old drives and stopes, looking for small stringers and patches missed in the early days of the field, or picking over old mullock tips. Mr. W. H. Argall, manager of the Kapanga, is doing good

work. This Company have put their shaft down 600 feet, and intend, if funds will allow it, or they have any luck with their crosscuts, to sink as deep as they are likely to meet gold bearing country. This Company certainly deserves to succeed. Were it not for the spirit and energy displayed by them in prosecuting the work in their mine, gold mining at Coromandel would be in a hopeless state of stagnation. As I said in my last year's report, this part of the field will never prosper, or the Tokatea Range produce more gold until an entirely different system is adopted. The mine owners cannot expect the tributers to open up the mines properly. They have their living to make, and in many instances large families to keep, therefore they only work in parts of the mine where they hope to pick up a small patch that may have been missed. They have not the means to do much dead work, timbering, or clearing away more mullock than they can possibly help. Everything is done with a strict regard to economy. And so in a short time the levels which they are not compelled to clear to get in and out by get "mullocked up" and fall in, and the mine literally falls to ruin. One cannot blame the tributors, they have to work as cheaply as possible in many instances to live, but the short-sighted policy of the mine owners, for if they retain their mines it will cost them hundreds of pounds in the future to repair the mischief now being done; but perhaps they hope not to be interested in the ground when that day comes.

Tiki Matawai and Manaia.

A little prospecting is still carried on from time to time at these places, and I hear Mr. George McLeod (the old Tokatea prospector) has picked up what is supposed to be the lost run of gold at Te Tiki, but not having seen McLeod I cannot confirm the statement.

At Manaia the young Blackmores are working with their late father's old mate, Ruffen, but up to the present have not discovered anything to cause an influx of miners, and until that time comes Manaia will not bear the distinction it, with its beautiful stream of water for motive power, is destined to in the future pages of history.

Tapu and Waiomo.

The claim being worked at Tapu by Mr. Mahon and party may be said to be outside the old run of country or that worked in the early days of the field. Two tons of quartz sent to the Thames from this claim yielded 10ozs. to the ton, and if the reef continues as the owners think it will, they have a good claim, but no dependence is to be placed on Tapu runs of gold. They are rich while they last, but run off very suddenly, and often without any apparent reason, no change of country being noticeable. Sheridan works as continuously at his claim as ever with varying success.

At Waiomu Messrs. Peter Hansen and L. Melhose have been forced to allow their experimental plant to stand idle for some considerable time owing to the refactory nature of the ore. Although there is plenty of it the mine owners have not as yet discovered a satisfactory method of treating it. When they do this locality will assuredly come to the front, for there are as large bodies of stone here as at Waihi, only awaiting as that district did for many years a payable process to treat them. I expect, however, before next year's report has to be written to see several of the mines then in full swing.

Thames.

This district, the most populous and for very many years the real mainstay of the goldfields in the Hauraki Peninsula, shows this year a material decrease in the yield of gold, and is at present labouring under a depression. As a consequence, though most of the mines which have been in operation for years are still working, very little new work has been undertaken. It is not an easy matter to procure the necessary funds to support a declining industry. Two things are essentially necessary to restore prosperity to this goldfield: first, what has so often been alluded to in these reports, the discovery of gold at low levels, and secondly, the opening up of the back country immediately surrounding the present workings. The first has for years been recognized as a necessity; but it involves an undertaking of some magnitude, and is dependent upon the expenditure of a larger amount of capital than appears at present capable of being obtained. Although, as previously stated, there is good reason to expect that gold in payable quantities exists at lower depths than have yet been worked, no practical steps can be said to have been taken to test the fact. It is sincerely to be desired that some concerted and general scheme could be arranged by or among the owners of mining properties in the vicinity of the foreshore whereby this object could either be attained or shown to be attainable.

The question of prospecting the back ranges of the district has lately received much attention, but it is with difficulty the necessary funds can be raised to prosecute the work with vigor. That payable reefs exist there seems very little reason to doubt, as the auriferous belts of country in which the present workings exist can be traced across the Peninsula. The occasional discovery of gold-bearing quartz strengthens this opinion and leads to the conviction that could sustained and systematic prospecting of the back country be carried on, new finds rivalling in richness those for which this field was once famous would be brought to light. This is a question so closely affecting every resident in the goldfield that it is surprising that more energetic measures have not been taken to explore and prospect the less known portions of the district.

There is one circumstance connected with this portion of the district which has not previously received much attention, but which in discussing measures to retrieve the declining fortune of the place is worthy of some consideration. All the crushing mill are situated near the sea so that they may avail themselves of the cheap motive power afforded by the Thames County Water Race. Owing to this fact many reefs known to exist at some distance from the town in mines at present working and in many more long since abandoned containing gold in moderate quantities are not at present worked owing to the expense in transit to the batteries. Could some cheap motive power be supplied in the vicinity of these mines, many reefs now neglected could be profitably worked and employment given to large numbers of men. The most obvious remedy appears to be by the adoption of electricity as a motive power, generated at one of the large streams of the Peninsula and conveyed by wire over hills and at altitudes unapproachable by water power.

At Tararu Creek, the only mines in which continuous and systematic work has been carried on, during the past year, have been the Sylvia and the Norfolk. The former, I am sorry to say, has not been fortunate enough to obtain remunerative returns, and work in the mine is now almost suspended, pending certain financial arrangements now in progress. The Norfolk Company have been steadily working with an average of twelve men; but the yield of gold has not met expenses. The ore obtained is highly mineralized, and difficult to treat. A Luhrig concentrator is being erected in connection with this Companys crushing mill. The City of Dunedin Mine has also been worked intermittently.

One or two prospecting parties have been out on the ranges, at the head of this creek, but as yet have made no discovery of any moment. Work has been carried on in the Shellback Creek chiefly in the Nordenfeldt, Waitemata, and Mountain Flower Mines; while at the Kuranui, Hansen's Kuranui No. 3, and Comer's Kuranui No. 2, have worked continuously, with respectively eight and fourteen men, and the returns, though not large, have been remunerative. In the Moanataiari Creek the chief mines are the Hazelbank (including the once famous Caledonion), a large number of wages-men and tributers were employed. The yield of gold averaged for the year nearly two ounces per ton. The Moanataiari Company has employed a large staff of wages-men and tributers in works in various portions of their extensive holding, chiefly in the Reuben Parr section. About 15,000 tons of quartz were treated for a yield of about 1,700 ounces of gold. The Alfred, Freedom, and New Whau Mines have been at work throughout the year, the two former largely with tributers. The Orlando has been occupied chiefly in driving a low level tunnel, employing an average of six or seven men. During the year the Alburnia Company have driven from the Whau level to meet Dixon's reef, and rich gold was struck. A winze has been sunk seventy feet to a lower level, and the reef has been driven along for some distance. Some rich quartz was obtained, a crushing of 18 loads yielding 603oz. of gold. Contrary, however, to expectations, the run of gold did not continue. Work is being carried on in the block now opened. In the Waiotahi Creek the Waiotahi and Cambria are the chief mines at work. They have both been worked steadily and systematically, with large staffs of wages-men. The returns have been remunerative. The Fame and Fortune Special Claim has been worked by tributers; some rich patches, but of limited extent, have been worked on during the year. A number of smaller claims have been worked, but the yield of gold has been by no means large. At the Waiokaraka the Queen of Beauty has recommenced operations. The shaft has been cleared, winding machinery erected, and several drives cleared out; but no quartz has yet been sent to the mill. The May Queen Company Mine have cleaned out and repaired the old Queen of the May shaft, and have erected winding gear, and driven to connect with the old workings; and there is good reason to hope that operations during the ensuing twelve months will prove payable to the shareholders. In Crawford's Special Claim work has been confined to clearing out the old drive in the Nana section, but no large amount of quartz has been won. Work in the Karaka and Hape Creeks has not been carried on with any great vigour. The Adeline, Lone Hand, Claremont, and Hokianga have been the principal mines at work in the Karaka, and the Consols in the Hape; but in no instance have the returns been such as to attract any attention. The Dives, Occidental, Pride of Karaka, Magnolia, and North Star are the chief mines working on the Unu Hill. Occasional patches of rich stone are met with, but the yield on the whole has been by no means large.

Utunui, Puriri, Tairua, Whangamata, and Marototo.

At Otunui nothing has been done for sometime, the last ore treated at the battery there not paying. A few small parties of working miners have worked off and on at Puriri for the last year, but with very varying success. One party obtained 31oz. 10dwts. of gold from 44 tons of dirt; but the patchy nature of the ground, the difficulty of getting it to the battery, and want of funds have militated against vigorous and systematic mining being done. As, however, this locality is in one of the gold bearing channels, of country, the future I think will prove that good payable ore will be found between Puriri and the East Coast of this Peninsula. The McLiver family and a few of their friends are about the only miners who reside at Tairua. They have a battery and a few claims; but as the yield of gold for last year was only 65oz., the mining operations could not have been of great importance. Nothing further than a little prospecting has been done at Whangamata. There are several reefs known to exist there which perhaps wonld pay if there was a battery on the ground, but not to transport to the Thames or Auckland by cutter or scow. In the future, when this locality is better known, there is little doubt a thriving mining population will spring up, and cover the hills and valleys at present only known to gum diggers, for here, unlike Kuaotunu, there is plenty of water for motive power.

At Marototo there are still a few parties, but the work done can hardly be said to be more than prospecting. There is a small plant there that was erected by the company that bought out the prospectors at the opening of the field. It is only capable of treating the loose rubble that was found in the prospectors' reef. This property has recently passed into Mr. Judd's hands, who has let it on tribute.

Karangahake.

This part of the district is fast coming to the front, and if the large plant now being erected, and almost completed, is the success it promises to be, the increase of gold for next year should be very considerable. There was a number of mines with valuable reefs known to exist in them, and their development has been retarded by the want of a process by which the refractory and complex ores could be profitably treated, owing to their containing silver and it is said gold in chemical combinations. The loss is too great to treat them by the ordinary process. Several attempts have been made; but in all cases, though the ore was very rich, the methods proved to be too expensive. The MacArthur-Forrest (better known as the Cassell) process seems likely to supply the want so long felt—a method at once efficient and sufficiently cheap. The Crown Mines Company, who have had ample opportunity of testing it, appear to be satisfied with its efficiency in erecting at great cost their reduction works, which have been constructed on the most improved principles at present known. It consists of one stone-breaker, two drying kilns on the American pattern, twenty head of 9cwt. dry stamps, and a complete plant for the treatment of ore by the MacArthur-Forrest process, and is supposed to be capable of treating from twenty to thirty tons of ore per day. The buildings have been erected on the slope of the hill below

their tramway, thus allowing them to take every advantage of the nature of the ground. The ore being delivered at the top of the plant, passes through the stone breaker, and then falls from stage to stage by gravitation, requiring the least possible handling until it is ultimately delivered at the bottom, in a fine pulverised state, for the treatment of the before-mentioned process. As, however, the Manager, Mr. John McConnell, to whom I am indebted for the foregoing particulars, informs me he has provided Mr. H. A. Gordon, Inspecting Engineer, with a plan, full particulars of machinery, and method of treatment, for his report to the Hon. Minister of Mines, it will be unnecessary for me to go more fully into this matter.

The Waitawheta River has made a natural cross-cut for the Crown Mine, which the Company have taken full advantage of by running their tramway up the side of the gorge, though at great expense; but by adopting this course they have several hundred feet of backs on each side of the river. The reef crosses the river at right angles, and is a strong body of quartz, which has so far increased in thickness and value as it went down, and so far as the reefs have been driven on the results have been most encouraging.

Owharoa, Komata, and Waitekauri.

At Owharoa very little has been done. The Smile of Fortune is worked by tributers, and the other properties have been merely prospected on. That there is good gold here is the opinion of most persons qualified to speak on such a subject; but the heavy nature of the country, and distance that would have to be driven, makes it impossible for any but capitalists to undertake it, and as yet none have seen fit to embark in the venture; but should they do so the general opinion is they will be well rewarded.

The only mine at the Komata that can be said to be working is owned by Mr. T. H. Russell, who has done good work in opening up his mine and connecting it with his mill at Waitekauri, by a tramway of three miles in length. The energy, perseverance, and pluck shown by this gentleman has to a very large extent caused the present activity in mining in the Ohinemuri sub-district. The value of mining properties having improved in a very marked degree in consequence of the introduction, largely through his exertions, of a method of treating the ore of the district.

Waitekauri may at present be said to be at a standstill. The Jubilee Special Claim was worked vigorously for a time by Mr. Kersey Cooper; but unfortunately the ore treated did not equal the sanguine owner's expectations, and he has had to shut down till he can raise more capital to further develope the mine, and prospect for a better class of ore. The old Waitekauri Mine has only had a few tributers and wages men employed to keep the levels open since my last report. In the beginning of last October the Lowry Brothers, while prospecting, discovered what promises to be a valuable find. This new locality is north-east of Waitekauri, east of Komata, and south-east of Marototo. The country is good, and known to be one of the gold-bearing channels. Too little has at present been done to warrant me more than predicting its future value as a discovery. A great many holdings were pegged off on its becoming known, but nothing further done; and as applicants are, by Section 125 of "The Mining Act, 1891," allowed six months to complete and lodge their plans in the Warden's Office, nothing could be done, and the ground was locked up for nearly six months by most of the applicants. It appears to me this section might with advantage be amended, and the time made much shorter, because ample discretion has been given to the Warden to meet extreme cases. If this was done it would prevent license-holding peggers blocking the country at a new find for five and a-half or six months.

Waihi.

The Silverton Gladston and one or two of the minor properties have done a good deal of driving and prospecting but the principal work is carried on by the Waihi Company, who certainly have a very valuable property. During the past year they have crushed 18279 tons of ore, which yielded 29681ozs. 10dwts. of bullion valued at £48809, being an increase of 11274ozs of bullion for the year, and as far as can be judged this mine will continue to give a steady yield for years.

Tui, Te Aroha, and Waiorongomai.

Very little has been done at the Tui owing to the difficulty in treating the galena ore. The Champion Mine is well opened up, and could a process be found to deal with the zinc blend that is found in combination with the galena, there would then be no trouble about treatment, and this mine could put out a very large quantity of ore per week. Another licensed holding has lately been taken up to work the galena lode on the opposite side of the range to the Champion, but I am afraid they will not succeed any better than the Champion Company, who have sent samples of their ore to England and Germany, but as yet have not succeeded in finding a process efficient and sufficiently cheap. At Te Aroha a Prospecting Association was formed, and some prospecting done in the vicinity of the old prospectors' claim, but up to the present without success.

At Waiorongomai there are a few parties at work. Newsham and and party who got a portion of the ground taken from the Fergusson Syndicate Company, earn good wages, but have a difficulty in getting their stuff crushed. Mr. H. H. Adams, who owns the battery, has a few men working in the New Find, Silver King, and Warrior levels, and has crushed about 800 tons of quartz. He has also tried to treat some of these ores by the Cassell's Process, but I am informed on good authority this process is not suitable for this class of ore. A new lease has been entered into between the Crown and the owners of Lipsey's Block in Te Aroha Township, reducing the rent for the present. But as a fresh valuation is to be made every twenty years, and the lease to the Crown is only for 99 years instead of as long as it wished to retain it, it seems to me that although this new arrangement was made at the request of the majority of the inhabitants they have gained a very doubtful concession.

Subjoined is a comparative statement showing the ore crushed and the yield of gold and bullion therefrom for the year 1891-92 and 1892-93.

I have, &c.,

H. W. Northcroft, Warden.

The Under-Secretary, Mines Department, Wellington.

COMPARATIVE STATEMENT of RETURNS for HAURAKI DISTRICT for YEAR ended 31ST MARCH, 1892 and 1893 respectively.

1892.

NAME OF COUNTY.	AREA.			Average Number of Men Employed.		FOR OWNERS.																FOR TRIBUTERS.						TAILINGS.			
				Owners and Wages men.	Tributers.	Quartz Crushed.			Mullock.	Gold Obtained.			Bullion.		Value.			Ore Value.				Quartz Crushed.			Gold Obtained.			Quantity Treated.	Gold Obtained.		
	A.	R.	P.			Tons.	cwt.	lbs.	Tons.	ozs.	dwts.	grs.	ozs.	dwts.	£	s.	d.	£	s.	d.		Tons.	cwt.	lbs.	ozs.	dwts.	grs.	Tons.	ozs.	dwts.	grs.
Coromandel ..	668	..	23	240	36	12,203	1	40	..	11,170	16	..	..	..	..	..	..	..	..	..		391	10	..	875	15	..	435	144	13	..
Thames ..	945	1	30	568	156	39,331	12	62	21,953	27,462	12	..	9,864	7	7,874	5	..	..	..	..		7,865	..	40	4,427	19	..	17,000	3898	15	..
Ohinemuri ..	697	3	8	319	9	13,503	..	..	..	610	11	..	20,673	5	25,974	15	..	2,581	..	..		362	..	..	411	8	..	..	..	..	..
Piako	86	2	32	21	8	680	..	..	..	365	4	..	..	..	..	..	..	..	..	..		917	..	..	305	3	..	1,225	308	5	..
	398	..	13	1,148	209	65,717	13	102	21,953	39,608	3	..	30,537	12	33,849	..	..	2,581	..	..		9,535	10	40	6,020	5	..	18,660	4350	13	..

1893.

Coromandel ..	523	..	38	245	42	12,022	1	21	..	10,553	1	..	..	..	..	..	..	..	..	..		381	6	15	1,377	15	..	2,760	1,023	4	..
Thames ..	1,013	1	10	423	253	25,106	11	25	21,106	19,325	10	..	3,985	..	2,182	11	8	..	..	..		13,025	..	..	7,531	12	..	19,309	4,478	12	..
Ohinemuri ..	991	1	17	413	7	22,526	..	..	..	1,545	..	..	40,203	10	61,117	13	9	2,221	10	..		245	..	..	177	..	..	..	..	..	..
Piako	36	..	36	19	4	1,333	..	..	..	82	..	..	..	..	..	..	..	..	..	..		186	..	..	60	..	..	1,650	297	14	..
	2,564	..	21	1,100	306	60,987	12	46	21,106	32,243	11	..	44,188	10	63,300	5	5	2,221	10	..		13,837	6	15	9,146	7	..	23,719	5,799	10	..

	1892.	1893.
Estimated Value of Gold	£139,640 18 0	£123,872 3 6
Value of Bullion	33,849 0 0	63,300 5 5
Value of Ore sold	2,581 0 0	2,221 10 0
	£176,070 18 0	£189,393 18 11

Increase for 1893 .. .. £13,323 0 11

No. 4.

Mr. Warden ALLEN to the UNDER-SECRETARY of MINES, Wellington.

SIR,— Blenheim, 3rd May, 1893.

I have the honor to report as follows, *re* the Goldfields under my charge :—

There is nothing that requires any particular notice. I do not think the population of the Marlborough Goldfields hss decreased during the last 12 months. The Creek claims at Cullen's Creek are nearly worked out, but miners will find plenty of other places in this district that will pay for working ; and when the miners at present working in Cullen's Creek have given up their claims it will pay a company with moderate capital to work the Creek again. The Wakamarina District is improving, and several new claims will soon be at work. Payable gold has been found in the Waikakaho ; and possibly during the next Summer miners may be induced to give this district another trial. I am sorry to have to report the temporary suspension of work of the Ravenscliff Company, at Waikakaho. The representative of the Company informs me that he expects to be shortly at work again. There is plenty of stone in their claims, and the stone contains payable gold ; but the result of one or two crushings was not satisfactory. There is little doubt that they lost a large percentage of the gold. The representative of the Company has kindly furnished me with a return of trials of their concentrates sent away to be tested. I give table as follows :—

PARTICULARS *re* SHIPMENTS of CONCENTRETES made to AUSTRALIA for TREATMENT for the RAVENSCLIFF MINING COMPANY, LIMITED.

	SENT FOR TREATMENT TO		
	Wakaroo and Moonta Mining and Smelting Company, of South Australia.	Ballarat Pyrites Works, Victoria.	Clyde Smelting and Clorinating Works N.S.W.
Number of Bags	59	59	60
Original Weight (damp) T. cwt. qrs. lbs.	13 8 1 24		
	Tons. cwt qrs. lbs.	Tons. cwt. qrs. lbs.	Tons. cwt. qrs lbs.
Gross Weight Delivered Consignees	3 18 3 ..	4 2	3 16 1 12
Deduction for Moisture, &c., at Works	.. 1	.. 4 2 ..	.. 4 .. 12
Net Weight Treated	3 17 3 ..	3 17 2 ..	3 12 1 ..
	Gold.	Gold.	Gold.
	2 ozs. 16 dwts.	2ozs. 19dwts.	2ozs. 14dwts. 19grs
	Silver.	Silver.	Silver.
	Nil.	Nil.	7dwts. 19grs.

ASSAYS IN NEW ZEALAND.

GOLD.			SILVER.		
ozs.	dwts.	grs.	ozs.	dwts.	grs.
2	9	0	0	9	19
2	13	22	0	16	2
5	2	22	1	5	21
Average 2	11	11	0	12	22½

CHECK ASSAY of drawn sample made for Ravencliff Mining Company, Limited	Gold. 2ozs. 16dwts, 20grs.	Gold. 3ozs. 2dwts.	Gold. 2ozs. 13dwts. 21grs.
	Silver. 7dwts. 14ozs.	Silver. Nil.	Silver. 8dwts. 4ozs.
METHOD OF TREATMENT RECOMMENDED.	Not Stated.	Dead Roast and Chlorination.	Chlorination.
Gold paid for at rate of	80s. per oz.	83s. per oz.	80s. per oz.
Treatment Charge	50s. per ton. No Allowance for Silver.	60s. per ton.	60s. per ton.

A return of this kind speaks for itself. I hope the Company will soon be at work again, with better appliances for saving the gold.

In conclusion, I have only to repeat what I have stated on former occasions, viz.: that we have a large tract of payable auriferous, alluvial, and quartz country of great value to the Colony, that

should not be alienated from the Crown. It already carries, even with our very antiquated method of mining, a much larger population than would be found on the land under any other circumstances; and it would be very unwise to take this auriferous country from miners and turn it into a pasture for sheep. Sooner or later this district will be occupied by a much larger population of miners.

My annual returns have been already forwarded to you.

I have, &c.,
J. ALLEN, Warden.

The Under-Secretary Mines Department, Wellington.

No. 3.

Mr. G. WILSON, Inspector of Mines to the UNDER-SECRETARY of MINES, Wellington.

SIR,— Inspector of Mines Office, Thames, 5th May, 1893.

I have the honor to forward the following report on mines in the Hauraki District for the year ended 31st March, 1893:—

The returns of gold and bullion obtained shew that in the Coromandel County there has been an increase in the yield of gold, in the Thames County and Borough there is a decrease in the gold and bullion, in Ohinemuri County an increase of both gold and bullion, and in Piako County an increase in the gold.

COROMANDEL COUNTY.

Tokatea Range (Coromandal).

Tokatea Mine, 14 acres 2 roods.—The whole of the work done in this mine was carried on by tributers chiefly on the surface, and on surface veins. Nine men were employed, and 43 tons 6 cwt. of quartz yielded 162oz. 14dwt. of gold.

Royal Oak Mine, 10 acres 2 roods 27 perches.—The mine is now owned by Mr. J. H. Witheford, and has been worked by tributers. Five men were employed, and 1 ton 9cwt. 20lbs. of quartz yielded 296oz. of gold.

Bismark Extended Mine.—This mine has been worked by a party of three tributers. The workings were from a rise from the Tokatea low level, the reef is from six inches to two feet in thickness, but rich stone only is saved for crushing. About 7cwt. of stone of stone yielded 79oz. 19dwt. of gold.

Harbour View Claim.—Four men's ground, formerly a portion of the Harbour View Licensing holding. Two tributors are employed working on small leaders. 1 ton 4cwt. of quartz yielded 16oz. 17dwt. of gold.

Rob Roy Claim.—Two men's ground, is worked by a party of two tributers. 85 tons 10cwt. of quartz yielded 23oz. 10dwt. of gold.

Mayn's Claim.—This claim has been taken up on the large reef, or blow, on the Tokatea Road. Two men were employed. A parcel of 85 tons 10cwt. was carted down to Mayn's battery and crushed, but the return of 17oz. 1dwt. was not payable.

Mayn's Claim.—This claim is about four men's ground, and is a portion of the old Harbour View licensed holding. Work was carried on by two men on small leaders. 2 tons 38lbs. of quartz yielded 31oz. 8dwt. of gold.

Blue Peter Claim.—Two men's ground. One man worked during the year. 8 tons of quartz crushed yielded 10oz. 18dwts. of gold.

Sundry other claims were worked about the Tokatea Range, fossicking near the surface and picking over mullock tips was the chief work done. About 10 men were employed in this way, and 50 tons of quartz yielded 81oz. 19dwt. of gold. In the Try Again Mine which yielded handsome returns last year, the owners have not been successful in discovering another run of gold, although a great deal of work has been done.

KAPANGA DISTRICT.

Kapanga Mine, W. H. Argall, Mine Manager.—This mine includes the Kapanga Proper Mine, the Blagrove Freehold, and the Beach Mine, previously knewn as the Coromandel Mine. Work has been done in sinking and driving, completing the erection of the Pumping Engine at the Kapanga Shaft, and also in altering and improving the Winding Engine and Gear. 44 men were employed on wages, and 9 men as tributers. The Company crushed 286 tons of quartz for 177oz. 6dwt., and the tributers 40 tons for 127oz. 7dwt. of gold.

In Kapanga Proper.—Larnach's Engine Shaft was sunk during the year 38 feet, intersecting what is believed to be Scotty's footwall branch. Driving on it is now carried on at the 600 feet level, the reef is in places broken and disordered, underlying south-west at an angle of 46 degrees, its width is about one foot. The composition of the reef is pug or clay, colour dark, quartz, carbonate of lime, mica, iron and arsenical pyrites. During the driving a few colours of fine gold have been seen, which shows that at this depth (600 feet) the reef is auriferous. At this same level (600) they are also driving a crosscut west to cut the Kapanga reef. During the year a large amount of work has been accomplished in the shallow levels, particularly round the 300, but the results have been most unsatisfactory.

Coromandel Section.—The tributers have been working steadily, but nothing of importance has been discovered.

Blagrove's Section.—The engine shaft was sunk to a depth of 93 feet. The sinking has been suspended for the present.

Scotty's Mine.—This mine, area 29 acres 1 rood 20 perches, adjoins the Kapanga Mine to the northward. The explorations in the old levels have so far not led to any valuable discovery, and the plan of working from the old shaft has not yet been adopted. Four wages men were employed and a party of five tributers crushsd 110 tons of quartz, obtained from the old workings, for a return of 97oz. 18dwt. of gold.

Coromandel Mint Mine.—This mine was worked during a portion of the year. About 150 feet of driving was done from the shaft, but the mine was flooded out in November last, and no further work has been done.

Prince's Mine—Which is in private property. A tributer named Anderson obtained 11oz. 6dwts. of gold from 3½ tons of quartz.

Cabbage Bay District.

Vizard's Mine, 10 acres.—A considerable amount of work was done in conveying a small battery of two stamps to the ground and erecting it on the claim. A parcel of quartz was crushed, but the owner left the country and no returns were sent to me.

McKenzies' Claim, adjoins Vizard's. A reef about 2 feet in thickness has been cut, but no returns have been obtained.

The Maories' Claim adjoins McKenzie's, and a considerable amount of prospecting has been done, and a reef about 1ft. 6in. cut containing a little gold.

Tiki District.

Very little work has been done in this district. Eccleson and party (two men) marked out a claim on the old Castle Rock licensed holding, and obtained from over the low level a parcel of 2cwt. 54lbs. of quartz, which yielded 31oz. of gold.

Kopukaitahi District.

McDonald obtained 5oz. 17dwt. of gold from 42lbs. of quartz taken from a small leader near the surface.

Waikoromiko District.

Dyer and Party, three men, have met with very encouraging prospects, and are opening up a reef about 2 feet in thickness. 1 ton 57lbs. of quartz yielded 14oz. 11dwt. of gold.

Lillis' Claim, 10 acres, is situated on the Kauri Timber Co.'s property. The reef worked on is about 18 inches in thickness, and 2½ tons of quartz yielded 127oz. 6dwt. of gold. Two men are employed.

A considerable amount of prospecting has been done in this district during the year, and the show is very encouraging.

Opitonui District.

Lanigan's Claim has not been worked during the year, but Little and party have taken up a claim to the southward and have worked on a reef about two feet in thickness. 16 tons 10cwt. of quartz were crushed for a yield of 15oz. of gold. Three men were employed.

Ryan and Party, two men, who prospected in this district during the year, obtained 20oz. 5dwt. from a small parcel of quartz.

Owera District.

Owera Mine.—Work was vigorously carried on during the year, and the run of gold stoped out from the intermediate level over the low level to the surface. 1496 tons of quartz yielded 1921oz. of gold. An average of 12 men were employed. The quartz proving poor, crushing was discontinued, and most of the men paid off, and I learn that the mine will soon be let on tribute, or shut down.

Matarangi District.

Ocean View Mine, 14 acres 2 roods 30 perches —McNeil and party took up this ground, which had remained idle for over twelve months. Work was continued in the ends where the old owners had worked the reef, and the quartz crushed—34 tons—yielded 100oz. of gold. Six men were employed. The quartz was conveyed to the Thames by sea and crushed, but the owners are endeavouring to get a small battery to be erected near the mine.

A considerable number of men were employed prospecting after McNeil took up his claim, but nothing payable was discovered and they soon left the district.

Mahakinau District.

The claim, formerly worked by McPherson and party, has been abandoned, and discovery of a gold-bearing reef was made on the north side of the main creek opposite McIsaac's creek. There has been a considerable amount of surface work done, and 60 feet driven on the reef, but so far a sufficient quantity of quartz has not been crushed to know if the reef will pay.

About a quarter of a mile further down and on the south side of the main creek very rich prospects of loose gold and small specimens are obtained.

Sluicing operations have been carried on, and some gold obtained, but I have not yet been acquainted with result.

Four men were employed in this district.

Moewai District.

There is some prospecting being carried on in this district, but the prospectors have not discovered any payable quartz.

Kuaotunu District.

Try Fluke Mine, 19 acres (John Goldsworthy, Mine Manager).—32 wages men employed. This mine is well opened up. Stopes are open on No. 1 reef from the low level up to No. 2 level. There is a large body of rubbly quartz, a portion of which only is payable. 348 fathoms have been stoped out in this reef. On No. 2 reef a winze has been sunk from No. 2 to No. 3 level, and about 400 fathoms stoped out. The workings are well timbered and ventilated, the stopes being filled up with refuse quartz and mullock. In the battery amalgamating pans have been taken out and tanks for the Cyanide Process substituted. 1542 tons of tailings treated with Cyanide yielded 550oz. of gold. The cost of treatment is reasonable, 5s. 6½d. per ton, Cyanide costing 3s. 9d., and handling 1s. 9½d. per ton. The quantity of quartz crushed was 4116 tons for 2186oz. of gold, making a total of 2736oz. of gold.

The Carbine Mine has lately been purchased by the Try Fluke Co., and added to their licensed holding.

Kuaotunu Mine, 15 acres.—Five men have been employed in this mine, the work being driving and stoping on the reef—which is the same as Try Fluke No. 2—and is worked through their No. 2 level. 250 tons of quartz yielded 19oz. 10dwt. of gold.

Red Mercury Mine, 14 acres (Thomas Blair, Mine Manager).—24 wages men were employed in this mine. The chief work done was on the east and west branches of the Red Mercury reef, and driving on the Try Fluke reef. About 400 feet of driving was done on the first-named reefs, and about 700 fathoms of the reef stoped out. 2391 tons of quartz yielded 2307oz. 2dwt. of gold.

A new level is also begun to cut the reef at a deeper level, as the quartz over the present level is now exhausted.

Great Mercury Mine, 28 acres (Henry Goldsworthy, Mine Manager).—33 men were employed, and 2312 tons of quartz crushed for 2304oz., and 1190 tons of tailings treated by the Cyanide Process for a yield of 461oz. 11dwt. of gold. The quartz crushed was mined chiefly from near the boundary of the Red Mercury Mine and from the same reefs. A considerable tonnage was also taken from the workings on the west side of the range, from the supposed Try Fluke reef.

This Company also have worked out all available quartz over their low level, and are now engaged in driving a crosscut on the west side near the new level of the Red Mercury, which will give about 100 feet of backs.

A new level is also being driven on the west side to connect with the workings on the Try Fluke reef.

A plant has been erected to treat all the tailings and crushed quartz by the Cyanide Process, and the results so far have been satisfactory.

Just in Time Mine, 8 acres 2 roods 24 perches.—Five men have been employed on tribute in this mine, and 276 tons of quartz crushed for a yield of 321oz. 18dwt. of gold.

Mariposa Mine, 4 acres 2 roods 6 perches (John Primrose, Mine Manager).—Twelve men were employed, and 300 tons of quartz yielded 171oz. of gold. A ground tramway has been laid from the mine to the County Road, the quartz is then carted to the Company's battery of 10 stamps, which has been erected near Dugend's stores. The battery was fitted with John Fraser's pans, but it is intended to discontinue them and adopt the Cyanide Process of saving the gold.

Irene Mine, 7 acres 2 roods (John Campbell, Mine Manager).—Eight wages men were employed, and 333 tons 10cwt. of quartz crushed for 257oz. 17dwt. of gold. The ownership of the mine being unsettled work has been discontinued.

Otama Mine, 20 acres 1 rood 20 perches.—This mine has been partly worked on wages and partly on tribute. Two men on wages obtained 50oz. of gold from 4 tons of quartz, whilst the tributers had 373oz. from 19 tons.

Black Jack Claim.—This claim has been worked by the present owners for about six months. Three men were employed. 37½ tons of quartz yielded 154oz. 10dwt. of gold.

Waitaia Mine, 25 acres.—This mine was worked by three men during the early part of the year, and 50 tons of quartz was crushed for 71oz. 7dwt. of gold. One man only has been latterly employed working on a small leader in the low level tunnel.

The *Invicta*, *Kapai*, *Vermont*, *Brilliant*, *Excelsior*, *Lucky Hit*, *Victoria*, and other claims have been worked for moderate returns. An average of 13 men being employed.

THAMES COUNTY.

Tapu District.

Sheridan's Mine, 20 acres 3 roods 4 perches (Dan Sheridan, Owner).—Five men have been employed in stoping out the reef over low level. 21 tons of quarts yielded 204oz. 12dwt. of gold.

Several other claims were occasionally worked in the Tapu District, and 37oz. 14dwt. of gold obtained.

A prospecting party has lately discovered a reef on a branch creek, about four miles up the main creek, which promises to be of value. Several claims have been taken up in the vicinity.

Waiomo District.

The plant erected by Hansen and party to treat the quartz from the Golden Gem and Monowai Mines proved ineffectual in saving a sufficient percentage of the bullion contained in the stone, and operations have ceased pending the adoption of the Cyanide Process.

The other mines are given up, protected, or abandoned.

Puru District.

Parties of Natives have been prospecting on the upper branches of the Puru Creek, and Tahu and party crushed 38lbs. of stone for 4oz. 1dwt. of gold.

Tararu District.

Norfolk Mine, 30 acres, (James McLean, Mine Manager).—Twelve wages men were employed, and 1700 tons of quartz yielded 392oz. of gold. The quartz was chiefly obtained from the level opened last year, and was of a highly mineralized character.

A Luhrig ore concentrating plant has been added to the Company's battery.

City of Dunedin Mine.—This Mine is situated at Tinker's Gully. Several old drives were cleaned out, and 120 tons of quartz obtained and crushed for a yield of 33oz. of gold.

Sylvia Mine (Edward Quinn, Mine Manager).—This mine was worked for the greater part of the year, the blocks of ground towards the surface being stoped out. 300 feet was driven on the main reef at the No. 3 level, but it proved to be greatly broken up, and very little quartz was found fit to be treated at the mill. A winze was sunk below No. 3 level to a depth of 40 feet, but the reef at this part proved poor, and no further work was done below the level. The new crosscut commenced last year was driven in hard rock for 300 feet. 2400 tons of quartz were crushed, and 104oz. 7dwts. of gold obtained. The concentrates yielded 3985oz. of bullion, value £2182 11s. 8d. An average of 24 men were employed.

In consequence of the falling off in the quantity of payable quartz, the mine has for the present been shut down.

Several parties occasionally prospect towards the head of the creek, but little, if any, quartz has been brought down for treatment.

Shellback District.

Nordenfeldt Mine.—Thorburn and party, two men—have been at work, and 80 tons of quartz yielded 91oz. 13dwt. of gold.

The Waitemata Mine.—Two men were tributing, and obtained 10oz. 13dwt. of gold from 29 tons of quartz.

The Mountain Flower tributers had 24oz. 13dwt. from 30 tons of quartz; and from sundry other small claims crushings amounting to 25oz. of gold.

Kuranui District.

Hansen's Kuranui, No. 3, 14 acres 3 roods 10 perches (P. C. Hansen, Mine Manager).—Eight wages men and 15 tributers were employed. 2,906 tons of mullock and surface-dirt were crushed, for a yield of 136oz. 6dwt. gold; and the tributers crushed 7,623 tons for 490oz. 11dwt. of gold.

Comer's Kuranui, No. 2 Mine, 13 acres 1 rood 37 perches (Robert Cromer, Owner and Manager.)—The chief work in this mine has been taking mullock from an open cutting, and putting everything through the mill. 10,267 tons were crushed for 663oz. 10dwt., being 1·292dwt. of gold per ton. Mr. Cromer says that one pennyweight per ton pays expenses, so that there is a profit in crushing poor dirt when it is easily mined.

The tributers crushed 154 tons quartz for 186oz. 6dwt of gold.

Fourteen wages men and six tributers were employed.

Hazelbank Mine, 16 acres 1 rood 23 perches (James Coutts, Mine Manager).—This mine comprises the Hazelbank and Caledonian ground, the Company having purchased the old Caledonian mine. The work by 27 wages men was chiefly carried on on three reefs, between No. 2 and No. 3 levels, in the Caledonian shaft, The reefs vary from four to eighteen inches, there was therefore a large amount of driving done on the reefs—540 feet and 1,157 fathoms of reef sloped out for 1,150 tons of quartz, yielding 2,232oz. 7dwt. of gold. Five men working a tribute crushed 508 tons for 95oz. 19dwt. of gold.

Moanataiari District.

Moanataiari Mine, 94 acres 3 roods 26 perches (G. S. Clarke, Mine Manager).—88 wages men and 57 tributers are employed. The chief work done by the Company has been driving and stoping on the reefs opened in the Reuben Pass section of the mine; driving a cross-cut from the main tunnel, and putting a rise up to the surface, for the purpose of working the mullock and surface-dirt on the Eureka Hill. A cross-cut is also driven from the main tunnel towards the old Inverness mine. There are several leaders in this direction which will pay when opened up. The amount of driving done on reefs by the Company was 750 feet, and 2,347 fathoms stoped out. 11,734 tons of quartz were crushed for 299oz. 10dwt of gold.

The tributers, who are working in levels near the surface in various portions of the mine, crushed 2,752½ tons quartz for 139oz. of gold.

Alfred Mine, 10 acres 1 rood 5 perches—Is chiefly worked on tribute. One wages man and 10 tributers are employed. Work is being carried on in three different levels, and the leaders are about one foot in thickness. 35 tons of quartz were crushed for the owners for 78oz. 17dwt. of gold, and 132 tons for tributers for 189oz. 5dwt. of gold.

Freedom Mine.- Two tributers were employed who obtained 70 tons of quartz from the surface portion of the mine which yielded 46oz. 15dwt. of gold.

Orlando Mine, 15 acres (Chas. D. Waite, Mine Manager).—The chief work done in the mine was driving a low level from near the creek at the foot of the steep incline on the County Tramway. 460 feet were driven, and a rise put up for 76 feet for ventilation. 66 tons of quartz were crushed for a yield of 39oz. 13dwt. of gold. Six wages men were employed.

New Whau Mine, 3 acres 2 roods 28 perches (Lucas and Party, Owners)—Four owners or wages men and five tributers were employed. The owners crushed 100 tons of quartz for 190oz., and the tributers 1700 tons of quartz and mullock from old stopes for 400oz. of gold.

New Alburnia Mine, 15 acres 1 rood (Thos. A. Dunlop, Mine Manager).—16 wages men and 8 tributers were employed. A crosscut was driven on the Whau level and the Dixon's reef cut in a new place. The quartz proving very rich, a considerable amount of driving was done on the reef at this level, and a winze sunk to another level opened 70 feet deeper. The block of ground now opened has every appearance of producing a large quantity of rich quartz 400 feet of driving was done, and 200 fathoms of reef stoped out, and 349 tons of quartz crushed for 1466oz. 11dwt. of gold.

The tributers who are working in the Whau and battery levels crushed 222 tons of quartz for 220oz. of gold.

A large amount of work was done by the Company in clearing up and timbering up the Sons of Freedom level, and repairing the main pass up to the 70 feet level, thus giving an opening to the new blocks opened on Dixon's reef.

Dixon's Extended Mine.—This mine was entirely worked by tributers who crushed 2560 tons of quartz and mullock from old stopes for 628oz. of gold. Eight men were employed.

New Chum Mine (Harms, Tayler and Party, Owners)—Crushed 1 ton 2cwt. 48lbs. of quartz for 57oz. of gold.

Sundry Other Claims in Moanataiari Creek district crushed 89 tons of quartz and 1000 tons of mullock for 312oz. of gold.

A considerable amount of prospecting has been done in the *Phœnix, Coliban, Acme*, and other claims for no returns of gold.

Grahamstown District.

Saxon Mine, 17 acres 1 rood 31 perches (Thos. H. Crawford, Mine Manager)—Nine wages men and twenty tributers were employed. The reefs at No. 6 level did not turn out as well as was expected, and the water was allowed to rise to No. 5 level, above which all working has for the most part of the year been carried on.

The Company crushed 349 tons of quartz for 215oz. 10dwt., and the tributers 59 tons for 122oz. 2dwt. of gold.

Victoria Mine, 34 acres 1 rood 30 perches (Thos. A. Dunlop, Mine Manager).—The chief work done in this mine was from the Fookey shaft. The engine and winding-gear from the Prince Imperial shaft was erected at this section of the mine. Several old levels have been cleaned out, and prospecting drives put in near the Caledonian boundary; but the results have not been very great.

The Company crushed 120 tons of quartz for 208oz. 5dwt., and the tributers crushed 60 tons for 52oz. 7dwt. of gold.

Fourteen wages men and six tributers were employed.

Sundry parcels of mullock and quartz picked up in this district were crushed for 218oz. 5dwt. of gold.

The chief tailings' plants are in this district. 19,309 tons of tailings, from all sources, yielded 4,478oz. 12dwt. of gold.

Waiotahi District.

Waiotahi Mine, 19 acres 3 roods 15 perches (James E. Smith, mine-manager).—Thirty-four wages-men were employed. The work carried on was chiefly on leaders and veins between Nos. 2 and 3 levels in the main shaft, and from Nos. 1 and 2 levels in the Mary Ann shaft. 2,298 tons were crushed for 2,578oz. 11dwt. of gold. 900ft. of driving and 800 fathoms of reef stoped out during the year.

New Manukau Mine, 3 acres and 15 perches (James E. Smith, mine-manager).—Four wages-men and three tributers were employed. The company crushed 110 tons for 153oz. 17dwt., and the tributers 400 tons of clay for 140oz. 16dwt. of gold. This mine has been disposed of to the Waiotahi Company.

Cambria Mine, 15 acres 2 roods 17 perches (William Baker, mine-manager).—Work in this progresses steadily, and thirty-three men are employed on different levels, where a number of reefs and leaders are opened up; 350ft. of driving has been done, and 450 fathoms of leaders and reefs stoped out. 2,277 tons quartz crushed yielded 2,001oz. 3dwt. of gold.

Fame and Fortune, 55 acres and 11 perches (Henry Willetts, mine-manager).—Four wages-men and an average of thirty-two tributers were employed. 49 tons 10cwt. of quartz were crushed for the owners for 25oz. of gold, and for the tributers 949 tons 10cwt. for 1,791oz. 19dwt.

Golden Age Mine, 2 acres 3 roods 34 perches.—This mine was worked by two men on tribute. 66 tons of quartz yielded 65oz. 10dwt. of gold.

The *West Coast, Bright Smile, McCurdy's, Mount Edwards*, and several other claims in this creek were worked for various returns. 164 tons of quartz and 500 tons of mullock were crushed for a yield of 327oz. 7dwt. of gold.

Waiokaraka District.

May Queen Mine, 29 acres 2 roods 27 perches (Thomas B. Hicks, mine-manager).—The machinery from the Trenton shaft was erected on an old shaft in this mine, formerly known as the Queen of the May. This shaft was repaired, and a level driven to connect with the workings from the old shaft. A considerable amount of stoping and driving was done on the reef, and 823 tons 10cwt. of quartz yielded 494oz. 6dwt. of gold.

Crawford's Special (now known as the St. Hippo), 78 acres and 7 perches (W. H. Burch, mine-manager).—The chief working during the year has been clearing up the old drives in the Nana

section, but no quartz was crushed for the company. A small parcel crushed for a tribute yielded 6oz. 18dwt. of gold.

Queen of Beauty Mine (Thomas A. Dunlop, mine-manager).—The shaft has been repaired, and the winding-gear and engine formerly on Crawford's Special purchased and erected. Several of the drives have been cleared, but no crushings of quartz have taken place.

KARAKA DISTRICT.

Adelaide Mine, 12 acres and 30 perches (George W. Bull and party, owners).—The mine has been worked entirely on tribute. Nine men were employed. 130 tons of quartz yielded 169oz. 13dwt. of gold.

Lone Hand Mine, 26 acres 3 roods 35 perches (Thomas Moyle, mine-manager).—Two wages-men were employed, and 168 tons of quartz crushed for 132oz. of gold. Twelve tributers crushed 567 tons for 370oz. of gold.

Claremont Mine (George Briant, owner).—Two men were employed during the year, and 4 tons 13cwt. 14lb. of quartz crushed for 266oz. 9dwt. of gold.

Christmas Eve Claim.—One man crushed 55lb. of quartz for 20oz. 12dwt. of gold.

Hokianga Mine (Jenkins and party, owners).—Two men were employed, and 50 tons of quartz crushed yielded 56oz. 9dwt. of gold. The workings are under water-level, and a small pump driven by water-power is used for raising the water.

Karaka Mine, 10 acres.—This mine is worked entirely on tribute. Seven men were employed, who crushed 653 tons of quartz for a yield of 198oz. 12dwt. of gold.

The *Iona, Enterprise, Hauraki, E and M, Ophir,* and several other claims in this locality have been worked for occasional rich patches. 127 tons 11cwt. 63lb. of quartz crushed yielded 429oz. 6dwt. of gold.

UNA HILL AND TE PAPA DISTRICT.

Dives Mine, 21 acres 3 roods 15 perches.—The mine has been worked on tribute. Six men were employed, and 67 tons 10cwt. of quartz crushed for a yield of 86oz. of gold.

Occidental Mine, 21 acres and 9 perches (Alexander Bruce, mine-manager).—Six men were employed. The workings are chiefly in the low level on the main reef and small leaders; 90 tons 1cwt. 12lb. of quartz were crushed for 381oz. 16dwt. of gold.

Pride of Karaka.—Two tributers stoped out a considerable portion of the reef, which was cut in the low level, and crushed 66 tons of quartz for 69oz. 18dwt. of gold.

Magnolia Mine, 17 acres 2 roods 30 perches (Henry Rabe, mine-manager).—Six wages-men were employed, and 300 tons of quartz crushed for 134oz. 10dwt. of gold. Four tributers crushed 63 tons for 49oz. 12dwt. of gold.

Boyle's Claim (Homeward Bound).—Two men crushed 16 tons of quartz for 30oz. 15dwt. of gold.

North Star Mine, 30 acres (Ronald McDonald, mine-manager).—Six wages-men and four tributers were employed during the year. The reef was cut at the new low level and good prospects obtained. Stoping was done on the intermediate and upper levels. 48 tons of quartz crushed for 133oz.; and the tributers crushed 77 tons for 198oz. 8dwt. of gold.

Just in Time Claim.—One man's ground, situated near the head of Te Papa Gully, and the surface portion of the Hague Smith Reef worked on. 63 tons of quartz yielded 13oz. 12dwt. of gold.

Several other parties occasionally work in this district, and small parcels of rich stone are obtained. 34 tons 10 cwt. of quartz yielded 116oz. 18dwt. of gold.

HAPE CREEK DISTRICT.

Consols Mine, 29 acres 3 roods 31 perches (John F. Carter, mine-manager).—This mine has been worked solely by tributers, both in surface levels and in the No. 2 and 3 levels in the shaft. Twenty men were employed, and 805 tons 10cwt. of quartz crushed for 480oz. 17dwt. of gold.

Souvenir Mine has been worked by a party of two tributers, who crushed 43 tons of quartz for a yield of 34oz. 13dwt. of gold.

Several others small claims were worked for fair returns. 20 tons of quartz were crushed for 60oz. of gold.

OTUNUI DISTRICT.

Several parties occasionally prospect in this district, but no returns of gold have been made.

PURIRI DISTRICT.

The *Puriri Mine,* situated about two miles and a half up the creek, has been worked by two men, who crushed 44 tons of quartz for 31oz. 10dwt. of gold.

A little prospecting has been done in the locality, but no returns of gold have been made.

TAIRUA DISTRICT.

Bonnie Scotland Mine, 5 acres.—This mine is owned and worked by Finlay McLiver, who obtained 65oz. of gold from 45 tons of quartz. Three men were employed.

OHINEMURI COUNTY.

MARATOTO DISTRICT.

Maratoto Mine, 18 acres 2 roods 10 perches.—This mine is worked on tribute; three men employed, and 83 tons of ore treated for 576oz. of bullion.

Several parties have occasionally prospected in this district, and one licensed holding—the Camoola—taken up, but very little work has been done.

KARANGAHAKE DISTRICT.

Ivanhoe and Truro Mine, 42 acres (John McCombie, mine-manager).—The workings in this mine have been chiefly on the surface and in levels near the top of the Taukane Hill. The owner crushed 220 tons of quartz for 138oz., and the tributers 115 tons or 109oz. of gold. Two wages-men and four tributers were employed.

Woodstock Mine, 30 acres (John McCombie, mine-manager).—A considerable amount of work has been done during the year on the No. 3 reef, which averages about 12in. in thickness; 90ft. of driving was done, and 136 fathoms of reef stoped out. Several parcels amounting to 110 tons of ore were crushed at the Ivanhoe battery for a yield of 467oz. of gold, and a parcel of 51 tons of ore was shipped to Freiberg, the assay-value of which was £40 per ton. Ten wages-men were employed.

Crown Mine, 116 acres (John McConnell, general manager, and G. Y. McGruer, mine-manager).—One hundred and twelve men have been employed by the company, about one-half in the mine and the other half in surface-work. The work in the mine in the early part of the year consisted in driving on three levels on the south side and the levels on the north side of the Waitawheta Stream, and in stoping the reef from the south low level upwards. 394 tons of quartz were treated at the company's mill by the Cassel process, and 45oz. of gold and 3,266oz. of bullion extracted. Crushing was then stopped, and the tramway completed from the mine to the new battery-site.

The erection of the 20-stamp mill with all latest improvements in labour-saving machinery and plant for the cyanide extraction process is almost finished.

The water-race—about one mile in length—from the Ohinemuri River to the new battery-site has also been constructed.

Upwards of 1,000 tons of quartz are stacked near the battery, and the whole of the passes in the mine are filled with quartz ready for transport to the mill. The chief work in the mine lately has been in advancing the levels and opening blocks of the reef for stoping. 103 fathoms of reef were stoped, and 1,500ft. of driving done on the reef, which is from 4ft. to 6ft. in thickness.

Talisman Mine, 30 acres.—This mine is situated higher up the hill than the Woodstock, the reef worked on being probably a continuation of one of the reefs worked in that mine. The reef has been driven on for about 100ft., and some stoping done. About 100 tons of quartz are in the paddock and 5½ tons were shipped to Freiberg, the assay-value of which was £33 per ton.

Earl of Glasgow Mine, 26 acres 3 roods.—This mine is part of the old Adeline Amalgamated ground, and was taken up in October last. A crushing of 5 tons of quartz yielded 28oz. of gold.

The Diamond Mine, also a portion of the Adeline Amalgamated ground (Tresize and party, two men), crushed 4 tons of quartz for 27oz. of gold.

The Imperial Mine was worked by the owner, R. Clements, who crushed 3 tons of quartz for 15oz. of gold.

Sundry other small crushings from this district yielded 26oz. 4dwt. of gold.

A considerable amount of prospecting has been done in the *Crown Prince*, *Taukane*, *Shaughraun*, *Bonanza*, *Golden Treasure*, and *Mint* licensed holdings, but no quartz has been crushed from them.

OWHAROA DISTRICT.

Smile of Fortune Mine, 12 acres 3 roods 2 perches (Archelaus Thomas, mine-manager).—The chief work has been driving and stoping at the low level by the owners, and stoping out a surface block by the tributers. Ten wages-men and three tributers were employed. The owners crushed 480 tons of quartz for 168oz., and the tributers 130 tons for 68oz. of gold.

Worth and party have taken up the *Success Special Claim*, of *55 acres 3 roods 2 perches*, on the land behind the *Smile of Fortune*, and have cleaned out an old drive and driven about 60ft. on a reef, but no quartz was crushed.

The owners of the *Madden's Folly Claim* have been engaged in driving a tunnel from the face of the hill to connect with the Government tunnel of some years ago. Two men were employed, and the tunnel is now in over 100ft.

WAITEKAURI DISTRICT.

Jubilee Mine, 103 acres and 15 perches.—The tramway to connect the mine and battery was completed, and 140 tons of quartz forwarded, which, when crushed, yielded 102oz. of gold; but some difficulty ensued with respect to ownership, and the mine was closed and protected. An average of eight men were employed.

Very little work was done in the *Waitekauri Mine* or any other mine in this part of the district, but there are always a few parties prospecting about. The number may be set down at about twenty men.

WHAKAMOEHAU (WAITEKAURI NORTH) DISTRICT.

Golden Cross Mine.—A discovery of gold was made in this district by the Lowrie Brothers during last year, and a licensed holding of 26 acres and 20 perches was granted to them on a branch of the Waitekauri Creek, about three miles above the Waitekauri battery. Six men were employed. A reef was discovered, and opened in two places. Towards the north end the reef, where cut, is about 10ft. in thickness, and consists of strong, hard, white quartz; but about 5 chains to the south the reef is about 10ft. to 12ft. in thickness, of very friable loose brown quartz, some portions being very rich. Two tons of this quartz were conveyed to the Thames, and crushed for 29oz. of gold.

Several other licensed holdings are taken up round the Golden Cross, but no further discoveries have been reported.

Another discovery, which promises to be of value, was made on another branch of the Waitekauri Creek, about 10 chains below the Komata Company's tramway, at a point about two miles and a half from the battery. The reef, which is from 4ft. to 8ft. in thickness, was driven on

for 24ft., and from the heap of quartz in the paddock an average sample was taken, and when assayed was worth £9 11s. 6d. per ton.

The number of men prospecting in this district may be estimated at about twenty.

Komata District.

Komata Gold-mining Company's Mine, 60 acres (William Morgan, mine-manager).—Fifty men were employed. This mine consists of several licensed holdings which were purchased by Mr. T. H. Russell. The tramway commenced last year was completed, and 2,000 tons of quartz conveyed to the Waitekauri battery. This quartz was crushed wet and treated by pan-amalgamation for a yield of 6,680oz. of bullion; value, £5,632 16s. The blocks on the reefs opened above the tramway-level were worked on, and the runs of gold stoped out. One reef is 5ft. and the other 9ft. in thickness. A low-level cross-cut about 100ft. deeper was put in, and the reef cut and driven on. The show in this level promises to be better than nearer the surface.

Mr. Russell informed me he had commenced sinking a winze below this level, and the quartz obtained from it was rich. It is expected that a large quantity of quartz will be crushed from this mine during the year.

Waihi District.

Waihi Mine, 422 acres (H. P. Barry, general manager; Thomas Gilmour, mine-manager).—The low-level cross-cut to work the Martha reef was completed, and the drive continued on the reef in both directions. A winze was sunk from the smithy level above, which afforded good natural ventilation to this level. Stoping is now carried on in this level, and openwork from the upper levels. The reef is worked from 10ft. to 30ft. in width. Another level has been opened on the Union reef from the shaft, and the blocks of ground on the run of gold stoped out. It is the intention to leave this part of the mine at present, as the workings on the large reef at the Martha are capable of supplying quartz for the mill at less cost.

The length of driving done in the mine for the year is estimated at 3,000ft., and upwards of 650 fathoms of reef were stoped out, giving 18,279 tons of quartz, which yielded 29,681oz. 10dwt. of bullion, valued at £48,809 1s. 1d.

The wet-crushing process was tried for some time, twenty stamps being employed in that way; but it was found that it was more profitable to have dry crushing only, so that the wet method was discontinued.

The plant for the Bohm process of cyanide treatment was completed and tried, but a very limited quantity of crushed ore was treated, it being impossible to force percolation through the slimes.

The mine, battery, and surface-works employ a large staff of men, the average for the year being 150.

Silverton Mine, 83 acres and 38 perches (F. J. Hollis, mine-manager).—The chief work during the year has been in stoping on the reef over the low level, and working in open face on the reef at the surface. The low level was stoped, as the owners have resolved to discontinue it for a time. The cyanide process is now adopted at the battery, and 800 tons of quartz was crushed for 500oz. of gold. An average of eight men were employed.

Gladstone Mine.—Two men have been prospecting during the year, endeavouring to find the Silverton reef near the surface. A shaft was sunk 30ft., and about 70ft. of cross-cut drive, but so far the reef has not been discovered.

Very little work has been done in any of the other mines. In Walker's Grand Junction an attempt was made to sink a shaft, but the pump employed was not sufficient to keep the water down in the surface-clay, so the rock was not reached.

Te Aroha–Waiorongomai District.

Te Aroha Syndicate Mine, 31 acres and 36 perches.—(This mine is managed by Mr. H. Adams.) A considerable amount of work has been done in the surface-level of the New Find, Silver King, and Warrior sections, and 853 tons of quartz was crushed for 540oz. of gold. A party of tributers working in the New Find section crushed 186 tons for 60oz. of gold. 1,650 tons of tailings were treated at the mill for 297oz. 14dwt. of gold. Sixteen wages-men and four tributers were employed. The cyanide process is now adopted at the battery, and the whole of the thirty berdans used for grinding tailings have been removed and sold.

Newsham Claim, 5 acres (Newsham and party, owners).—Operations were confined to stoping a block on the old Premier reef, near the surface. The reef is from 10ft. to 12ft. in thickness. 480 tons of quartz was crushed for 280oz. of gold. Three men were employed.

Tui District.

The *Champion Mine* has been almost idle during the year.

A new licensed holding is applied for in this district.

Broadbent and party intend to work a galena reef on the eastern side of the range, and use the Champion wire tramway to convey the ore to the flat.

Drainage.

Big Pump (Thames Drainage Board, owners; W. H. Phillips, manager).—The usual pumping operations were carried on during the year, except in the month of April, and twenty days in the month of May, 1892, when the water was allowed to rise up to the 400ft. level. It was kept at that level until the month of March last, when it had to be lowered to a depth of 50ft. below the 400ft. level, in order to drain the workings of the May Queen Mine.

It appears that in the explorations in new country at the low level in that mine when the reef was cut the flow of water increased, and gradually rose in the drive; therefore, as there is no open communication between those workings and the Pump, it took a long time for the water to find its

way through the breaks and fissures in the country rock, and, in consequence, work could not be carried on until the water-level was lowered by the Pump a further distance of 30ft.

The accompanying extracts from the report in the *New Zealand Herald* of the annual meeting of the Board—the manager's report and balance-sheet—will show the cost of pumping for the year ended 31st December, 1892.

The manager's estimate that 1,600 tons of coal would be required to pump the water from the 400ft. level for twelve months will probably be exceeded, as already it is necessary to pump from 430ft.; but if the cheapest coal is used the cost of drainage for the year 1893 will not greatly exceed that of 1892, as the wages paid during the March quarter of the present year are £117 12s. 1d. less than for the same quarter of last year.

Accidents.

No fatal accident occurred during the year. The accidents reported were as follows:—

Thomas Johns had his leg broken by fall of cage in May Queen shaft on 13th August last. A charge against the manager for negligence was dismissed by the Magistrate.

John Robinson broke his arm in the Norfolk battery in moving the belt driving the vanner to a loose pulley, on the 7th February last. Robinson was solely to blame for the accident.

Thomas Gentles sustained a fracture of the skull through being struck with a piece of rock from a blast in the New Alburnia Mine, on the 12th January, 1893. The charge had hung fire in consequence of *inferior fuse* being used, and the man returned to the face shortly afterwards, when the charge exploded, causing the injury. He was solely to blame in returning too soon to a missed charge.

Explosives.

The chief explosives used are blasting-powder, gelignite, dynamite, rack a rock, and gelatine. The fuse used is chiefly double-tape safety fuse. The use of felted fuse has been discontinued since the accident at the New Alburnia Mine in January last.

General Rules.

The general rules for the regulation of mines under "The Mining Act, 1891," are, on the whole, well observed in the Hauraki District. The managers of all mines employing twelve men keep the books required under subsection (39) of section 323.

The cages used for the ascent and descent of men in shafts are fitted with appliances to prevent a sudden fall down the shaft. With the exception of the Kapanga at Coromandel none of the mines use detaching-hooks to prevent the cages from coming in contact with the poppet-heads, but in most cases the guides are contracted towards the top so that the engine would be stopped by the cage getting jammed before it could come in contact with the poppet-heads.

Ventilation.

The mines are ventilated by natural draught; a water-blast or fan is the usual method of ventilating drives and tunnels.

General Remarks.

The returns of gold show an increase from last year for the Coromandel County. This increase has been due to the yield from the Owera Mine, and the treatment of tailings at Kuaotunu; and there is reason to assume next year's returns will be as good as the present.

At the Thames there has been a great falling-off—4,535oz. of gold and 5,879oz. of bullion. The falling-off in gold may be said to be chiefly in the area drained by the Big Pump, although there has been a decrease in the return from several of the mines in the Thames County; still, others have shown an increase. The falling-off in bullion is on account of the decrease in the Sylvia returns. In the drainage area, the Saxon had 4,427oz. less than last year; and, as the water has been allowed to rise in the low levels, there is not much hope for a large return next year. The May Queen had 1,574oz. less than last year; but as they are opening up new country there is every probability of a good run of gold being discovered. The decrease in the Trenton is 197oz. 13dwt.; and Caledonian, 157oz. The Waiotahi shows a decrease of 283oz. 9dwt., which need not be considered, the yield from this mine being so regular. The increase—from the Victoria, 32oz. 12dwt.; Moanataiari, 1,297oz. 18dwt.; Cambria, 436oz. 4dwt.; Hazelbank, 115oz.; New Manukau, 254oz. 15dwt.; Comer's Kuranui, 81oz. 6dwt.; and Hansen's Kuranui, 148oz. 1dwt.—reduces the total decrease within this area to 4,270oz. 14dwt.

The yields from the surface to the water-level portions of the ground in the drainage area are each year becoming more precarious. Prospecting operations for exploring new ground are at present limited, the chief work being confined to working out reefs and leaders in blocks not recently opened. The companies working mines at the Thames do not appear to have the means to prospect low levels, nor even the ground already drained; and without prospecting fresh finds cannot be expected. It is to be hoped that measures will soon be taken to amalgamate interests with a view of testing the deeper levels.

Another matter that is now engaging the attention of mine-owners and managers will tend to help future returns, namely, improved methods of dealing with the quartz. In the past history of this district very little, if any, provision was made to ascertain the value of the quartz before milling. The quartz was crushed, and as much gold saved as could be readily done on copper-plates, and by amalgamation in pans and berdans; but lately steps have been taken to sample the quartz by catching a portion of the crushed quartz and water at the gratings every quarter of an hour, and drying, sampling, and assaying the parcel at the end of a week, or longer, as the case may be. There is no

doubt, when the loss is ascertained in this way, methods of treatment to save a larger percentage of the gold originally contained in the quartz will be adopted, by concentration, and treatment of the concentrates by the cyanide, chlorine, or other process. Unless more vigorous prospecting is carried on, and a larger percentage of the gold saved, an increase of the returns at the Thames can hardly be hoped for.

The increase in Ohinemuri County of gold, 700oz. 1dwt., and bullion, 19,530oz., is due to the returns from the Crown, Komata, Waihi, and Silverton Mines; and a continuation of good yields may be expected from Waihi, Komata, and Karangahake Districts.

On the whole it is evident that an increase of value of gold and silver may be looked for throughout the district during the next year.

I have, &c.,
GEO. WILSON, Inspector of Mines.

The Under-Secretary, Mines Department, Wellington.

No. 5.

Mr. Warden HEAPS to the UNDER-SECRETARY of MINES, Wellington.

SIR,— Nelson, 28th April, 1893.

Herewith I forward the annual mining returns for the portion of the Karamea Mining District under my jurisdiction. From them you will gather that the amount of mining done in this district during the past year has been small. Only about thirty men are now engaged solely in mining in the Wangapeka District, but during the best part of the summer some twenty more men were at work on the upper branches of the Wangapeka River, where some heavy nuggety gold was obtained, there being good authority for stating that at least one nugget of about 30oz. was found. On the Mount Arthur Tableland only eight men were at work.

The year, however, has not been entirely without interest from a mining point of view, and the men at work are reported to have been fairly paid for their labour, notwithstanding the season was against them owing to the excessive rainfall. The methods of working practised in the district are fossicking, sluicing with boxes, and ground-sluicing. On the Tableland one man, who commands a good supply of water, is said to have done well.

In the Wangapeka District there is some shallow alluvial ground, but the principal work is done in the beds of rocky mountain-streams, where some good patches are reported to have been come upon. It is not considered, however, that on the average more than about £2 per week per man has been made. Besides the regular miners, the settlers in the district supplement their incomes by digging at odd times. The chief interest of the year, however, has centred round the prospecting parties which were out in the upper waters of the Karamea and its tributary, the Crow River. It will be remembered that, early in the season, I forwarded an application from a Mr. Robert Henry—one of the prospectors referred to above—for assistance in prospecting this country, and in reply the Hon. the Minister of Mines was good enough to say that if a Miners' Association or local authority would adopt Part XV., page 25, of the Regulations under "The Mining Act, 1891," a subsidy would be provided under Class I. thereto, being the only provision applicable. Apparently a Miners' Association was not formed, but Mr. Henry, it appears, wrote to the Chairman of the County Council with a view to securing this subsidy, but got no reply. A sum, however, was subscribed locally, and at first a party of four went out and were away for five weeks. On their return they reported having traversed most of the principal creeks emptying into the Karamea as far down as the mouth of the Crow River, and found them all carrying gold, there being plenty of ground that would pay between two and three pounds sterling per week if there was a pack-track through, but which will never be worked until there is such a track. After this two parties of four each made their way to the mouth of the Crow River, and after four months' prospecting Henry reports that, generally speaking, it is a country of fine gold, at which small but steady wages could be made, and that "it is a magnificent country for settlement," there being thousands of acres of rich river-flats and branching valleys, lightly timbered, capable of growing anything—a country in which small settlers would never be short of a few pounds, for in the beaches, terraces, and feeders of the Karamea for thirty miles there is from £2 a week upwards to be made; and goes on to say, "I speak with certainty of this, for we proved them, and in fine gold there is no difficulty in striking an average." As it is now, however, the digger has to carry his tucker on his back a four-days' trudge over the ranges. This, and the loss of time through bad weather, handicap the country against being worked to advantage. When once it is opened up, he says, it will be a country splendidly suited for a class of men who would combine settlement with mining. When the time comes for opening it up, which cannot be too soon, he thinks it must be done from the Nelson side, there being some twenty miles of a granite gorge from the Karamea settlement to the Roaring Lion River, to put a track through which would cost as many thousands as it would take hundreds to open the country from the Nelson side, from which side three routes are practicable—the Kiwi saddle in the Wangapeka, the Baton saddle, and the Leslie River from the Tableland—but gives the preference to the two former as they would open up the Crow River, and could then be continued down the Karamea River to the Roaring Lion River, which is a noble river with elbow-room for a hundred prospecting parties. Under the circumstances, and after reference to Mr. Browning, Chief Surveyor, I have no hesitation in recommending that steps be taken to continue the present horse-track, with dray-road grades, from the Wangapeka saddle to the Karamea River.

I have, &c.,

The Under-Secretary of Mines, Wellington. WILSON HEAPS, Warden.

No. 6.

Mr. Warden GREENFIELD to the UNDER-SECRETARY for MINES, Wellington.

Sir,— Warden's Office, Westport, 16th May, 1893.

In transmitting herewith the statistical returns for the Karamea Mining District for the year ended 31st of March, 1893, I have the honour to report on the mining industry in the various localities or mining centres within this district. The report will be brief, as there has been very little alteration, improvement, or change since my report for the previous twelve months.

ADDISON'S.

All the old claims have done well, even better than any previous year for some years past: this may probably be attributed to the fact that the rainfall during the year was more regular and more plentiful, and consequently the work was more continuous.

The Venture Gold-mining Company, to which I referred in my last report as a revival of an old industry—viz., crushing black-sand cement, has been doing well all through the year.

A new company has been formed to work the Shamrock Lead. Up to the present time the efforts of the company have been confined to the water-supply by cutting a head-race from the Totara River.

The only other new claim is one taken up by Mr. Basset on Wilson's Lead, north of Addison's, which is now being worked.

There has been a good deal of prospecting during the year by small parties of miners, but as yet no discovery of payable gold has been reported.

CHARLESTON.

There has been no change in this district in the mining industry that calls for special notice. The syndicate formed, or, rather, said to have been formed, to work certain special claims on Brown's Terrace, fell through, and it is doubtful if the ground will now be worked on any large scale.

MOKIHINUI.

There has been no gold-mining in the Mokihinui District proper, but there may be about ten or twelve miners between Mokihinui and Ngakawau.

In this district, owing to the starting of the Mokihinui and Westport-Cardiff Coal Companies, there has been a demand for land for homesteads and settlement. Several blocks were surveyed into five-acre sections for selection under the village homestead clauses of the Land Act, but, owing to the alteration of the law vesting the administration of the lands on the Buller Coal Reserve in the Minister of Mines and Warden, *to be dealt with under the Mining Act*, the land could no longer be dealt with under the Land Act. Many sections will, I believe, be taken up under the Occupation License Regulations, although the tenure is not considered satisfactory for such small areas for building and homestead purposes only.

In addition to the above, I have had a township surveyed in quarter-acre sections a few miles up the Mokihinui Valley, on the Westport-Cardiff Company's leasehold. This township I have named Durham, and many of the sections have been taken up under business licenses. It seems, however, rather hard on the people to have to pay £3 per annum for a quarter of an acre of land, while others not very far from the township can take up 5 acres at 5s. per annum, the maximum rent of an occupation license, although the business license gives the right to trade.

I also desire to point out that at Mokihinui and in other parts of the Buller Coal Reserve there are large tracts of non-auriferous land—hill-tops, terraces, and swamps—that would readily be taken up if some tenure could be given at reasonable rents of much larger areas than is allowed under occupation licenses, which would be a great advantage to the district, and add considerably to the revenue.

The right to grant licenses to cut flax on the Buller Reserve and Mining District is also much required: at present there is no power to grant such licenses within the reserve.

NORTH BEACH.

It is estimated that there are about 35 miners still employed as "hatters" working this beach, and as a rule they make very poor wages.

OLD DIGGINGS.

There is no alteration in this field since my last report worthy of note.

LYELL.

During the past year mining in this district has been very quiet, no discovery of any importance having been made, and the following are the particulars of the mines at work, viz.:—

United Alpine Company.—The operations of this company have been fairly successful, seldom failing to pay a monthly dividend, although the stone crushed was not of very rich quality. In No. 7 level operations have been confined to breaking out quartz and sinking a winze on the reef, which is now down about 90ft., the reef showing good gold. The company are also prospecting in No. 4 level by extending the tunnel. It is expected that another block entirely different to that at present being worked and lying about 100ft. to the westward of same will be struck in about a month's time or less.

Crœsus Company.—The licensed holding held by this company now belongs to Messrs. Edge and Kelly, of the Tyrconnell Mine, who purchased it with the crushing-battery.

Lyell Creek Extended Company.—The work of extending the tunnel has been steadily carried on, in the early part of the year by wages-men, and now by contract. No reef has been struck yet, but the indications to some appear favourable.

United Italy Company.—This mine is worked by tributers, who were engaged in the early part of the year prospecting for a leader, which was struck after they had driven 600ft. of a tunnel. They are now engaged in getting out stone which is considered payable, and they expect to crush within a month or two.

Tyrconnell Company.—This is another leader claim, worked by four men. During the year two crushings were got out, both being very payable. The holders of this claim are engaged in sinking on the leader in order to get out another crushing, and also in prospecting, and they have applied to increase their area.

There is nothing to report on alluvial mining.

MURCHISON.

Matakitaki Dredge.—The company has been re-formed, and under the new management the dredge machinery was strengthened. Greater success appears to attend the operations now, and I understand their liabilities are being rapidly paid off, and that a dividend is shortly expected.

Alexandra Dredge.—Alterations have been made in this dredge, materially reducing the working-expenses, and for some time past there has been a substantial margin of profit on the company's operations. This has been devoted to reducing the liabilities, which were heavy, hence the absence of dividends.

With regard to alluvial mining there is nothing requiring special mention, excepting that a good many Chinese have left the district. The European mining population remains about the same as last year.

COLLINGWOOD.

There is very little to chronicle in this district that is new, as no fresh ground has been opened. Johnston's United Mine has again been placed under the management of its former manager, Mr. W. Johnston, who has taken charge under a second-class certificate, so that only twelve men may now be employed underground. Formerly some twenty-five to thirty men were so employed. I am afraid the present outlook is not over promising, as a new level is required, and as this will probably cost a few thousand pounds to open it is not likely to be undertaken by the present company. Sinking a winze may be attempted, but that would necessitate pumping- and winding-gear, and it is doubtful if it would pay. The company crushed during the year 6,375 tons, which yielded 1,142oz. No dividends were paid during the year.

The Parapara Hydraulic-sluicing Company, newly formed during the year, purchased the Glengyle Claim, and all the mining rights of the Red Hill Company, and water-rights held by McCarthy, Adams, and Gilmer. Mr. John Guthrie was appointed manager, and some twelve men have been pretty regularly employed prospecting, and the company have also secured some additional water-rights.

Messrs. Beetham and party, under the management of Squires and Bray, are constructing an extensive tail-race to open up ground into the Rocky River, which is estimated to cost about £2,000. Some half a dozen men are employed, and are getting on well with the work, and with good prospects of satisfactory results.

The Parapara Iron Lease.—The Onehunga Ironworks Company have had some ten men employed, in order to comply with the labour clauses of the lease. It is rumoured that the company is waiting for a duty to be put on imported iron, when extensive works will be started.

There are prospects of dredging-claims being taken up on the Aorere River. Alluvial working appears to be falling off.

Land-clearing and settlement has been steadily advancing, but the difficulty of acquiring land within a mining district for settlement will, I am afraid, seriously interfere with such advancement.

I have, &c.,

The Under-Secretary of Mines, Wellington. ALFRED GREENFIELD, Warden.

No. 7.

Mr. Warden STRATFORD to the UNDER-SECRETARY of MINES, Wellington.

SIR,— Warden's Office, Reefton, 29th April, 1893.

I have the honour to forward to you herewith the usual statistical returns for the year ended 31st March last, and beg to submit the following report on the Inangahua District for the same period.

I very much regret to say that the results of the year's operations are not as satisfactory as could have been wished, the dividends being confined to five claims. Comparing the past year with the previous one, I find that this year the calls made were less by £7,156 14s. 2d.; and the dividends also were less by £13,843. A little larger quantity of stone has been crushed, for a smaller yield. From the date of the opening of the district to the 31st March last, 579,812 tons of quartz have been raised and crushed, from which 427,584oz. of gold were obtained, representing a value of £1,666,913, out of which sum dividends were paid to the amount of £532,749. The yield of alluvial gold for the same period is approximately estimated at 113,599oz., valued at £417,508: making the total production of the district 541,183oz. of gold, of the value of £2,084,421.

The following list gives a detailed account of the calls made, dividends declared, &c., by the various companies in the district for the past twelve months:—

List of Calls made, Dividends declared, &c., by various Companies.

Name of Company.	Calls made.	Dividends declared.	Stone crushed.	Yield.	Value.
	£ s. d.	£ s. d.	Tons.	Oz.	£ s. d.
Globe	...	2,700 0 0	9,297	3,584	14,356 0 0
Keep-it-Dark	500 0 0	...	1,550	470	1,880 0 0
No. 2 South Keep-it-Dark ...	600 0 0	2,200 0 0	2,406	1,664	6,656 0 0
Eureka	150 0 0	...	...	...	...
Supreme	233 6 8	...	400	17	51 0 0
General Gordon	300 0 0	...	...	...	...
Wealth of Nations ...	1,625 0 0	...	721	218	872 0 0
Wealth of Nations ...	...	...	Tailings.	99	396 0 0
Big River	...	4,200 0 0	1,444	2,555	10,215 10 3
Golden Treasure	1,200 0 0	...	...	...	...
Welcome United ...	600 0 0	...	...	...	...
Exchange	800 0 0	...	...	...	...
New Golden Point ...	600 0 0	...	...	...	...
Cumberland	...	6,600 0 0	3,952	4,304	17,500 15 8
Durham	200 0 0	...	...	...	...
Kapai	300 0 0	...	...	...	...
Success	200 0 0	...	...	...	...
St. George	400 0 0	...	15	35	140 14 1
Sir Francis Drake... ...	1,800 0 0	...	...	...	...
Golden Hill	400 0 0	...	39	9	36 7 1
A1	50 0 0	...	3	43	176 17 1
Inglewoood	150 0 0	...	500	334	1,300 0 0
Merrijigs...	100 0 0	...	...	...	...
Golden Bar	100 0 0	...	...	...	...
Pandora	500 0 0	...	...	...	...
Hercules...	1,000 0 0	...	107	40	161 1 0
Homeward Bound ...	275 0 0	...	17	55	219 17 8
Venus	700 0 0	...	365	204	816 0 0
Energy (private company) ...	...	...	583	560	2,240 0 0
Gallant	700 0 0	...	224	63	253 13 9
Golden Lead	...	...	5,439	937	3,745 16 10
Inkerman	1,166 13 4	...	393	165	614 4 1
Inangahua Low-level Tunnel	100 0 0	...	...	...	...
Scotia	343 10 10	...	...	...	...
Progress	...	1,200 0 0	9,695*	3,878	15,515 0 0
Sir Charles Russell ...	1,000 0 0	...	...	...	...
Dillon	150 0 0	...	...	...	...
Frying-pan	500 0 0	...	...	...	...
Lord Edward	400 0 0	...	...	...	...
Specimen Hill	750 0 0	...	...	...	...
Fiery Cross	806 5 0	...	150	145	584 8 6
Fiery Cross	...	...	Tailings.	154	622 1 6
Royal	100 0 0	...	135	114	457 6 1
Golden Fleece (private company)	...	...	210	382	1,528 0 0
Welcome	...	...	Tailings.	85	340 0 0
Argus (private company) ...	...	...	48	57	215 11 6
	£18,799 15 10	16,900 0 0	37,693	20,171	80,894 5 1
Alluvial gold	...	...	...	4,207	16,407 6 0
Totals	...	...	...	24,378	97,301 11 1

* In this case the tonnage is only given approximately.

Following the plan usually adopted in reports from this district, I now beg to submit for your information a short account of the work performed by the principal companies in the district.

Devil's Creek.

Globe.—The main shaft has been sunk to a depth of 125ft. below No. 4 level. A cross-cut was put in to intersect the western reef, which was met with after driving 216ft. The reef has been driven on 100ft., the stone averaging 4ft. 6in. in width. There will be 162ft. of backs from this level. The winze, which at the date of the last report had been sunk 70ft., was continued to a depth of 136ft. An intermediate level was opened from this winze at a depth of 70ft., and stone of an average width of 15ft. has been driven on 100ft. The principal part of the stone crushed during the year was obtained between Nos. 2 and 1 levels on the eastern reef. No. 1 level on the eastern reef was extended further east a distance of 100ft., with the view of picking up another block of stone found on the surface, but without any important result. During the year 9,297 tons of quartz have been crushed, yielding 3,584oz. of gold, valued at £14,356, out of which dividends to the

amount of £2,700 have been declared. This company has a very valuable asset in the shape of 40,000 or 50,000 tons of tailings stacked ready for treatment, and for which I understand they refused £4,000. From the opening of the mine 60,033 tons of quartz have been crushed for a yield of 30,410oz. of gold, valued at £120,462, from which £40,000 were given in dividends.

Progress.—When the last report was written No. 3 level had just been opened; but on rising on the reef an extensive fault was found to exist, which rendered the level unremunerative to a great extent, and disappointed the anticipations then held out. A reference to that report will show that in No. 3 level over 240ft. of payable stone had been driven on and consequently left on the floor. Since that time the main shaft has been sunk to a further depth of 150ft., a winze also being sunk to the same depth. A chamber was constructed at the bottom of the shaft, and a connection with the winze established. This connection is now known as No. 4 level. The reef was first opened on from an intermediate level 55ft. above No. 4 level, and there it is 14ft. in width, the stone being of good quality. In No. 4 level the reef was cut in establishing connection between the chamber and the winze, and is at this point of great width, being 34ft. 6in. from wall to wall. The mine has at no time in its previous history looked so well and promising as at the present time, a very large body of stone having been proven to exist between Nos. 4 and 3 levels of a highly-payable character. The battery started crushing on 20th March with one shift, but is now running three shifts. Up to the present time 895 tons have been crushed for a return of 2,078oz. of amalgam. The highly-payable character of the stone is thus established. The whole of the plant is in excellent working order, so that, with the very large amount of payable stone in sight, a long and prosperous career may be looked to. During the year about 9,695 tons of quartz have been crushed, giving 3,878oz. of gold, valued at £15,515, out of which £1,200 has been expended in dividends. The total output, &c., of the mine is as follows: 36,045 tons of quartz crushed, yielding 15,578oz. gold, valued at £62,058; dividends, £8,400.

Big River.

Big River.—On the completion of the shaft to No. 3 level, a cross-cut was driven 136ft. in a northerly direction to reach the perpendicular of the winze, which was connected with the level by an uprise of 70ft., and opening out from this point stone was stoped up to No. 2 level. On driving the main level, a block of stone was met with 55ft. from the chamber, and this was stoped up 70ft., when it ran out. A winze has been sunk on this stone to a depth of 70ft. below No. 3 level, the stone being of good width, being at least the width of the winze, and of a highly payable character. The main shaft is being sunk for No. 4 level, and is now down to 42ft. The new level should be opened in about six months' time. During the year 1,444 tons of stone have been milled, yielding 2,555oz. of gold, valued at £10,215, out of which shareholders have received £4,200 in dividends.

Merrijigs.

Golden Lead.—During the year a considerable amount of prospecting has been done, and crushing has been carried on continuously, the auriferous veins being stoped out above No. 2 level. There are two distinct runs of stone being worked, about 12ft. of hard sandstone separating them at the low level; but as the workings are carried upwards the distance between the lodes increases in width, until, at the highest point reached, they are about 30ft. apart, leading one to suppose that at a still lower level they may come together, and probably form a permanent lode. There is still a large quantity of water on No. 2 level, so that sinking cannot be resorted to, unless at a very heavy expense. Further and deeper prospecting will have to be done by driving a low-level tunnel to cut the lode 350ft. below the present workings, which will necessitate driving a tunnel 1,100ft. in length. The crushing-dirt is conveyed from the mine to the battery in Deep Creek by an aërial tramway, 67 chains in length; the difference in fall between the terminals is 1,010ft. 5,439 tons of stone have been crushed for the year for a return of 937oz. of gold. The mine is cheaply worked, and a small improvement in the yield would return dividends to the shareholders.

Sir Francis Drake.—Since completing the sinking of the winding-shaft to the depth of 230ft., a winding-engine and substantial poppet-heads have been erected, and a tunnel driven from the bottom of the shaft 450ft. The reef was struck after driving about 250ft., and has been driven alongside of for about 200ft. The reef at the end of the drive is about 5ft. wide, and is considered payable. A connection has been made with the winze, and the mine is now being opened up, and it is expected crushing will commence about the beginning of May; and, having about 190ft. of backs, the battery should be kept continuously crushing for many months to come, and it is anticipated with profitable results.

Cumberland.—During the year the main level was extended about 150ft. in a north-westerly direction, at which point the reef was intersected. The reef has been driven on in the low level for 110ft., the stone being of an average width of 12ft. The opening of a new level is contemplated, and it is proposed to sink an incline-shaft alongside the reef, working it by means of compressed air or electrical machinery. As, however, the lode is irregular in direction and dip, I believe a winze will be sunk on it before starting the shaft. The erection of a plant for the treatment of tailings by the cyanide process is contemplated. The company have already about 7,000 tons of tailings stacked, the average value of which is about 11dwt. per ton. Since the mine was opened 7,582 tons of stone have been crushed, yielding 7,742oz. of gold, of a value of £31,407 19s. 8d., out of which £10,800 have been paid in dividends.

Crushington.

No. 2 South Keep It Dark.—The principal prospecting work done during the year has been the extension of the Hercules Company's lowest level into this company's ground, but as yet nothing payable has been met with. Some prospecting has also been done above No. 2 level, about 200ft. south of the block of stone lately worked out. Quartz has been disclosed, about 2ft. thick, carrying good gold, but sufficient work has not yet been done on it to prove its extent. The company

has purchased the Pandora licensed holding of 29 acres, and its half interest in winding-engine and shaft formerly jointly held by the two companies. The lode at the southern end of the claim was nearly on the boundary of the two claims. The main shaft will now be sunk and the reef developed at a lower level.

Wealth of Nations.—The sinking of the branch winding-shaft has been continued to a depth of 150ft. below the 200ft. level, and the winze, which was sunk partly on the reef, was continued to the same depth, and a level driven connecting the two openings. In this level two new blocks of quartz were intersected, further south than was expected. Trial crushings were taken from them, but the stone was found to be too poor to be profitably worked. An intermediate level has since been driven from the winze, and payable stone has been found further north. One hundred tons of stone from this block have just been crushed, yielding at the rate of 10½dwt. of gold to the ton. The dimensions of the block are not yet known. The 350ft. level is now being extended to intersect this reef below.

Keep It Dark.—There is not much to report of a favourable nature for the past twelve months. Stoping was continued between Nos. 5 and 4 levels. On No. 4 level a drive was put in west for a distance of 120ft., and a little stone of low grade was found. On the No. 3 level a cross-cut, east and west, was put in at the north end, but without striking any stone. At the present time a drive is being put in north from the inside shaft. On No. 1 level some stone left in the old stopes was taken out and crushed, but it was not payable. On the battery level a cross-cut was driven east 270ft. to intersect the old Keep It Dark block, and an uprise of 184ft. was taken up, and about 200 tons of stone were taken out and crushed, yielding about ½oz. to the ton. The total output of the mine has been 112,194 tons of quartz, which yielded 59,596oz. of gold, valued at £232,010, out of which dividends were paid to the extent of £108,083.

GENERAL.

In Murray Creek, the Venus and Royal Companies are working on tribute, and occasional crushings are being taken out. The Inglewood Company was until recently also worked on tribute. In the Painkiller district driving for the reef in the low level is being continued. In the Boatman's district but very little work is being done. The Homeward Bound and Eureka Companies have amalgamated. The Eureka incline-tunnel has been cleared out, and I believe driving for a continuation of the old Welcome Reef at a lower level will shortly be commenced. The Cassel Gold-extracting Company have extended their operations here, and a plant, subsidised by the Government, has been erected by the Boatman's Tailings Company to treat their tailings by the cyanyde process. Everything will be ready to commence operations in a few days. A very great amount of interest is felt in this matter, as in the event of the process being successful other plants will be immediately erected at other mines, which will undoubtedly prove of great benefit to the district by increasing the yield of gold. It is a matter for regret that but few companies in the past took the precaution to save their tailings, and it cannot be denied that many thousand pounds' worth of gold has thus been lost.

Some time since, the people of Reefton, recognising the necessity of finding employment for those out of work, and developing the district, endeavoured to form a prospecting association. But unfortunately, owing to a want of unanimity, the scheme fell to the ground. The miners working at the Globe Mine then took the matter in hand and formed an association of their own, a step in which they are heartily to be commended. A prospector was sent out, and he recently discovered a reef of good quality in the Painkiller district. Sufficient work, however, has not been done on it at present to determine its value.

So far, none of the companies in this district have created a reserve fund, nor have the workings been sufficiently advanced beyond present requirements, with the consequence that, with the exhaustion of payable stone, funds have not been available to prospect for new makes of stone at deeper levels; and it is to the existence of such that the permanency of the district must greatly depend. These are matters, I think, worthy of consideration, and must sooner or later engage the attention of those interested in mining.

In conclusion, I have to thank managers of companies for much information kindly given.

I have, &c.,

The Under-Secretary of Mines, Wellington. H. A. STRATFORD, Warden.

No. 8.

Mr. N. D. COCHRANE, Inspector of Mines, to the UNDER-SECRETARY of MINES, Wellington.

SIR,— Inspector of Mines' Office, Westport, 29th April, 1893.

I have the honour to report as follows on the gold-mines in the Marlborough, Nelson, and Westland Districts, and to enclose summary of battery-returns for the past year:—

WAIKAKAHO.

Southern Cross Quartz-mine.—(6/12/92): Not working at present; probably waiting to see how the crushings from the reef in the adjoining claim turn out. I learned that a good deal of surveying had been done lately in connection with lines for water-races and aërial tram.

Ravenscliff Quartz-mine.—(6/12/92): Stoping going on from an intermediate level below No. 1. From the bottom of the pass a distance of 86ft. has been driven to north on the reef, which then pinches. In the stopes above this there is about 2ft. of stone, and in the south stope the width of the lode is about 8ft., of which 6ft. is quartz, the remainder being two bands of country rock within the stone. Air good. Copy of Act at office. Manager's name posted, but general rules not yet received from printer. Twenty-three men in all employed. A past crushing has turned out poor,

so the crushing at present going on will have an important bearing on the future of the field. This crushing of 275 tons has since resulted in a yield of only 35oz. of gold, and work has been suspended. The result is to be regretted, both on account of the large outlay which the company has made and the reverse which it will cause to quartz-mining in the district.

COLLINGWOOD.

Johnston's United Quartz-mine.—(14/12/92): On entering this mine by the incline I found that the timbering therein, to which I had previously directed attention, had been renewed. Owing to the flat underlie, the workings are similar to a coal-mine. Five men were working, forming pillars above the No. 2 level, in the eastern face of which the quartz had pinched out. The stone runs from 2ft. to 4ft. in thickness. Air rather dull in this section, so I requested Mr. Johnston to stop some of the openings, to conduct a better current into the faces; and this he agreed to do. Two men were working in the No. 2 level, where the air was good. Two shifts are worked, and, including battery, a total of twenty men are employed. Report two days behind. Copy of Act at mine, but the old rules still up. Crushings have not been so good lately, but most of the pillars left are believed to contain payable stone. This mine was revisited on the 22nd February, on account of a serious accident—the only one, fortunately, which has occurred during the year in any of the quartz-mines in my district. A miner named William Norton, on the 17th of that month, had lighted his fuse and retired, but returned directly, as he thought it had not caught, when the charge went off, injuring his hand and eyes so badly that the right arm had to be amputated above the wrist and the left eye removed. Returning to his shot after lighting the fuse was in direct violation of the general rules. These I found duly posted on this occasion.

REEFTON.

Progress Quartz-mine.—(29/9/92): Mr. Fahey was now manager, as I had notified the company that Mr. Flanigan could not continue in charge when he had not gone forward to examination during the period of his exemption-certificate. I drew attention to one or two places flaking in the No. 2 level. No safety-catches on cage at blind shaft, but the men use the ladders. Two men were driving in No. 3 level. In addition to stoping in new block of stone, a winze, which was down 36ft., was being sunk from that level. Stoping was going on in Adam's block, and the main shaft was also being sunk. This was down 108ft., and it was intended to open out at 150ft. Plan kept. Copy of Act in office. Report up to 24th instant only. Fifty-three men in all employed. Some time after this, as I heard of Mr. Fahey's resignation, I notified the company that a certificated manager must be appointed. After this, but before it could be pushed to a conclusion, a complaint came in about there being no first-class certificated manager. Mr. James McCallum, formerly of the Inkermann Mine, was appointed before the time for taking legal action had expired. (7/3/93): Workings in Smith's block discontinued, as stone too poor, running only 2½dwt. Ladders to No. 3 in good condition. Winze being sunk to connect with lower level; in this the stone lined down over a hundred feet. In No. 4 level face quartz is beginning to show; this will connect with the winze in a day or two. Some timbering requiring attention in No. 2 level and pass to stoping: this is to be seen to. Plan up to 17th January. Manager's name posted. As the safety-catches and cover on cage were still wanting, I notified the legal manager that these and indicator must be at once provided. Since date of inspection another reef has been got, which was missed by the winze, and which has much improved the prospects of this mine.

Globe Quartz-mine.—This mine was inspected in September. When I revisited it (8/3/93) an intermediate level and one stope were working below No. 4. I drew Mr. Grunish's attention to some loose stone here, which he ordered to be seen to at once. A cross-cut from the shaft at a depth of 625ft. strikes the line of reef at 215ft., and thence the No. 5 level is being extended to the east. There are 160ft. of backs from No. 5 to No. 4 levels, and the length of this block, which was good payable stone in the latter, was about 160ft., but it has only been driven on for some 50ft. in the intermediate level. Fourteen men are stoping below the No. 1 level, in two shifts, but the stone here is poorer. Some of the timber in this level requires renewal, and is to have attention. Rules and signals posted, but manager's name not up. Plan behind, so I notified the legal manager to have survey made at once. Forty-six men in all are employed at this mine.

Wealth of Nations Quartz-mine.—(7/10/92/): A block of quartz has been worked below the No. 1 level, but was found too poor and therefore discontinued. Now working from shaft, and only three men employed per shift, or a total of eleven men. More cannot be put on till a connection is made for air. Air poor, but will be improved when through on winze. Detonators attended to. (11/3/93): Fifty feet below No. 1 level two men are working on a 9ft. reef, 3ft. in the hanging wall from the one the winze was sunk in. Gold showing in face; and as the other reefs proved poor the prospects are now improved. One hundred feet below this two men are extending No. 2 level to north to intersect this block of stone. Ladders in good order. Fair current of air. General rules and manager's name posted up. Report and plan properly kept.

Keep It Dark Quartz-mine.—(7/10/92): No. 3 level, which is at a depth of 500ft., is being retimbered to allow some prospecting to be done. The air here was poor and warm, so I notified the legal manager, as well as directing Mr. Fitzmaurice's attention to it. No work doing in No. 4, but in No. 5 the reef was worked underfoot for 37ft. in depth, when it pinched out. Four men are stoping 80ft. above this level, and a like number, in two shifts, extending a cross-cut from the battery-level to strike the line of the Hercules reef. (11/3/93): Nothing doing in No. 5 level, and only two men working in No. 4, extending it to the west. This was not formerly worked, as the stone was considered too poor. I drew the manager's attention to the logging of pass from No. 3 to No. 4 level, and it is to be attended to. Two men per shift are also engaged retimbering in No. 3 level. Rules posted, survey made four months ago, but plan not at mine. The prospects of this mine are not promising at present.

Hercules Quartz-mine.—(7/10/92): The No. 7 level has now been connected with the No. 2 South Keep It Dark workings, where the face is standing on the track of the reef. In this level 150ft. to the south of where the cross-cut strikes the lode, a winze is being sunk and is now down 60ft. The average thickness of stone in this is about 2ft., and it lines underfoot. A second winze is sinking 350ft. further south, in which the stone is poorer, but of greater thickness, averaging perhaps 3ft. It is proposed that the main shaft should be sunk if the stone from the winze proves payable. Last crushing yielded 8dwt. per ton. No report kept, and manager's name not posted up. This will be attended to in future. (11/3/93): No one about outside the mine, and I had not time to wait and inspect it. General rules posted, and Act hanging up. The main shaft is being sunk below No. 7 level. Nothing else is or will be doing until this is completed. The prospects of this mine are improved.

No. 2 South Keep It Dark Quartz-mine.—(6/10/92): J. S. Treloar, certificated, in charge, as Mr. Lawn was laid up with a cold through the strong current of air occasioned by connecting with the Hercules Mine. I have never required to find fault with Mr. Lawn for bad air, but managers should keep themselves accustomed to a good current. Sets and laths being renewed in No. 2 level. Two men stoping from winze in north end, where the stone is about 18in. thick, but it does not extend further towards the Hercules boundary and only lived down 33ft. This is the winze which is connected with Hercules No. 7 level. Five men are also stoping near the surface, from a winze near the old filling-shaft. Signals posted; plan not at mine. Report not kept since Mr. Lawn left, a fortnight ago. A contract has been let for an extension of the Hercules No. 7 level into this mine. The prospects are not too promising.

Pandora Quartz-mine.—(6/10/92): Only two men working, extending to the south-west the No. 1 level, which corresponds with the No. 2 level of the No. 2 South Keep It Dark. The face is following the track of the reef, but only leaders showing. Air not too strong, and, as it would be insufficient when shot-firing, I notified Mr. Collings, the legal manager. I am informed this mine has since been stopped.

Energy Quartz-mine.—(10/10/92): Working from top level as formerly. Two men are stoping, one filling in and one sinking a prospecting-winze, which is down 40ft. from the level. The stone so far has lined down, and is about 14in. thick on the foot-wall; there is then a few inches of casing, and then 4ft. of barren quartz, making a total width between the walls of 5ft. 6in. Two men are also working in a drive to the east of the stoping, cutting out a chamber to sink for some stone on the foot-wall. The reef lies very flat. There is a fair current of air led in in boxes. I requested the top of winze on travelling-road to be protected.

Royal Quartz-mine.—(1/10/92): Only one man stoping, and another uprising, about 100ft. above the lowest or No. 3 level. Two other men, who sometimes work in the mine, were in the bush getting timber at the time of my visit. Air, poor; so I wrote the legal manager. The block of quartz being worked is only some 40ft. in length, and averages 18in. in width. (10/3/93): Six men stoping 150ft. above No. 3 level. A slight improvement noticeable in the air, but not yet as good as it should be. I notified the legal manager that it must be attended to or action would be taken, and recently received a telegram that the directors had instructed tributers to connect with upper workings, failing which it would be done at their expense. The average thickness of quartz is now about 10in., and more or less in bunches. No rules, and no copy of the Act; but I am informed they have since been provided.

Venus Extended Quartz-mine.—(1/10/92): Five men stoping three sets above No. 3 level, where the stone runs from 1ft. to 2ft. in thickness. Air right here. A cross-cut below the No. 4 level has just struck the reef. Air not too good, but will be improved in a day or two when the places are connected, as there is only some 5ft. to go. Three men are working on tribute in No. 1 level. Air good. Reef here is bunchy. Some of the timbering requiring attention, which it is to have. Manager's name, and copy of rules not posted. (10/3/93): Eight men in two shifts stoping from No. 3 level. Air fairly fresh. Some stoping is also being done from the No. 4 level, employing four men. The work in No. 1 has been stopped. Detonators on roadside to be removed. The new rules, which were not up at last visit, have now been obtained, and, with manager's name, are duly posted.

Golden Treasure Quartz-mine.—(10/3/93): Not working; no one about, and hut locked up.

Inglewood Extended Quartz-mine.—(10/10/92): Working as formerly from winze underneath the low level. Nine men in all, in two shifts, working on tribute. Plan kept. Air very good. The reef at present being worked averages 2ft. in width, and is separated from the other reef by from 2ft. to 8ft. of the hanging-wall. The latter reef varies in width from 1ft. up to 7ft., and is a poorer class of stone. This mine is stopped at date of writing, and a call has been made to pay liabilities and undertake prospecting.

Golden Fleece Quartz-mine.—(10/3/93): A party of tributers are at present retimbering the No. 1 level and ladder-way thence to bottom of shaft. Cross-bar required as protection for shaft in No. 1 level. Good air. Two men also working under No. 2 level on bunch of stone left by old company. I drew attention to some of the timbering, which is to be seen to. No cover on cages, and safety-catch off, as baling is going on. It is expected to take two months more to get the water out. No copy of the Act or rules, so I wrote the owner, Mr. F. Hamilton, to provide them.

Sir Charles Russell Quartz-mine.—(4/10/92): The low-level tunnel, which is being driven to cut the line of reef below the bottom of the winze, mentioned in last year's report, is now in some 530ft., running a little south of east. When the reef is cut some 200ft. or 300ft., it will require to be driven on its course to the south, and then an uprise of 60ft. made to connect with the winze. The country is hard. Three shifts of two men each are employed.

Cumberland Quartz-mine.—(3/10/92): Mr. Casley, the new manager, was absent at a meeting of the Board of Examiners, of which he is a member, and Mr. Harvey was in charge. I drew attention to some sets which have sunk in the main cross-cut and No. 1 Level, and they are to be attended to. All above this is worked out. The principal work now is in two intermediate levels

below No. 1. Four men, in two shifts, are working in the No. 2 level, which is connected with those above. The course of the reef is not a straight line, but rather a curve. The underlie, which throughout has been variable, in the No. 1 intermediate is to south, but in the No. 2 intermediate changes to north. Such a reef must be more than usually puzzling to the management. Twenty-five men in all are employed at the mine. (7/3/93): Timbering spoken about at last visit has been renewed. No. 2 level face is standing, but in the drive from it to north and west twelve men in three shifts are working on stone which is about 11ft. in thickness. Only one slope working above this level, employing six men in three shifts. One slope is also working above No. 2 intermediate, where four men are working, making a total number of thirty men employed at the mine. Air, fresh; timbering, good. Report and plan kept. Copy of Act at mine. Rules and manager's name posted up. The prospects of this mine are very good. Ninety feet has been driven on the reef in the No. 2 level, and there are about 75ft. of backs, of an average width of 10ft. Plans are being prepared for fitting-up of the Cassels' cyanide process, the application to use which having been granted. During the year, when passing through Reefton, I was informed that the late manager had left a day or two previous, and that the mine was being managed without a certificated manager; so I at once notified the legal manager, with the result that the present mine-manager was appointed within a week.

Exchange Quartz-mine.—(3/10/92): Five men in all are working, in two shifts, but on a different reef to what is worked in the adjoining Cumberland Mine, in which this line of reef proved unpayable. The two levels are connected by a winze, so the air is good. This crushing of quartz having turned out very poor, the only hope is to drive to cut the reef on which the Cumberland is working, and which may run through a part of this claim. (7/3/93): I found all work had been stopped on the 4th instant, pending an application for protection, as funds were said to be exhausted. A cross-cut has been driven from the east level, since my last visit, parallel to the boundary of the lease, and the face of which is now some 4½ chains distant from the south-western boundary, but the line of reef has not yet been cut. It is unfortunate that operations should have been delayed at a time when success or failure would so soon have been known.

Sir Francis Drake Quartz-mine.—(6/10/92): A coupled Hornsby winding-engine has now been fitted up; also poppet-heads, which are 55ft. high from surface-level. The depth to the bottom of shaft is 200ft., and thence a drive runs a distance of 105ft. in a direction a little west of north. The lode is expected to be cut before long, and then connection is to be made with a winze overhead. Signals posted. Good ladders, with iron rungs, all the way down. Timbering, both of level and chamber, very good. Three shifts working, of two men each; a total of eight men being employed. (8/3/93): Some of stage-boards in ladder-way wanting, but these are to be put in at once. The reef has now been cut at a distance of 290ft. from the shaft. The stone is about 18in. in thickness. The drive is being continued past the line of reef to make connection with the winze. Good current of air from hand-fan at bottom. Very well timbered. A few detonators at bottom, but these are to be removed. Nine men in all employed. General rules posted up.

Gallant Quartz-mine.—(4/10/92): Work had at this date been stopped for a month, but I went through the mine with Mr. Notman, who had been in charge when working. Some stoping has been done above the main level, and the worked ground filled in. The returns from the quartz crushed just paid expenses, but there is no more even of that class of stone. Two short cross-cuts have been driven to west without making any discovery, but a block of quartz has been got on the surface at a point about 160ft. ahead of the present level face. This company is waiting until they can raise enough money to develop their mine. (8/3/93): No one about.

Scotia Quartz-mine.—(3/10/92): Not working. A short cross-cut, about 30 yards, has been driven to the north from the main level, but nothing encouraging has been met with. The level itself has been extended some 70ft. since my last visit, 50ft. of which is in the Gallant Company's ground. Nothing else has been done in the mine. One man is prospecting on the surface, but I did not see him. (8/3/93): No work being done, and no one about.

Inkermann Quartz-mine.—(3/10/92/): Four men, in two shifts, driving a cross-cut to east from No. 3 level at a depth of 300ft. They are 150ft. in from shaft, and expect to cut the lode shortly, but it is intended to drive some 800ft., then rise 200ft., and connect with the tunnel of the old Inkermann workings. Country very hard. Air right at present, but as the drive advances boxes are to be put in. The cage-covers were hung up and catches tied, as timber had been lowered, but these will be seen to at once. Since date of inspection all work has been suspended and the property sold.

Lady Louisa Quartz-mine.—(30/9/92): Some work has been done by the Inkermann Company at this mine during the year, but, at the above date, there was no one about and the rails were lifted. I was informed that the stone was too poor, running about 4½dwt.

Supreme Quartz-mine.—(30/9/92): A party of tributers are giving a further test to this mine. Work has been started on the top of the hill, where the reef is very wide. A winze from the surface connects with the chamber in the level of the old Rainy Creek Company, and this is at present being retimbered. Underhand stoping is to be gone on with from the surface. I requested Mr. Haylen to protect the mouth of old shaft. Six men in all are working, including one at the battery and another at the coal-mine. Work has since been stopped, as the crushings turned out unexpectedly poor, only some 17oz. of gold being got from 400 tons of stone.

Golden Lead Quartz-mine.—(3/10/92): No. 1 level stopped, all work being from No. 2, above which stoping is going on. A total of eighteen men is employed at the mine, all in one shift, except in the drive, where two shifts are working. About one-third of the vein-stuff is crushed, the remainder being thrown behind as filling-in. At places, the face is a mass of leaders, eight or ten, at others only one, with casing. The underlie becomes more vertical towards the south, nearing the A1, which is probably the same line of leader. Well-timbered in stopes, and air good. Weekly report kept. Manager's name posted. Plan kept, but last survey only in pencil.

Rise and Shine Quartz-mine.—(3/10/92): Not working.

A1 Quartz-mine.—Not visited, as only one man working on same leader as formerly.

Big River Quartz-mine.—(5/10/92): Nothing doing in old tunnel, and all above No. 2 level worked out. The No. 3 level was broken away from the shaft at a depth of 340ft., and struck the lode after 55ft. of cross-cutting. Four men are stoping about 50ft. above the No. 3 level in a block of stone which has pinched out at both east and west faces. The length of this block is only some 30ft. Two men are uprising to connect with winze near the boundary of the Lord Edward claim, which will open up from this. Half the cost of this uprise is paid by each company. Twenty-four men are employed, exclusive of battery. Plan not at mine. Report behind detonators at chamber in No. 3 level. Doors to be provided at bottom. Manager's name to be posted. I have written Mr. Black, the mine-manager, as to these requirements of the Act, and if he continues to neglect them it will be necessary to prosecute.

BOATMAN'S.

Fiery Cross Quartz-mine.—(6/4/92): Six men, in three shifts, driving to north in No. 6 level on what is believed to be the course of the reef, but to-day a start is to be made to cross-cut to east. Air forced in by a hand-fan, and rather dull. Stoping is also going on from an intermediate level below No. 5, but this is just finishing. Total number of men employed at the mine, sixteen. (4/10/92): Three shifts of two men each driving to south in No. 6 level, 230ft. in from cross-cut. Some of the rungs of the ladders require to be renewed, which Mr. Lawn promised to see to. Detonators on roadside, but moved at once. Engine-man certificated. Signals posted. Proper safety-catches and covers on cage. Revisited on the 8th October; being in the district I had heard of a slight accident. It appears that on the 6th October, Peter O'Neill and John Coghlan, after starting work in the afternoon-shift, had drilled some holes, fired the shots, and then started to drill in part of an old hole left by the day-shift, when a slight explosion occurred, more or less stunning Coghlan and slightly burning O'Neill. The former was able to work next day, but O'Neill was off for a few days. The particulars of the prosecution for the breach of the Act will be found under the heading "Legal."

Welcome Quartz-mine.—(6/4/92): The only work doing is four men, in two shifts, re-timbering the No. 6 level. It is intended to put up a winze towards the north end of the lease, a part which was not prospected in the early days. Amalgamation with the adjoining leases is also spoken of, as this once rich mine has now worked out all the known payable stone.

Homeward Bound Quartz-mine.—(6/4/92): Four men in two shifts sinking a winze from the No. 3 level on the track of the reef. It is down 12ft., with a flatter than usual underlie, which is considered an unfavourable feature. The air, although not bad, is none too strong.

Welcome United Quartz-mine.—(9/3/93): The famous old Welcome Mine has now ceased to be as a separate concern, and is now amalgamated with the Eureka Company under the above title, and in whose ground operations are now going on. The incline, which is 1,800ft. long, dipping at 1 in 3, has been unwatered, and where the timber was bad it has been renewed. The air, as is to be expected, is not too good at places. The only work doing at present is retimbering the level some 500ft. in from the incline. Only three men in all are employed. Mr. Rooney, formerly of the Welcome mine, is in charge. A distance of 160ft. is yet to go before connecting with the No. 9 level.

Specimen Hill Quartz-mine.—(9/3/94): This is a new find of stone, which has been missed by the old tunnels. The work done consists of two adits, in the upper of which stone shows about 15ft. from the mouth. The quartz is white and sugary, prospects well, and is very soft, having evidently been crushed by movement. The country rock is not solid, and the place where the quartz is seen must be considered broken ground. The other drive, which is 33ft. lower in level, had recently been connected with the former, giving good air. Four men in all were working in two shifts.

LYELL.

United Alpine Quartz-mine.—(1/12/92): Four men stoping in south block, 16 stopes above No. 7 level. Width of reef, about 9ft., and length of block, 140ft. Sixteen men stoping in north block, 11 stopes up from No. 7 level, having 35 stopes up to No. 6 yet to be worked. The length of this block of quartz is 180ft., with about the same thickness as the south block. The air in this section was poor, but not so bad as to call for a prosecution. Eighteen feet had to be driven to make a connection, when the air would be first-rate. I requested Mr. Wilcox, the manager, to hasten this on, and notified the legal manager. In a few days I received notice that the places had been holed through. No work doing in No. 6 level. General rules and manager's name not posted up. Plan not at mine. These are to be seen to. (2/12/92): No. 4 level has been retimbered where any weakness was to be seen, and two men are driving in it inside the filling-shaft, prospecting for the rich leaders worked in the early days of this district. Air good. Adit runs north, and is in a distance of 520ft. Mouth of filling-shaft covered, as usual, with the quantity of filling that comes down the hill.

United Italy Quartz-mine.—(1/12/92): No. 2 level is worked out, and mining is confined to No. 3, on the same leader as was worked in the upper levels. Nothing is being done on the thin vein which was working a year ago. Where the cross-cut intersects the leader at a distance of 570ft. the stone is about 5in. in thickness. At present they are just opening out, and intend to drive both north and south on the course of the lode. Good air, and timbering right. Dynamite on roadside, but Mr. Fitch will see to its removal. General rules not yet obtained. Six men in all working on tribute.

Tyrconnel Quartz-mine.—(1/12/92): Three stopes, working southwards, about 10ft. under the No. 5 level. Below this is stoped out from the bottom of the winze, which was down 50ft. Average thickness of leader, a little over 1in. A cross-cut has been driven some 40ft. in the hanging-wall, but was stopped on account of the water, which probably comes from the line of the dyke which crosses the adit. The cross-cut will be continued when the stopes are worked out. The driving of a low-level tunnel, which will require to be 1,300ft. long, has been considered, and will

be gone on with if the cross-cut does not turn out favourably. Air, fresh. Rules not posted, but will be obtained. Detonators on roadside, but moved before I left. One wages-man is now employed, making four men in all.

Crœsus Quartz-mine.—(2/12/92): Not working. I am informed that the plant and mine have since been sold.

Lyell Creek Low-level Tunnel.—(1/12/92): This is being driven on contract, a further length of 200ft. having been let; this starts from a point 2,800ft. from the mouth of the adit. Four men in all are employed, in two shifts. Air not too good, but sufficient, time being allowed between the shifts for the smoke to clear. Two or three leaders cross the tunnel, with a westerly underlie, which is opposite to that of the Alpine reef, but these have not been found gold-bearing. Country at face, indurated sandstone and standing well.

MAHAKIPAWA.

Alice Fell Claim.—(8/12/92): Working from the same shaft as formerly, but with water-wheel moved nearer, to lessen the length of the connecting-rods, and have pipes in two lifts to equalise the work. The drift is very heavy, lying on the slate bottom, and has not hitherto proved payable, only some 12oz. of gold having been obtained altogether. Air good. Sets of timber braced, but some of these requiring to be joggled to make the staying effectual. This will be attended to. Since my inspection the lead of gold has been struck with very good results. This opens up further possibilities for the Mahakipawa Field, as the run of gold will probably extend through the flat.

Golden Gate Claim.—(8/12/92): This mine, which is just above the Alice Fell, has not yet struck payable gold. This to be regretted, as they are more capable of coping with the water than most of the claims, even although the depth is 48ft. greater than the King Solomon shaft above them. Some of the braces only nailed; these are to be joggled in future. Air led in in a small iron pipe, and sufficient for present requirements; ladders in good order. Operations have since been suspended for want of funds. This, when payable gold is now known to be in the claim immediately below as well as in the one above them.

King Solomon Claim.—(8/2/93): This mine was flooded out in December, but having heard some remarks about the timbering it was specially visited on above date. Laths at two places requiring renewal; this is to be seen to. Heavier timber, 9in. instead of 6in., is being put in and sets efficiently stayed. At my request a new ladder was being prepared for shaft. Mr. Wearne, the manager, appears to be exercising every care. The gold during the past week has given out, but this is owing to the gutter being narrower and steeper, allowing the gold to be swept away. Good returns have since been obtained.

Davis and Carr Claim.—(8/12/92): Operations are now confined to sluicing, which is carried on by two parties of tributers. Seven men in all are at work, and good returns are being obtained.

Hibernian Extended Claim.—Was flooded out at the time of my visit in December.

Just in Time Claim.—(8/12/92): This claim has been given up by the original owners, and is now worked by the three following parties:—

Waite and McKinnon, who have been working for five months, and expect to have three or four months more work, but have not hitherto made wages. Timber strong enough, but not very regular owing to the nature of the ground.

Charles Laundre also holds part of this ground, but is not working at present, as too much water.

Nesbit and mate have been working a strip of ground left by the old company, but have not made wages during the past twelve months. I went down the shaft and into the face, where the sets were right and properly stayed, but the water was running in so freely that the lights could not be kept burning. Nesbit expects to finish in a month or two.

Boys Own Claim.—(8/12/92): This is worked by a party of four. The shaft is 27ft. deep, and thence they have blocked out to west as far as the water would allow. I drew Mr. Lyford's attention to the lining of the terrace-shaft, some of the sets being loose. These are to be secured. The other shaft is in good condition.

CHARLESTON.

O'Keefe and Party's Claim.—(20/12/92): This is a deposit of cement about 5ft. thick; it requires to be crushed in the battery, which consists of four heads of stamps. The cement is overlaid by about 1ft. of surface, and underlaid by 3ft. of sand lying on another bed of cement which rests on the granite.

O'Connor and Party's Claim.—(20/12/92): This is a similar claim, working a deposit of cement which is here 12ft. thick. Water is used in bringing it down, and an eight-head stamper-battery for crushing it. The yield is said to be about 1dwt. per ton.

Parsons, Woodhead, and Party's Claim.—(20/12/92): This party have only completed their battery, which is five heads of stamps, about two months ago. It is now crushing cement, but there has been no washing-up as yet.

Homan and Party and *Higgins and Party* (20/12/92) have each a fine stamper-battery and are working similar deposits of cement.

Three other claims which were not visited are at work cement-crushing.

None of these batteries had sent in the returns required by the Act, and the owners appear reluctant to disclose their earnings on account of being private parties, but those I saw have promised to comply with the Act.

GREY VALLEY.

Perfect's, West and Kelly's, and *Keating's Claims,* at Ford's Creek, were inspected in connection with an application by the Midland Railway Company for a block of land at Blackball. None of these call for special mention. Lingren's Terrace is auriferous, but appears to be too poor to pay for driving, although it would probably pay well to sluice if other conditions are favourable.

Duffer's Creek Gold-mining Company's Claim.—(19/10/92): Was inspected on account of an accident, which resulted in the death of one of the miners named Patrick Rodgers, on the 15th October. The deceased and his mate had been working in the face of the drive, which was to be used as a tail-race, when they were warned by the trucker that water was coming down in the drive behind, and who said he thought the creek (which usually ran in tunnels through spurs on the opposite side) had changed its course. After securing the face, they left their work, passed the first air-shaft, and in attempting to ascend the second, Rodgers was overwhelmed by a rush of water and gravel, and when extricated was dead. Another perfectly safe and easy outlet existed only a few chains away, but the other was the customary road for that shift. The shaft where Rodgers met his death was 19ft. in depth. and was broken away in the vertical cliff, which forms the bank of Duffer's Creek, at a height of only 4ft. 6in. above the level of the creek-bed. It was on the level for a few feet and then sloped down to the head-laths of the tunnel. When I inspected it the tailings brought down by the flood had silted the creek-bed till only a foot of margin was left. A heap of gravel and *débris* was lying on the head-laths, filling the bottom of the shaft. A short drive had also existed to the creek-bed, but nothing of this was to be seen. The course of the creek-bed was direct on the cliff in which the shaft-mouth was open, with no protection but the few feet of elevation if the tunnels on the other side of the creek should get choked, or if the creek were to resume its course in any other way and allow the water to rise. In the circumstances, even although there was another means of escape, I considered there was negligence, and requested your authority to prosecute. Particulars of the case will be found under the heading "Legal."

Taylor's Dredging Claim.—(29/7/92): Is situated on the north beach, Greymouth, and is worked by a Shank's patent grab-dredge, which raises about 200 tons in eight hours. It is at present cutting a channel through to where an old lead is believed to run. The bucket-elevators are at a standstill, and the portable engine is now disconnected from them, and used for pumping.

WESTLAND.

Frank Cruhan, when working alone in his claim near Stafford, on the 20th September, was killed by the tunnel caving in. The timber was weak and badly set; with such it could only be a question of time till an accident should occur.

Ross United Company's Claims.—(28/4/92): A fatal accident had occurred on the 23rd instant to a miner named Joseph Haddock, who was boss of shift. It appears that the manager before leaving had given orders to another miner, who was next in charge, in the absence of Haddock, who was attending to the electric light, to bring down no more stuff that night. These instructions were told to the deceased, who, however, continued using the water from the hydraulic nozzle on a corner which he did not like the look of for about three-quarters of an hour, when a large fall came away, completely covering him. The verdict of the jury was accidental death. Some dissatisfaction was signified to me at the manager's orders not having been given direct to the deceased, but, after careful inquiry, there were no grounds on which a charge of negligence would have had the slightest chance of success, nor was it desirable that such should be made.

As there was a shadow cast by the electric light, I notified Mr. Grimmond that it must be rectified. This, with other minor requirements, he wrote me had been attended to, except the raising of the nozzle, which he gave satisfactory reasons for keeping where it was.

H. Williams and son were working, on tribute, for the Ross United Company in two short drives, badly timbered, and in bad ground. As I insisted on these being made secure, the work was thrown up.

Evans and mate and Purvis and son were also driving, but had their ground properly secured. Four men were also working in Scott's shaft, and two in the No. 2 shaft. Timber at the top of the latter requiring attention, and this is to be seen to. All these were working on tribute.

The following accidents have also occurred in sluicing claims:—

George Piner had a leg and arm broken by a fall in his claim at Kanieri River, on the 29th April.

Nicholas Pascoe was killed when working in a tail-race near Rutherglen, on the 10th June, by a fall of earth.

LEGAL.

1. Charles Flowers, registered owner of a tail-race near New River, Greymouth, having made a claim for compensation, owing to the railway having crossed his race, I inspected the ground, in company with the Resident Engineer; and, as there had been no work done for a number of years, I applied for cancellation of his tail-race on the 3rd August, in the Warden's Court, Greymouth. After two adjournments, my application was granted.

2. I also applied for the cancellation of Griffin and Olsen's tail-race, Auckland Beach. The case was similar to that of Flowers, but I did not require to appear, as, on judgment being given against the latter, they surrendered their certificate.

3. In my absence, proceedings were taken in the name of the Mining Registrar, in the Warden's Court at Havelock, on the 19th October, against William Hayes, manager of the Golden Bar Company, for not advertising a statement of affairs in the *Gazette* as required by "The Mining Companies Act Amendment Act, 1890." A fine of £5 and costs was inflicted. Mr. Hayes had always temporised when requested to advertise; but, in a letter after the prosecution, he was indignant, and stated it was through sheer ignorance that the law had not been complied with. I pointed out to him that I had, on four occasions, warned him in writing of the requirements of the Act. The company appears to have been a poor one, but it is for the interests of the shareholders in such that, I presume, the law is made, for when a company is prosperous there is little inquiry.

4. An information was laid against John Coghlan and Peter O'Neill for drilling in the remaining portion of a hole in which a charge of nitro-glycerine compound had been previously exploded, in contravention of "The Mining Act, 1891." This arose from the slight accident at the Fiery Cross Mine, which disclosed the offence, and proceedings were taken—not with the view of recovering a

heavy penalty, but to act as a warning to others, and to discourage such a dangerous practice. The case was heard at Reefton, on the 8th November, and each defendant was fined 5s. and costs, 22s. and 24s. respectively.

In this connection it is noteworthy that the only other accident in quartz-mines this year was in shot-firing, and incurred through returning to a fuse which had been ignited, in violation of the rules. It is almost impossible to get a conviction for most of such offences, as no one but the offenders is present.

5. An information was laid against the Duffer's Creek Gold-mining Company (Limited) for not securely protecting and making safe the air-shaft or ladder-way, which has already been referred to. The case was heard before Justices at Ahaura on the 26th January. Mr. Guiness and Mr. Jones appeared for the defendants, while I had to rely on my junior counsel, Mr. Joyce, as Mr. Purkiss was unable to be present. After the case for the prosecution had been heard, counsel for defence announced that they would not call any evidence, but would rely on the legal side of the case. After legal argument, the case was dismissed without prejudice—equivalent to a nonsuit. I consider the fact of defendants calling no evidence, when they had their witnesses at hand, satisfactory proof that I had made out my case, for few people would be satisfied in such a charge with getting off on a legal point if confident that they could rebut the evidence of the prosecution. At the same time it was not desirable to re-open it, as the case for the prosecution had been fully disclosed.

Occupation Licenses.

Onamalutu Creek was visited in connection with a complaint that Mr. John Langley Adams was not residing on his occupation license. This was found to be correct, but as the license had not been issued the complaint was premature. Other licensees were found to be not in actual occupation of their ground; but in bush-country like this a reasonable amount of time requires to be allowed to make suitable preparations for residence. Mr. Warden Allen informs me that all these will be dealt with after the lapsing of such periods as are suited to the respective cases.

Battery Returns for 1892.

Name of Battery.	Quartz crushed.		Produce of Amalgam.		Retorted Gold.	
	Tons	lb.	Oz.	dwt.	Oz.	dwt.
Ravenscliff	763	0	296	0	91	0
Johnston's United	5,712	0	2,547	0	1,081	0
Big River	1,219	0	5,951	0	2,010	0
Golden Lead	4,633	0	2,550	0	872	0
Sir Francis Drake	1,192	0	1,232	0	455	0
Sir Francis Drake, for A1	3	448	101	5	44	0
Sir Francis Drake, for Exchange	45	1,120	3	10	0	16
Venus Extended	1,390	0	3,107	0	1,048	0
Wealth of Nations	556	0	547	0	147	0
Wealth of Nations (tailings)	Quantity unknown.		407	0	112	0
Minerva	532	0	307	0	131	0
United Italy	20	0	60	0	24	0
Welcome	180	0	659	0	183	0
Welcome (tailings)	749	0	484	0	160	0
Welcome, for Homeward Bound	41	0	47	0	14	0
Welcome, for Homeward Bound (tailings)	36	0	66	0	18	0
Inglewood Extended	520	0	1,430	0	467	0
Globe	9,452	0	13,977	0	4,650	0
Keep It Dark	1,710	0	1,866	0	569	0
Keep It Dark, for No. 2	2,899	0	5,962	0	1,937	0
Keep It Dark, for Pandora	53	0	20	0	6	10
Fiery Cross	762	0	1,959	0	603	0
Fiery Cross (tailings)	172	0	607	0	153	0
Fiery Cross, for Argus	31	0	121	0	38	0
Fiery Cross, for Argus (tailings)	11	0	5	0	1	10
Fiery Cross, for Mr. Boardman (tailings)		195	1	3	0	10
Inkermann	651	0	924	0	312	0
Alpine	10,910	0	15,970	0	6,025	0
Cumberland	3,067	0	10,435	0	3,484	0
Golden Fleece	320	0	1,150	0	426	0
Progress	8,960	0	11,457	0	4,001	0
Supreme	402	0	190	0	17	0
Tyrconnel	26	0	659	0	346	0

Cancellation.

Just in Time Quartz-mine.—(6/4/92): This mine was specially visited on account of a complaint that no work was being done, while the complainants were willing to work it. Nothing was doing; all the plant was in a state of disuse. The rent was also unpaid for some time, as all the capital of the company, some £2,700, had been expended. Some time after, when in the district, I was told that the morning after the claim was cancelled the legal manager pegged it out afresh, before

the complainants knew anything of it. It would appear from this that if parties desire cancellation they should apply for it themselves and they will then be deemed first applicant; although in this case there was a difficulty in the way, in the claim being granted under an old Act, in which the provisions for cancellation were not very clear.

Golden Treasure Quartz-mine.—A complaint was also made that this mine was not being worked while the complainants stated they were willing to work it. It was found undesirable to apply for cancellation in this case, as a new board of directors had recently been elected who were honestly doing their best to carry on the mine, having made a call and engaged two men to start work. The recent delay has been caused through the calls not coming in well.

Many of the mines in the block reefs of the Reefton District cannot be expected to comply fully with the manning clauses of the Act, for the quartz may suddenly give out, and there is then no place for all the men; but this is very different from doing nothing at all—keeping others from working the ground and not even paying rent, like the Just in Time.

GENERAL.

Westport disappears from the list of localities where quartz-mining is going on, the Beaconsfield, Red Queen, and South Pacific companies having ceased working. An attempt is to be made to re-form the latter company.

In the Reefton District want of capital to develope the mines is being felt; this is no doubt largely a reaction from the speculation of the past.

The tribute system appears to find some favour, but while it has some advantages it has this drawback, that it tends to throw the responsibility of carrying out the Act on to the men, who sign to do so, and on whom therefore the penalty would practically fall if a prosecution of such a company should become necessary, for the agreement with the tributers would then be void, and they would lose the value of any dead-work they might have done.

I have, &c.,

N. D. COCHRANE, Inspector of Mines.

The Under-Secretary, Mines Department, Wellington.

No. 9.

Mr. Warden STRATFORD to the UNDER-SECRETARY for MINES, Wellington.

SIR,— Warden's Office, Greymouth, 6th May, 1893.

I have the honour to forward herewith the statistical returns, and to report upon the district under my charge for the year ending the 31st of March, 1893. I forward the returns and report relating to the Inangahua District separately.

Waimea Valley.—There has been a steady decline in mining in the Waimea District during the past year. Kelly's Terrace is still unworked, no arrangement having been come to between the owners and parties of tributers willing to work the ground. Mr. Batchelor, the owner of the Wheel of Fortune Claim, completed the elevators for working the ground, and is now working whenever water is available, with encouraging results. His expenditure has been very large—between £2,000 and £3,000—and the washings during the last six months have been such that there is a fair show of more than recouping himself for his outlay. A powerful steam-dredge was erected for the purpose of working the bed of the Waimea Creek, in the neighbourhood of the bridge on the Hokitika Road, but it has up to the present time proved a failure. The owners of the dredge, apparently, trusted to reports of payable gold existing in that position of the creek-bed they attempted to work. The reports on which they trusted for the success of the undertaking were those of old miners who had done work in the locality more than twenty years ago, but they proved altogether misleading, and an expenditure of several thousand pounds was incurred without any result. The owners of the dredge, apparently, did no prospecting on their own account prior to the erection of the machinery.

During the year a small rush occurred on the line of the new race being constructed from the Waimea Race at the pipe-line towards Callaghan's, but it has hitherto proved very poor, although there are still claims at work, the owners of which expect the ground to be payable when the water from the new race is available. The race now being brought in will supply water to Callaghan's and the middle branch of the Waimea Creek, in both of which places there is a large extent of unworked ground likely to be payable. At Gillam's Gully, in the neighbourhood of Ballarat Hill, and on the watershed towards Flowery Creek, a prospecting-shaft is being sunk under the auspices of the Stafford Miners' Association. The shaft is now 120ft. deep, and a drive is being put in towards the deep ground in the gully, where payable gold is said to exist. At Sixth Terrace, between Stafford and the Kapitea Creek, where there is large extent of untried ground, energetic prospecting is being carried on by Mr. Raby, with a fair chance of striking payable wash, and should he be successful a fresh impetus would be given to mining in this district, as there is plenty of room for a rush of considerable extent, the terrace he is prospecting being about a mile and a half in width. At Callaghan's a drive is being put in from Kapitea Creek, which will drain a portion of ground known to be payable, and probably lead to considerable extension of the same. The drive is now in a distance of more than 2,000ft., and a further distance of 1,000ft. has to be driven to reach the ground, in which good prospects have been obtained.

Kumara.—During the past year mining in this division has to a great extent been uneventful, and there is nothing of much importance to bring under notice. Although some claims have been worked out, and some miners have left the district, there is no appreciable difference in the population.

An effort is being made to ascertain if there exists a second bottom or lead of gold-bearing wash on this field. A prospecting-shaft has been sunk on Mignonette Flat, and some driving and other

prospecting work done, but no satisfactory results have as yet been obtained. Some attention has lately been given by miners to a piece of country called Payne's Gully, near Hay's Terrace, and nearly opposite Dillman's, on the northern bank of Teremakau River, where Anderson and party have been for some time working. Several claims have been taken up, but it remains yet to be proved if the ground is payably auriferous. A little prospecting is being done at Stoney Creek, on the Christchurch and Dillman's road, situate between Dillman's and Harcourt's accommodation-house.

In the Greenstone portion of my district mining affairs are apparently as they have been for years, and the miners seem to be plodding along quite contentedly. The road to Lake Brunner being converted into a dray-road causes some traffic between here and the Lake, and it seems to be quite a holiday resort for the Kumara people.

The co-operative railway and other public works in this district have been of great service in giving employment to those in need. Taking all things into consideration it has been a fairly good year for the miners and working-men of this district. There has been a good supply of water to meet all demands nearly all through the year, and the present management of the Government water-races (which are the chief supplies) on this field appears to give general satisfaction. The total population may be estimated at 2,500 souls. Regular sittings of the Resident Magistrate's and Warden's Courts have been held at the appointed times during the year, and a considerable amount of business has been dealt with, as the tables subscribed will show.

Return of cases disposed of in the Resident Magistrate's and Warden's Courts, Kumara, for year ending the 31st March, 1893: Civil, 131; criminal, 67; Warden's, 12.

The revenue for the year, amounting to £740 7s. 4d., collected in the Kumara Court, is made made up as follows: Warden's Department, £670 4s. 4d.; Resident Magistrate, £70 3s.: total, £740 7s. 4d.

Particulars of revenue collected in the Warden's Court for year ending the 31st March 1893:—

	£	s.	d.
Miners' rights	315	0	0
Business licenses	6	10	0
Water-races	6	7	6
Registrations	19	18	0
Rents and royalties	304	15	10
Fees and fines	13	3	0
Miscellaneous	4	10	0
	£670	4	4

Mining applications dealt with during year, 204.

Moonlight.—In the last report on this district mention was made of a rush to Stewart's Terrace. The prospectors obtained prospects of good wages, and several parties put in tunnels of a very expensive nature, as they had to be driven through rock, which in all cases were found to be on too high a level, consequently valueless to prove the ground; and as the parties exhausted their funds in the driving of these tunnels they abandoned the ground. I have no doubt it will be again tested. There is at present a rush to a terrace at the head of Dougall's Gully; in fact, it is a continuation of the terrace mentioned above—it is thought by a number of miners to be a continuation of the same run of gold. The prospects are very good indeed. Should the find prove to be a lead it will give employment to a large number of men for a considerable time. There are about seventy-five miners at Moonlight. Touching Baxter's, Caledonia, and Shellback there is nothing worth mentioning during the past year.

Waipuna and Granville.—These districts take in Noble's, Mosquito, Duffers', and Half-ounce Creeks. About the same number of miners are employed as last year, and they appear satisfied with the returns obtained. A rush took place to a terrace situate between Half-ounce Creek and Barry's Gully. The ground was taken up under ordinary claims. The terrace had been an old camping-ground, and it was thought that the formation of the terrace was old-man reef, until two miners scratched up the face of the terrace and obtained wash with excellent prospects, the result being that seven parties obtained claims now paying over £8 per week. The ground is dry and easily worked by tunnelling.

Orwell Creek.—Everything is very quiet here; the exceptionally dry season operates injuriously at this place. About the same number of miners are, however, at work as last year. The Napoleon Hill Company resumed work during the year, which finds employment for ten men, with apparently satisfactory results.

Nelson Creek.—There is a large number of miners employed at this place, and judging from appearances it should be fairly prosperous. The *modus operandi* is principally ground-sluicing, the Nelson Creek Gold-mining Company and Law and party being the exceptions. The first-named company are now engaged bringing in and completing a water-race of large carrying-capacity, and the extension of their tail-race, involving an outlay of about £4,000. When finished they will resume work at their special claim. Law and party have completed their tail-race, which has taken them three years to construct, and are now reaping the reward of their enterprise, as the claim is good and will find the party profitable work for some years to come. Their tunnel tail-race is over one mile long.

Blackball.—There has been no new find in this division during the past year, and about the same number of miners are employed as last year. The Roaring Meg Company have finished their tail-race to their face, and are about ready to commence sluicing. Between this company's ground and Anderson and party's claim, a little higher up the creek, there is a stretch of auriferous country that will be taken up. The ground contains very large boulders that require blasting before they can be removed. Now that the track is completed to the Roaring Meg Company's ground, no doubt this

part of the district will receive more attention. There are about the same number of miners in and about Ford's Creek as last year.

No Town.—The same number of miners at work here as last year, but no new discovery.

Big River.—This district takes in Slatey Creek and Barebottom. There are about the same number of men employed as last year. Nothing new has been found. Stream tin has been found in this locality, and is now receiving some attention.

I have, &c.,
H. A. Stratford, Warden.

The Under-Secretary, Mines Department, Wellington.

No. 10.

Mr. Warden Macfarlane to the Under-Secretary for Mines, Wellington.

Sir,— Warden's Office, Hokitika, May, 1893.

I have the honour to forward statistical returns for the year ending 31st March, 1893, together with annual report on mining matters in the districts under my charge. In the Hokitika district the gold returns for the year are—in spite of the unusual number of dry days we have had during the past year—above that of last year. The Humphrey's Gully United Gold-mining Company (Limited) shows in their tenth annual report that, "471 shifts have been worked, for a result of 720oz. 6dwt. 14gr., value £2,809 5s., as against £1,351 2s. 6d. obtained during the preceding year, and it is estimated that at least 200oz. are now in the boxes, showing that the ground is going very nearly 2oz. to the shift; and the opinion of the mining superintendent and the tributers is that the next washing will give much higher results." But, notwithstanding the increased output of gold and their improving prospects, the company, under present conditions, are only playing with their property, with no prospects of dividends—present or remote—to shareholders; sufficient prospecting has been done to warrant a considerable expenditure in bringing in a large water-supply, so as to work the claim at a profit to the shareholders. There has been a good deal of talk about reconstruction and increase of capital, but so far nothing definite has been done. The possibilities for hydraulic mining in this block are immense, and the steady returns from this claim—which is only a patch in a seven-mile stretch of well-known auriferous terraces—should command the attention of capitalists and the Government.

Back Creek, Seddon's Terrace, and Rimu are terraces of a similar character, and carrying a fair population of miners, who are in a number of cases making a good deal more than wages, but in many more a good deal less; but here, again, the great want is water for wholesale hydraulic operations. Some few months ago the Rimu Mining Association made a move in the direction indicated. Amongst other things, the Hon. the Minister of Mines was waited upon. However, not having any definite scheme or plans to lay before him, nothing came of it. The association not having the means, and the County Council being in an equally impecunious state, the matter was dropped. The cost of a preliminary survey and report by a competent engineer would cost at least £500. This not being forthcoming, nothing could be done. This is to be regretted, as the future prosperity of the West Coast depends in a large degree on the careful conservation and intelligent use of an abundant water-supply in hydraulic mining. Several sources of supply were suggested: one from the Totara, another from the Hokitika, another from Lake Kanieri, and the last from the Arahura River. Knowing a good deal of the country on the different lines, I think there can be no dispute as to the superiority of that from the Arahura. A race constructed from the Arahura would not only contain abundance of water at a high level, but would be less than half the length of one taken from the Hokitika. At least half the distance would be through well-known auriferous terraces, terminating on the Blue Spur Ranges, from which a pipe-line of about two miles and a half would land it on Back Creek and Seddon's Terraces. I trust the Mines Department will take this matter up, and give such substantial assistance as will enable even the present number of miners to quadruple their present output of gold through being able to utilise the grand water-supply now running to waste in our rivers and streams. If it is right to offer inducements to men to settle on the land in agricultural districts by building roads and railways, it should be equally the care of the Government to keep the miners on the goldfields when they are there, by building or, at least, helping to build, the great arterial water-races required in wholesale hydraulic mining. There need be no fear that over-production will restrict enterprise, as gold is always immediately marketable.

The Kanieri Lake Water-race and Gold-mining Company went into liquidation during the year, and was bought by the shareholders of the Mont d'Or Company, Ross. The claim is let for twelve months to a party of miners. The owners of the race propose repairing it, so as to bring the fifty Government-heads it was supposed to carry down towards the Kanieri. This race, originally constructed to carry water to work the Houhou lead, was, through lack of enterprise—after a spasmodic attempt to open the ground, but which was never accomplished—allowed to fall into disrepair, and was ultimately sold for a trifle; the company never having made a decent effort to make use of one of the most magnificent water-supplies on the coast. Looking to the method of mining in Otago—known as Perry's hydraulic up-cast system, in use at Tuapeka, and on Mr. John Ewing's claims—the possibilities underlying this race are enormous. Kanieri, Tucker, Constitution, and Commissioner's Flats—richer by far than any of the ground worked by the same method in Otago, some lie 300ft. below the level of this race, offering wonderful facilities for working by the above methods. That this was not done when the race was first built is only explicable on the grounds that the present methods were not then known, and that those having the control of the company were not as well up in mining matters as they should have been. Should the company turn their attention in the direction indicated, there would be a phenomenal output of gold.

The tributers in what is known as Croy's claim have entered into fresh arrangements with Mr. Croy, and there are now three parties at work.

Colloroy and Cameron's claim on the same terrace is giving large returns, and on the cement lead, near the same claim, the owners of the four-head battery are making over wages.

Considerable inquiries have of late been made with regard to cements, and to their treatment by the cyanide or Cassel process. So far, nothing of any consequence has been found, but careful tests are being made from samples taken from several of the old leads in the neighbourhood of Scandinavian Terrace, Lamplough, and the Blue Spur.

The Mining Association, when their funds would permit, have been doing good work in putting down prospecting-shafts, driving tunnels, and boring. Nothing very rich has been found, but several parties are at work in shafts sunk by the association.

The boring on the beach between Lake Mahinapua and the sea-beach disclosed two distinct black sand leads—a black lead—but they were not rich enough in gold to induce men to go to work on them. However, the fact that leads (60ft. wide) exist at a workable depth, although poor where the bore-hole was put down, should encourage miners to take out a paddock or two. These leads run for miles, and as it is a characteristic of all black leads that they are notoriously patchy, they should be more thoroughly tried before being condemned as non-payable.

On Commissioner's Flat, Kanieri, Maks and party here are now on wash, averaging 6dwt. to the load. They have sunk 5ft. into this wash, and find it improving as they go down. No one knows the depth of wash on this flat, as hitherto the large quantity of water met with in sinking defied all previous efforts to get down. The success of the present party is due to a drainage-tunnel having been taken in from the river, draining the ground to a depth of 20ft. The water at the lower level will be lifted by a jet-pump, worked by a Pelton wheel driven by water from their head-race.

Owing to one of the landowners on the Kanieri River demanding more compensation than was considered reasonable, the Government have been unable to proclaim this river as a watercourse into which tailings may be discharged. The proclamation of the Kanieri would be a great boon to miners, and an incentive to miners to undertake larger hydraulic ventures.

Lakes Kanieri and Mahinapua are being made more accessible to visitors and tourists by the construction of well-gravelled tracks along their margins; and as the bridge over the Kanieri River is now open for traffic, and boats available for the use of visitors, the coming season will no doubt show a large increase in the number of visitors to this beautiful lake.

As showing the urgent necessity there is for immediate action being taken with regard to an increased water-supply for Back Creek terraces, I have just been informed that a number of new claims on the upper end of the Back Creek terraces, and facing the Hokitika River, are on payable gold, *i.e.*, when they can get sufficient water to work with. This is not obtainable at present, hence the necessity for immediate action. That we have an immense goldfield admirably adapted for hydraulic mining at our doors, is a fact being proved to us every day, through the opening of new faces along the front of this terrace.

Sub-district of Ross.

There is nothing of importance to report from this district. About the usual number of men are at work, scattered about the various gullies and terraces. The Mont d'Or Company show very little change in either output of gold or quantity of material dealt with, both being regulated by water-supply, which is somewhat intermittent. The Ross United Gold-mining Company (Limited), in their tenth annual report state as follows: "The yield of gold has been well maintained, the figures being £1,620 1s. 6d., as against £1,615 7s. 6d. for the previous year; while the cost of obtaining it has been reduced from £1,786 17s. to £1,451 13s., showing that a saving of £334 4s. has been effected, viz., in working-expenses of £244 17s. 5d., and in administration or management of £89 6s. 7d., the result being a credit to profit-and-loss account, which stands to the credit of the company's bank account in form of fixed deposits and credit balance of current account. Probably, shareholders will think this small, but at any rate it must be considered satisfactory (being cash available), having been obtained by working the surface only—ground that has been worked over and over again during the past twenty-five years, and which may be depended upon to give similar results for some time to come. However, your directors again desire to point out to you the extreme folly of allowing such valuable property to be undeveloped, as it is from the deep levels that shareholders must look for substantial returns, and they [the directors] think they are quite justified in again urging you to provide the means (estimated at £30,000) to effectually work them, and leave a margin for contingencies."

The above extract—both as regards the value of the property and advice tendered by the directors to the shareholders as to the do-nothing policy pursued for the last few years—receives my complete indorsement. The non-utilisation of this valuable mining property is an economic mistake, the blighting effect of which is painfully realised by every business man in Ross, as well as by the directors of the company; and the sooner the work of reconstruction is begun the better will it be for all concerned.

In quartz-mining there is nothing much doing. The old Donnelly's Creek had a small crushing a short time ago, giving about 1½oz. to the ton. The vein is still very thin, and I have been informed that they are about to try at greater depth.

The William Tell Company have been prospecting by tunnel, but, so far, without results. The work is at a standstill owing to some misunderstanding about the Government subsidy.

A large number of men have been employed on widening the Bowen and Okarito or main South Road. It is now fit for dray-traffic to about a mile south of Hindy's Ferry on the Big Wanganui River; and Mr. Shain, the District Engineer, is now laying off the sections to the south of the portion completed. The widening of this road will be a great boon to the people of Okarito and the settlers all along the line.

Sub-district of Okarito.

There is nothing of special importance to report from this district. Population keeps about the same. Lake Mapourika and the Waiho carry the most miners, and the average returns are fairly

good. The members of the mining association here are doing good work. They have raised about £45 by subscription for prospecting. This amount they expect to be increased pound for pound by the Government. In spending this, their efforts will be directed towards tracing the vein of gold from the Lake diggings towards the source in McDonald's Creek, and down the banks of the Okarito River towards the Forks, both most promising looking localities. I have been informed that a fine sample of coarse gold is being obtained by some of the men who were at work on the road near where the South Road crosses the Omeoroa River. A number of men have been at work on this creek for years, but the higher reaches, owing to the roughness of the country, have never been worked. The nuggets being obtained show recent detatchment from matrix. About the usual number of miners are at work on the beaches along the coast, some of them doing remarkably well, whilst others are waiting for payable sand to be thrown up.

SUB-DISTRICT OF JACKSON'S BAY.

With the exception of a few men at Bullock Creek, most of the miners are at work on the beaches. The promising auriferous mining block to the south of Barn Bay, described in my report of 1892, is still untouched. The non-completion of pack-track to Barn Bay—three-fourths of which was done early in the year—still bars the way to miners who would gladly go on to it. The remarks made in my 1892 report are of equal force now, and I trust the Mines Department will see fit to have the track finished to the sea-beach, so that access may be had to this valuable stretch of country. The Great South Road through to Lake Wakatipu is a very necessary work, and it would greatly benefit the settlers if it was opened right through; but side tracks over which a pack-horse can be taken, when giving access to auriferous country not otherwise approachable, should not await the completion of the main arterial lines. The Haast Pass track from the Clark Bluff to the sea requires looking to. This road is now a good deal used, and would greatly benefit the settlers if put, and kept, in passable condition. The main road from Blue River to Haast is in very good order, and no complaints have reached me from that quarter; but the main road from the Arawata up the Jackson is in places very bad. The necessity for roads and tracks receiving more attention arises from the fact that the sheep-country is being rapidly taken up, one mob of sheep—600—having been brought over from Otago, *via* the Haast Pass, to be put on the Okuro-Matakitaki Range. Another mob for the Cascade country goes by steamer in a week or two to add to the flock already there, and, seeing that everything has to be packed, it is only right that attention should be paid to the roads.

Dredging.—This is an industry that promised great things for the Coast, but unfortunately every company that was started failed of success. Since I wrote last year, with the exception of the dredge on the Hokitika, they have all collapsed. There is a slight reaction taking place at present. Mr. Wellman has raised his dredge on the Saltwater, and given her a complete overhaul, and I understand it is his intention to work a portion of the beach. Mr. Wellman, whose energy is unbounded, and who has, under great difficulties, accomplished almost single-handed such a feat, deserves a large measure of success. The Three-mile dredge is still lying idle, and the same has to be said of the Von Smitt dredge at Gillespie's Beach. The Ball dredge, the forerunner of Mr. Cole, has passed into the hands of Mr. Dickens, of Okarito. After having raised her he gave her a thorough overhaul, and moved her on to what was known as the Ten-acre Drain on the Five-mile. I saw the dredge at work in April, but they had just started, and I cannot say what measure of success will follow Mr. Dickens's plucky venture. The remaining dredge is that of the Kanieri Gold-mining Company. This, unlike the others, is a bucket-dredge, and was started with a fair show of success, the prospect from the river having been very good. However, after a considerable expenditure of time and money it was found that the wash was very much deeper than reckoned on, and also very much tighter, and contained much larger boulders than they had calculated on meeting with. A second attempt was made further down, and on the opposite side of the river: here the dredge worked splendidly, putting through about 60 tons per hour, and dredging to a depth of 20ft. The buckets never touched the solid wash, and, contrary to expectation, the loose river-shingle gave almost a *nil* return. After this the company called tenders for lengthening the bucket-ladder; this being done, work was again resumed on the old face, but after working about eight or ten days the return was only 5oz. The indurated nature of the wash-dirt, together with the immense boulders, defied all their efforts. There is splendid gold in this tight wash, but the dredge cannot deal with it. They have now dropped down the river below the Shenandoah flat, where it is said the wash-dirt is finer and shallower. The result will be known shortly. This dredge is well adapted for dealing with ordinary river or beach-shingle, and would give a good account of herself on our beaches south, but no dredge that ever was built could succeed with such indurated wash-dirt as was found where they first started. Therefore I am very much afraid this will add another to our failures.

During the season we have been visited by Mr. Goodlet, in the interests of the various Schools of Mines on the Coast, and also later on by Mr. Aitken, from the Reefton School of Mines; he spent a week in Hokitika, instructing and testing. However, owing to the want of a furnace and other appliances, now on their way out from Home for the use of the Hokitika Society, less was done in the way of testing than otherwise would have been the case. On his next visit, three months hence, the society will be better prepared to take advantage of his instructions.

I have, &c.,

17th May, 1893. D. MACFARLANE, Warden.

APPENDIX I. (PART 2.)

No. 11.

Mr. Warden KEDDELL to the UNDER-SECRETARY of MINES, Wellington.

SIR,— Oamaru, May 19th, 1893.

I have the honour to forward herewith the statistical information requested in your circular letter of March last, and to submit the following remarks on the progress and condition of mining affairs in the district under my charge.

During the past financial year no noteworthy change or events of any kind have occurred, and mining has been prosecuted steadily without interruption, and with satisfactory results.

The past summer has been very favourable for hydraulic mining, there being throughout an unusual and abundant supply of water, and there has consequently been little lost time—in ordinary seasons there is invariably a cessation of work for want of water.

The water-races that suffered so much from the ravages of the flood of February, 1892, have been fully repaired, and put in working order, and they now give employment to a number of miners, who would otherwise have to seek work in distant parts of the province. Nearly the whole of the miners are working on their own account—not more than perhaps a dozen in the district are working for wages; and of those working for themselves, notwithstanding they have to pay £2 a week for a Government head of water, they are able to make a fairly comfortable living, aided by the produce of their gardens and the assistance of having the use of the Mining Reserve as a run for their cattle.

There are no large prizes gained or even hoped for, but the claims, once in working order, and saving accident by flood to the head- or tail-races, for the most part yield a certain steady return to the industrious miner. The Mining Reserve having been placed under the control of the miners themselves, is likely to be productive of good and to promote settlement. The great want is a larger water supply, as there is plenty of scope for the employment of a far larger quantity than is at present brought on the field. This is likely, in a short time, to be to a certain extent remedied. The Mountain Hut race is now under construction, and on completion will give employment to a large number of men. The projectors have had about 12 men steadily at work on this race during the past 16 months, and when completed, it will be 15 miles long, crossing the north branch of Maerewhenua River in iron piping, and will be of sufficient altitude to command all the auriferous drift on the west side of the Maerewhenua. About seven miles of this race is finished, and if no unforeseen difficulties arise, next year should see this necessary work completed.

With regard to the prices charged for water showed in the accompanying return. The Pioneer Company, on the east side, is £2 per week; on the west side the charge is £1 6s. 8d. per head per week.

I have, &c.,

The Under-Secretary, Mines Department, Wellington. JACKSON KEDDELL, Warden.

No. 12.

Mr. Warden HAWKINS to the UNDER-SECRETARY of MINES, Wellington.

SIR,— Warden's Office, Laurence, 26th April, 1893.

I have the honour to forward the annual report for the districts of Tuapeka, Tapanui, and Waikaia.

These districts came under my charge on the first day only of the present month.

I am necessarily dependent for the materials of my report to a very considerable extent on the ready assistance and information given by Mr. Abel, the Mining Registrar and Receiver of Gold Revenue at Laurence.

The statistical returns accompany this report.

TUAPEKA.

There is very little change to note in mining matters since to date of the Warden's last report. The number of mining applications are nearly the same as in the year ending 31st March, 1892, but the number of cases both in the Warden's and Resident Magistrate's Courts have increased.

The principal claim here is that of the Blue Spur and Gabriel's Gully Company. This company hold a special claim of 66 acres, which embraces all the gold-mining leases formerly held by the original owners of the Blue Spur claims, together with the claims of the Tailings Company in Gabriel's Gully. The company were for some time at work with the elevator plant in treating the tailings and portions of the old lead of Gabriel's Gully, but are now working entirely in the cement at the Blue Spur. They employ on an average 46 men.

Mr. J. Howard Jackson, the general manager of the company, estimates that during the year about 250,000 tons of cement have been broken up and dealt with. When it is considered that the whole of this stuff has been elevated to a height of about 65ft., some idea may be formed of the quantity of work done in the mine. The yield of gold for the year was 2,029ozs. The amount paid in wages was £5,233, and the cost of roburite and powder, £655.

The Local Industry Company have been working steadily in Gabriel's Gully with their elevator plant. This is a small company, employing about six men. They have dealt with about 70,000 tons of stuff during the year. The yield of gold was 422ozs.

In Munro's Gully, Kitto and party continue to work, so far as their water supply will permit. They have entered into an arrangement with Mr. Jackson for the use of his surplus water from the Blue Spur, but the supply is not as constant as the persons interested would desire.

Mr. J. M. Perry, the introducer of the elevator system of mining, has applied for a prospecting area, for dredging in the bed of the Tuapeka River, about a mile or so below the outlet of Gabriel's Gully. He intends to bring his plant down from where it is at present—on the Clutha River—if the prospects warrant him in doing so.

At Weatherston's, and along the Tuapeka River to the Tuapeka mouth, and also at the Beaumont, mining is being carried on, but there is no account of any exceptional finds, and it is inferred that all or most of those employed are making a decent livelihood.

The Undaunted Gold-mining Company has achieved a considerable success. They are working with an elevator on the Clutha River, about Horseshoe Bend. Their returns, which in 1890 were 329ozs., in 1891 475ozs., increased in 1892 to 970ozs.

Waitahuna.

There are about 60 Europeans and 30 Chinese miners at work at Waitahuna.

All the workings here are alluvial. The Waitahuna Quartz-mining Company have ceased working, and are now in process of liquidation.

Messrs. Thomson and party have recently taken up a claim of 26 acres as a licensed holding. This claim is in the main gully. They have erected an elevator plant similar to that in use at Gabriel's Gully and other places, and are now enabled to work profitably ground which could not be made to pay by the ordinary method of sluicing. In this claim, and those of Ferris and party, Callanan, O'Kane, and Quigley, about 30 men are employed. There are no exceptionally rich returns from any of these claims, but the average appears to be of a paying character.

At *Manuka Creek*, *Glenon*, and *Adams' Flat*, there are from 18 to 20 Europeans and 12 Chinese engaged in mining a portion of the year, the rest of the time being filled up with agricultural and other pursuits.

Waipori.

In this portion of the district, work is being carried on with considerable energy in some of the claims.

The total number of men actually engaged in mining is estimated at 240, of whom 60 are Chinese.

The principal claims are those of the two dredging companies, and that of the Amalgamated Deep Lead Company. The dredging companies are the Upper Waipori Company and the Jutland Flat Company. The former company have two dredges, only one of which, however, is now in use, and the latter one dredge. Both these dredges are at work in the bed of the Waipori River and on the adjacent flats. The greater part of the stuff treated consists of tailings that have accumulated in the river since the workings at Waipori first began, now well nigh on to 30 years. The Upper Waipori Alluvial Gold-dredging Company during the year obtained 1,495ozs. of gold, and the Jutland Flat (Waipori) Gold-mining Company 1,281ozs.

The Amalgamated Waipori Deep Lead Company have been steadily at work with their elevator plant during the year. They succeeded in getting 354ozs.

There are a number of other alluvial claims, which are being worked with apparently satisfactory results. With respect to the quartz workings, there are only now two claims in active operation. Stuart and Gore employ on an average nine men. During the last 12 months they have put in a tunnel about 280ft. through hard rock, at a cost of over £1,000, and have struck the reef at a depth of 150ft below the surface. Ritchie and party employ about six men. The output from the first claim is about 50 tons per month, but this will be considerably increased in the future.

The Lammerlaw Antimony Company carry on work on the Lammerlaw Ranges, about eight miles from Waipori, and 14 miles from Laurence. They hold a mineral lease of 60 acres. This company have carried on operations continuously during the year, with the exception of a break of eight weeks, when, on account of their water-races being frozen, everything was brought to a standstill.

A considerable quantity of driving has been done in the claim. The main shaft is now 100ft. in depth. One thousand five hundred and seventy-five bags of ore have been taken out of the mine during the year. This means about 110 tons. The result has been obtained at a cost of £1,600. The mine being somewhat wet, it is expensive to work. Eight men are constantly employed in and about the mine. These men receive 9s. per day as wages.

At *Tapanui*, and in its vicinity, there are about 20 men at work engaged in mining, but there is nothing of importance to record about them.

At *Waikaia* the mining population remains about the same. There are 80 Europeans, it is estimated, and 110 Chinese miners. Most of these are earning a poor living.

The Gow's Creek Dredging Company erected a dredge at Gow's Creek, about 12 miles above the Waikaia township; but after a few trials, it was found not to be a success.

The Waikaia Gold-mining Company have extended their water race from Steeple Creek to the Scrubby Terrace, where there are now nine or ten claims being worked with fair success.

There are no reliable returns obtainable of the yield of gold, but it is estimated that a considerable falling off has occurred, as compared with last year.

I have to call your special attention to a case which arose, at a sitting of the Assessment Court, under "The Gold Duty Abolition and Mining Property Rating Act, 1890." The Island Block Gold-mining Company, who are working on the banks of the Clutha, above Horseshoe Bend, were assessed in the sum of £30,000.

The company objected to this valuation, on the ground that the mine and mining rights and works were all carried on on the lands of a private owner, and evidence to that effect was given by the manager. A dam, water-races, and piping were alone on Crown Lands.

The Act gives power only to rate "mining property," and the definitions of mining property in section 3 does not include the lands of private owners.

The only mining property, therefore, of this company liable to rates under the Act was the dam, water-races, and piping on the Crown Lands only, whereby the assessment was reduced to £6,500.

Was it intended that mining property under rich encumbrances should be exempted?

I have, &c.,

To Under-Secretary Mines Department, Wellington. Robert S. Hawkins, Warden.

No. 13.

Mr. Warden Dalgleish to the Under-Secretary of Mines, Wellington.

Sir,— Warden's Office, Naseby, 30th April, 1893.

I have the honour to forward herewith the annual statistical returns of the Mount Ida District for the year ending 31st March, 1893, and to submit for your information the following particulars from the various centres; but ere doing so, I may be permitted to make a few remarks on the whole district. The past year has, I am glad to say, again been a very satisfactory one with regard to the general supply of water for sluicing and other purposes, and this being the great essential towards success, I feel justified in saying that advantageous results have actually been attained. Miners, as a rule, throughout the entire district, have been enabled to work more continuously than for quite a number of years, and are, I believe, in improved positions. The calamitous effects to the district of a succession of dry seasons prior to 1892, in addition to the almost ruinous losses sustained by speculations at Nenthorne, are, I am glad to say, gradually disappearing, and it is to be hoped that the bitter lessons taught by those rash undertakings will have a beneficial effect in the future.

Although no new discoveries of importance have been reported during the year, the number of miners on the field has not altered materially since my last annual report, and, so far as I can ascertain, the prospects of a continuance of work of a profitable nature may be looked upon as satisfactory.

The recent purchase by the Government of Johnstone's water-race at Blackstone will augment the supply to the Mount Ida water-race; and, in addition, the energetic steps adopted for cleaning out the main race along its entire course, will, no doubt, be most beneficially felt, as it is anticipated that from the race alluded to, and the cleansing of the whole, the quantity of water available for distribution will be increased by some twelve heads, which will, of course, enable a much larger number of men to find work.

The agriculturists have again enjoyed a fairly good season, although the crops have not, perhaps, in the aggregate, been as heavy as the previous year. Permanent settlement of the land is progressing favourably, evidences of it being apparent throughout the entire district in the shape of new homesteads, fresh land being under crop, substantial fencing, &c. Large and satisfactory sales of stock are now constantly being held—proving that the small settlers are now enabled to secure a market for that description of commodity—the gradual extension of the Otago Central Railway has contributed in a great measure to this end, and no doubt the further development of that line will largely increase the facilities in this respect, and tend to establish a large population on the vast areas through which it will pass. I am induced to make these remarks, as so many of the small settlers now in the district have been drawn from the mining community, and showing that, to a certain extent, gold-mining and the permanent settlement of the land can and will advance harmoniously and successfully together.

I have previously alluded to the effective conservation of water in this district, as being a question of ever-increasing interest, engrossing the earnest attention of all who have the welfare of the miners and settlers at heart—the attempt now being made by the Government to secure an artesian supply on the Maniototo is beyond doubt a step in the right direction, and if success is attained in this, it would be difficult to over-estimate the benefits which would result to the whole district. At the time of my last visit to the locality where the well is being sunk, I found the contractor had attained a depth of 320ft. up till that time, but very little water had been met with - sufficient only to raise to within some 35ft. of the surface. A small seam of coal was met with at a depth of 240ft., but it was not of any great thickness, consequently of little value.

Hyde, Macraes, Nenthorne, &c.

With regard to *Hyde*, I cannot, I regret to say, report any marked progress during the past year, notwithstanding the increased supply of water. A number of the old miners are gradually disappearing, or turning their attention to other pursuits, whilst the rising generation appear to be more desirous of obtaining work otherwise than mining, wherein the remuneration is perhaps more certain, or, where opportunity offers, becoming permanent settlers even in a small way—this feature is no doubt satisfactory—showing the desire to settle when the gold-mining industry declines, and that the locality possesses sufficient attractions in that respect to retain the population in the future. There are, however, still a few parties scattered about working in the old places, showing an amount of patient perseverance worthy better results than, I am afraid, has recently fallen to their lots; and as indicating the probabilities of a more satisfactory state of things in this neighbourhood, I am informed that there is every likelihood of a more combined and satisfactory effort being made in the near future to work the Main Gully at Hyde, and that steps are now being taken to obtain a lease, embracing a considerable area of ground, which is pretty well known to be payable if worked in the manner indicated. I am led to believe that the parties interested in the undertaking are of the right stamp to do full justice to it.

Macraes has not altered materially. On the Flat there are about the same number of miners at work, both European and Chinese, making a living, at any rate, if nothing more. At Horse Flat there have been some instances of better results, notably a Chinese miner, who, it is stated, managed to obtain some £500 worth of gold in the one season, and subsequently sold his claim to a party of European miners at the substantial figure of £130, a price which the subsequent workings, apparently, has not warranted. Another instance is reported to me of another Chinaman who in 14 weeks succeeded in securing 100ozs. in a gully adjacent to the Golden Point Battery. The workings at Station Hill are not advancing; the ground is very patchy and difficult to work. I understand there

are but two parties left there. In quartz-mining, nothing new has been reported. The Bonanza Mine has been profitably worked during the year. Dividends to the extent of £1500 have, I am informed, been distributed. The stone treated is represented to have yielded an average of 25dwts. per ton. A tunnel at a low level is now being put in, which it is hoped will soon cut the reef again and enable the proprietors to resume crushing, which has, I believe, been suspended in the meantime, pending the result of the workings at the low level. The Golden Point Battery has, I am informed, just commenced crushing with water-power, and the wheel (a "Pelton") is working very economically and satisfactorily to the proprietors, who have gone to considerable expense in bringing in their water-race. Some two miles of very rough country had to be negotiated, including half-a-mile of fluming and 1000ft. of 15in. piping. The reef is described as fairly large, and the quartz is brought to grass and delivered at the mill for 4s. per ton. The owners estimate that 2dwts. per ton will more than cover expenses. The Highlay Company has practically ceased operation in the meantime.

At *Nenthorne*, work has been carried on at one or two of the old claims. The Surprise has, I am led to believe, been carried on with satisfactory profit, although the reef is small, running only 4 to 6 inches; but the yield, at any rate up till recently, was up to 2oz. per ton, which was sufficient to pay very well for the time being. The Crœsus has only been partially worked on tribute, and, I fear, has not been a success to the tributors. The Eureka was also worked on tribute by the former manager, but the return was not payable, and I understand the mine is again idle. The Jacob and the Daddy have both been worked a little during the past year, and it is expected that work will be resumed on those claims. Other small attempts have been made in some of the abandoned claims, but not of sufficient importance to make any special note of. It is still thought by some of the residents that payable quartz in large quantities is procurable at and near Nenthorne, now that it can be crushed at a moderate cost. The population of Nenthorne has still further decreased, and the place is now comparatively deserted. I have discontinued the holdings of the courts there.

Hamilton's, Sowburn, and Serpentine.

No change, requiring any special comment, has taken place at any of these places, the population remaining about the same, excepting perhaps the latter locality, where it appears there are a few more Chinese miners setting in to work.

Kyeburn.

In this place also little or no change has taken place. The miners are getting over the disastrous consequences of the heavy floods which took place in 1892, whereby a number of water-races were seriously injured, involving a large outlay in many cases to repair damages, both from the flood and subsequent landslips, which, bringing down enormous quantities of *debris*, filled the creeks in some cases many feet above their old levels, and altering the ordinary course of the water several times in the course of a day, thus increasing very considerably the labour necessary for permanent repairs. One water-race from German Creek, which previously had been of good service, has been unworkable ever since from this cause. Parker and party are constructing a new dam in connection with their new water-race, and it is believed, when in working order, they will have the command of a considerable area of payable country. Brown's party have carried out considerable work in their races and claims, thoroughly cleaning out their head-race for a distance of some fourteen miles, and constructing a somewhat expensive tail-race. This party intend ere long to commence elevating, as they find some of the wash to be treated is at a depth of 25ft. below their tail-race.

At *Little Kyeburn* good work is being pushed forward by the men at work in that locality, by the formation of new races at greater elevations, to command ground believed to be highly payable on the Little Kyeburn slope. I believe the elevating system is also to be introduced there. Iron piping is, to a large extent, now taking the place of the old-fashioned canvas hose, and the exchange is proving satisfactory to all. I am led to believe that the prospects of the miners in this neighbourhood are fairly good, and that there is a very large tract of auriferous country still almost undeveloped in the various gullies and terraces between Kyeburn, Little Kyeburn, and Naseby. I trust soon to hear of work being commenced in some of these places.

Naseby, &c.

Miners generally in this neighbourhood have been kept fairly at work during the past year, and so far as I can gather, the returns have, as a rule, been favourable, but no specially large yields have been reported. The claims on Mount Burster are stated to be still yielding well. Inder and Guffie have treated a much larger area of ground this year, and although the washing-up is not yet completed, there is every reason to believe the returns will be proportionately as good as in former years.

During the progress of the cleaning-out works on the Government head-race, some of the men employed prospected ground on the Ida Burn, and found what they describe as fairly payable sluicing prospects. It is too early yet to hazard an opinion of the value of the discovery, but I am expecting definite particulars from the place immediately, which I will at once advise you of. Judging even from the somewhat meagre accounts yet to hand, it is quite possible that a large area of ground may be opened up. I fear, however, there will be difficulty in getting water on the spot, it being situated at a higher elevation than the Government head-race, and the available water in Ida Burn is practically all absorbed by existing rights. I have already granted several extended claims at the place, and other applications are pending.

Ophir, Ida Valley, &c.

These localities have not participated to any degree in the increased supplies of water enjoyed elsewhere, and consequently mining has not advanced during the past year. Black's Flat, which in years gone by was almost unworkable on account of an over-abundance of water, is now comparatively deserted from the very opposite cause. Two or three claims are held in the vicinity of Green's reef, where some fairly good seams of quartz exist; but no permanent work is being carried on owing to the absence of motive power for crushing.

In proof that enterprise in mining has not entirely died out here, I may mention that a small party has lately been formed to fairly test the gold-bearing qualities of the Manuherikia River. The company is now erecting a dredging-plant near Black's Bridge. The dredge is a small one, suitable for prospecting, but if the results obtained will justify it, a larger plant will be put on.

Tinkers.—Good accounts still continue from this place. The Undaunted Company, owing the first right to seven heads of water out of Thompson's Creek, and four heads out of the principal tributaries of Chatto Creek, has been enabled to work continuously throughout the year. Since my last report they have constructed a race from Thompson's Creek about a mile higher up than their present head, with a view to alter their first right of water into it; and when this has been effected, the company will have ample fall for elevating, which hitherto they could not accomplish. The alteration will necessitate a considerable expense, but the advantages to be secured will, without doubt, quickly repay the company. I am informed that the result of their last washing was about 700ozs., and in May an equally good return is relied on with considerable certainty. As showing the confidence felt by the shareholders, they have, during the last three years, expended £8000 in acquiring additional water rights, and £2000 in the construction of races. That the confidence has been justified already is evidenced by the gratifying fact that during the same period, after paying all working expenses, the company has been enabled to pay off the whole of the large sums named. The Mountain Race Company is disposing of its interest in the first right out of Thompson's Creek to the Undaunted Company, and I fear that the small supply left at the disposal of the Mountain Race Company will hamper their operations very much. Some four men are employed. No washing up has been reported, and the result of last year's work is not known to me. Read and party, known as the "Sugar Pot," are still on exceedingly rich ground, but unfortunately their supply of water will not enable them to work more than about eight or nine months in the year. They are now at a standstill, and unable to wash up until the autumn rains set in. Ewing and McConnochie had an excellent supply of water at the commencement of the season, and took advantage of it to sluice back through the "granite" and overhanging rock, to test the value of the back layers, which have always been considered by the leading miners in the locality to be the best, could they be properly worked; but the result of Ewing and McConnochie's operations has not borne out that idea by any means. They have since been working in a portion of their claim known to be payable, but it is unlikely that they will wash up at present. Simes and Morgan have been working considerably to the south of existing workings on the granite formation. Water in their case has been somewhat short. The yield from their claim has not reached me, but it is believed to be satisfactory. The Matakanui party draws their supply of water from the Lander Creek, and having superior rights, have been able to carry on sluicing all the year with but few interruptions. They now have very fair prospects, which their several years of labour (hitherto without much benefit) thoroughly entitles them to. They are now operating on ground in close proximity to that worked so profitably by the Undaunted Company, which was about as good as any in the locality. The last washing of the Matakanui party was 800ozs., and they expect as good a yield in May. About seven men are employed. There are several other parties at Tinker's and the adjacent gullies, who are, I am informed, doing fairly well.

Drybread.

There are some twenty men at this place, some of them carrying on pretty extensive operations—notably, Mellor, Jones, Wilson, and others; but Lander Creek, from whence the principal water supply is obtained, is very low, consequently mining is somewhat depressed for the present.

Blackstone Hill.

No alteration worthy of note has taken place, excepting perhaps that the Blackstone Hill Gold-mining Company are persevering with the construction of their water-race, heading out of the Manuherikia River. They have succeeded in bringing the water on as far as Dunsmuir's Flat, where a prospect—which at first was believed to be payable, with the large supply of water at the command of the company—was found, but the results so far have not borne out their anticipations, and the company has determined to continue the race to a point where payable ground is known to exist.

The water-race which up till recently was the property of Mr. R. Johnstone has now become the property of the Government, and I have little doubt that it will prove a great adjunct to the Mount Ida water-race, into which it is proposed to turn it. A party of miners have been working on the quartz lodes on the Roughridge. I am informed that good work has been done by these men (Perry and party), but I have not heard of the actual results of their crushings.

St. Bathans, Cambrians, &c.

Reports from these localities are favourable for the year, and if no great expansion has taken place, it is satisfactory to be enabled to report that the prospects and returns already secured are most satisfactory. The Scandinavian Company during the year enlarged and improved very materially the upper portion of their water-race, and will now be in a position to discharge 12 heads in almost the driest weather. The work alluded to, the frosts of last winter, and washing up the Muddy Creek channel has precluded the company from washing up generally. It is not intended to do so until about December next.

The United M. & E. Company washed up some months ago at their claim on Surface Hill, and obtained some 165ozs., a yield hardly up to expectations. The company is now engaged washing up their Blue Gully claim, and expect 200ozs. for six months' run. They, last month, partially cleaned up the Muddy Creek channel, and from some 60 chains of it, a mile below the discharge of the tail-races, £500 worth of gold was secured at a cost for cleaning up of £200—a very satisfactory result, as the work was undertaken with the view of erecting gold-saving tables, more than with the expectation of realising profit from the cleaning up.

The St. Bathans Channel Company have continued working well, and have put through a large area of ground with fairly good prospects; 500ozs. is expected from the cleaning down now taking

place. It is anticipated by the company that during the next 12 months the heavy expenditure entailed by the nature of their operations will be completed.

Mr. Ewing has continued working in his well-known claim at Kildare Hill, in the usual systematic and energetic manner which characterises the whole of his large undertakings. The results are good. During the greater part of the summer he has been engaged stripping, but for the last few weeks the water supply has somewhat failed, necessitating a temporary stoppage. Since last winter he has secured 1000ozs., and fully expects an equal amount as the result of the next two months' work from the wash now stripped—a most gratifying and well-earned return. Mr. Ewing is now elevating to a height of 75ft., and is making preparations for another 25ft. with a partly suction elevator.

Eagle and party are understood to be obtaining fair returns, but the exact amounts have not reached me. The St. Bathans Water-race and Sluicing Company have not washed up this season. The last results, I am informed, were not of a very encouraging character. There are one or two small parties who have to purchase water, who are stated to be doing fairly well.

At *Cambrian's*, Gay and party are, I believe, doing moderately well, working an old block on the Saddle. There are also several parties of Chinese miners who purchase their water from Mr. Ewing, who is now the owner of the large race with first rights out of Dunstan Creek. Mr. Ewing has taken up a licensed holding on a terrace opposite the township, and contemplates working it on a large scale. His race has a capacity of 12 heads, and is seldom without a full supply. Fossickers, both European and Chinese, have, during the past 20 years, made wages on this terrace. Working it, therefore, on a large scale, with a good supply of water, will almost to a certainty show good results. At Station Hill there are a few parties at work, but the water is somewhat limited. I understand Mr. Ewing is extending one of his water-races some five miles, so as to command this ground at a higher level, and to sell the water. It is hoped by this that a considerable area of ground will be opened up and worked profitably. At Vinegar Hill, extensive workings are still carried on by Mr. Ewing. During the past year he has stripped three acres of ground, and during the same period has obtained from his tail-boxes and shallow ground some 250ozs. But the more important workings have not yet been washed up; from that portion a return of 700ozs. is looked for. A full stream of water is necessary for washing up and working this ground, it being elevated 25ft. Morgan and Hughes have completed their new tail-race, and are now on good gold. For six months' work just on the margin of this good ground, they are stated to have obtained 75ozs., only two men being employed. Watson and party are also securing good returns at Vinegar Flat. The return for last season is stated to have been 250ozs. for three men's work. Coulson and Excell, I believe, continue to make good wages, driving in ground left under foot in Morgan and Hughes' old claim. T. Morgan and party, Shannon, and others are also believed to be remuneratively employed in that locality. It is the opinion of not a few that quite an extensive area of payable ground exists in Two-mile Flat, which is over a mile in length by some 25 chains in width. Unfortunately, there is but little fall, and to elevate it would require water to be brought in from a long distance in iron pipes, to secure the necessary pressure.

I attach particulars of the principal business transacted at the various courts comprising the district.

I have, &c.,
S. Mead Dalgleish, Warden.

The Under-Secretary, Mines Department, Wellington.

Wardens Court complaints		59
General applications		517
General applications opposed		88
Licensed holding applications		16
Occupation license applications		70
Miners rights issued		611
Water licenses		277
General registrations		619
Resident Magistrate Courts	Civil	277
	Criminal	239

No. 14.

Mr. Warden Wood to the Under-Secretary of Mines, Wellington.

Sir,— Warden's Office, Clyde, 12th May, 1893.

I have the honour to enclose herewith the annual report and statistics for the Dunstan and Wakatipu divisions of the Otago Mining District, under my supervision.

Since the spring, the rainfall in my district has been very much below the average of previous years, and as a consequence both the mining and agricultural interests have suffered to a greater or lesser degree; several creeks, which hitherto could be relied on for supplying the rights down to the third or fourth all the year round, have, during the last three or four months, only succeeded in satisfying the first. Dredging, however, has profited by the lowness of the river, consequent upon the absence of snow on the mountains and scarcity of rain, and this branch of mining—yearly becoming more important—must take the credit of maintaining the average return of gold for the year in these parts.

Clyde and Alexandra.

The bank of the Clutha, on the west side, is still occupied by the same parties, the water used, brought across the flat from the Earnscleugh Gorge in open races, as it is, gives them no pressure for elevating purposes, therefore they are compelled to confine their operations to the upper seams, losing them one by one, from want of fall, as they got back in the flat. If water had to be paid for at the rates current in some parts of my district, I have little doubt but that this system of working the ground would be abandoned; but, fortunately, they are all owners of races, and succeed in making fair wages.

The Golden Gate Company are, I believe, doing well on the Dunstan Commonage, as also are three or four other parties working in a smaller way.

Mr. John Allan, at Spring Vale, continues to realize good returns. During the past year he has sluiced away several acres of shallow ground, and no sooner does he work out one claim, than he takes up another with the utmost confidence, leading one to suppose that the whole country-side is payable, and the wonder to me is that this ground has remained untouched so long.

There are a few working in Blackman's Gully and the adjoining terraces, where good gold is known to exist, but unfortunately the best ground cannot be touched on account of the opposition by the farmers on the Earnscleugh Flat, who, having irrigation rights out of the creek, object to the pollution of the water.

The Molyneux Hydraulic Company, at Alexandra, have completed their plant, and have commenced work, but, like others, are suffering from the continued drought, and can barely keep the elevator going one shift. The fear, however, expressed at first, that the available pressure was not sufficient to work the ground, I think can fairly be set aside, for on my visiting the claim a fortnight ago, I saw that bottom had been reached, and that with a little less than five heads of water they were elevating 25ft. In consequence of broken time, barely sufficient gold has been obtained to pay current expenses, but I think there is little doubt of the ultimate success of the company.

Jackson and party, under many difficulties, are gamely persevering with their water-race from Gibralter Creek to Tucker Hill, near Alexandra. I cannot ascertain how long it will take them to complete the work, but the energy and pluck displayed by the party so far, is a fair guarantee that they will see the undertaking through, and on its being accomplished, will merit all the success they anticipate.

At Poverty Beach and the gullies around Alexandra, mining is still being carried on with fair success; there seems to be no diminution in the number engaged, and, so far as I can hear, no decrease in the quantity of gold obtained.

Dredging.

The pneumatic dredge placed upon the river in the gorge below Frenchman's Point by a Melbourne syndicate, about 18 months ago, prosecuted its searches for some considerable time without success. Since then a party of local miners took over the plant on tribute, and at once removed the dredge higher up the stream, to a point half-a-mile below Alexandra. This removal and the change of management seems to have acted as a charm, for in a very short time payable gold was struck, and the tributors are so satisfied with their prospects that an application has been lodged for a special claim.

Mr. Gards continues to keep up his returns from his stream and current wheel-dredges at and near Sandy Point, averaging from the two about 30ozs. a week, the value of which leaves him a very handsome surplus after expenses are paid.

Messrs. Drijon and Magnus, since my last report, have shifted to a point a couple of miles lower down the stream, where the ground is shallower. I have not heard with what result, but report has it that they are doing well.

Spencer and party have just completed the re-erection of their steam dredge, which they purchased from the Kawarau Big Beach Company, and removed from the Kawarau River. The total outlay is about £2,000, which is less than half of the original cost of the dredge. Mr. Sparrow, the contractor, has just given them a trial of the machinery, and everything works satisfactorily. The special claim taken up by the party is situate about two miles below Clyde, to which place they intend removing.

Since my last report, a party of four, residents of the Clyde, purchased from the liquidator the Frankton Beach Company's dredge, and after removing it from the Shotover, and re-erecting the same, at a cost altogether of a little under £2,000, commenced dredging in the Clutha, opposite the Dunstan Hospital, where they have applied for a special claim. It was at or about this spot that the spoon-dredges did so remarkably well upwards of 20 years ago. Since that time, through the flood of 1878, and consequent falling in of the banks, the river has widened considerably, so that although the bottom, as it originally existed, was probably pretty well skimmed over by the spoons, the increased width will give the present party a large area of virgin river. The machinery works very smoothly, and after they had fairly opened out on the bottom their periodical washings indicated something over 20ozs. a week, and this amount is expected to be increased in the future rather than otherwise.

Quayle and party are just now constructing a spoon-dredge at the Fourteen-mile Beach, and expected to have it completed in about a fortnight. The party is composed of six working miners, and the outlay, it is hoped, will not much exceed £200. In the early days some very rich patches were obtained on and about this Beach, and good gold was traced into the stream, beyond the reach of the methods then adopted, and it is this that the enterprising party are endeavouring to recover. Until the scheme proves a success, manual labour will be utilised for working the winch; but this, it is intended, shall be superseded by steam when the prospects warrant the expenditure.

During the last fortnight there has been a large influx of miners, chiefly Chinese, to the river between Clyde and Cromwell, and most of the beaches are occupied by busy workers. Judging from present indications, the coming winter should see the river lower than it has been for many years; and if so, I estimate that 500 or 600 people will find profitable employment on the banks of the Clutha in this locality.

Bald Hill Flat and Old Man Range.

This locality continues to present a prosperous appearance, and although the population has considerably increased during the last year or two, I am of opinion the time is not far distant when the present number will be nearly doubled.

There are ten water-races now terminating on the Flat, aggregating a length of 60 miles, with rights attached amounting to 59 heads; in addition to these, there are five tail-races, forming together a length of 4,500 yards by a depth of 10ft. Most of these have been constructed during the last two years, and are all in active work, and proving profitable investments. Hesson, Simmonds and party, during the past year, completed their race from Shingle Creek, a distance of over 17 miles, and having

purchased from the Quayle Brothers their rights in that creek, can now deliver on the Flat about 15 heads, which will enable them to keep two elevators going almost continuously. This enterprising party hold upwards of 70 acres on the Flat, which is known to be highly payable. Operated upon with a plant such as they possess, and with the supply of water now at their command, they have doubtless one of the best mining properties in Otago.

Wilkinson's claim, at the upper end of the Flat, shows no signs of being worked out. During the last year remarkably good gold was obtained by him, including some two- and three-ounce pieces; and on this becoming known to the public, some pegging-out in the vicinity took place, resulting in Mr. Wilkinson losing a portion of the area within his pegs, which included more ground than his certificate authorised. Sufficient, however, is left him to occupy his attention for many years to come, and to warrant its being proclaimed a valuable property.

The Bald Hill Sluicing Company, whose operations at the date of my last report were confined solely to Mr. Butler's freehold, have since purchased the claim and water rights of McCloskey and another at the lower end of the flat; in addition to this they have taken up a licensed holding adjoining Wilkinson, and are now about to remove their plant to the former claim. The want of water in the past has been their greatest drawback, and with a view to an increase of this valuable commodity, a right of eight heads out of Butcher's Creek has lately been applied for, and granted to the company, for the months of September, October, and November in each year. This right, it is expected, will prove a valuable assistance to them at a time when their other rights are not available, heading, as they do, considerably above the snow line.

Carroll and party, adjoining Simmonds and others, are working steadily and profitably, as also are Mitchell Brothers, they having completed their long and costly tail-race. About 20 others are engaged about the flat, in a small way, and a similar number are located on the slope of the Old Man Range in the gullies and terraces. It is, however, very difficult to get at what all are doing, but from report and general appearances, I believe most of them are making rather above the average rate of wages.

Quartz.

White's Reef is still being worked by the Symes Brothers, but I think the operations for some months past have chiefly been confined to the surface. A third share has lately changed hands, Mr. Andrews, now of Tasmania, but one time manager of the mine for White's Reef Company, being the purchaser, at £280. The desire of the present party is to put in a low-level tunnel, and should they succeed in accomplishing this heavy undertaking, no doubt the property will again be heard of as a gold-producing one Failing this, I fear nothing sensational will be obtained, as the presence of water proves a serious obstacle to sinking below the level of the present workings.

Since the beginning of last year, Crossan and Gray have developed a rich and, so far, well-defined reef on Coal Creek Spur, adjoining that on which White's is situated, but a little lower down the hill. During the past six months they have got out and crushed 315 tons, which realised 766ozs. of gold. Up to that time they had been sluicing off the surface, by which process they netted 114ozs., making in all for the year 880ozs. The quartz, though friable, runs in a distinct lode, from three to ten feet wide, between two hard walls. They have worked the reef for a distance of 170 yards on the surface, and tested it all that distance to a depth of 42ft. by shafts, sunk on the underlie of the reef. At this depth the lode appears to be of the same width and quality as near the surface. The gold, which is very fine, is found in a free state, and is easily amalgamated. This would indicate that the lode can have no connection with White's Reef, as most of the gold found there was of a coarse nature. Their battery of three head of stamps is driven by a Pelton Hurdy-gurdy, with a pressure of about 58ft., and was erected at a cost of somewhat less than £150. I look upon this discovery as being a very valuable one to the mining interest in this locality, and bears out what I have always maintained, viz., that the eastern slope of the Old Man Range is simply teeming with similar deposits, which, in their working, are peculiarly adapted to the miner of small means, because of the surface indications, the friableness of the quartz, and the invariable presence of free gold, where it is found.

Farm produce, stores, and the necessaries of life generally are sold here at Alexandra prices, and I am told that a single man can live comfortably at about 10s. per week.

The crops last year, although very moderate, were fully up to the average of other portions of my district, and this speaks well for the quality of the land, which has been under continuous cultivation for upwards of 25 years.

Roxburgh.

Although a large quantity of gold is being obtained about this district, I cannot say that the mining interest presents a more prosperous appearance than it did last year. This, to a very great extent, is attributable to the scarcity of water. It was expected when the large companies took charge, by consolidating the rights, thereby concentrating the force of water to fewer channels, and by the introduction of the latest improvements in hydraulics, superseding the modest though practical operations of the old identity miner, that an era of prosperity was about to dawn upon the district, calculated to gladden the hearts of the trader. I think it is safe to say, however, that after a considerable trial these expectations have not been realised.

The Hercules Hydraulic Sluicing Company, having the first right out of the Teviot stream, have been able to work one elevator almost continuously, with fair results. The ground which is being worked now is not as good as that which they opened out on in the front part of the claim, but they succeeded in obtaining 1,196ozs. during the year, which enabled the directors to divide £1,200 among the shareholders.

The Roxburgh Amalgamated Compauy have had a considerable amount of broken time during the last few months, the manager finding it difficult to keep one elevator at work. Fortunately advantage was taken of the abundant spring supply to strip a large area of the top seams, which are considered valueless, so that when water does come nothing but gold-bearing seams need be put through the elevator for some time. One thousand two hundred and fifty-nine ounces were obtained during the year, and £1,147 found its way to the shareholders.

The Hercules No. 2 Company, as was prognosticated by some a year ago, has retired from active life. Messrs. Ewing and McConnochie, of St. Bathans, purchased the plant from the liquidator for £1,800, and continued working the ground when water was available; but this being seldom, however, leads me to fear that so far the speculation has not been a paying one.

In consequence of the lowness of the river, most of the bank claims, worked by ordinary sluicing, have had a fairly successful year. The lower seams generally are relied upon for the best results, and the condition of the river has enabled the necessary fall to be brought up to reach them. There are about 50 men employed in this class of mining at Roxburgh and Coal Creek, made up of small parties of two's, three's, and four's, and, requiring as they do much less water to carry on operations than the elevating companies, the dryness of the season has not so materially affected them, and probably I am within the mark in estimating their average weekly earnings at from £3 to £5.

Upper Waikaia and Campbell's.

About fifty Europeans and Chinese are engaged in mining in these parts, the majority of whom are located in the Waikaia River. Many years ago some exceedingly good finds were made here, and several parties succeeded in netting sufficient quantities of the precious metal to enable them to return to their respective home countries. Since then, although no sensational finds have been made, a population of from 40 to 50 have found profitable employment. During the last year parties of young men succeeded in obtaining good prospects in the river, the bed of which is stoney and rough, and entails a large amount of labour in working—labour beyond the capabilities of the elderly men who have for years been located there, and probably the advent of younger blood may result in new discoveries being made. The climate is very good, and presents no obstacles to winter work, while the cost of living is not very much higher than at Roxburgh.

Pomahaka.

The Rise and Shine Company have not succeeded in realising their expectations, and from what I can hear probably will not, with the small amount of capital at their command. The management has lately been changed, no doubt with a view to a final effort being made. Sometimes a change in this direction brings about favourable results, and it is hoped so in this case, but during the last 15 years so many similar changes have been made, and so many different ideas brought to bear in attempts to open up the ground, that I am afraid the shareholders will again meet with disappointment.

There are several parties, both European and Chinese, employed in this locality, and seem to be quite satisfied with what they are getting.

Miller's Flat and Horseshoe Bend.

The Island Block Extended Company are, when water is available, operating on some very good ground at Miller's Flat. The directors, however. have had a lot of leeway to make up, and the 1250ozs. obtained during the year went to pay current expenses and towards discharge of encumbrance; but given a good supply of water, with the prospects they have in view, I have little doubt but that during the coming year the shareholders will be recouped some of their large outlay.

Island Block Company, at the Horseshoe Bend freehold, are and have been in full work. The ground, I believe, is somewhat patchy, and the golden seams, when dropped upon, rather difficult to follow, thereby necessitating the manipulation of a quantity of poor ground; but I am informed from good authority that the gold obtained during the year substantially exceeded 2000ozs., which should leave a fair amount of profit. Mr. Rawlins, who first opened up the ground, is again in charge of affairs, and is very hopeful of shortly placing his company on the dividend-paying list.

I am sorry to say that Mr. Perry has not met with any success so far in his bank claim near the mouth of the Benger—not from any fault of the working of the machinery, I am informed, but from the absence of sufficient gold. Mr. Perry, however, is not easily daunted, and will, I understand, give the ground another trial before finally abandoning the scheme.

Dredging.

There are ten steam and one current-wheel dredges at work on the river between Horseshoe Bend and Coal Creek, representing a plant value of £25,000, and employing continuously 65 men. Six of these are owned by registered companies, and the remainder by private parties. Through the courtesy of the secretaries of the companies, I am enabled to give their last year's returns, but those of the private parties are not obtainable.

The Golden Run Company, whose steam dredge cost a little over £2000, commenced work in the river at the north end of the Island Block about five months ago, and, as was expected, dropped on payable ground at once. Up to the 31st March they obtained 999ozs., which enabled the directors to clear off all liabilities and present the fortunate shareholders with 8s. per scrip.

The Miller's Creek Company, at Miller's Flat, has the largest and perhaps the best dredge on the Clutha. Its operations, however, are seriously impeded by the difficulty experienced in getting clear of their tailings; and more especially does this apply to the portion, viz., "Sheehy's Beach," known to be highly payable. During the year they succeeded in obtaining 698ozs., but as the expenses are considerable, the margin of profit was not large enough to declare a dividend.

The Ettrick Gold Steam Company are still dredging in the river near the mouth of the Benger, but as yet have not succeeded in picking up the rich run which was lost there some years ago. Their expenses are not very great, however, and, I am told, the 490ozs. procured last year enabled the directors to build up a substantial reserve fund.

John Dewar and party, at the Dumbarton Rock, can only work steadily when the river is low. But with all their broken time, Mr. Dewar tells me they have averaged from five to six ounces a week. This does not appear a very large return when compared with those of some of the other steam dredges, but their expenses are not great, and a surplus is left equal to fair wages.

The Roxburgh Steam Dredging Company commenced operations opposite the Hercules Company's claim about the end of July last, and have proved their claim to be a very valuable one. A few delays have been incurred by breakages; but dispite these hindrances, up to the 31st March they succeeded in winning 555ozs., which wiped out all liabilities, and returned the shareholders a dividend of 1s. per scrip.

The Dunedin Dredging Company, at Coal Creek, may confidently lay claim to having the richest claim on the river. Since the beginning of April they have been getting some phenomenal returns.

During the past year they seem to have been working upon the outer edges of the lead, to which position, I am told, they are forced when the river is high. Its present low condition, therefore, suits them admirably, and accounts for the increased returns. The directors did not see their way clear to declare a dividend out of the 922ozs. obtained last year, although they have gladdened the hearts of the shareholders since.

Besides the dredges I have mentioned, there are those owned by Brazil and others, Bennett and party, Pringle and party, and Aitken and others. The three former were originally current-wheelers, but lately the paddles have been superseded by steam, and by their increased returns have satisfied the owners that the conversion was a step in the right direction.

Cromwell.

During the last season comparatively little rain has fallen, which circumstance has had a very depressing influence upon mining generally throughout this district, more especially at Criffel and Bannockburn.

Although the rivers did not attain so low a level last winter as was anticipated, numbers of men—more notably of Chinese—did fairly well on the different beaches, and many are now looking forward to greater success this incoming winter, as the streams are now exceptionally low for this time of the year, with every prospect of their falling very much lower. I am told that Chinese are coming from far and near to the prospective harvest.

Kloogh and party, who are the only dredge-owners in this district, have dropped down to near "Deadman's," but whether they have bettered their takings thereby, I cannot say. I understand, however, that for the season just gone by, although their takings have not been large, they have made decent wages.

There has been nothing out of the usual way in either the Resident Magistrate's or the Warden's Courts. In the former, sittings were held on 30 days, and 46 civil and 38 criminal cases disposed of, the revenue accruing (inclusive of licensing, and birth, death, and marriage registration fees) being £98 7s. 6d.; while in the latter, sittings were held on 22 days, disposing of 283 applications, and 15 cases by complaint and summons, including two cases wherein mining partnerships were dissolved, and the estates wound up by the Court. The revenue (inclusive of Warden's Court fees and fines) amounted to £482 12s.

Although the expectations entertained regarding the benefits to be derived from the increased race accommodation of the Carrick Company have hardly been realised, owing to the small snowfall and dryness of the season generally, yet very few complaints have been heard from claimholders on the Bannockburn as to lack of water.

Carrick and Bannockburn.

Miners in this locality still keep working on quietly and apparently contentedly, and although a few have left for other places, no great change is visible. Mr. William Roy has gone to Roxburgh, where he has invested in dredging property; and Messrs. J. McKersie and J. H. Robertson, who bought out Sinclair Scott and party at Nevis, are now busy there bringing in a new water-race, to enable them to profitably work their new venture; while Mr. Lewis Jean Hubert, so long connected with reefing, died in the Cromwell Hospital, his interests being bought by Mr. Edward Lawrence. The latter and Mr. Archibald Blue are now the sole representatives of the reefing interest actively employed on the Carrick.

Nevis.

Here matters seem to have been more lively during the last season than they have been in many of the small centres throughout the district. Adie and party are understood to have done well, and the others, European as well as Chinese, are all at work and, to all appearance, getting sufficient to keep them satisfied.

As already mentioned, McKersie and Robertson are bringing in a large new race, which they think will enable them to thoroughly work their ground, which has heretofore rather languished for want of a sufficient water supply.

The Pactolus syndicate have lately consolidated their water rights, and are now bringing in a race capable of conveying 90 heads of water. On this work they have for a considerable time been employing between 30 and 40 men. They have also lately, through Messrs. Richardson and Perry, acquired an additional area of 86 acres, bringing their holding up to 186 acres, which, in such energetic hands, promises well for the future of the Nevis.

Roaring Meg.

In this locality, mining affairs have remained very much as they were last season. Messrs. Henderson and Williamson have some likely ground, and are now bringing in four heads from Moonlight Creek to work it, and have every faith in their enterprise turning out profitably. One or two parties of Europeans and a number of Chinese still cling to the Meg, but with what profit to themselves I am unable to say.

Fraser River.

The same parties who were at work here last year still keep quietly working away, making no finds sufficiently large to tempt others to rush them, but yet large enough to prevent any leaving the river to try new fields.

BENDIGO.

The reconstructed "Jubilee" party are still working at the Rise and Shine Gully, but I have not heard of their making more than wages. A number of others are scattered about in the various gullies, but no exceptional finds are being made as far as I know.

The Cromwell Company, which, unfortunately for the district, were obliged to suspend operations during the greater part of last season, have succeeded in raising £12,500 in England, and intend expending £500 of it in prospecting the old workings for a period not to exceed 26 weeks, during which time, I am told, a manager and four men only will be employed. It is to be hoped that during that time they will find sufficient payable stone to induce them to go in more largely, as their stoppage has been a sad blow to the district at large.

CRIFFEL.

The dry season, as may readily be supposed, told very much against mining here. Still, the returns from Criffel have, on the whole, been fairly satisfactory. Although it is well known that a large tract of country is auriferous, yet until some more extensive water supply is available, no great results can be looked for. At present the holders of water let the same for half the gold returns, which seems a high rental, although it may possibly be none too much to recoup them for their original outlay.

FIVE-MILE.

Things are here very much what they were when I last wrote. Wood and party continue to do well, and the others still cling to their claims, and seem able to pay their way; but no fresh undertakings are reported.

QUARTZ-REEF POINT.

Although the rush here has died down, yet a considerable number of claims are still being profitably worked, and others paying good wages. Bethune and party and Tillman and party are reported to have done well for the season.

A few parties are doing fairly well on the Molyneaux, near the Halfway House, and a considerable number are finding payable gold on the Lindis Downs.

WAKATIPU GOLDFIELDS.

My report for the Queenstown and Arrowtown sub-division of the Wakatipu goldfields for 1893 will be very similar to that of 1892, there being nothing of importance to report upon. Although there have been no exciting finds or rushes in any part of the district, I am able to report that mining generally has been fairly satisfactory to those engaged in it.

Queenstown.—At the Head Lake Wakatipu, the only quartz-mine in operation is the Rees Valley Quartz-mining Company, Limited, who are still prospecting the old Invincible mine, but so far without success. In alluvial mining there has been a perceptible increase in the yield of gold, owing to miners turning their attention to creeks which have hitherto been considered not payable. The population of Moke, Twelve-, Seven-, and Five-mile Creeks remains about the same as in my last return, and there is nothing worthy of record in these localities. At Arthur's Point, the Sew Hoy Big Beach Gold-mining Company, Limited, and Reduced, are working three dredges with good results, and are also to declare dividends at regular intervals, and to reduce their capital. If other companies took example by this one, and worked on the same lines, there would be more dividend-paying companies in New Zealand—ample capital, good management, and energy. There are a few miners located around the Point in various gullies doing well. In the Upper Shotover district, mining matters are very quiet. Two quartz-mines only are in operation. The Gallant Tipperary Quartz-mining Company, Limited, and the Phœnix. The former company has had a very poor season, the latter a fairly good one. The enterprising owner of the Phœnix has been able to float his mine on the London market for £100,000, keeping £50,000 in shares in his own name. With an unlimited supply of payable quartz in sight, the new company has a future before it. Operations at the Londonderry Terrace Sluicing Company, No Liability (a Melbourne company), have been suspended, pending the result of legal proceedings. The yield of alluvial gold has fallen off, as compared with last year; but this is attributable to the scarcity of water, caused by the unprecedented dry weather experienced for the past 12 months. The Sandhills Gold-mining Company, Limited, have not met with any great success, but have been able to declare a small dividend. This company and the Sew Hoy are the only dredging companies now in this district.

Owing to the continued dry weather, the Shotover River is now lower than it has been since the gold-fields were first opened, and quite a large number of miners are earning good wages on the beaches and in the gorges, being able to work a good distance into the river-bed. This, of course, is only temporary, as the first flood will drive them out.

Arrowtown.—The Arrow Tunnel Sluicing Company, No Liability (a Melbourne company), is in the same position as the Londonderry Sluicing Company. Both claims are in complete working order. It is greatly to be regretted that after thousands of pounds have been spent, and everything in readiness for work, that these ventures should be blocked by legal disputes, thereby losing a season's work, and with a chance of damage, to which all unworked claims are liable. At Macetown the Premier Consolidated Gold Company, Limited (a London company), are still opening up their property, and from various crushings returns have been obtained which give hope of a good thing being in store for the shareholders. This company has absorbed by purchase the Sunrise Lease Gold-mining Company's property, which company has fallen into financial straits, and has had to be liquidated. The Tipperary Gold-mining Company, Limited (now a London company), are preparing to resume work on a large scale, and it is to be hoped that they will meet with success. Alluvial mining remains at about the same level as last year. There are two other large quartz claims held by a private individual, who is at present at Home trying to float companies in the London Market. The Crown Terrace excitement has completely died away, and the rush is now represented by half-a-dozen miners. The Cardrona District is entirely alluvial, and supports a good number of miners, some of whom have done remarkably well. From the remaining portions of the Wakatipu Goldfields there is nothing of importance to report.

I have, &c.,

The Under-Secretary, Mines Department, Wellington. J. NUGENT WOOD, Warden.

No. 15.

Mr. Warden Carew to the Under-Secretary of Mines, Wellington.

Sir,— Warden's Office, Dunedin, 12th May, 1893.

In forwarding the enclosed statistical schedules in respect of the Hindon portion of the Otago Mining District for the year ended 31st March, 1893, I have the honour to inform you that comparatively little has been done, either in quartz or alluvial mining, in the district referred to since the date of my last report.

At Hindon proper, the only reef on which anything has been done is that locally known as the "Gladstone," by Sheppard and party, who have got out and put through their small battery at Machine Creek upwards of 100 tons of quartz, yielding from 10 to 12dwts. to the ton. At the Game Hen Reef and Begg's claims nothing has been done, and the batteries at both places are idle.

At Barewood, Wolter and party have continued working steadily throughout the year, and have put through a considerable quantity of stone, yielding from 10 to 17dwts. per ton, their present prospects being very favourable. The Barewood Company is now in liquidation. The tributors, Messrs. Porter and Hocking, in the early part of last year raised and crushed about 250 tons of stone, but the yield (some 115ozs.) was not sufficient to meet expenses and pay the company the stipulated proportion of the proceeds by way of tribute, and the mine is now closed.

In alluvial mining, the only matter worth mentioning is that of the tail-race in course of construction by Harrison and party in Styles' Gully, with a view of working what is believed to be a valuable piece of ground, all previous attempts to work which have proved abortive, in consequence of the tail-race being destroyed by floods. The tail-race now being constructed by the party mentioned has been completely roofed in for a considerable distance with large stones, forming a kind of culvert, by which expedient it is hoped to avert the disasters which have hitherto been the cause of failure.

The number of miners on the field has been smaller than for some years previously, but the settled agricultural population of the district remains about the same.

I have, &c.,

The Under-Secretary, Mines Department, Wellington. E. H. Carew, Warden.

No. 16.

Mr. Warden Rawson to the Under-Secretary of Mines, Wellington.

Sir,— Warden's Office, Invercargill, 3rd May, 1893.

I have the honour to forward herewith the annual returns, and to submit the following report on mining matters in the sub-districts under my charge, for the year ending 31st March, 1893:—

Longwood, Orepuki, Roundhill, and Waipapa.

There is nothing to record of importance with respect to these districts. The Roundhill is about played out for individual alluvial mining by reason of want of fall, and is practically in the hands of the Roundhill syndicate. This company, with their excellent hydraulic appliances, can, as it were, create their own fall as they proceed, and thus work ground which could not possibly be utilised by the common method of sluicing. Most of the gold that can be profitably secured by ordinary sluicing has evidently been extracted from much of the known land in the above-mentioned district. So much so, that I think the time has now arrived when some of the land should be withdrawn from the goldfields and thrown open for selection for agricultural purposes. The Commissioner of Crown Lands, at the request of the Land Board, has submitted to me tracings of certain portions which it may be advisable to so withdraw, and I am endeavouring to ascertain from the mining community here whether there is any valid objection to such a course. Of course, lands within a mining district not immediately required for mining purposes can be taken up on occupation licenses; but as such land may be resumed, without compensation, after three months' notice, there is no inducement for the tenant to make any improvements on his holding. With respect to some portions of Orepuki district, it really seems a misfortune that gold should have been deposited in such land at all. Such portions of the land to which I particularly refer were originally level and of the richest agricultural quality, but are now sluiced into unsightly deep excavations, and for ever rendered unfit for ordinary farming.

The interest of the mining community here is now, of course, centred in the Wilson's River goldfields.

Preservation Inlet.

A number of applications for licensed holdings will come before the Warden's Court at Riverton on Friday next for the final hearing. I have not myself visited the diggings, as it would be impracticable and useless for me to do so at present.

The Inspector of Mines lately paid the district an official visit, and will no doubt, in his annual report, furnish all the practical and useful information that was then available.

I have gathered from the miners who from time to time visit Invercargill that nothing whatever has, up to the present time, been done to open up or test the value of the reefs supposed to be included within the licensed holdings applied for. Naturally, there is a disinclination to spend much money before the licensed holdings are surveyed and granted, and the surveys have only just been completed in respect of those first applied for. The country is also so exceedingly rough, as well as covered with deep swampy moss and forest, that it will take much outlay and labour to make tracks to get about at all, and more particularly to put any machinery upon the ground. Thus evidently a considerable time must elapse before it can be ascertained whether the Wilson's River reefs will support a large mining population or otherwise.

I have, &c.,

The Under-Secretary, Mines Department, Wellington. C. E. Rawson, Warden.

No. 17.

Mr. J. Gow, Inspector of Mines, to the UNDER-SECRETARY of MINES, Wellington.

Waikaka Deep Lead Mining Company (22nd December, 1892).—About two years ago Mr. David Lamb, of Waikaka, and some others, sank, and well timbered, a shaft 60ft. deep, to test the value of the several layers of quartz-wash standing on edge, and running east and west across the country through the Waikaka township. When the shaft reached the depth stated, the quantity of water met with interfered so much with the sinking operations that further work was suspended for the time being. Quite lately a new party was formed, and a fresh start made. The shaft was sunk another 12ft., and at 65ft. an opening drive was made, and driven through one of the gravel layers, 13ft. thick, of which 4ft. is said to be fairly payable. The drive was then continued another 10ft. to a second layer, said to be richer than the 4ft. in the first layer. This was the extent of the prospecting done up to the day of my visit. The tunnel was being continued straight ahead, in order to go through and test the value of several layers said to exist for a further distance of about 150ft., some of which layers are supposed to be payable if properly mined by tunnelling and timbering. I examined the work and found it very wet over head and under foot. The drive is much too small to enable the men to do their work well, or to be of any utility after it is completed. The drive should have been at least 6ft. by 4ft.; but I think it is very little more than half that size in sectional area. It must be very disheartening to the men to work all day in such a cramped-up place, dripping with water at sides and over head, with inches deep of sticky mud everywhere under foot. I instructed Mr. Lamb to have the timber properly fitted in a frame before sending it into the mine. If any of the layers in this large body of wash should prove payable, if mined like a quartz-reef, there is room here for a large number of men.

The Jutland Flat (Waipori) Gold-mining Company (1892).—This dredge is 87ft. by 20ft., and draws 4½ft. of water. The engine is 47 h.p., and the quantity of coal (Kaitangata) used per week is about 10½ tons, which costs on the ground about 29s. per ton. The depth dredged is 16ft., of which about 4ft. is supposed to be gold-bearing. The quantity dredged per week is estimated at about 10,000 tons, and the average number of men employed is ten, divided into three shifts. The dredge has turned over about 10 acres of land during her 12 months' work. Now that all the plant is in good going order, and the men having become familiar with the work, it is more than likely that 500,000 cubic yards per annum will be put through. The company hold 240 acres.

The following details of the first year's workings may prove interesting:—Dredging, wages time for period, 5,879 hours; actual dredging during same, 5,398 hours; estimated quantity of stuff lifted, 390,721 cubic yards; gold obtained, 1,003ozs. 15dwts. 13grs.; average yield of ground, 1.23grs. per cubic yard. The amount of dividend paid in same time is £750. The dredge and machinery is very complete, and was designed by Mr. Robert Hay, M.I.C.E., of this city.

The Waipori Deep Lead Gold-mining Company (1892).—This company own several head-races, all leading into one main race, from which 18in. and 15in. pipes are laid to the claim. The length of these several races is abont 25 miles, and the total quantity of water available varies from six to twenty heads. There is a reservoir connected with the races, and distant about four miles from the claim, estimated to be capable of storing ten and a half million gallons of water. It is intended in the near future to raise the embankment 5ft., which would increase its storing capacity by about six and a half million gallons. There are, in all, about one and a quarter miles of pipes on the ground, and two nozzles at work under a head of 400ft. at the bottom of the workings, which are in the deepest part about 65ft. below the general level of the surface. When the claim is in full swing, it is estimated that 3,000 yards of stuff are put through every day, and the average yield per cubic yard 1¼grs. This yield is considered fairly payable, and the half of it will about pay working expenses.

Since this company commenced operations about 2½ years ago, the yield of gold is 850ozs., but nearly a year of this time was spent in prospecting and doing other preparatory work. The average number of men employed is about ten, divided over three shifts. The area of ground held is 125 acres. The deep gutter leading through the claim will take, it is said, about seven years to work out, and the shallow ground will take some years to put through, if it be found to be payable.

The Upper Waipori Alluvial Gold-mining Company (1892).—No. 1: This dredge has been working two and a half years, during which time there have been 30 acres of ground worked. The average depth is from 11ft. to 13ft., 2ft. of which is gold-bearing. There are about 7,760 cubic yards put through every week, working three shifts in the 24 hours, and the yield of gold is about one grain to the cubic yard. From 13 to 14 cords of manuka wood are consumed every week, at a cost of £2 per cord—the ten miles cartage makes it so costly. There are eleven men employed on the dredge during the three shifts, and 14 bushmen, including the teamsters, who work 32 horses. The engine is said to be 40 h.p. The weekly expenditure is about £60. The dredge measures 93ft. by 18ft., is all steel, and cost £3,500. The size of claim is 300 acres.

No. 2 dredge—same company—is much smaller than No. 1, and is capable of dredging only 6,500 cubic yards per week. The engine horse-power is said to be the same as in No. 1, and requires 12 tons of coal per week of three shifts. The yield of gold per yard is a little less than one grain, which is not payable. The amount of money spent on plant, claims, &c., &c., equals—No. 1 dredge £3,500, No. 2 dredge £2,300, besides the value of all the gold obtained out of the ground, viz., 2,783ozs.

Longwood Sluicing Company (14th September, 1892).—It is 12 months since my previous visit to this claim, and I was agreeably surprised to see so much work done in that time with the small quantity of sluicing water available. The sluicing away of the loose *debris* and mullock in the gully has at last exposed some quartz leaders, which cross the gully at right angles, but at the time of my visit the gully was so filled with mud and timber by a landslip at the head of the workings, caused by heavy rains two days before, as to prevent me seeing anything but the sides of the open cutting near the surface. The material filled into the cutting prevents any prospecting being done. I saw some old dressed timber jutting out of the mullock, supposed to be the slabs of the old shaft sunk on the quartz-lode many years ago, where some very rich ground was found. It will take several weeks to sluice out all the slip to the level of the sluice-boxes, so as to expose the lode if it is there. When the slip is removed and the sides dressed down to be safe for the workmen, it is intended to put in a

strongly-timbered drive on each side and along the supposed lode to test its value. Further operations will depend on discoveries that may be made by driving these prospecting tunnels. Nearly all the gold obtained in the sluice-boxes has quartz adhering to it. The bulk of the gold consists of minute specimens, which, I think, indicate payable stone somewhere handy.

Round Hill Gold-mining Company (20th September, 1892).—Since my previous visit a cutting has been sluiced from the low flat into the terrace some distance, and having an average depth of probably 25ft. The material from the surface to the bottom consists of good soil, clay, sand, and fine gravel, all of which is easily disintegrated and carried in suspension into the creek below the tail-boxes, where the finest of it spreads over the low-lying land towards the sea. The elevator is said to be lifting 43ft. with a head of 300ft. The length of pipes from the race to the place of operations is 75 chains, consisting of 55 chains of 13-inch and 20 chains of 10-inch, all of which piping, I have no hesitation in saying, is much too small to do the work required efficiently. Sluicing operations commenced on the 20th November last, from which date to the time of my visit the manager's estimate of the area of ground sluiced away equals nearly six acres, and his estimate of the yield of gold per cubic yard is 2 1-9th grains on the work done up to the month of June last. Most of the ground put through the boxes had been previously mined—driven out—by Chinese and others. The very large quantity of old mining timber I saw lying in the worked-out ground was good evidence of a large amount of work having been done some years ago. The natural advantages here for underground mining, and the apparently systematic way it has been carried out, justifies me in assuming that a very small percentage of the gold now being obtained comes from the bottom of the workings; therefore, since the claim is said to be paying, it is clear the bulk of the gold won must have come from the sand layers —feet thick in places—immediately above the old timber.

If I am correctly informed that the bulk of the ground held by the company has been previously mined in a manner similar to much that has lately been put through the pipes, then there is a hopeful prospect of a fair-sized area of ground (considered by the manager as payable) yet to be treated, without taking into consideration the very large body of silt and tailings said to be payable, if properly treated by sluicing on a large scale. I fear, however, that two, or two and a-half inches fall to the chain in the proposed tail-race or channel is not likely to save more than a very small percentage of the gold said to be found in the Round Hill tailings. I may mention that the fall above stated as proposed to be given to this large tail-race is not equal to that of one of the Government head-races in the Kumara goldfield. A tail-race of less dimension than that started at the sea, with the proposed fall of 2in. per chain, should, I think, carry all the water, after being fairly charged with silt and sand, that is ever likely to be conveyed to it from the races at present constructed, or those which may hereafter be constructed from any of the streams on the eastern watershed of the Longwood Ranges; but in order to save the gold, a much greater fall should be given, which can only be obtained by a succession of lifts to the height required for the gold-saving boxes, and water-power—the cheapest and best—to do this work is, I fear, out of the question. I learn from the manager that a survey of a new race from the head-waters of the Pourakino stream has lately been completed. The length is estimated at 26 miles, and the average quantity of water available at 20 Government heads. I sincerely hope the estimated quantity of water is correctly ascertained by actual measurement. If 26 miles of race is to be constructed, there should be no doubt as to the quantity of water available in the driest time of the year, and I think it would be a mistake to construct such a length of race to terminate at the same level as the present one at the pipe intake, if it be possible to make it much higher without any considerable loss of water or adding very much to its length. I am prompted to make these remarks on account of a conversation I had thereon with Mr. Evans, the manager.

Nenthorn Quartz-mines.

Eureka Mine (6th October, 1892).—It was the discovery of this reef, I believe, that caused the rush to Nenthorn, where many thousands of pounds were squandered in a most reckless manner. The first ton of stone taken from the surface in the head of a little gully yielded about 10ozs. gold, but no quantity of stone was ever after found to give a fairly payable yield. A shaft was sunk 216ft., but the stone at that level was not payable.

The line of reef was then driven on 350ft. to the east, carrying stone about 2ft. wide all the way, but too poor to pay.

Since then two brothers Sligo, as tributors, made an opening at a 130ft. level, which they had driven eastward a distance of 180ft., but the stone was very poor all the way. The mine made much water at this level, and it had to be lifted by a horse-whim. Then at a distance of 332ft. on the east side of the main shaft, a whip-shaft was sunk 60ft., at which level some work was done. At 40ft. from this shaft stoping is being done, and will be continued to the surface. The average thickness of stone here is about 15in., and the yield is expected to be about 15dwts. per ton.

When this block of stone is taken out, it is the intention of the tributors to do some prospecting by sinking shallow shafts on the line of reef several hundreds of feet to the east of the present workings. Their prospects of getting a good reef are not very promising. There was erected for this mine a Huntington centrifugal roller-mill, said to be capable of crushing 75 tons per week if worked continuously. The plant has a Westinghause engine attached to it, said to be 50 h.p. The engine is very compact. There are three berdan-pans. The Sligos do not use this plant to crush their stone. They find it suits them better to cart the stone to Wick's battery of 10 stampers, driven by a Pelton-wheel, where they do all the work, and pay 10s. per ton for the use of the battery.

Bonanza Quartz Mine (7th October, 1892).—This mine is about five miles east of the town of Nenthorn, and on the watershed of the Waikauiti stream, south of Palmerston. The crushing plant comprises an 8 h.p. Marshall portable steam-engine, which drives a small-sized 3½ft. Huntington centrifugal roller-mill, and a Stahl Rew patent grinding-pan, which is said to do its work very satisfactorily. The engine uses seven tons of coal weekly, and crushes 60 tons of stone in the same time. The cost of coal, delivered at the engine, is £2 7s. per ton. Mining timber costs £5 per hundred for short caps and props, and 5ft.-laths cost £3 10s. per hundred. The present manager, Mr. Brown, has been in charge during the last 11 months, and has had six crushings from several parts of the lode. The first

crushing of 150 tons gave a return of 117ozs.; second, 40 tons, 18ozs.; third, 93 tons, 112ozs.; fourth, 154 tons, 220ozs.; fifth, 120 tons, 150ozs.; and 6th, 151 tons, 334ozs. The second lot, 40 tons, was a trial crushing of surface stone from the extreme western end of the reef, and should not be included in the lot as average stone. If this lot be left out of the reckoning, the reef may be estimated as yielding on an average nearly 2ozs. of gold per ton. The thickness of reef is from 1 to 3½ft., and has been worked along the lode for a length of about 800ft., but to a shallow depth only on account of the water. In the eastern workings, the reef has been sunk on to a depth of 140ft., where it is slightly thicker than that worked at the higher levels, and is also the best stone yet found in the mine. It was the intention of the manager to sink this shaft to a much greater depth, in order to test the depth and value of the stone; but after reaching the depth stated, the quantity of water was found to be too heavy for man or horse to make anything like fair progress in. The shaft below the level of the workings was then made secure and allowed to fill up with water for the time being. Since the reef has been found to extend so strong and good at the 140ft. level, it is thought more than likely it may live to 300ft. deep, or much more. It is therefore deemed wise and necessary, to facilitate future mining operations, to put in a low-level tunnel from near the creek, which runs parallel with the reef, and probably not more than 800 or 900ft. from it, by which, it appears to me, the line of reef can be cut at probably 400ft. below where it is known to exist in the trial shaft. In the event of a low-level tunnel striking a payable reef, the battery would have to be shifted down the creek about half a mile from where it now stands, and at which place it is supposed sufficient water is available to do the work by a Pelton-wheel.

The stopes are filled up as the work proceeds. The foot wall is solid hard rock, but the hanging wall is rather soft in places. The water is lifted by a horse-whip.

Surprise Quartz-mine (6th October, 1892).—An adit has been driven from the side of a gully a total distance of 600ft. along the reef. This adit is all the time being continued with sufficient fall to carry away the drainage, which is increasing as the tunnel proceeds The stoping is following the extension of the main drive very closely, and to a height of from 60 to 90ft.; this depth of stoping is likely to increase with the rise of the hill as the work proceeds. The reef is from 1in. to 1ft. thick, and the last crushing of 69 tons averaged 1½oz. per ton. The stoping is in hard, dry country, where very little timber is required, the side excavations being nearly sufficient to fill up the stopes as the work goes on. The stone is carted about 1½ miles to Mr. Wick's battery, where the mine-owners attend to the crushing, and pay 10s. per ton for the use of the plant. The carting costs 4s. 6d. per ton. The reef is said to be strong under foot all along the adit. There are employed two shifts of four men each. Mr. Mills is manager. The air is good throughout the workings.

Premier Consolidated Gold-mining Company (Arrow, 26th October).—Most of the stoping in the mine ceased shortly after my previous visit, but the construction of the low-level tunnel was proceeded with and completed about a month ago. The driving was carried on from the outside and inside the mine at the same time, till the two faces met. This tunnel is on a level with the lowest mine workings, and the tram-line is being continued outside from the tunnel-mouth with an easy gradient for a distance of ten chains, to where the stone will be dumped into a strongly-built stone paddock 40ft. below, and capable of holding about 400 tons. From the bottom of this paddock another tramway seven chains long is being laid to the battery, where the stone is again tipped into the shed immediately above the stampers. These two tramway lines are nearly completed, and probably in a few days the stone will be conveyed through the new tunnel and along the lines to the battery. There are 17 men getting stone, and they have a quantity at the level ready to be taken out. There are three stopes being worked, and others will shortly be ready. The main level tunnel, it is said, will be driven ahead along the line of reef as speedily as possible, in order to keep in advance of the stoping. The average thickness of the reef is about 2½ft. The air-current is now strong throughout the workings, and with a little care and attention, the miners should not be troubled with bad air for some time to come. These alterations and improvements, made since my last visit, will effect a great saving in the cost per ton of stone delivered at the battery, and also in the cost of the mining timber delivered in the mine. The tunnel saves the labour of four men, a horse and cart, and three tons of coal per week, at a cost of £2 8s. per ton. The length of the main level tunnel from its mouth to the reef is 1,410ft., where the lode is now 18in. thick, and carrying gold. Crushing commences to-day on a quantity of stone lying at the battery, which is thought to be sufficient to keep her going till the new tramways are completed, after which crushing will be carried on steadily till the head-race freezes in winter. The plant will crush about 60 tons per week, working 24 hours, and it will require ten or twelve miners to get this quantity of stone.

Sunrise Quartz-mine (26th October, 1892).—This mine was not being worked at the time of my visit.

Phœnix Quartz-mine (21st October, 1892).—Examined the several workings, and find every care is being taken to strongly timber them. All the working faces are in good order, and generally fairly dry, where the men can do a good day's work with comfort. The men appear to be well cared for when small contracts are in hand. I think they should thoroughly appreciate this paternal consideration for their good. The air is good throughout the mine, and the winding plant appears to be in good order. There are in all 76 men employed about the mine and battery works, and the quantity of stone crushed per week equals 90 tons only, which is said to keep 15 stampers going.

The Gallant Tip Mine (22nd October, 1892).—From the low-level tunnel, at a distance of 1,100ft. in from the surface, the stoping is going on above, in an intermediate level about 115ft. above the adit floors, where the reef is just now 7ft. thick, but poor. This part of the reef is probably 200ft. below the surface of the hillside. The work is going west. There are eight miners, one trucker, and three battery men—in all, 12 men—who manage to get and put through the battery of 15 stampers 60 tons per week.

Sandhill's Dredge, Shotover (22nd October, 1892).—The dredge was idle at the time of my visit, and had not been working during the preceding two weeks, in consequence of a breakdown of some part of the machinery. I saw the manager in Queenstown on the 26th, and he informed me that he expected to get the dredge in working order in about a fortnight. The dredge has worked nearly two miles of the river since she first started. I understand the yield of gold has not come up to expectations.

Perseverance Quartz-mine, Rough Ridge (10th November, 1892).—This mine was opened 13 years ago, and was known as the "Great Eastern." Working ceased about 11 years ago, since which time it has remained till about five months ago, when a party of seven working men purchased the plant and mine. They have taken out a few tons of stone in various places as trial crushings. In order to get out these trial lots, some dirty places had to be cleaned out, and the shaft repaired. This work was in hand at the time of my visit. What appears to be solid stone is now in sight under foot, and preparations are being made to take out this stone in a face, so as to keep their little battery of five stampers constantly going. The battery is now being driven by a turbine wheel, and the old steam-engine standing in the same shed is no longer required. The thickness of stone in sight, it is thought, will average 18in. The shafts (two) are 80 and 90ft. deep, to which level the stone was taken out by the former workers. It is all new country to the east of the top shaft, in which direction it is intended to prospect from the level of the old workings. The underlay is slightly to the north. The reef now being tried runs parallel with and is about 400 yards south of the Great Eastern lode. The owners think the two reefs are likely to join at a considerable depth. The stone is being hoisted by horse-whip. Mr. Rolliston is manager.

Barewood Reefs (30th June, 1892).—Walters' reef was being worked on a small scale at the time of my visit. A shaft had been put down by following the line of reef to a depth of 72ft., in a shoot of fairly payable stone, said to be 20ft. long on line of reef, outside of which the stone is not considered payable, the yield being only 6dwts. per ton. The returns from the 20ft. shoot is from 16 to 20dwts. per ton. The good stone yields 5 per cent. of pyrites, which, when clean, gives a return of 10ozs. per ton; but it appears the pyrites have to be sent to Melbourne to be treated, at a total cost of about an ounce of gold per ton. The present returns from the mine pay expenses only. The men were bailing water from the shaft with a bucket while I was there, and told me I could not see the reef if I went down. The company's five-stamper battery is placed on the "Flat Stream," about 1½ miles from the mine, which distance the stone is carted at a cost of 2s. per ton. The battery is capable of crushing about 30 tons per week, with a consumption of five tons of coal. The coal is carted from the Barewood Siding, a distance of five miles, and it costs at the battery 16s. per ton. There are seven men at the reef and two at the battery—in all, nine or ten men.

Hawking and Porter Tributors (Barewood, 30th June, 1892).—This mine is to the westward of, and on the same line of reef as that on which Walters Company is working. The shaft follows the reef to a depth of about 130ft., at which depth the reef is from 3 to 4ft. thick, and is said to yield about ½oz. per ton. The yield of clean pyrites is 1 per cent., and a small quantity on hand at the time of my visit was expected to give 15ozs. per ton. The average output of stone per week is fifty tons, by two shifts in the 24 hours, and five men in each shift. There are 17 men, all told, mine and battery. The mine makes a considerable quantity of water, which is hoisted in a large bucket by a horse-whip. It requires steady bailing during eight hours in the 24 to keep the water down. Some better pumping appliances will have to be adopted shortly, if the mine is to be kept open. The tributors are paying the company 75 per cent. of the gold returns, which I do not think they can possibly continue to do much longer and pay their way. The payable shoot of stone appears to be narrow, outside of which there is little or no gold in the stone.

The Undaunted Sluicing Company, Clutha River.—This company constructed about four miles of head-race from the Tallaburn, which empties into the Clutha close by. The lower end of the race is about 400ft. above the river. There are 3,500ft. of 11in. piping from the race to the claim, which generally carries from 12 to 14 Government heads of water. The pipes are carried across the Clutha on a wire-rope suspension-bridge, 360 or 370ft. from pier to pier, and 700ft. from anchor to anchor. There are about six acres of ground sluiced away, and there is supposed to be another four years' work in the claim. The depth to be washed away varies from 20 to 100ft., the bulk of which is fine gravel and silty sand. I saw a sample of a few ounces of clean gold of good colour, some of which was extremely fine. There are several lengths of boxes, carrying perforated plates, and cocoanut matting under the plates, by which means most of the very fine gold is saved. There are two very long lines of sluice-boxes, paved with 7 to 9in. stones, and which discharge the tailings directly into the river. It is very clear to me that the pipes are very much too small to carry the body of water mentioned, and do good work through the large nozzles used.

Island Block Sluicing Company.—Since my previous report the sluicing plant has been shifted nearly half a mile higher up the flat, where a new paddock has been opened, and some bottom cleaned up with a more hopeful result than from the last few washings in the first paddock opened, yet not nearly up to the first washings when near the river. It is hoped the new ground now being opened will improve quickly in richness as the work proceeds upward, till the yield be sufficient to give handsome dividends to the shareholders. I think the present prospects are hopeful. It will, however, take time, probably a long time, to thoroughly test the flat—possibly 20 chains wide here—to find the best run of gold-bearing wash. As the flat widens very noticeably, going upward, there is a danger of the gold, that should be in one run, being scattered or divided into two poor runs, in which case I think the eastern run, if there be two, would be the better one to follow. Although it may appear a slow method of prospecting this very large old river bed, by making fresh openings crosswise at intervals of a few chains, I think it the best and surest way to ascertain for a certainty where the lead is and if it be payable; and I think with care and judgment very little good ground need be lost behind an opening through washed *debris* being put thereon. The ground at the head of the flat has lately been proved by the Golden Run dredge to be remarkably rich, and there is nothing on the surface or in the rock formation to lead one to suppose that this good ground does not extend for an indefinite distance down the old channel.

Accidents in Otago Goldfields.

I have to report two fatal accidents for the year.

Thomas P. Mitchell, on 12th March, was killed in a shaft while he was removing the timber. The shaft caved in from the sides while he was removing the stabs. He showed a want of judgment.

Thomas Bryden, on 4th October, was killed by a shot in the Phœnix mine. The fuse of two shots were lighted, and when one went off, Bryden went to the spot to see why the other did not go off. When he reached the spot, it then went off, and killed him. I have, &c.,

J. Gow,

The Under-Secretary, Mines Department, Wellington. Inspector of Mines.

No. 18.

Mr. A. Aitken, Manager of the Waimea-Kumara Water-race, to the Under-Secretary of Mines, Wellington.

Sir,— Kumara, 10th June, 1893.

I have the honour to submit the following report on Waimea-Kumara water-races for year ending 31st March, 1893 :—

Waimea Water-race.

The total sales of water from this race for the year amount to £1,015 12s. 3d., and the total expenditure on maintenance for the same period £858 0s. 4d., leaving a credit balance of £157 11s. 11d. on the year's transactions. The average number of miners supplied with water from this race was 66, and the approximate quantity of gold obtained was 2,499ozs., valued at £9,746 2s.

The sales of water are £106 3s. 11d. less than for the preceding year, and the yield of gold is 91ozs. less, valued at £354 15s.

The expenditure for maintenance is greater than for the previous year by £73 6s. 6d. The increased expenditure was caused by extensive repairs to the high fluming at Kawhaka and a larger number of slips and breakages than for some years past.

Besides the sales of water, free water has been supplied to the value of £14 13s. 1d., and a considerable quantity of waste water has been supplied to parties prospecting in new ground, none of whom, so far, have been successful in finding payable gold, with the exception of Batchelor, who has had one good washing, but will take a considerable length of time to get back the large amount of capital he has invested in the claim.

During the Christmas holidays repairs were effected to tunnels, trestle-work, and fluming, and the race is now in a fair state of repair.

The gradual decline in the number of miners using water from this race still continues, and few, if any, of the claims are paying standard wages. The number of miners working in ground not commanded by the race is getting smaller, and very few of them are making standard wages.

Branch Race to Callaghan's.

The ditching, tunnelling, and fluming on 2 miles 10 chains of the branch of the Waimea water-race towards Callaghan's was let during the year, in 13 co-operative contracts—10 contracts for ditching and tunnelling, and three for fluming. All the ditching and tunnelling have have been completed, and the fluming will take about two months to complete.

The total expenditure on this work, to 31st March, has been £1,547 5s. 5d.

The work has been well and faithfully done, and should require no repairs for many years. In separate places along the line of race gold was obtained in executing the cuttings necessary for the construction of the race, and several claims have been taken up, and are now at work, with every probability of more ground being taken up and worked as soon as a supply of water is available. There is a very great extent of unworked ground (about 150 acres) at the Callaghan's end of the race, in portions of which payable prospects have been obtained. A drainage tunnel, 3,500ft. in length, is now approaching completion, which will enable one of the large flats to be thoroughly prospected and worked. Gold has been traced from the gullies and sidlings of the range into this flat, and there is reason to believe that a considerable portion of the flat will prove payable.

Branch Race towards Middle Branch of Waimea Creek.

Plans and specifications have been prepared for the construction of a branch race to supply water to the Middle Branch of the Waimea Creek, 47 chains in length, and the work will be let in four co-operative contracts—three for ditching and one for fluming—at a total cost of £510 8s.

This branch will enable the large extent of unworked auriferous ground (about 80 acres) to be worked, no water supply having hitherto been available for that purpose.

Kumara Water-race.

The total sales of water from this race during the year amounted to £5,789 0s. 9d., and the expenditure for maintenance was £1,782 11s., leaving a credit-balance of £4,006 9s. 9d. The average number of miners supplied with water from this race was 147, and the approximate quantity of gold obtained by parties using the water was 8,648ozs., valued at £33,724 4s.

Besides the sales of water above-referred to, water to the value of £398 7s. 8d. was supplied to parties as subsidies on the cost of deviations of race, which in all instances consisted of the substitution of iron and steel piping for portions of race in open cutting and high fluming. Free water to the value of £65 was supplied to assist in opening up new claims, and free water to the value of £379 15s. 8d. was supplied to assist claims having a succession of poor washings.

When assistance was given to poor claims, the value of gold obtained from each, and the expenditure on the same for the previous six months, was fully enquired into.

The total value of water supplied from the race during the year was £6,632 4s. 1d., exclusive of water for flushing channels (33 sluice-heads daily), water for pumping deep-level shaft, water for washing-down purposes, water for fire purposes, leakage, and waste.

For nine working days during the year no water at all was supplied from the race, and for 26 working days there was no water for the channels. Besides the above, the miners observed 17 holidays,

making a total of 43 working days, or seven weeks and one day when the sale of water was only nominal.

During the year ended 31st March, 1892, three claims were worked out, using 20½ sluice-heads; four claims ceased work on account of poor washings, using 42 sluice-heads; and during the year ended 31st March, 1893, six claims were worked out, using 52 sluice-heads, being a total of 114½ sluice-heads. Only one new claim was started during the past year, using 10 sluice-heads of water, so that the quantity of water now supplied from the race is about 104½ sluice-heads daily, less than it was about Christmas, 1891.

During the past year water was being lost over the dams on 117 separate days, and during that time the total quantity of water lost would have given a full supply to the field for 87¼ days, if it could have been impounded.

Except in long continued dry weather and severe frosts, the supply is always largely in excess of the demand.

Several new claims are preparing to open out and start sluicing, so that there is a probability of the demand rather increasing than decreasing.

To provide for working new claims, several small extensions and deviations of races have been constructed during the year.

Between the lower dam and the head-race tunnel, and at the lower end of the head-race tunnel, where the water is distributed from the main-race into the several branches, the main-race had to be timbered in a substantial manner, so as to safely control the large body of water at those places.

I have, &c.,
ALEXR. AITKEN,
Manager Water-races.

The Under-Secretary, Mines Department, Wellington.

BALANCE-SHEET of the MOUNT IDA WATER-RACE TRUST for the Year ended 31st December, 1892.

Receipts.	£	s.	d.	*Expenditure.*	£	s.	d.
To Amount of cash received for water-sales	1,379	9	11	By Balance, 1st January, 1892	271	18	11
Grant from Government	300	0	0	Maintenance of head-race	502	13	0
				Cleaning head-race	287	0	0
				Maintenance of channels	82	19	0
				Timber, tools, carpenters' and blacksmiths' work, and sundry expenses ..	197	8	2
				General management	234	0	0
				Printing and stationery	5	13	0
				Clerk's and Treasurer's salaries ..	65	0	0
				Office rent	20	16	0
				Petty cash	7	10	10
				Balance, Bank of New Zealand, 31st December, 1892 .. £25 17 0			
				Less outstanding cheques .. 20 16 0			
				Underpaid .. 0 10 0			
				21 6 0			
					4	11	0
	£1,679	9	11		£1,679	9	11

Statement of Water-sales.

	£	s.	d.		£	s.	d.
To Amount owing for water, 31st Dec., 1891	1,684	3	1	By Cash received for water during 1892 ..	1,379	9	11
Water sold during the year 1892 ..	1,396	0	4	Owing for water, 31st December, 1892	1,700	13	6
	£3,080	3	5		£3,080	3	5

N. P. HJORRING,
JAMES MITCHELL,
W. GUFFIE,
} Members of the Mount Ida Water-race Trust.

Examined and found correct,
JAMES EDWARD FITZGERALD,
Controller and Auditor-General.

APPENDIX II.

No. 1.

STATEMENT showing the REVENUE of the GOLDFIELDS collected in the several DISTRICTS, and the GOLD DUTY of the COLONY of NEW ZEALAND, for the Period from the 1st January to the 31st December, 1892.

District.	Miners' Rights.	Business Licenses, Machine and Residence Sites.	Water-races, Sluices, &c.	Gold-mining Leases, Rents, and Royalties.	Registration.	Fees and Fines, Wardens' Courts.	Miscellaneous.	Totals.
AUCKLAND.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Coromandel ..	261 10 0	79 0 0	2 0 0	272 7 0	4 1 0	..	12 12 0	631 10 0
Te Aroha ..	30 10 0	30 10 0	0 5 0	711 12 6	4 7 0	0 12 0	11 17 0	789 13 6
Thames and Ohinemuri	266 10 0	298 15 0	48 10 0	1,403 10 2	14 19 0	15 15 0	138 11 0	2,186 10 2
Puhipuhi ..	8 10 0	3 0 0	..	124 10 0	2 0 0	8 17 0	3 2 6	149 19 6
Totals ..	567 0 0	411 5 0	50 15 0	2,511 19 8	25 7 0	25 4 0	166 2 6	3,757 13 2
NELSON.								
Collingwood ..	62 0 0	2 0 0	11 7 6	185 10 0	16 0 0	3 8 0	41 3 6	321 9 0
Westport ..	139 0 0	10 5 0	17 0 0	261 0 0	10 2 0	15 1 0	107 6 0	559 14 0
Charleston ..	111 12 0	..	14 7 6	59 7 6	10 13 0	..	8 14 2	204 14 2
Ahaura ..	302 0 0	1 10 0	20 2 6	217 3 0	36 0 0	..	4 15 0	581 10 6
Reefton ..	239 0 0	15 15 0	9 5 0	1,416 12 1	11 2 0	19 10 6	53 7 0	1,764 11 7
Wangapeka ..	9 0 0	..	0 5 0	..	0 5 0	..	0 18 6	10 8 6
Lyell	29 10 0	..	3 0 0	46 5 0	2 9 0	..	2 9 0	83 13 0
Motueka ..	5 0 0	..	0 5 0	..	0 2 0	..	0 5 6	5 12 6
Murchison and Owen's	87 10 0	3 0 0	7 10 0	2 10 0	4 8 0	..	3 10 6	108 8 6
Totals ..	984 12 0	32 10 0	83 2 6	2,188 7 7	91 1 0	37 19 6	222 9 2	3,640 1 9
MARLBOROUGH.								
Havelock ..	90 1 0	..	3 0 0	199 4 8	7 1 0	13 11 0	2 1 6	314 19 2
Picton ..	4 0 0	..	..	..	..	..	..	4 0 0
Totals ..	94 1 0	..	3 0 0	199 4 8	7 1 0	13 11 0	2 1 6	318 19 2
WESTLAND.								
Hokitika and Kanieri	225 10 0	24 10 0	11 7 6	128 7 0	11 12 0	4 3 0	49 10 9	455 0 3
Greymouth ..	309 0 0	9 0 0	26 17 6	23 15 6	23 6 0	..	37 8 8	429 7 8
Ross	56 10 0	1 0 0	1 2 6	285 10 0	6 6 0	5 1 0	2 12 6	358 2 0
Stafford ..	59 0 0	..	8 12 6	38 5 0	3 6 0	5 0 0	21 5 0	135 8 6
Kumara ..	306 0 0	6 0 0	6 0 0	159 12 9	19 8 0	11 14 0	3 5 6	512 0 3
Jackson's Bay ..	2 10 0	..	..	..	0 1 0	..	..	2 11 0
Goldsborough ..	70 10 0	..	14 12 6	..	6 10 0	3 2 0	5 2 6	99 17 0
Okarito ..	33 10 0	10 10 0	4 2 6	26 5 0	2 2 0	..	14 18 11	91 8 5
Totals ..	1,062 10 0	51 0 0	72 15 0	661 15 3	72 11 0	29 0 0	134 3 10	2,083 15 1
OTAGO.								
Black's ..	62 0 0	8 10 0	4 17 6	228 10 3	8 11 0	6 17 0	2 5 6	321 11 3
Tapanui ..	5 0 0	..	0 2 6	..	0 11 0	0 6 0	..	5 19 6
Hindon ..	67 5 0	2 10 0	1 7 6	94 9 9	1 1 0	..	3 0 6	169 13 9
Naseby ..	253 10 0	22 5 0	38 2 6	925 18 4	21 18 0	18 3 6	5 6 6	1,285 3 10
Roxburgh ..	114 0 0	..	7 15 0	424 3 6	8 5 0	9 16 0	63 5 0	627 4 6
Alexandra / Clyde ..	139 10 0	8 10 0	11 0 0	159 12 0	8 4 0	17 8 0	9 5 0	353 9 0
Pembroke ..	22 0 0	..	0 10 0	4 17 0	0 3 0	..	..	27 10 0
Cromwell ..	222 0 0	9 0 0	16 7 6	168 17 0	21 2 0	11 12 0	11 15 0	460 13 6
Queenstown ..	130 0 0	24 5 0	6 5 0	622 3 11	8 19 0	8 4 0	13 15 6	813 12 5
Arrowtown ..	176 0 0	2 0 0	9 17 6	367 4 9	18 17 0	6 10 0	3 4 0	583 13 3
Lawrence ..	191 0 0	5 0 0	16 5 0	412 11 6	11 1 0	18 5 0	81 11 0	735 13 6
Waikaia ..	98 10 0	0 10 0	6 15 0	50 6 0	7 5 0	13 19 0	0 9 6	177 14 6
Orepuki, Longwood and Riverton	114 4 0	13 15 0	11 4 0	90 1 6	5 18 0	17 5 0	9 3 6	261 11 0
Macrewhenua ..	30 0 0	..	6 7 6	61 4 0	2 10 0	1 9 0	0 9 0	101 19 6
Wyndham ..	7 0 0	1 5 0	0 5 0	71 11 1	1 13 0	..	0 6 6	82 0 7
Nenthorn ..	11 0 0	3 0 0	..	..	..	..	..	14 0 0
Totals ..	1,642 19 0	100 10 0	137 1 6	3,681 10 7	125 18 0	129 14 6	203 16 6	6,021 10 1
Grand Totals ..	4,351 2 0	595 5 0	346 14 0	9,242 17 9	321 18 0	235 9 0	728 13 6	15,821 19 3

No. 2.

STATEMENT showing the REVENUE of the GOLDFIELDS collected in the several DISTRICTS, and the GOLD DUTY of the COLONY of NEW ZEALAND, for the Period from 1st January to 31st March, 1893.

District.	Miners' Rights.	Business Licenses, Machine and Residence Sites.	Water-races, Sluices, &c.	Gold-mining Leases, Rents, and Royalties.	Registration.	Fees and Fines, Wardens' Courts.	Miscellaneous.	Totals.
AUCKLAND.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Coromandel ..	39 10 0	5 10 0	..	96 16 0	2 7 0	..	2 14 0	146 17 0
Te Aroha ..	31 0 0	11 15 0	0 5 0	218 5 6	1 16 0	..	4 1 0	267 2 6
Thames ..	40 10 0	58 2 0	0 10 0	397 14 3	0 16 0	3 1 0	1 5 0	501 18 3
Puhipuhi ..	3 0 0	..	..	..	0 2 0	..	0 4 0	3 6 0
Totals ..	114 0 0	75 7 0	0 15 0	712 15 9	5 1 0	3 1 0	8 4 0	919 3 9
NELSON.								
Motueka ..	1 10 0	..	..	..	0 2 0	..	..	1 12 0
Collingwood ..	21 0 0	1 0 0	0 5 0	90 5 0	1 19 0	0 3 0	0 1 0	114 13 0
Westport ..	40 0 0	..	1 12 6	56 5 0	1 11 0	1 15 0	1 17 0	103 0 6
Charleston ..	44 0 0	..	2 17 6	27 7 6	3 1 0	2 17 0	1 5 0	81 8 0
Ahaura	73 0 0	1 0 0	3 0 0	138 10 0	5 13 0	..	1 8 0	222 11 0
Reefton.. ..	75 10 0	8 0 0	3 2 6	402 0 0	3 14 0	2 8 0	2 18 0	497 12 6
Wangapeka ..	2 0 0	..	..	..	..	..	0 5 0	2 5 0
Lyell	16 0 0	..	1 12 6	31 10 0	0 13 0	..	0 10 0	50 5 6
Murchison ..	37 10 0	..	2 15 0	25 0 0	1 3 0	..	1 1 6	67 9 6
Totals ..	310 10 0	10 0 0	15 5 0	770 17 6	17 16 0	7 3 0	9 5 6	1,140 17 0
MARLBOROUGH.								
Havelock ..	19 0 0	0 10 0	0 5 0	50 12 0	1 7 0	1 8 0	..	73 2 0
Picton	1 10 0	..	..	..	..	..	..	1 10 0
Totals ..	20 10 0	0 10 0	0 5 0	50 12 0	1 7 0	1 8 0	..	74 12 0
WESTLAND.								
Hokitika and Kanieri	46 10 0	4 10 0	1 15 0	29 0 0	2 12 0	2 11 0	7 3 6	94 1 6
Greymouth ..	65 0 0	..	3 10 0	13 7 0	7 17 0	..	22 3 0	111 17 0
Ross	18 10 0	..	0 12 6	27 10 0	1 11 0	0 4 0	0 17 6	49 5 0
Stafford.. ..	18 10 0	..	1 15 0	..	1 4 0	2 8 0	5 7 6	29 4 6
Okarito	7 0 0	3 0 0	0 15 0	..	0 10 0	..	..	11 5 0
Kumara ..	86 10 0	1 10 0	0 15 0	150 8 1	4 17 0	1 9 0	1 10 0	246 19 1
Goldsborough ..	25 12 0	..	3 5 0	..	2 9 0	1 7 0	0 18 0	33 11 0
Jackson's Bay ..	..	..	..	..	..	0 6 0	..	0 6 0
Totals ..	267 12 0	9 0 0	12 7 6	220 5 1	21 0 0	8 5 0	37 19 6	576 9 1
OTAGO.								
Black's	19 10 0	..	0 12 6	53 18 9	1 14 0	..	0 5 0	76 0 3
Tapanui ..	0 10 0	..	..	..	0 5 0	..	..	0 15 0
Hindon	15 0 0	0 10 0	0 10 0	5 15 0	0 4 0	0 2 0	0 4 0	22 5 0
Naseby	58 0 0	4 10 0	9 17 6	189 6 0	5 8 0	..	0 11 0	267 12 6
Alexandra } Clyde .. } ..	14 0 0	3 0 0	1 7 6	92 2 0	2 10 0	1 11 0	2 5 0	116 15 6
Roxburgh ..	19 0 0	..	2 5 0	220 17 0	2 4 0	1 8 0	2 3 0	247 17 0
Cromwell ..	53 0 0	4 10 0	2 11 0	52 0 2	4 18 0	2 9 0	0 4 0	119 12 2
Queenstown ..	36 11 0	11 10 0	1 14 0	315 17 1	1 12 0	1 16 0	23 1 1	392 1 2
Arrowtown ..	38 0 0	2 0 0	2 12 6	159 15 6	3 14 0	2 17 0	33 15 0	242 14 0
Lawrence ..	38 0 0	0 10 0	3 10 0	54 19 0	2 9 0	3 13 0	1 2 6	104 3 6
Orepuki and Longwood	29 0 0	3 0 0	3 17 6	39 13 0	3 2 0	3 12 0	..	82 4 6
Pembroke ..	4 10 0	..	..	1 0 0	..	..	0 4 0	5 14 0
Maerewhenua ..	7 0 0	1 0 0	1 0 0	16 8 0	1 3 0	..	0 5 0	26 16 0
Waikaia ..	30 10 0	..	1 10 0	0 12 0	1 19 0	0 14 0	..	35 9 0
Wyndham ..	..	..	..	6 5 0	0 8 0	..	0 4 0	6 17 0
Nenthorn ..	1 10 0	..	..	..	..	..	..	1 10 0
Totals ..	364 1 0	30 10 0	31 7 6	1,208 8 6	31 10 0	18 2 0	64 7 7	1,748 6 7
Grand Totals ..	1,076 13 0	125 7 0	60 0 0	2,962 18 10	76 14 0	37 19 0	119 16 7	4,459 8 5

No. 3.

COMPARATIVE RETURN of REVENUE derived from the GOLDFIELDS in the several DISTRICTS of NEW ZEALAND during the Years 1891 and 1892, showing INCREASE or DECREASE under each Head of Revenue.

District.	Miners' Rights.	Business Licenses, &c.	Water-races, Sluices, &c.	Gold-mining Leases, Rents, and Royalties.	Registration.	Fees and Fines, Wardens' Courts.	Miscellaneous.	Gold Duty.	Totals.
AUCKLAND—	£	£	£	£	£	£	£	£	£
Year 1891	470	261	24	3,496	37	49	391	4,541	9,269
Year 1892	567	411	51	2,512	25	25	166	4,616	8,373
Increase	97	150	27	..	..	..	..	75	..
Decrease	..	..	..	984	12	24	225	..	896
WELLINGTON—									
Year 1891	..	..	..	..	..	..	..	..	..
Year 1892	..	..	..	..	..	..	..	..	..
Increase	..	..	..	..	..	..	..	..	..
Decrease	..	..	..	..	..	..	..	..	..
NELSON—									
Year 1891	895	25	95	3,134	89	36	498	16	4,788
Year 1892	985	33	83	2,188	91	38	222	..	3,640
Increase	90	8	..	..	2	2	..	..	..
Decrease	..	..	12	946	..	..	276	16	1,148
MARLBOROUGH—									
Year 1891	100	..	2	206	10	11	..	..	329
Year 1892	94	..	3	199	7	14	2	..	319
Increase	..	..	1	..	..	3	2	..	..
Decrease	6	..	..	7	3	..	..	..	10
WESTLAND—									
Year 1891	1,075	54	91	1,231	97	18	56	2,009	4,631
Year 1892	1,063	51	73	662	73	29	134	..	2,085
Increase	..	..	..	..	..	11	78	..	..
Decrease	12	3	8	569	24	..	..	2,009	2,536
OTAGO—									
Year 1891	1,715	117	183	4,777	160	132	686	7	7,777
Year 1892	1,643	100	138	3,682	126	130	204	..	..
Increase	..	..	..	..	..	..	..	..	..
Decrease	72	17	45	1,095	34	2	482	7	1,754
Total Increase	97	138	..	..	..	..	..	..	..
Total Decrease	..	..	37	3,601	71	10	903	1,957	6,344

No. 4.

COMPARATIVE RETURN of the TOTAL AMOUNTS of GOLDFIELDS REVENUE (exclusive of Gold Duty) collected in the several Districts during the Years 1891 and 1892, and the Quarters ending 31st March, 1892 and 1893 respectively, showing the INCREASE or DECREASE in respect of each District.

District.	Years 1891 and 1892.				Quarters ending 31st March, 1892, and 31st March, 1893.			
	1891.	1892.	Increase.	Decrease.	1892.	1893.	Increase.	Decrease.
AUCKLAND.	£	£	£	£	£	£	£	£
Coromandel	602	632	30	..	37	147	110	..
Te Aroha	1,066	790	..	276	178	267	89	..
Thames	2,550	2,187	..	363	777	502	..	275
Puhipuhi	510	150	..	360	9	3	..	6
NELSON.								
Motueka	6	6	..	..	3	2	..	1
Collingwood	348	321	..	27	140	115	..	25
Westport	733	560	..	173	141	103	..	38
Charleston	311	205	..	106	74	81	7	..
Ahaura	543	582	39	..	264	223	..	41
Reefton	2,437	1,765	..	672	555	498	..	57
Wangapeka	15	10	..	5	6	2	..	4
Lyell	264	84	..	180	13	50	37	..
Murchison and Owen's ..	116	108	..	8	23	67	44	..
MARLBOROUGH.								
Havelock	330	319	..	11	177	75	..	102
WESTLAND.								
Hokitika ..	376	455	79	..	145	94	..	51
Kanieri ..								
Greymouth	594	429	..	165	203	112	..	91
Ross	682	358	..	324	154	49	..	105
Stafford	238	135	..	103	29	29	..	..
Okarito	146	91	..	55	24	11	..	13
Kumara	478	512	34	..	89	247	158	..
Jackson's Bay	6	3	..	3	..	..	..	..
Goldsborough	102	100	..	2	30	34	4	..
OTAGO.								
Hindon	257	170	..	87	50	22	..	28
Naseby and Black's ..	1,294	1,607	313	..	545	344	..	201
Alexandra ..	283	353	70	..	87	117	30	..
Clyde ..								
Roxburgh	651	627	..	24	256	248	..	8
Cromwell	604	461	..	143	122	120	..	2
Arrowtown	1,067	584	..	483	278	243	..	35
Queenstown	1,469	814	..	655	365	392	27	..
Pembroke	22	28	6	..	6	6	..	..
Lawrence	1,233	736	..	497	191	104	..	87
Waikaia	155	178	23	..	49	35	..	14
Tapanui	13	6	..	7	2	1	..	1
Orepuki and Longwood ..	321	262	..	59	89	82	..	7
Maerewhenua	99	102	3	..	19	27	8	..
Wyndham	144	82	..	62	9	7	..	2
Invercargill	11	..	..	11	7	..	..	7
WELLINGTON.								
Wellington	..	..	..	..	..	..	..	..
CANTERBURY.								
Christchurch	..	..	..	..	..	..	..	..
Totals	20,076	15,812	597	4,861	5,146	4,459	514	1,201
Net decrease ..	..	..	..	4,264	..	..	..	687

No. 5.

RETURN of GOLD DUTY credited to LOCAL BODIES for the Year ended 31st December, 1892, and Quarter ended 31st March, 1893.

Local Body.	For the Year ended 31st December, 1892.	For the Quarter ended 31st March, 1893.
	£ s. d.	£ s. d.
COUNTIES—		
Buller	..	..
Collingwood	..	..
Coromandel	821 6 2	259 15 0
Fiord	..	..
Grey	..	..
Inangahua	..	..
Lake	..	..
Maniototo	..	..
Ohinemuri	1,196 11 0	459 10 2
Piako	50 5 10	25 9 3
Southland	..	..
Taieri	..	..
Thames	1,629 18 1	390 18 10
Tuapeka	..	0 2 0
Vincent	..	..
Waikouaiti	..	..
Waimea	..	..
Waitaki	..	..
Wallace	..	..
Westland	..	..
Whangarei	0 10 0	..
BOROUGHS—		
Brunnerton	..	..
Hokitika	..	..
Kumara	..	..
Ross	..	..
Thames	917 17 11	210 10 2
Totals	4,616 9 0	1,346 5 5

No. 6.

RETURN of the QUANTITY and VALUE of GOLD ENTERED for DUTY* for EXPORTATION from NEW ZEALAND from 1st APRIL, 1857, to 31st DECEMBER, 1892.

PRODUCE OF THE GOLDFIELDS IN		DURING THE QUARTER ENDED 31ST DECEMBER, 1892.		ENTERED FOR EXPORTATION TO THE 30TH SEPTEMBER, 1892.		TOTAL ENTERED FOR EXPORTATION FROM NEW ZEALAND TO THE 31ST DECEMBER, 1892.	
County or Borough.	District.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
		Oz.	£	Oz.	£	Oz.	£
County of Coromandel	Auckland	2,949	11,793				
" Thames		4,024	16,096				
" Ohinemuri		4,970	20,688				
" Piako		209	838				
" Whangarei		5	15				
Borough of Thames		1,991	7,963				
		14,148	57,393	1,716,156	6,429,920	1,730,304	6,487,313
County of Hutt	Wellington	..	..	188	706	188	706
County of Marlborough	Marlborough	790	3,161	75,692	293,930	76,482	297,091
County of Collingwood	Nelson	510	1,917				
" Waimea		23	87				
		533	2,004	1,660,496	6,585,934	1,661,029	6,587,938
County of Buller	West Coast	4,738	18,949				
" Inangahua		8,274	33,097				
" Grey		5,770	23,082				
" Westland		6,309	25,237				
Borough of Kumara		318	1,272				
" Hokitika		231	924				
" Ross		987	3,948				
		26,627	106,509	3,859,423	15,337,806	3,886,050	15,444,315
	Canterbury	..	..	24	96	24	96
County of Taieri	Otago	354	1,334				
" Tuapeka		7,650	30,959				
" Vincent		4,341	17,503				
" Maniototo		2,596	10,430				
" Waihemo		1,040	4,106				
" Waikouaiti		184	676				
" Waitaki		490	2,004				
" Lake		4,619	18,538				
" Wallace		1,314	5,314				
" Fiord		155	635				
" Southland		1,191	4,778				
		23,934	96,277	4,930,163	19,473,641	4,954,097	19,569,918
Unknown	..	..	..	122	484	122	484
Totals		66,032	265,344	12,242,264	48,122,517	12,308,296	48,387,861

* Gold duty abolished in the South Island on the 31st March, 1891, by "The Gold Duty Abolition Act, 1890."

Department of Trade and Customs,
Wellington, 14th January, 1893.

W. T. GLASGOW,
Secretary and Inspector.

No. 7.

COMPARATIVE RETURN of the QUANTITY and VALUE of GOLD ENTERED for DUTY* for EXPORTATION from NEW ZEALAND for the YEARS ended 31st DECEMBER, 1892 and 1891.

PRODUCE OF THE GOLDFIELDS IN THE DISTRICT OF	DURING THE QUARTER ENDED—				TOTALS FOR YEAR 1892.		TOTALS FOR YEAR 1891.	
	31st March, 1892.	30th June, 1892.	30th September, 1892.	31st December, 1892.	Quantity.	Value.	Quantity.	Value.
	Oz.	Oz.	Oz.	Oz.	Oz.	£	Oz.	£
Auckland ..	11,724	7,029	12,654	14,148	45,555	183,655	45,392	181,185
Marlborough ..	1,371	1,342	395	790	3,898	15,429	5,649	22,576
Nelson ..	936	567	499	533	2,535	9,604	4,445	16,896
West Coast ..	28,982	27,565	19,932	26,627	103,106	412,383	109,268	437,126
Otago ..	18,321	20,812	19,866	23,934	82,933	333,467	87,209	349,573
Unknown ..	32	20	..	..	52	206	33	132
Totals for 1892	61,366	57,335	53,346	66,032	238,079	954,744	..	..
Totals for 1891	36,827	99,667	62,876	52,626	..	..	251,996	1,007,488

* Gold duty abolished in the South Island on the 31st March, 1891, by "The Gold Duty Abolition Act, 1890."

Department of Trade and Customs,
Wellington, 14th January, 1893.

W. T. GLASGOW,
Secretary and Inspector.

No. 8.

RETURN of the QUANTITY and VALUE of GOLD ENTERED for DUTY* for EXPORTATION from NEW ZEALAND, from 1st APRIL, 1857, to 31st MARCH, 1893.

PRODUCE OF THE GOLDFIELDS IN		DURING THE QUARTER ENDED 31ST MARCH, 1893.		ENTERED FOR EXPORTATION TO THE 31ST DECEMBER, 1892.		TOTAL ENTERED FOR EXPORTATION FROM NEW ZEALAND TO THE 31ST MARCH, 1893.	
County or Borough.	District.	Qu'ntity	Value.	Quantity.	Value.	Quantity.	Value.
		Oz.	£	Oz.	£	Oz.	£
County of Coromandel ..	Auckland	1,073	4,261				
" Thames ..		1,784	7,035				
" Ohinemuri ..		3,161	13,216				
" Piako ..		67	268				
Borough of Thames ..		1,136	4,440				
		7,221	29,220	1,730,304	6,487,313	1,737,525	6,516,533
County of Hutt ..	Wellington ..	..	..	188	706	188	706
County of Marlborough	Marlborough ..	528	2,104	76,482	297,091	77,010	299,195
County of Collingwood ..	Nelson	1,156	4,478				
" Waimea ..		37	143				
		1,193	4,621	1,661,029	6,587,938	1,662,222	6,592,559
County of Buller ..	West Coast	4,435	17,740				
" Inangahua ..		5,661	22,645				
" Grey ..		8,661	34,646				
" Westland ..		7,687	30,845				
Borough of Kumara ..		257	928				
" Hokitika ..		41	164				
" Ross ..		770	3,080				
		27,512	110,048	3,886,050	15,444,315	3,913,562	15,554,363
	Canterbury ..	..	..	24	96	24	96
County of Taieri ..	Otago	310	1,219				
" Tuapeka ..		3,628	14,841				
" Vincent ..		3,154	12,694				
" Maniototo ..		3,135	12,784				
" Waihemo ..		355	1,365				
" Waitaki ..		664	2,721				
" Lake ..		1,594	6,412				
" Wallace ..		1,416	5,752				
" Fiord ..		314	1,282				
" Southland ..		907	3,674				
Stewart Island ..		15	60				
		15,492	62,804	4,954,097	19,569,918	4,969,589	19,632,722
	Unknown ..	..	..	122	484	122	484
Totals		51,946	208,797	12,308,296	48,387,861	12,360,242	48,596,658

* Gold duty abolished in the South Island on the 31st March, 1891, by "The Gold Duty Abolition Act, 1890."

Department of Trade and Customs,
Wellington, 15th April, 1893.

W. T. GLASGOW,
Secretary and Inspector.

No. 9.

COMPARATIVE RETURN of the QUANTITY and VALUE of GOLD ENTERED for DUTY* for EXPORTATION from NEW ZEALAND for the QUARTERS ended 31st MARCH, 1893, and 31st MARCH, 1892.

District of	Quarter ended 31st March, 1893.		Quarter ended 31st March, 1892.	
	Quantity.	Value.	Quantity.	Value.
	Oz.	£	Oz.	£
Auckland	7,221	29,220	11,724	47,026
Marlborough	528	2,104	1,371	5,450
Nelson	1,193	4,621	936	3,616
West Coast	27,512	110,048	28,982	115,908
Otago	15,492	62,804	18,321	73,948
Unknown	..	..	32	126
Totals	51,946	208,797	61,366	246,074

* Gold duty abolished in the South Island on the 31st March, 1891, by "The Gold Duty Abolition Act, 1890."

Department of Trade and Customs,
Wellington, 15th April, 1893.

W. T. GLASGOW,
Secretary and Inspector.

No. 10.

STATEMENT showing the PRICE of GOLD per OUNCE, PRICE charged per TON for CRUSHING QUARTZ or CEMENT, and PRICES charged for WATER per SLUICE-HEAD per WEEK, during the Year ending 31st March, 1893.

Mining District.		Price of Gold per Ounce.	Price charged per Ton for crushing Quartz or Cement.	Price charged for Water per Sluice-head per Week.	Remarks.
		£ s. d.	£ s. d.	£ s. d.	
AUCKLAND—	North Hauraki	2 15 0	0 12 0	3 0 0	..
	South Hauraki	2 10 0	0 6 0	3 0 0	..
	Ohinemuri	2 10 0	0 10 0	..	..
	Te Aroha	2 15 0	..	..	..
	Puhipuhi	..	3 0 0	..	..
MARLBORO—	Pelorus and Wairau ..	3 17 0	..	..	..
NELSON—	Wangapeka	3 14 0	..	..	..
	Motueka	3 14 0	..	..	..
	Charleston	3 17 0	..	2 15 0	40in.
	Inangahua	3 18 0	4 1 0	8s. to 10s.	..
	Collingwood	3 14 6	..	..	..
	Westport	3 19 0	..	..	..
	Murchison	3 17 0	..	..	..
	Lyell	3 18 0	..	..	..
WESTLAND—	Hokitika and Kanieri / Waimea	3 18 0	..	3 0 0	40in.
	Totara and Ross	3 18 0	0 12 0	1 10 0	..
	Stafford	3 18 0	..	1 10 0	40in.
	Greymouth	3 18 0	..	1 15 0	40in.
	Kumara	3 18 0	..	2 0 0	40in.
	Ahaura	3 18 0	..	1 10 0	40in.
	Okarito	3 18 0	..	1 0 0	..
	Jackson's Bay	3 18 0	..	..	..
OTAGO—	Hindon	3 17 6	0 16 0	..	..
	Tuapeka	3 17 0	..	£1 4s. to £1 10s.	For 8 hours.
	Dunstan	..	..	..	..
	Longwood	3 10 6	..	1 0 0	40in.
	Orepuki and Roundhill ..	3 18 6	..	0 15 0	40in.
	Arrow (Wakatipu Goldfield) and Queenstown	3 17 6	0 15 0	..	..
	Mount Ida	3 17 0	..	1 0 0	16in.
	Macrae's, Hyde	..	..	..	..
	Hamilton, Serpentine ..	..	..	..	..
	Maerewhenua	3 15 0	..	1 6 8	20in. by 2in.
	Cromwell	3 17 6	0 12 0	1 10 0	..
	Waikaia	3 18 0	..	2 0 0	..
	Tapanui	3 15 0	..	..	..
	Wyndham	3 18 0	..	..	..
	Roxburgh	3 17 6	0 10 0	..	..
	Clyde and Alexandra ..	3 17 6	0 10 0	..	..
	Black's	3 17 6	0 12 0	..	..
	Waikawa and Fortrose ..	3 18 0	..	..	..

No. 11.

RETURN showing the AVERAGE PRICES of PROVISIONS and LIVE-STOCK for the Year ending 31st March, 1893.

Mining District.	Beer.	Brandy.	Bread—Wheaten.	Butter—Fresh.	Butter—Salt.	Cheese.	Coffee.	Flour.	Grain—Wheat.	LIVE-STOCK. Cattle—Horned.	Goats.	Horses.	Sheep.	Swine.	MEAT. Beef.	Mutton.	Pork.	Milk.	Rice.	Salt.	Sugar.	Tea.	Tobacco.	Wine.
	Per. hhd.	Per gall.	Per lb.	Per lb.	Per lb.	Per lb.	Per lb.	Per 100lb.	Per Im. bushel.	Per head.	Per head.	Per head.	Per head.	Per head.	Per lb.	Per lb.	Per lb.	Per qt.	Per lb.	Per lb.	Per lb.	Per lb.	Per lb.	Per gallon.
AUCKLAND—			d.							£		£			d.	d.	d.	d.	d.	d.	d.			
Ohinemuri	80/–100/	27/	1½	1/	/10	/8	1/10	12/6	3/6	6	7/	7–50	15/	35/	4½	4	5	2–4	3½	0¾	3½	2/3	6/	18/
North Hauraki	100/	25/	1¾	1/	/10	/7	1/10	13/	5/	6	5/	5–50	10/–15/	9/–15/	3	4	6	6	3	1	3	3/	1/8–2/6	6/6
South Hauraki	90/	28/	3½	1/	/9	/7–/10	1/6–2/	11/	4/	7	15/	5–50	15/	40/	5	4	6	4	3	1	3	1/6–3/	6/	10/–35/
Te Aroha	90/	28/	3½	1/	/9	/8	1/8	12/	4/	7	15/	10–30	15/	40/	5	4	6	4	3	1	3	2/	6/	15/
Puhipuhi	150/	40/	2½	1/	/10	/8	2/	13/	4/	9	..	10	15/	30/	4	3	6	6	3	1	4	2/6	6/	18/
MARLBOROUGH—																								
Queen Charlotte Sound / Pelorus .. / Wairau ..	100/	30/	2	1/	/10	/8	2/	13/6	4/	5	20/	10	10/	20/	4	3	5	4	4	1½	4	/6	6/	5/6–25/
NELSON—																								
Wangapeka	..	..	2	/9	/8	/6	2/	15/	..	5	8/	5–20	10/–12/	3/–8/	3	3	4	2	3	1½	4	2/6	5/6	..
Collingwood	100/	25/	2	1/	/8	/8	2/	12/	5/	5	..	7–15	7/–10/	5/–50/	4	4	6	4	4	2	4	3/	6/	16/
Inangahua	100/	25/	2	1/3	1/	/8	1/9	12/6	4/	8	30/	10–30	10/–12/	50/–60/	6	5	6	4	4	2	4	3/	6/	21/–28/
Lyell	120/	26/	2½	1/6	1/6	/9	1/9	17/	8/	5	15/–20/	10–15	12/	40/	5	5	6	6	3	2¾	4	2/9	6/	20/
Murchison	120/	25/	2½	1/	1/	/10	2/	17/	9/	8	10/	5–25	9/–17/	60/	4	4	5	6	4	2	4½	2/9	6/6	12/–18/
Westport	105/	26/	2	1/3	1/	/8	2/	14/	5/	8	20/	10–50	17/	60/	7	7	7	5	3	1½	4	2/6	7/	24/
Charleston	130/	26/	2	1/6	1/3	/8	2/	15/	6/	8	15/	20–30	16/	30/	7	7	8	4	4	1	4	2/6	7/	16/
Ahaura	105/	25/	2	1/6	1/3	/9	1/6	15/	5/	6	2/6	10–30	13/–20/	80/	5	5	9	6	4	2	5	3/	7/	18/
WESTLAND—																								
Stafford	120/	30/	2	1/3	1/3	1/	2/	15/	6/6	5–16	10/	5–30	15/	30/–60/	8	8	8	6	4	2	4½	2/6	6/6	25/
Waimea .. / Hokitika and Kanieri	100/	25/	2	1/6	/10	/8	2/	15/–20/	5/	5–10	15/	6–20	12/–18/	20/–60/	6–8	6	8	6	4	4	6	3/4	6/–7/	20/
Ross	110/	24/6	2	1/3	1/	/8	1/6–2/	16/	6/	4–6	5/	10–20	12/–16/	43/–60/	6–8	6–8	8	4	4	2	4	2/6	6/	20/–30/
Okarito	120/	63/	6	1/6	1/	/9	2/	20/	6/	7	15/	10	18/	15/	5	5	6	4	5	4	6	2/	7/6	20/–30/
Kumara	120/	23/6	2	1/6	1/	/10	1/6	18/	5/	10	10/	10–30	15/	40/–100/	5	3	8	6	3	2	5	3/	6/	22/
Greymouth	85/	24/–36/	2	1/6	1/9	1/3	2/	14/	6/	8	15/	7–30	15/	15/–100/	5	5	6	6	3	2	4	2/6	6/	15/–35/
Jackson's Bay	..	30/	..	1/	1/	1/	1/6	15/–18/	..	2–6	..	8–15	20/	20/–100/	3	4	5	..	4	2	4	2/6	5/6	..
OTAGO—																								
Hindon	..	..	1½	1/2	1/	/8	1/8	12/–15/	4/	..	..	5–30	10/6	..	4	4	6	4	3	2	3–6	2/6	6/	..
Tuapeka	100/	26/	1½	/10	/9	/8	2/	3/	3/–6/	..	5/–20/	5–10	5/–40/	5/–6/	4	3	1½	3	3	1½	3	2/	5/6	24/
Tapanui	90/	24/	1¾	/10	/9	/6	2/	9/	3/	1–6	..	2–10	15/	10/–60/	4	3	6	3	4	1	4	2/6	6/	18/
Cromwell	100/	23/	2	1/3	1/	/8	1/9	11/	4/	3	..	9	9/	50/	4¾	4½	6	6	3	2	4	2/3	5/6	18/
Clyde .. / Alexandra ..	120/	30/	7	1/3	1/	/8	1/9	14/	4/6	4	..	5–25	6/6–20/	60/	5	4½	8	5	3	1½	4	2/6	5/	25/
Roxburgh	110/	28/	7	1/	1/	/6	1/6	12/	3/6	3	..	5–25	5/–15/	60/	4	4	6	5	3	1	4	2/6	5/	20/
Black's	120/	30/	7	1/	1/	/7	1/6	13/	4/	4	..	5–25	5/–20/	60/	5	4½	8	5	3	1½	4	2/6	5/	20/
Queenstown	110/	28/	2	1/3	1/	/9	2/	12/	2/6	5 10/	..	10–30	3/–15/	25/	6	4	7	6	3	2	4	2/6	6/	20/
Wyndham	80/	24/6	1½	1/	/10	/4½	1/9	8/6	3/6	4	..	20	12/	26/	4	4	6	3	1	0½	3	2/	6/	20/
Arrow (Wakatipu Goldfield)	120/	30/	2	1/3	1/	/9	2/	12/	2/6	5 10/	..	10–30	3/–15/	25/	6	4	7	6	3	2	4	2/6	6/	20/
Mount Ida .. / Nenthorn ..	120/	27/	2	1/3	1/3	/10	2/	..	4/3	4 10/	15/	10 10/	12/6	30/	6	3	6	4	5	2	4	2/9	6/	16/
Waikaia	120/	18/	1½	1/	/10	/9	2/	11/	2/6	4–6	..	6–30	12/	10/–50/	6	4½	6	4	6	2	4	2/6	5/6	17/6
Orepuki and Longwood ..	90/	27/	1½	/8	/8	/6	2/	11/	3/6	6	20/	10–18	15/	40/	5	5	5	3	4	1	3½	2/	6/	24/
Maerewhenua	130/	26/	1½	/10	/10	/7½	1/9	11/	4/3	4 10/	..	12–10	11/6	30/	4	3	3½	4	4	2	4	2/6	6/	..
Waikawa and Fortrose ..	80/	24/6	1½	1/	/10	/4½	1/9	8/6	3/6	4	..	20	12/	26/	4	4	6	3	1	0½	3	2/	6/	15/–21/

No. 12.

TABLE showing the AVERAGE RATE of WAGES per WEEK for the Year ending 31st March, 1893.

Mining District.	General Managers.	Legal Managers.	Mining Managers.	Engineers.	Engine-drivers.	Stokers.	Blacksmiths.	Carpenters.	Miners.	Labourers.	Boys.	Chinese.	Agricultural Labourers.	Domestic Servants.
AUCKLAND—	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	
North Hauraki ..	£5 to £10	1 0 0	5 0 0	3 10 0	2 8 0	2 8 0	2 10 0	2 10 0	2 8 0	2 0 0	10/ to 30/	..	2 0 0	7/ to 14/
South Hauraki ..	10 0 0	1 0 0	5 0 0	3 10 0	3 0 0	..	2 8 0	2 8 0	2 5 0	1 16 0	10/ to 15/	..	1 10 0	7/ to 10/
Te Aroha	..	..	5 0 0	..	..	..	2 8 0	2 8 0	2 8 0	1 16 0	0 10 0	..	1 10 0	7/ to 10/
Tuhipuhi	..	1 0 0	3 10 0	3 0 0	2 8 0	2 0 0	3 12 0	3 0 0	2 8 0	1 16 0	..	..	..	..
Ohinemuri	10 0 0	1 0 0	5 0 0	3 10 0	3 0 0	..	2 8 0	2 8 0	2 8 0	1 16 0	10/ to 15/	..	1 10 0	7/ to 10/
MARLBOROUGH—														
Wairau ..	..	1 0 0	3 15 0	..	1 10 0	..	3 0 0	12/ a day	2 14 0	2 2 0	0 10 0	..	1 5 0	8/ to 12/
Pelorus ..														
NELSON—														
Collingwood	4 10 0	1 0 0	4 10 0	3 10 0	2 14 0	2 8 0	2 14 0	2 14 0	2 8 0	2 2 0	..	..	1 5 0	8/ to 15/
Inangahua	..	£1 to £3	£5 to £6	£5 to £6	3 10 0	..	4 0 0	4 0 0	3 0 0	3 0 0	30/ to 50/	..	1 10 0	20/
Charleston	..	..	3 0 0	..	..	..	3 0 0	3 0 0	3 0 0	3 0 0	1 0 0	..	1 0 0	10/
Westport	..	0 15 0	4 0 0	..	3 10 0	3 0 0	3 10 0	3 10 0	3 0 0	3 0 0	10/ to 20/	1 10 0	£2 to £2 10/	10/ to 20/
Lyell	..	3 0 0	6 0 0	..	..	..	4 15 0	4 4 0	3 3 0	3 0 0	2 10 0	..	1 5 0	15/ to 20/
Ahaura	..	..	..	..	..	..	3 10 0	3 12 0	3 0 0	£1 10/ to £3	0 15 0	..	1 10 0	8/ to 12/
Murchison	..	..	5 0 0	3 0 0	3 0 0	3 0 0	3 0 0	3 0 0	3 0 0	3 0 0	..	1 18 6	15/ to £1 10/	10/ to 12/
Wangapeka	..	..	..	..	..	..	2 8 0	2 14 0	..	1 16 0	..	..	1 10 0	7/
Motueka	..	..	..	..	..	..	2 8 0	2 14 0	..	1 16 0	0 15 0	..	1 16 0	9/
WESTLAND—														
Waimea and Stafford ..	..	..	..	..	..	..	4 0 0	4 0 0	3 0 0	3 0 0	1 10 0	2 10 0	2 10 0	20/
Hokitika and Kanieri ..	4 0 0	1 0 0	£4 to £5	5 0 0	3 0 0	3 0 0	£3 to £4	4 0 0	3 0 0	3 0 0	1 10 0	1 10 0	..	10/ to 15/
Ross	..	1 5 0	£4 to £5	3 10 0	..	4 0 0	3 12 0	3 0 0	3 0 0	£1 10/ to £2	£1 10/ to £2	..	0 15 0	..
Kumara	4 10 0	1 10 0	3 10 0	..	3 0 0	..	4 0 0	4 0 0	3 0 0	3 0 0	1 10 0	1 5 0	1 10 0	8/ to 12/
Greymouth	..	1 0 0	£4 to £6	£4 to £5	3 0 0	2 5 0	3 5 0	10/ to 14/	£2 10/ to £3	7/ to 9/	10/ to 12/	£1 to £1 10/	£1 to £2	7/ to 15/
Okarito & Jackson's Bay	..	..	..	..	..	..	..	3 12 0	3 0 0	3 0 0	0 15 0	..	..	8/ to 15/
OTAGO—														
Hindon	4 0 0	..	4 0 0	3 10 0	3 0 0	..	2 8 0	3 0 0	2 8 0	2 0 0	1 0 0	..	1 0 0	12/
Tuapeka	4 0 0	2 10 0	4 0 0	3 0 0	2 10 0	2 2 0	2 5 0	2 8 0	2 2 0	2 2 0	0 5 0	1 0 0	1 5 0	12/
Tapanui	..	..	..	..	..	..	3 0 0	3 0 0	2 8 0	2 2 0	0 10 0	15/ to £1	1 0 0	8/ to 10/
Cromwell	5 0 0	0 10 0	4 0 0	3 10 0	3 0 0	2 10 0	2 10 0	3 0 0	2 10 0	2 0 0	1 7 6	1 4 0	1 0 0	9/
Clyde ..														
Alexandra ..	5 0 0	0 12 6	4 0 0	3 0 0	2 10 0	..	3 0 0	3 10 0	2 8 0	2 2 0	0 10 0	1 5 0	1 0 0	7/6 to 15/
Black's ..														
Roxburgh	5 0 0	12/6 to 21/	4 0 0	3 0 0	2 10 0	..	3 0 0	3 5 0	2 8 0	2 2 0	0 10 0	1 5 0	1 0 0	7/6 to 12/6
Waikaia	4 0 0	..	..	..	..	..	2 10 0	2 8 0	2 2 0	2 0 0	0 10 0	1 16 0	0 15 0	10/ to 12/
Orepuki and Longwood	5 0 0	1 0 0	3 0 0	..	2 10 0	..	..	2 14 0	2 2 0	1 16 0	0 15 0	1 10 0	1 0 0	10/
Arrow	5 0 0	1 0 0	5 0 0	4 0 0	3 0 0	2 10 0	3 0 0	4 0 0	3 0 0	2 8 0	0 15 0	1 10 0	1 5 0	10/ to 15/
Queenstown	5 0 0	1 0 0	5 0 0	4 0 0	3 0 0	2 10 0	3 0 0	4 0 0	3 0 0	2 8 0	0 15 0	1 10 0	1 5 0	10/ to 15/
Mount Ida	..	..	£3 10/ to £4	..	..	..	3 0 0	£3 to £3 10/	£2 8/ to £2 14/	2 2 0	0 15 0	2 8 0	1 0 0	10/ to 15/
Maerewhenua	..	..	3 0 0	..	..	..	..	..	2 0 0	2 0 0	..	..	1 0 0	8/
Wyndham	..	..	..	3 10 0	2 10 0	..	1 0 0	3 0 0	2 2 0	2 2 0	..	..	1 5 0	15/
Waikawa and Fortrose ..	..	..	..	3 10 0	2 10 0	..	1 0 0	3 0 0	2 2 0	2 2 0	..	..	1 5 0	15/

No. 13.

NUMBER of MACHINES employed in ALLUVIAL and QUARTZ-MINING, and the VALUE thereof, for the Year ending 31st March, 1893.

Mining District.	Machinery employed in Alluvial Mining.														Machinery employed in Quartz-mining.								Approximate Value of all Mining Plant included in this Return.
	Steam-engines employed winding, crushing, &c.		Puddling Machines.	Whims.	Whips or Pulleys.	Sluices, Toms, and Sluice-boxes.	Water-wheels.	Hydraulic Hose.	Pumps.	Dredges.	Quicksilver and Compound Cradles.	Derricks.	Stamp-heads crushing Cement.	Boring Machines.	Steam-engines employed winding, crushing, &c.		Crushing Machines.	Stamp-heads.	Water-wheels.	Whims.	Whips or Pulleys.	Derricks.	Berdans.	
	No.	Aggregate h.p.													No.	Aggregate h.p.								
AUCKLAND—																								£
Ohinemuri ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3	160	10	163	12	..	..	..	80	28,650
North Hauraki ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	8	200	11	120	3	..	..	..	47	30,000
South Hauraki ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	12	350	26	350	25	..	..	..	233	62,350
Te Aroha	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	20	3	..	..	..	..	2,000
Puhipuhi ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1	..	..	..	..	..	..
Totals ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	23	710	49	654	43	..	..	..	360	123,000
MARLBOROUGH—																								
Wakamarina ..	1	16	..	..	..	20	..	..	5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	350
Cullen's Creek ..	..	..	..	..	..	60	30	..	5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	750
Waikakaho ..	..	..	..	..	..	20	2	..	..	..	..	..	..	..	..	..	1	$\frac{1}{10}$ stp.	..	..	..	..	..	10,000
Other places ..	..	..	..	..	..	70	..	..	10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	250
Totals ..	1	16	..	..	..	170	32	..	20	..	..	..	..	..	..	..	1	..	..	..	..	..	..	11,350
NELSON—																								
Sherry and Tadmor	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Baton	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wangapeka ..	..	..	..	..	..	125	..	3	..	..	..	..	..	..	..	..	1	4	..	..	..	..	..	70
Collingwood ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	17	2	20	..	..	..	2,000
Inangahua ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	20	398	21	340	17	2	3	..	65	148,280
Charleston ..	..	..	..	..	..	80	8	80	..	..	50	..	37	..	..	..	..	..	..	..	..	..	..	4,000
Lyell	..	..	..	..	..	110	..	16	..	..	..	..	..	..	..	..	6	63	2	..	..	..	..	16,000
Murchison ..	..	..	..	..	..	650	2	1	2	2	..	..	..	..	..	..	..	..	..	..	..	..	..	9,750
Westport	..	..	..	8	..	50	1	20	..	..	..	..	8	..	..	..	3	25	3	..	..	..	..	6,000
Ahaura	..	..	..	..	..	1,554	3	540	..	..	..	..	..	..	..	..	1	10	1	..	..	..	..	4,300
Totals ..	..	..	..	8	..	2,569	14	660	2	2	50	..	45	..	20	398	33	459	25	22	3	..	65	190,400
WESTLAND—																								
Stafford	..	..	..	2	3	8,000	5	650	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	20,000
Ross	..	..	..	2	..	60	4	40	..	2	..	..	..	..	..	..	1	5	1	..	..	..	..	14,000
Hokitika and Kanieri	..	..	..	..	20	95	1	53	..	1	5	..	5	..	..	..	..	..	..	..	..	..	..	7,500
Greymouth ..	2	39	..	..	..	2,500	2	900	30	1	30	..	..	10	..	..	..	..	..	..	..	..	..	15,000
Kumara	..	..	..	7	20	140	6	92	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3,000
Okarito	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Totals ..	2	39	..	9	45	10,795	18	1,735	31	5	35	..	5	10	..	..	1	5	1	..	..	..	..	59,500
OTAGO—																								
Tapanui	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Hindon	..	..	..	..	..	23	..	2	..	..	..	..	..	..	4	80	6	35	2	..	..	..	..	10,000
Tuapeka	..	..	..	..	..	500	15	11	30	4	..	..	..	..	..	..	2	25	1	..	..	..	..	9,000
Cromwell	..	..	..	..	..	..	..	5	..	..	..	..	..	..	2	20	6	31	1	..	..	..	..	14,890
Clyde and Alexandra	..	..	..	1	1	310	3	5½ mls.	3	6	..	..	..	..	..	..	3	23	2	1	1	..	..	38,500
Roxburgh ..	..	..	..	..	1	680	3	10 "	4	11	..	1	..	..	..	..	..	..	..	..	..	..	..	75,000
Black's	..	..	..	1	1	765	2	6	3	..	1	..	..	..	..	..	2	14	1	1	..	..	..	32,500
Orepuki and Longwood	2	30	..	..	..	170	..	3	..	..	..	..	..	..	..	..	1	2	1	..	..	..	..	3,150
Waikaia (Switzer's)	1	12	..	..	..	210	3	40	3	1	..	..	..	..	..	..	..	..	..	..	..	..	..	21,000
Arrow	..	..	..	..	..	300	..	60	..	..	..	..	..	..	1	4	4	30	3	..	..	..	..	16,000
Queenstown ..	..	..	..	..	..	400	..	50	..	4	..	..	..	..	1	8	5	70	..	..	..	..	..	75,000
Naseby	..	..	..	..	..	250	..	85	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2,000
Kyeburn and Clarke's	..	..	..	..	..	70	..	50	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3,400
Hamilton's and Sowburn	..	..	..	..	..	65	..	25	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	450
Hyde and Fullerton's	..	..	..	..	..	15	..	10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	200
Macrae's, Strath-Taieri, and Shag Valley	..	..	..	..	..	70	..	15	..	..	..	..	..	..	..	..	3	15	..	..	..	..	..	1,680
Maerewhenua ..	..	..	..	..	..	135	..	36	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	550
Serpentine ..	..	..	..	..	..	20	..	5	..	..	..	..	..	..	..	..	1	5	1	..	..	..	..	1,000
St. Bathan's, Ida Valley, and other localities	..	..	..	..	..	120	..	80	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3,250
Wyndham, Waikawa, and Fortrose	2	130	..	..	..	5	..	..	2	2	..	..	..	..	..	..	..	..	..	..	..	..	..	17,000
Totals ..	5	172	..	2	3	4,108	26	498½	45	28	1	1	..	..	8	112	33	250	12	2	1	..	..	324,480
SUMMARY.																								
Auckland	..	..	..	..	..	..	..	..	..	..	..	..	..	..	23	710	49	654	43	..	..	..	360	123,000
Marlborough ..	1	16	..	..	..	170	32	..	20	..	..	..	..	..	..	..	1	..	..	..	..	..	..	11,350
Nelson.	..	..	..	8	..	2,569	14	660	2	2	50	..	45	..	20	398	33	459	25	22	3	..	65	190,400
Westland	2	39	..	9	45	10,795	18	1,735	31	5	35	..	5	10	..	..	1	5	1	..	..	..	..	59,500
Otago	5	172	..	2	3	4,108	26	498½	45	28	1	1	..	..	8	112	33	250	12	2	1	..	..	324,480
Totals ..	8	227	..	19	48	17,642	90	2,893½	98	35	86	1	50	10	51	1,220	117	1,368	81	24	4	..	425	708,730

No. 14.

TABLE showing approximately the NUMBER, DESCRIPTION, and VALUE of the WATER-RACES, TAIL-RACES, DAMS, RESERVOIRS, and GROUND-SLUICES in Operation during the Year ending 31st March, 1893.

Mining District.	Water-races.				Tail-races.		Dams.		Reservoirs.		Ground-sluices.		Approximate Total Cost.
	No.	Length in Miles.	No. of Sluice-heads.	Approximate Cost.	No.	Approximate Cost.	No.	Approximate Cost.	No.	Approximate Cost.	No.	Approximate Cost.	
AUCKLAND—				£		£		£		£		£	£
Hauraki North ..	17	5	30	1,750	..	..	..	..	..	..	..	..	1,750
Hauraki South ..	9	4¾	34½	4,100	..	..	..	..	..	..	..	..	4,100
Te Aroha ..	4	4¾	16	5,000	..	..	..	..	..	..	..	..	5,000
Puhipuhi ..	1	25ch.	10	200	..	..	1	100	..	..	..	..	300
Ohinemuri ..	12	16¾	89	13,950	1	1,000	2	1,800	..	..	..	..	16,750
Totals ..	43	31½	179½	25,000	1	1,000	3	1,900	..	..	..	..	27,900
MARLBOROUGH—													
Pelorus	28	30	50	2,056	20	300	15	350	..	..	..	..	2,706
NELSON—													
Wangapeka ..	8	8	43½	300	22	160	10	..	..	..	..	..	460
Collingwood ..	63	92	490	89,065	126	1,544	30	2,170	..	..	..	..	92,779
Inangahua ..	221	174	1,714	43,285	429	23,843	477	17,770	..	..	..	..	84,898
Charleston ..	187	90	200	15,000	170	5,000	400	8,000	1	3,000	80	3,000	34,000
Westport	196	257¾	1,200½	34,770	101	10,003	173	5,260	..	..	..	..	50,033
Lyell	53	33½	176	4,683	12	478	26	1,314	..	..	..	..	6,475
Murchison ..	133	111	379	6,495	56	1,811	44	1,178	..	..	..	..	9,484
Ahaura	633	593½	2,150	104,235	61	1,900	54	1,500	..	..	..	..	107,635
Motueka ..	2	..	2	10	..	..	..	..	..	..	..	..	10
Totals ..	1,496	1,360	6,355	297,843	977	44,739	1,214	37,192	1	3,000	80	3,000	385,774
WESTLAND—													
Hokitika & Kanieri	265	130	370	14,500	220	1,700	230	15,300	..	..	..	..	31,500
Ross	108	80	227	24,230	160	17,000	66	1,600	..	..	50	620	43,450
Kumara ..	190	103	370	24,500	185	15,000	65	5,000	11	7,000	50	8,000	59,500
Greymouth ..	912	750	2,030	50,000	670	8,500	841	7,620	..	..	30	840	66,960
Jackson's Bay ..	6	6½	16	800	3	350	..	..	..	..	..	..	1,150
Okarito	49	42	240	2,170	24	130	14	250	..	..	1	60	2,610
Stafford	750	400	1,000	20,000	600	10,000	600	9,000	50	2,000	600	2,500	43,500
Totals ..	2,280	1,511½	4,253	136,200	1,862	52,680	1,816	38,770	61	9,000	731	12,020	248,670
OTAGO—													
Hindon	48	63	152	6,700	16	800	35	1,000	..	..	49	190	8,690
Tuapeka ..	282	740	1,686	14,840	371	6,040	260	5,200	..	..	..	..	26,080
Tapanui ..	3	6	15	90	2	40	2	20	..	..	..	..	150
Clyde & Alexandra	152	609	567	24,250	105	6,500	85	8,100	..	..	..	..	38,850
Black's	98	426	403	35,850	101	6,050	84	8,008	..	..	..	..	49,908
Arrow	110	200	250	15,000	200	5,000	30	1,500	30	..	..	..	21,500
Roxburgh ..	139	310	950	27,500	100	9,800	66	4,100	1	1,200	..	..	42,600
Cromwell ..	355	963	1,196	67,454	192	9,600	118	8,260	..	..	..	..	85,314
Waikaia ..	84	194	314	7,000	146	1,784	97	2,025	..	..	23	164	10,973
Orepuki and Longwood	265	308	578	17,500	120	6,000	130	1,600	3	100	120	2,300	27,500
Queenstown ..	110	175	500	50,000	150	5,000	40	1,700	30	..	..	..	56,700
Naseby	65	290	208	46,000	..	..	..	..	..	..	..	..	46,000
Kyeburn & Clarke's	85	300	315	10,300	..	..	..	..	..	..	..	..	10,300
Hamilton's and Sowburn	32	116	20	7,300	..	..	..	..	..	..	..	..	7,300
Hyde & Fullerton's	18	90	64	10,150	..	..	..	..	..	..	..	..	10,150
Macrae's, Strath-Taieri, and Shag Valley	30	48	55	4,100	..	..	..	..	..	..	..	..	4,100
Serpentine ..	36	88	93	5,000	..	..	..	..	..	..	..	..	5,000
Macrewhenua ..	24	185	54	16,200	40	1,000	35	1,020	..	..	..	..	18,220
St. Bathan's and Ida Valley	96	320	350	32,400	..	..	..	..	..	..	..	..	32,400
Waikawa, Fortrose, and Waipapa	5	12	11	320	..	..	5	1,000	..	..	4	..	1,320
Totals ..	2,037	5,443	7,781	397,954	1,543	57,614	987	43,533	64	1,300	196	2,654	503,055

SUMMARY.

Auckland	43	31½	179½	25,000	1	1,000	3	1,900	..	..	..	..	27,900
Marlborough ..	23	30	50	2,056	20	300	15	350	..	..	..	..	2,706
Nelson	1,496	1,360	6,355	297,843	977	44,739	1,214	37,192	1	3,000	80	3,000	385,774
Westland	2,280	1,511½	4,253	136,200	1,862	52,680	1,816	38,770	61	9,000	731	12,020	248,670
Otago	2,037	5,443	7,781	397,954	1,543	57,614	987	43,533	64	1,300	196	2,654	503,055
Totals ..	5,879	8,376	18,618½	859,053	4,403	156,333	4,035	121,745	126	13,300	1,007	17,674	1,168,105

No. 15.

RETURN of CASES in the WARDENS' COURTS, and COSTS AWARDED, for the Year ending 31st March, 1893.

Mining District.	Number of Mining Disputes adjudicated on.	Aggregate Amount of Value.		Amount of Costs Awarded.	Cases wherein Judgment has decreed Specific Performance.
		Claimed.	Recovered.		
AUCKLAND—		£ s. d.	£ s. d.	£ s. d.	
North Hauraki	30	19 0 0	15 0 0	32 12 6	..
South Hauraki	66	99 17 6	19 17 6	35 19 0	..
Te Aroha	1	38 0 0	13 0 0	9 5 0	..
Puhipuhi	..	..	..	..	32
MARLBOROUGH	3	402 0 0	28 0 0	15 8 0	..
NELSON—					
Collingwood	5	30 0 0	..	2 6 0	1
Inangahua	16	718 19 6	689 9 6	21 1 0	..
Lyell	3	5 0 7	5 0 7	1 8 0	..
Westport	10	135 0 0	..	8 0 0	1
Charleston	3	..	..	3 4 0	3
Ahaura	11	..	..	38 0 6	11
Murchison	1	..	..	..	..
WESTLAND—					
Kumara	12	126 17 0	35 15 0	24 19 0	..
Greymouth	21	612 5 0	9 5 0	72 17 0	1
Hokitika and Kanieri	8	120 0 0	4 10 0	7 0 0	..
Waimea } Stafford }	24	28 3 0	1 11 0	11 3 6	184
Jackson's Bay	..	..	..	..	..
Ross	4	8 10 0	0 10 0	5 2 0	1
Okarito	..	..	..	..	..
OTAGO—					
Tapanui	..	..	..	..	..
Hindon	..	..	..	..	..
Tuapeka	28	..	..	30 19 0	..
Cromwell	15	60 0 0	8 0 0	23 4 0	2
Roxburgh	13	30 0 0	5 0 0	11 13 0	..
Black's	7	..	..	12 7 0	..
Clyde and Alexandra	30	23 0 0	5 0 0	49 1 0	..
Waikaia	9	60 0 0	..	17 15 6	..
Orepuki and Longwood	24	69 5 0	55 2 6	121 10 0	..
Arrow (Wakatipu Goldfield) ..	8	..	..	35 10 0	..
Queenstown	17	7 10 0	7 10 0	11 11 0	..
Mount Ida	40	316 0 0	151 8 6	76 15 0	4
Maerewhenua	4	30 0 0	15 0 0	1 0 0	..
Wyndham	..	..	..	..	..
Totals	413	2,939 7 7	1,068 19 7	679 11 0	240

No. 16.

RETURN of the NUMBER of MINING LEASES or LICENSES and AGRICULTURAL LEASES in Force on the 31st March, 1893, the EXTENT of GROUND LEASED or held under LICENSE, and RENTAL per ANNUM.

Mining District.	Mining Leases. No.	Mining Leases. Gross Acreage.	Mining Leases. Rental per Annum.	Agricultural Leases. No.	Agricultural Leases. Gross Acreage.	Agricultural Leases. Rental per Annum.
		A. R. P.	£ s. d.		A. R. P.	
AUCKLAND—						
Hauraki North	34	529 2 6	319 3 0	..	..	..
Hauraki South	108	2,066 0 4	1,065 14 0	..	..	..
Te Aroha	5	84 3 12	69 5 0	..	..	..
Puhipuhi	22	599 0 18	300 0 0	..	..	..
Ohinemuri	53	2,058 2 30	974 9 0	35	1,730 0 0	129 16 6
MARLBOROUGH—						
Wairau and Pelorus	15	975 0 0	178 0 0	8	495 0 0	24 15 0
NELSON—						
Collingwood	5	64 2 18	66 0 0	..	..	..
Inangahua	46	639 0 22	670 0 0	1	38 1 25	3 18 0
Charleston	3	19 0 35	20 0 0	2	12 0 31	1 7 6
Ahaura	4	81 0 10	50 0 0	2	149 0 5	15 0 0
Westport	..	..	..	4	282 1 0	30 10 6
Lyell	..	..	..	3	50 1 24	5 2 0
Murchison	..	..	..	..	..	..
Owen's	..	..	..	..	..	..
WESTLAND—						
Jackson's Bay	..	..	..	..	..	..
Okarito	..	..	..	..	..	..
Hokitika and Kanieri	7	277 0 20	146 10 0	6	242 0 3	14 16 0
Kumara	9	164 0 29	124 0 0	..	..	..
Stafford	14	434 0 0	204 0 0	..	..	..
Greymouth	..	..	..	..	..	..
Ross	..	..	..	..	..	..
OTAGO—						
Waikaia	..	..	..	..	..	..
Cromwell	..	..	..	19	2,397 0 0	299 12 6
Hindon	15	339 0 0	220 10 0	9	435 2 0	23 12 3
Tuapeka	7	136 1 8	68 10 0	..	..	..
Black's	13	302 0 0	184 5 0	1	31 0 0	3 17 6
Clyde and Alexandra	12	416 0 0	215 5 0	5	841 2 0	105 10 0
Roxburgh	31	1,106 0 0	531 10 0	2	420 0 0	52 10 0
Naseby	49	1,073 0 0	456 0 0	41	2,316 0 0	186 17 6
Arrow (Wakatipu Goldfield)	..	..	..	3	166 0 24	20 17 6
Queensland	..	..	..	18	392 1 2	30 16 0
Maerewhenua	..	..	..	21	434 0 0	42 1 0
Tapanui	..	..	..	..	..	..
Totals	452	11,365 0 32	5,863 2 0	180	10,432 2 34	990 19 9

H. J. H. ELLIOTT,
Under-Secretary for Mines.

COAL-MINES REPORTS.

APPENDIX III.

No. 1.

Mr. G. WILSON, Inspector of Mines, to the UNDER-SECRETARY of MINES, Wellington.

SIR,— Inspector of Mines Office, Thames, 19th May, 1893.

I have the honour to transmit to the Hon. the Minister of Mines the following report on coal-mines in the Auckland District, made in compliance with section 67 of "The Coal Mines Act, 1891":—

KAWAKAWA DISTRICT.

1—*Kawakawa Mine.*—The workings in this mine at the time of my last visit consisted in driving a new incline to work the coal left in that part of the mine where the earliest work was done. The pillars are being drawn, and all coal removed down to water-level, and it is not likely that any further attempt will be made by the Bay of Islands Company to pump out water. Great care is exercised in taking out the old pillars, and a large quantity of timber is used. The provisions of the Act are complied with.

The output of coal for the year was 15,426 tons.

Sixteen men on surface and 32 men below were employed.

The area of pillars to be removed is of very limited extent, and the staff of men cannot be employed much longer.

HIKURANGI DISTRICT.

2—*West Bryen's Mine.*—The output of coal for the year was 3,089 tons. The workings are safe, the roof stands well, the places being from 7 to 8ft. wide, and the thickness worked from 5 to 7ft.

This mine, with others, can be made to furnish a large output when the Kamo to Hikurangi railway is opened.

Four men were employed.

There are several owners of land in this district who intend to amalgamate their interests, and form a strong company to work the coal.

Mr. Moody, the manager of the Kawakawa Mine, informs me that a new mine will be opened when the railway is within three months of completion.

WHANGAREI DISTRICT.

3—*Kamo Mine.*—The new incline driven through the creep which occurred last year, was completed, and ventilation again secured. The intake air-way was carried through a portion of the workings that had been crushed, and the consequence was that combustion ensued in the intake. A new air-way was then driven through sound ground, and all places carefully stopped up. Later on, the return air-way, which is down the incline, shewed signs of heating, and this is now being lined with clay stoppings in every opening and crevice in the timbering. The whole of the return air-way will require stopping in this manner. There will still be a danger of combustion taking place, especially in the return, where all the pillar coal has been crushed. Since the new intake was driven, there is not much danger of combustion arising there; it would more likely be in the return where it would shew.

The mine is carefully worked, and the provisions of the Act complied with. Examination of the workings is frequently made, and there does not appear to be any extra danger even should fire break out, as it would give sufficient warning to enable men to get out by the intake. There is, however, always a danger of the fire breaking out and causing the mine to be abandoned.

The ventilation is sometimes rather sluggish, and should be aided in some manner by exhaust-fan, or steam-jet, to cause up-draught in the air-shaft.

The output of coal for the year was 9,924 tons. Twelve men were employed on the surface, and 32 below.

NGUNGURU DISTRICT.

4—*Kiripaka Mine.*—A considerable amount of work has been done in the preparation to open this new coal-mine. The mine is situated near the Ngunguru River. A self-acting tramway, about 10 chains in length, and a horse tramway, 1½ miles, being made from the mine to deep water, where hoppers are to be erected. The hoppers will be 5 miles from the Heads, and vessels drawing 6ft. of water can come up to them.

The seam of coal crops out, and can be worked water free; its thickness appears to be from 4½ to 6ft. The coal is semi-bituminous, and promises to be of a quality to suit ocean-going vessels.

An average of 20 men were employed on surface-works during the year. Mr. F. Armitage is mine manager.

WAIKATO DISTRICT.

5—*Waikato Mine.*—The workings in this mine have been carefully carried on during the year. The ventilation is sometimes sluggish when a change of wind occurs.

The provisions of the Act are well complied with.

The output for the year was 8,049 tons. Six men on surface and 17 men below were employed.

6—*Ralph's Taupiri Mine.*—The working shaft, 10ft. by 6ft., was sunk to a depth of 185ft. during the year. Very little difficulty was experienced in sinking. A bore-hole was made where the shaft was to be to a heading driven from the first shaft, the water drained down the bore-hole, and was pumped up the shaft, which is now used for a pumping and air-shaft.

The coal seam is of great thickness, the bords are about 17ft. high, and the coal is strong and hard, standing well.

An incline from the bottom of the shaft is being driven under the Waikato River in the direction of a large coal area on the western side of that river. A strong cover to the coal was found in a bore-hole on the west side, and as there is good cover where the shaft is situated, the heading may be deemed secure, if it is driven on the bottom, as a great thickness of coal will form the roof.

The ventilation is very good. The provisions of the Act are complied with.

The output for the year wat 8,410 tons. Six men were employed above and 14 below ground.

7—*Taupiri Extended.*—This mine has been steadily worked during the year. The ventilation is good; a powerful exhaust fan is fixed at the surface of the upcast shaft. The workings appear safe; a cover of not less than 4ft. of coal is left on the roof.

The provisions of the Act are complied with.

The output for the year was 28,212 tons. Eleven men were employed on surface and 54 underground.

8—*Taupiri Reserve.*—This mine has been steadily worked during the year. The ventilation is good. The provisions of the Act are complied with, and every care exercised. Twelve men were employed on the surface and 33 below ground.

The output for the year was 13,223 tons.

9—*Miranda Mine.*—This mine is still shut down.

10—*Mokau Company's Mine.*—(Joseph Lobb, Mine Manager): This mine is situated on the right bank of the Mokau River, and about 20 miles from the Heads. The coal is worked from an adit, and rises about 1 in 24. The seams, which are each about 3ft. 6in. in thickness, with a stone parting from 6in. to 4ft. in thickness, are both worked. The method of opening the bords from the heading tends to having too much open roof. This has been supported by substantial props, but if a land-weight pressure takes place, it is doubtful if props and the narrow pillars left would be sufficient to keep the roads open.

The bords are from 16ft. to 18ft. in width, and the pillars from 10ft. to 12ft. in the average width.

The Manager intends in future to open the bords in the usual manner adopted in other mines, by a narrow entrance, and gradually increasing the width until it reaches the required measurement. The bords are to be from 14ft. to 16ft. in width, and the pillars not less than 21ft.

The output for the year was 1,823 tons. An average of four men were employed. At the time of my visit, on the 10th inst., three men only were employed, as at this season the coal could not be taken away, on account of the uncertainty of vessels getting in or out of the river, which has a bar at the entrance. I examined the books of the Mokau Coal Company, the owners of the mine, and found that since the beginning of October, 1891, 2,538 tons of coal had been sold, but the contribution of 1s. 4d. per ton had not been paid. The Manager at once paid the sum of £2 12s. 11d. into the Post Office at New Plymouth on account of the Sick and Accident Fund, being the amount due up to 31st March, 1893.

The Co-operative Mine has not been worked during the past 18 months, and no information about previous work could be obtained, nor if any coal was sold during the last quarter of 1891.

From what could be learned, there appears to be a considerable area of coal on the Mokau. A seam 6ft. in thickness was worked several years ago at Stockman's Mine, which is about 2 miles further up the river, on the same side as the Mokau Mine. The Co-operative Company worked on a seam known as the Auckland, about a mile further up than the Mokau, but on the opposite side of the river. An out-crop of coal has also been discovered at Mangapuhoe Creek, about 3 miles further up than the Auckland seam.

The Mokau Coal Company have not been energetic in working their mine, chiefly on account of want of capital, but efforts are now being made to increase the number of shares and raise fresh capital. There is very little doubt that if the coal could be conveyed in suitable vessels, and a depôt made at Waitara and at New Plymouth, so that a stock of coal would always be available, there would be an increased demand for this coal, which is a superior quality of brown coal, and suitable both for household and steam purposes.

Accidents.

No very serious accidents occurred during the year. The list of accidents reported are as follows:—

Benjamin Housley got accidentally struck by a pick on 18th January, 1892, in the Taupiri Reserve Mine.

Alexander Buchanan was slightly injured by a skip falling against him on 22nd January, 1892, in the Kawa Kawa Mine.

William Patterson was injured by a rail bouncing up and striking him on the foot on 16th May, 1892, in the Taupiri Reserve Mine.

F. Fisher was injured by getting jammed between a skip and prop on 11th July, 1892, in the Waikato Mine.

Albert Tee got a blow on the eye from a piece of coal on the 15th August in the Taupiri Extended Mine.

James Sellick had his ribs hurt and leg badly bruised by a fall of stone from roof on 3rd of November in the Kawakawa.

E. W. Coxon got accidentally scorched at the engine furnace on 14th November at the Taupiri Extended Mine.

C. J. Minnett was lifting a truck and wrenched his shoulder on 22nd November on the surface at the Taupiri Extended Mine.

J. R. Kitchin sprained his back in lifting a heavy rail on the 23rd November on the surface at the Kiripaka Mine.

Remarks.

The output from the Northern districts was 16,313 tons less than last year. This may be accounted

for by the limited quantity of coal at the Kawakawa Mine, and the time lost in raising coal at Kamo, on account of the creep and fire.

The output for the Waikato District shows an increase of 2,144 tons, compared with the return for last year. The difficulty of obtaining coal from Kawakawa tended to increase the sale of Waikato coal.

In Waikato District the demand for coal is not sufficient to admit of four mines being profitably worked, and steps are being taken so that some of them will be closed down.

Upon the completion of the Kamo to Hikurangi Railway, the Hikurangi mines can yield a large supply, and the Kiripaka Mine promises to add to the output during 1893, so that even when the supply from Kawakawa gets exhausted the returns will be kept up.

The coal discovered at Waitakururu has not been worked. A small shaft, about 70ft. in depth, was sunk in January, 1892, and two seams found, the upper about 10ft. and the lower 13ft. in thickness, but nothing further has been done.

The payments have been made to the Sick and Accident Fund by the owners of all the mines in Auckland District.

I have, &c.,

GEO. WILSON,

Inspector of Mines.

The Under-Secretary, Mines Department, Wellington.

No. 2.

Mr. N. D. COCHRANE, Inspector of Mines, to the UNDER-SECRETARY of MINES, Wellington.

SIR,— Inspector of Mines Office, Westport, 31st March, 1893.

I have the honour, in compliance with section 67 of "The Coal Mines Act, 1891," to report as follows for the information of the Hon. Minister of Mines, and to enclose list of the serious accidents, statement of the Sick and Accident Relief Funds, and table of statistics for the West Coast Coal Mines:—

11—*Wallsend Colliery, Collingwood.*—(13/12/92): This mine has been troubled with extra water during the year. Apparently, the cracks caused by working out the coal do not fully choke or silt up, leaving an increased quantity of water to be dealt with. This was restricting the operations at the time of my inspection. The dip face was under water, but to the north of this two faces were working in the upper division of the lower seam. The air here was fresh; plenty of props were used, and cribs where required. In the upper seam two shifts of two men each were cross-cutting from the upper to the lower band of coal, which is expected to be found three feet thick. The roof on the road into this section was cracked and shaken; but all loose pieces had been taken down, and the timber renewed where any sign of weakness had shown. Report kept up to date. Plan behind through some of the faces being under water. The air in the aggregate was well above requirements. The necessary general and special rules, with names, which were illegible last year, and which I had some trouble in getting Mr. Burford, the agent, to obtain, were now posted in case at mine mouth.

12—*Takaka Coal-mines.*—(15/12/92): These small mines have ceased working. Had the coal been bituminous this would no doubt have been averted.

13—*Mokihinui Colliery.*—(20/4/92): Eighteen men in all were employed. Another fault, with 33ft. of throw had been met and cut; beyond this the air was dull, as the connection had not been made, so I notified the manager that it must be hastened on. Shortly after I was informed that the drive to connect with the other workings had holed through. (12/2/92): Only four men working in each shift—eight in all. One place was driving through stone; in the other the coal was soft and the roof close lathed; the coal-field, as usual, being somewhat broken. The air was led in in boxes, which supplied a fair current. General and special rules, with names, posted at mine mouth. Report kept, and plan always well forward. Towards the end of the year work had practically stopped, pending arrangements about the Company's railway, which at date of writing is being made fit for heavy traffic.

14—*Ngakawau Coal-mine.*—Nothing has been done at this mine during the year, and it is now abandoned. The other operations of the Westport Wallsend Company will be referred to further on.

15—*Coalbrookdale Colliery.*—(11/2/92): Air, dull in some of the faces. Spragging requiring to be more generally attended to. The roof in the lower seam is at places coal; but where the seam is so thin that all the coal is taken out there is a stratum of shale exposed, which stands badly. In the section known as the "top end" the air is better, and more sprags used. In June I measured for Coalbrookdale Section 17,340 cubic feet of air per minute to supply a total of 60 men per shift. This shows an ample margin in the total, but in some of the advanced places the air is rather dull. Two adjoining sections, the Top End and Muncey's Creek, employing 26 and eight men respectively, are ventilated separately from the foregoing.

Ironbridge Section.—(10/2/92): Eighteen fast places going, employing 38 men, and seven more engaged at pillar work. Roof taking a lot of timber. Ventilation, chiefly natural; air at one or two of the faces rather dull. In June, I found a very good current of air circulating at the blind shaft, and a total of 45 miners working. I again inspected this section in September. Taken right through the roof is fair, though at one or two places the band of shale which divides the seam and forms the roof of the lower part is very soft. Owing to the work going on at Granity Creek, Mr. Brown is really general manager and Mr. Cameron has been appointed mine manager. The report-books are always duly kept, and the rules, with names, are properly posted; but the plans throughout have been behind. I have not pressed as to this, owing to Mr. Young being frequently at Granity Creek; but it cannot be allowed to continue.

The road to Coalbrookdale, the want of which I referred to in last year's report, has now been constructed, so that there is now no excuse for persons walking on the engine-plane.

16—*Granity Creek Tunnel.*—(13/9/92): This was in about 500ft., air being led in in 4- and 2-inch pipes. Drew Mr. Anderson's attention to detonators on roadside. This tunnel has since been put through, and work is going on further up the incline. An alteration has been made in the plans, which is a decided improvement.

17—*Waimangaroa Coal-mine.*—(30/5/92): Not working at this date. Some of the timbering in Nos. 4 and 5 levels requiring renewal. This is to be attended to. Air not too strong, but no fire-damp showing in indicator. Plan behind. Reports kept. This and the Wellington Mine have ceased working for some time, owing, I am told, to being unable to dispose of their coal, which is of a very soft nature, only suitable for coke making.

18—*Wellington Coal-mine.*—(30/5/92): Only two miners working, and they have since been stopped. I went round the air course, which, although low and narrow at one place, is sufficient as a second outlet.

19—*Whitecliff's Coal-mine.*—(26/1/92): Only a short drive in coal from an out-crop on the side of the Buller River. Thickness worked, 7ft., with coal roof and pavement. No one about, and since abandoned, as the Dredging Company who owned it have gone into liquidation.

20—*Powell's Coal-mine, Charleston.*—(20/12/92): This small mine was inspected on account of an accident to the owner, Thomas Powell. It is worked open-cast, and he had been working at an overhanging face, when a fall came away, which partly covered him. Although there were no marks of serious injuries, he died that night. He was an old man, and no inquest was deemed necessary by the doctor, who certified to death from collapse.

21—*Waitekere Coal-mine, Charleston.*—(20/12/92): This mine, like the foregoing, although not previously inspected, has been worked for about 20 years. At present it is only occasionally that anything is done—when the owner, Mr. Flynn, can find orders for the coal. The thickness is about 14ft., and it is also worked open-cast, but in a safe and workmanlike manner.

22—*Murray Creek Coal-mine.*—(8/3/92): Mr. Sara and a youth working at the top of the jig as formerly. Report kept. No plan, but one has since been sent me. This mine has been stopped subsequently, on account of dull trade.

23—*Golden Treasure Coal-mine.*—(8/3/92): Not working. (10/10/92): Mr. Rear only working, taking out head coal. Safety-lamp not used, but will be in future. Air good, with different outlets. No plan, but one has since been forwarded to me.

24—*Inkermann Coal-mine* has not been working on any of the occasions I have passed it. Mr. Wise states that nothing has been done during the second half of the year, and that it has been sold to Mr. Mills, of Greymouth.

25—*Lankey's Gully Coal-mine.*—(6/10/92): This mine was stopped for some time in the beginning of the year, but has now resumed work. Mr. Lamberton is mining in the new drive, where the coal is of rather better quality, but has thinned down to 4ft. 6in. in thickness. Roof bad, but workings kept narrow accordingly. Air all right. Safety-lamp not at mine, but it is to be used in future.

26—*Phœnix Coal-mine.*—(8/3/92): Timbering spoken about at last visit has been attended to. A survey has been made, but is not yet plotted. A copy of the plan has since been sent me. (18/10/92): Mr. Fox working by himself. Air sufficient. Coal roof. Act not at mine. Does not use safety-lamp, but will do so.

27—*Inglewood Coal-mine.*—This mine is not working now, as the mine mouth has been allowed to cave in, through too much coal being taken out.

28—*Murray Creek No. 2 Coal-mine.*—(8/3/92): No one about. Only a short drive in rather soft coal. Since abandoned.

29—*Progress Coal-mine.*—(9/3/92): Radcliff working alone in another drive in very much better condition than the old one. Air good, and second outlet. No Act, but one to be got. (29/9/92): Old mine abandoned, but a new drive opened up. The coal at first was only 2ft. thick, but has increased to 6ft. 6in. New staging has been erected, which certainly was needed. Marsant safety-lamp used in examining mine. Roof still bad, but plenty of timber. A second outlet has also been made at this mine, providing good air. I considered it desirable to have a plan made of the workings of this mine, and this has been done, which shows that they are outside the lease.

30—*Supreme Coal-mine.*—(30/9/92): This is only a short drive from an out-crop to supply coal to the battery of the Supreme Quartz-mine, so that very little work is done, although it is some 17 or 18 years since it was first opened. Roof bad, and requiring a little more timber, which Mr. Waylen will put in. This mine has since been abandoned, as the quartz from the Supreme reef has been found unpayable.

31—*Sir Francis Drake Coal-mine.*—(6/10/92): No work had been done for two months, but I went through the mine. Timber and air right. No safety-lamp nor Act. The open-cast work has ceased, as the dip of the seam entailed too much stripping.

32—*Devil's Creek Coal-mine.*—(9/3/92): A new drive is being put in, and is only down a short way. (19/8/92): An attempt is being made to find a payable seam on the east side of the road, where a prospecting drive is being put in. On the west side only a little coal is being taken out from the outcrop of the seam above the water-level.

33—*Inangahua Coal-mine.*—(9/3/92): An air-shaft has been sunk since my last visit, 40ft. in depth, to the bottom of the seam. This was uncovered, but will be seen to. (19/8/92): Very little coal being sold, as the quality is inferior. Air good. Drainage free. A boy 12 years of age, son of the proprietor, was driving a horse on the surface. Mr. Rutherford stated he was only on for a day or two, and was not employed at the mine. I requested him to get him sent away, and this he agreed to do.

34—*Cumberland Coal-mine.*—(30/9/92): Only one man working in a short drive with second outlet. Roof good, except at mine-mouth, to which I directed attention. Air good. Plenty of timber. No copy of Act, and no safety lamp. Although 11ft. of coal is taken out, Mr. Adams, who has been a quartz-miner, does not use sprags, and had never heard of them before. This and the other requirements he promised to attend to. I also notified the legal manager as to these.

35—*Reefton Coal-mine.*—(7/10/92): Two men on contract are extending an old level, which was driven some years ago. This is practically a prospecting drive, as the coal is only 1ft. 9in. thick. No safety lamp, but one will be procured. Air good, as a second level is driven for ventilation.

36—*Coghlan's Coal-mine.*—(6/4/92): Very little doing. No copy of Act, but will obtain one. Air good. When visited in October, no one was about.

37—*Burke's Creek Coal-mine* has been abandoned.

38—*Archer's Coal-mine.*—(4/10/92): This is a small mine, which has been opened nearer Capleston than Burke's Creek mine. It is a short dip-drive, with levels broken off. The seam is highly inclined, a thickness of 10ft. of coal is worked, and the slack is used as stowing. No sprags, but these will be used in future. No copy of Act.

39—*Stillwater Lease* has been abandoned.

40—*Blackball Coal-mine.*—No work has been done at this mine during the year, but a contract has been let for the erection of an aërial tram to convey the coal from the mine across the Grey River to the railway, some three miles distant. This should enable this colliery to appear as a producer towards the end of the year, and to take the place which the rapid exhaustion of Coalpitheath will leave. Whether the aërial tramway will afford a cheap enough means of transit in the circumstances, remains to be proved.

41—*Brunner Colliery.*—(2/5/92): The dip-drive referred to in last year's report, from which it was intended to work the remaining portion of the solid coal within the fault-lines, had been extended for some 25 chains, and here a thinning of the coal to 2ft. had occurred. As this appears to be a continuation of the line of thinning met with some years ago, to the extreme north-west of the workings, it decreases the area of workable coal within the faults, and means that, unless new areas are prospected, this mine will soon be worked out. Air good. Gas seen in one place. I drew Mr. Hodgson's attention to one place that should have been spragged. I found at my next visit that he had laid an information and secured convictions against three of the miners for not spragging, as required by the Act. In June, I found 49 miners working, of whom only two were at pillar work, as all the rest of the available pillars had been taken out. (20/10/92): The water in the dip had proved too heavy for hauling in chests, and pipes were being put down.

Reports duly kept. Rules and names posted.

The North Brunner or St. Kilda section, to which a tramway was laid, and at which a few faces were opened up, was stopped again, on account of the poor quality of the coal.

42—*Coalpitheath Colliery.*—(2/5/92): Lowest level drowned out by heavy water, occasioned through pillar-workings letting in surface drainage. New 9in. pipes being put in. Fifty-two men per shift working at pillars in mid- and upper-levels. This mine was also inspected in June. (20/10/92): The bottom-level is again drowned out, and during the preceding shift the water had gained 2½in., but it is expected to be drained off shortly, if fine weather continues.

Powder-smoke hanging rather badly in one place, but good current in aggregate. Some steam also escaping from a bad joint in the pipes, but this is to be attended to immediately. On my directing attention at different times to where extra timbering has been desirable, it has been put in hand at once.

A fire broke out on the afternoon of the 2nd November at the bottom of the old shaft, which is now used only for pumping. The Greymouth Fire Brigade lent valuable assistance, and it was extinguished by next morning. The origin is unknown. The miners were never in any danger, as a separate outlet exists.

The workings during the year have been, as formerly, confined to taking out pillars; these are getting rapidly exhausted, and the extra water will compel a greater number to be left along the side of the dip, and may occasion the loss of some in the lowest level. This cannot be avoided, as it would not do to imperil the safety of the men, but it will probably shorten the duration of work in the mine, which will be pretty well exhausted this year. As already reported to you, prospecting works are contemplated in other areas, outside the fault-lines, but within the lease. These should have been put in hand ere this.

Coal Seams on Fire.

43—*Waitahu River Seam.*—(19/8/92): The position of this is a few miles out of Reefton, and it was inspected to see what could be done to put it out. No water is available at any reasonable outlay, and even if it were it would not extinguish the fire, owing to how the dip of the seam runs. I accordingly recommended the filling-in of the vents, with the view of restricting the spread of the fire, but not with the idea of putting it out, as the ground below the main fissure is much too broken. This has since been done at a cost of £20. I have not re-visited it since the completion of the work, but I am informed it has been of good effect in checking the fire in the seam. The loose coal in the large slips is being allowed to burn slowly away; but it was worthless in any case.

Ten-mile Seam, Greymouth.—(30/7/92): This seam has burned along the out-crop for a great distance, but does not seem to find sufficient air to carry it far in from the face of the cliff along which it extends. It appears to have burned further in at the present position, owing to a vent it has found to the surface. Accordingly I recommended an expenditure of £30 for filling in, no water being available at moderate cost, nor likely to be of use, on account of the cliff allowing free exit, as there was good prospects of extinguishing the fire in its weak condition; but authority for this expenditure has not yet been granted, pending the result of the filling-in at Waitahu River. There is, however, much greater likelihood of extinguishing this fire by filling-in than the latter; in fact, if the cliff did not keep falling away, it would burn itself out.

Devil's Creek Seam.—The fire in this seam, which was referred to in last year's report, has evidently died out; the filling-in of the openings, which I recommended, appears to have choked its supply of air.

Coal Leases Applied For.

44—*Mokihinui Coal Company's New Area.*—(21/4/92): This consists of 960 acres adjoining the present works. Much of it is flat bush land, in which boring or sinking will be needed to determine whether it is coal-bearing or not. Granite appears at various places along the boundary lines, showing that the field will be more or less broken. Marls show over a large part of the area, from which it is to be inferred that coal underlies; but it does not follow, even if they are conformable to or part of the coal series, that the coal is continuous underneath.

45—*Bayfield's Area.*—(22/4/92): This comprises 1,800 acres. The block to the east of Chasm Creek is not satisfactorily proved, although a number of cuts have been made into outcrops. This part of the field should be very easily prospected, and should cost very little for opening up.

The conglomerate which underlies the coal crops out a few chains to the north of No. 6 outcrop, so that the coal is probably absent there; and as that outcrop shows only from 2ft. to 6ft. of coal, the thick seam may have thinned down.

At date of writing a satisfactory start has been made by the new company, some £500 having been expended, chiefly in surface works, which are being pushed on.

46—*Patten's Creek Company* claimed part of the area included in Bayfield's application. However the difference came about, it was clear at the date of my report that it could not be entertained. Further, I therein point out that there is land adjoining their area much more valuable to them than the rather inaccessible area of Bayfield's to which they laid claim.

47—*Westport-Wallsend Company's New Area.*—(16/5/92): Lies behind or to the east of the Granity Creek lease. Numbers of outcrops occur, but it has not been satisfactorily settled whether the thick seam underlies throughout most of the area or not. This can be easily done if bores are put down at the proper places. The strata are gently inclined, with the dip in favour of the haulage. Ventilation will be easy, and the pumping next to nil. The one great drawback is the position, which is three or four miles from the railway, and at an elevation of over 2,000ft. Some prospecting has been done, and a line for an incline tramway fixed on. At date of writing, this company intend to liquidate. To quote from my report: "Each of these three applications will have special natural difficulties to contend with, apart from the question of a market for the coal; and but for these various drawbacks, the areas would be too large, and would probably ultimately develop into what, with other large areas, would be looked on as a monopoly in a colony with such comparatively small resources in bituminous coal as New Zealand. Taking them as they are, they deserve every consideration, provided they work the fields themselves, and do not make use of favourable terms for speculative purposes."

Sick and Accident Relief Fund.

I have examined the books of all the larger mines, and noted that payments corresponded with the tonnage sold. All the mines have paid their contributions except the Waimangaroa Coal Company, against which proceedings have been taken for recovery of the amount due, £7 0s. 7d., but without result; and Coghlan's Mine, Boatman's, is also due a contribution, but of trifling amount. No payment is due from the Mokihinui Mine, as there have been no sales, all the coal put out having been stored at the mine. The following table shows the state of the funds in the different districts:—

Name of District or Mine.	Contributions paid in.	Amount paid in relief.	Balance at 31st Dec., 1892.
	£ s. d.	£ s. d.	£ s. d.
Coalpitheath and Brunner	371 15 2	282 3 4	89 11 10
Coalbrookdale	180 4 3*	..	180 4 3
	212 11 0	86 13 4	125 17 8
Waimangaroa	0 4 11*	..	0 4 11
Collingwood	5 3 4*	..	5 3 4
Boatman's (3)	0 11 9*	..	0 11 9
Reefton (6)	6 9 10*	..	6 9 10
	£777 0 3	£368 16 8	£408 3 7

* These amounts have been paid to the Public Trustee.

Associations, as required for the disbursement of relief, have only been formed at the Brunner and Coalbrookdale Mines. Notices of accidents and of amounts of intended withdrawals have been duly sent me. I have checked the books of the Associations and found them correct, and that there was a doctor's certificate for each case relieved.

The Association at Brunnerton was rapidly formed and got into working order. Mr. John Coulthard, the secretary, is a working coal-miner, and keeps the books and sends out the notices in a praiseworthy manner. Most of the accidents relieved have been of a slight character, among others bruised fingers and thumbs, dirt in the eyes, and falls on flatshuts occupying a prominent place.

The large number of these, 25, during the first quarter, made me go into the matter with the secretary, who informed me that this was little more than the average for the previous four years, as shown by the books of the Private or Doctor's Association, of which he is also secretary.

The amended Regulations of November last have had a salutary effect, as applications for relief have considerably decreased in number. In these the amount of relief is reduced from £1 to 10s. weekly. This will probably have the effect of building up a substantial fund, which will be available if any coal-mining disaster should occur.

The Coalbrookdale Association was not got into working order till about July. Frequent reminders to Mr. A. G. Wright, the then secretary, had no effect. The result of this was that the first two payments by the Westport Coal Company were placed to the credit of the Public Trustee's Fund. As the committee are still enquiring after this amount, it will doubtless stimulate them to do things in a businesslike style for the future.

The books were badly kept. Two other secretaries were tried with no better results; but recently Mr. J. M. McCubbin has been appointed, who has got things into proper working order.

A payment of £25 has also been made to the widow of Mr. John Young, who had been employed as a miner in the Mokihinui Mine, and who fell when carrying a rail, receiving injuries which were considered slight at the time. Some months afterwards paralysis set in, resulting in his death. This

payment could not have been legally enforced, but it was right that it should be made, and entirely in consonance with the spirit which has instituted this fund with its admirable purposes.

List of Serious accidents.

1—On the 20th January, in the Coalpitheath Mine, a miner named Benjamin Newman had one of his legs broken by a piece of coal coming away from the side of the bord he was working in.

2—On the 14th March a miner named Richard Polkinghorn was bruised and cut by a fall of coal in Coalpitheath Mine.

3—On the 7th April, in Coalbrookdale Mine, a miner named Alexander Senior, on hearing a slight explosion, returned to a shot which he had fired, and which then went off, blowing the tamping into his face and eyes.

4—On the 20th May, in Coalpitheath Mine, a miner named Matthew Swinburn had his leg hurt by a piece of coal striking it.

5—On the 9th December a miner named Thomas Powell was partially buried by a fall of coal in his mine at Charleston. He was not thought to be badly hurt at the time, but he died that night.

Remarks on Accidents.

The accident to Matthew Swinburn was not considered severe at the time, but he started working too soon, and his knee has never been right since. He is still on the Relief Fund.

General.

Some of my time has also been taken up with setting the questions for the Colliery Managers' examinations, and in attendance at the Assessment Courts at Westport and Greymouth, in regard to the valuation of mining properties. Two other matters require mention, both in regard to the Coalbrookdale mines:—(1) A difference having arisen between the manager and some of the men, the latter were discharged. They then made various complaints, chiefly as to the administration of the Doctor's Fund, the employment of unskilled miners, and the timbering. Mention was also made of poor air, and that a greater number of deputies should be employed.

I carefully investigated into all these charges, and I found the complainants moderate and reasonable men, although their complaints were at first wildly made. The administration of the Doctor's Fund, which gave the chief offence, is entirely a private matter. The man who wanted more deputies employed worked in the Ironbridge Section, where five such are employed to look after 43 miners. This is far above the average. As to the air, there is some ground for complaint, but so far there has been no occasion to prosecute.

Mr. Brown informs me that he is arranging to get a couple of fans. These should provide excellent air throughout, and bring the ventilation into line with the other arrangements at these collieries. Timbering, at my frequent visits, is abundant.

(2) An accident happened to Alexander Senior through returning to his place on hearing a report from a shot which he had fired, and a second or principal explosion then occurring. As this was the second case of the kind, I notified Mr. Brown that loose powder must be done away with and only cartridges used. Mr. Brown agreed to this, after we had gone into the question at length, without going to arbitration, which he had a right to do if he thought fit. At subsequent visits I have observed that this rule has been carried out genuinely.

I have, &c.,

N. D. Cochrane,

The Under-Secretary Mines Department, Wellington. Inspector of Mines.

No. 3.

Mr. J. Gow, Inspector of Mines, to the Under-Secretary of Mines, Wellington.

Sir,— Dunedin, 2nd May, 1893.

I have the honour, in compliance with section 67 of "The Coal Mines Act, 1891," to make the following report for the information of the Hon. the Minister of Mines.

The Canterbury coal-mines have not been visited by me since March, 1892, but my observations noted then were included in my last annual report. My present report, therefore, starts at the:—

Oamaru District.

48—*Ngapara Ngapara.*—(4/8/92): I carefully examined the adit timbers, there being a considerable length of it, and found it in a safe condition. I found the air current very strong.

49—*Roseburry, Otopopo.*—(4/8/92): I had to speak to Mr. Love about not having complied with the Act, and on learning that he had not yet seen it, I sold him a copy, and pointed out some of the clauses I wished him to read carefully. The mine is dry, and has a good roof.

50—*Early Bank, Herbert.*—(4/8/92): William Frame is the owner of this mine, but as he knows nothing about mining, he left that work to others, who opened the pit by sinking a shaft and driving a dip-tunnel. The tunnel is on too steep a gradient and too small to be of any use, and the shaft is too small to conveniently admit of any quantity of coal being hoisted up it with safety. It will, however, make a good air-shaft. Mr. John Willitts, of the old Prince Alfred Mine, Papakaio, has quite lately leased Frame's mine for a number of years, and is at the present time making a new dip-drive at an easy gradient, and large enough for a horse to work in and haul the coal-tubs to the surface, and a tramway, thence to a bin to be constructed at a suitable site for drays to be loaded. The mine should soon be in working order. I had to speak to Mr. Frame about the Coal Mines Act, of which he appeared to know nothing. I sold him a copy, and requested him to read it carefully.

51—*Shag Point Coal-mine.*—(5/8/92): The shaft has been sunk to 350ft., and is now about 14ft. from coal. The sinking stopped about two weeks ago, as it was found impossible to proceed speedily

with it until larger pumps were procured. In the meantime, one of the old air-shafts north of the engine-shaft is being fitted up, and will be used as a winding-shaft for a while. It is intended to work a third seam here till the main shaft is completed to the new seam, and room made for the regular shifts of men. A small and handy engine is being fixed in position to do the winding. The old workings south of the main shaft and near to the Boat Harbour are abandoned. There is no coal-hewing in the mine at present, and therefore all the miners are idle. (4/10/92): I found some of the men engaged sinking the shaft, which was down 354ft. and on coal—supposed to be the 5ft. seam bored through some years ago. It is intended to continue the sinking another 25ft., and then bore to the next seam, in order to ascertain its thickness. The pump is lifting 200 gallons per minute. The old upcast shaft is now supplying all the coal required by the pumping and winding engine, but in consequence of the thinness of the seam (2ft. 3in.), there are five men getting coal. The manager hopes to have the mine in full swing early in 1893.

52—*Allandale Coal-mine.*—(4/10/92): Most of the miners are working on the dip side of the incline in a good quality of coal, which is about 8ft. thick in places. A stone drive is being put in to get to a seam known to exist below the present workings, and believed to be a continuation of a 5ft. seam worked in the old pit some years ago. I examined all the working places and found good air throughout the mine. Since my previous visit the railway-line from Bushy Station to near the pit has been completed. The coal is now passed over large screens into the railway waggons, ready for the market.

CENTRAL OTAGO.

53—*Kyeburn Coal-mine.*—(14/11/92): The output of coal from this mine is small compared with that of a few years ago. The coal is now being stoped back towards the mouth of the adit. I am informed there is not much more coal to be got between this level and the surface. The seam stands nearly vertical. Mr. Crudy intends shortly to drive a new adit to a central part of the mine, which is south of the present workings.

54—*Kyeburn Coal-mine, Commercial.*—(14/11/92): Archer is again hewing coal in his adit-mine, and is stoping back towards the mine mouth. A block 120ft. long by 16ft. deep is now being operated on, and is the last of the coal between this adit level and the surface. A new tunnel at near the level of the Kyeburn Creek is now being driven; 100ft. are now done, leaving about 120ft. still to do to reach the coal. From this level to the floor of the old workings there is a large quantity of coal, which will yield a considerable output for some years. The mine is in good order, and air good. The mine on the flat or terrace by the side of the Kyeburn Creek is not being worked at present.

55—*Hill's Creek Mine.*—(10/11/92): This is an open pit, and is somewhat out of the line of coal-pits in the Mount Ida district. The coal is about 20ft. thick, of which there is from one to three feet of the seam said to contain a considerable percentage of kerosene. Its colour is a little browner than that at Cambrian's. The stripping is from six to ten feet, and the coal dips slightly to the east. The stripping will gradually be getting deeper as the work proceeds.

56—*Ida Valley Coal-mine.*—(10/11/92): This 30ft. seam is nearly flat, and has three thin seams of kerosene shale through it. The stripping is from 8ft. to 10ft. of good standing ground. The pit makes a little water, which is lifted by a horse-whip.

57—*Idaburn Rough Ridge.*—(10/11/92): This mine is close to Beck and McLean's, and in which the seam is also nearly flat. The stripping is about an even 6ft. all round the pit, probably 10 chains round. A large body of water was tapped in this mine in January last, which the windmill was totally unable to cope with, consequently the mine was flooded for about three months. It was then seen that something more powerful, and a larger pump would have to be procured, in order to get out coal in a reasonable time. A steam boiler and pulsometer pump was purchased, at a cost of £110, and fixed in position as early as possible, which took out all the water in three weeks, and now does the work in three hours in the 24. The intention is now to take out all the coal to the floor of the seam.

58—*Border Colliery-mine.*—(10/11/92): This is an open cast about two chains in length. The output for the year is small, in consequence of the mine having been flooded in February last. The bank of the creek caved in and filled the pit with gravel.

59—*Blackston Hill-mine.*—(10/11/92): This mine is much the same as it was 12 months ago. I did not find anyone there, and the mine did not appear to have been worked lately.

60—*Cambrian's (J. R. Jones) Mine.*—(5/11/92): The seam of coal in this mine is said to be 30ft. thick, but at present 20ft. only is being taken out, in consequence of the drainage-tunnel and tail-race not being deep enough. It would require a considerable amount of labour to make the tail-race a few feet deeper, and as the seam is dipping very fast it is thought that sooner or later some motive-power will have to be resorted to in order to get to the bottom and follow the seam into the terrace a few feet. The present tunnel-tail-race is 450ft. long, and a horse has to be employed to lift the water a few feet into it. In the coal left under foot there is a splendid seam of from three to four feet of kerosene shale, which will be very valuable some day—when the Central Railway reaches that district. The stripping is from 12 to 14ft., and gradually getting deeper as the work proceeds, and will soon be too deep to pay at the present price—6s. per ton weight. Mr. Jones intends shortly to give underground mining a trial. The dip is west, under a hill.

61—*Cambrian's (Dungey's) Mine.*—(5/11/92): This mine is situated on the crown of a small round hill. The stripping is now 10ft., and the depth of coal is 15ft., of very good quality. The dip is to the east, and although the two pits are only a few yards apart, the kerosene shale does not exist in Dungey's present workings, and there are no indications of it coming in.

62—*Alexandra Mine.*—(25/11/92): Accompanied by Mr. Thompson, I visited all the workings and found them in good order. A large body of coal is left over head, which does not flake or chip anywhere. The workings are dry and clean under foot, and the air is good.

63—*Maqueenville, Alexandra.*—(25/11/92): Visited the mine, but could not find any person there. Went down the shaft, but could not find a lamp or candle. Had to come away without visiting the workings.

64—*Excelsior Coal-mine.*—(15/4/92): This mine was worked by J. Burrows last year, and is now being worked by E. McNalty. The part of the mine being worked at the time of my previous visit

has been abandoned at that level. The seam stands nearly vertical, and a new dip-drive put down to the seam a little south of the original workings. The seam was worked northward, and the full thickness of the coal taken out in a reckless manner, without any timber being used. The consequence was a cave-in of the east side-wall near the end of the workings, which stopped any further work in that quarter. The ownership of the mine then changed hands, and the present owner secured the worst part of the old workings by timbering, and is working the mine in a more careful manner. There is not much more coal to be got above the present level, but a new and short dip-drive, well timbered, is being put down to a level about 25ft. below the present floor, and will soon be on the coal.

65—*Nali Secundus Mine.*—(15/4/92): Mr. Parcell's mine is not working, and, I learn, has not been mined since my previous visit, viz., 4/5/91. The coal, when followed into the terrace, ran out, or is cut off by a fault. It is intended to do some prospecting for the seam at some future time.

66—*Kawarau (Cromwell) Mine.*—(15/4/92): In Mr. Pryde's mine a new dip-drive is being put down about "half on the dip," and having a gradient of 1 in 4½. This dip will be continued a considerable distance—should the seam continue evenly and of the same thickness—to test the value of the mine and extent of coal in that direction. A sufficient depth has been reached to enable the miners to open out to the right and left on coal below the old workings. By the time I again visit the mine sufficient work will have been done to admit of many headings being started on each side of the dip-drive, which will show how the mine can best be ventilated and worked at the low levels. The workings so far are in good order, and appear to be carefully laid out. The upcast at present is into the old workings overhead. The air is good and the drainage light. A horse hauls up the water in a tank.

67—*Bannockburn (Cromwell) Mine.*—(15/4/92): These workings are not many feet above flood-mark of the Kawaru River. I did not find anyone there, but I examined the mine workings. The main drive is very small, going south. In this I found some sets of timber standing minus the caps, and some "caps" (stabs only) were broken. It appears to me there was no need of timber where I found it, if the roof were properly trimmed into shape and watched by the workmen. There is room for only one man at a time in the face. Some of the timber now standing may be removed, as it is doing no good. The output of coal is very small—I think for his own use only.

68—*Gibston Mine, Gibston.*—Cowan's mine is now being worked from a new adit, where a fair-sized block of coal is being taken out. The worked-out ground is being filled with earth from the surface, which is cast down a shaft to the workings. Bags of fine coal are built up one on another in the mine to keep the filling in its place till it takes the weight. The mine is dry, and air good. There were two men in the mine.

69—*Gibston Saddle, Gibston.*—The mouth of the old adit I found more than half blocked up with *debris* from the hillside, where some attempt has been made to sluice the surface off the coal when it crops out on the face of the hill. The old workings are now filled with water to the level of the *debris* at the adit-mouth. It is evidently the intention to strip the surface off the outcrop by sluicing, which, I think, will bare a good many tons of coal. The seam stands nearly vertical.

70—*Jones' (Roxburgh) Mine.*—In this mine there is a large open face of coal of great height, which is hewn down in benches to the standing-water level. No attempt has yet been made to ascertain the depth of coal under foot. I think the proprietor has some idea of either constructing a tunnel drain or getting a small pumping engine to enable him to take out all the coal to the floor. The surface has been sluiced off for some distance back from the face of coal. The output is larger this year than during any previous one, by reason of the mining dredges on the Clutha River, near Roxburgh.

71—*Perseverance, Roxburgh.*—Craig is mining under many difficulties, which, I fear, he cannot get away from. His mine is situated in the bed of Coal Creek, which, at his pit, has a very high terrace on each side. The stripping is a very coarse gravel of considerable depth, and very little room between the terraces to dump it on; so little, indeed, that it appears inevitable he will have to resort to tunnelling it out, which work, I think, cannot be done without timbering, the cost of which at this place may reduce the profit on the coal to a figure that will not pay. If a drain and tunnel be put up to the coal, it would have to be several chains in length, in order to get to the floor of the seam, where it may be more solid than what is now in view. This coal is said to be the best quality at Coal Creek.

72—*Mrs. McPherson's, Roxburgh.*—In this mine there is a considerable body of coal stripped, ready for hewing-out at the shortest notice. I also noticed a large quantity bagged in the pit, ready for carting away. There is now a face of coal several chains in length around the pit, of from 12ft. to 15ft. deep. It is intended in the near future to put in a tunnel-drain from Coal Creek to the pit, at a level that will drain the floor of the seam, the depth of which has not yet been ascertained, but supposed to be about 16ft. This depth of coal all over the open paddock will require some years to remove at the present yearly output.

OTAGO.

73—*Saddle Hill (Christie's No. 2).*—(18/4/92): I went through all the workings, and found the mine in good order. The main dip-drive into the mine, I found, had been re-timbered between each of the old sets throughout its length. The air is good through all the working-places.

74—*Glenochiel, Saddle Hill.*—(18/8/92): I found only two places working, where they are said to be leaving 12ft. of coal overhead for a roof. The air is good, and the workings in good order.

75—*Walton Park, Green Island.*—(19/8/92): Examined the Daily Record Book and find it carefully kept and posted up to date. Also examined the Register of Age of youths employed in the mine. Examined the plan of the workings, and find it plotted close up to the date of my visit. I went through all the workings and examined them carefully. In some places the floor has risen very much, and in others the roof has chipped up into narrow grooves. Wherever this chipping is supposed by the manager to be closely approaching the sand over head, it has been timbered in order to prevent a "run," which would be likely to fill in the main roads and working-places. Many of the working-places require careful attention at the hands of the manager to keep the roof from caving up to the sand layer.

The thickness of the coal varies very much, from 7ft. to 18ft. The ventilation is good. A pinion wheel on the engine shaft was being replaced on the day of my visit, the old one having had a cog broken out of it.

76—*Fairfield, Green Island.*—(20/8/92): This is an old mine, abandoned years ago as worked out; but Harris is of opinion that there is a fair-sized block of solid coal in the mine when he has put in a dip-drive. He is now on a four-feet seam, which he is hewing, while the other work proceeds towards a thicker seam. The roof is not very good, therefore the working-places are all very narrow in order to be on the safe side.

77—*Abbotsford, Abbotsford.*—(22/8/92): Went through all the workings, and find that in most of the working-places the men are bringing back the pillars toward the main level. In one working-place only did I find it decidedly warm, but was told that only one more shift would remove all the coal intended to be taken out at this particular spot. In some parts of the mine there is very bad standing ground, and although the working-places are very narrow, the roof chips and grooves out so much that it has to be closely timbered in all road-ways required to be kept open for a few weeks. The floor rises very much throughout the mine, and crushes the timber so much as to render it useless in a few weeks' time; therefore a gang of night-men are continually employed renewing the timber and brushing the top and sides of the main levels to keep them open for traffic. Many of the main headings, made six feet wide when first driven, are speedily reduced to the width and height of the coal-boxes, thus requiring the close attention every day of the manager, and the special attention of the night-shift appointed to do repairs. The upcast shafts are in good order, and the current of air good. The drainage is so little that pumping four hours removes the drainage of 24 hours.

78—*Chain Hills (Allen's Mine.*—(20/8/92): Went into the workings, but did not find anyone there. From what I saw I came to the conclusion that the output of coal must be very small. The working-places are in good order.

I again visited the mine on the 23rd inst., and found two men employed therein. It is an old mine, in which there has been no mining done for some years past. These two men have started to take out a little coal by splitting some of the largest of the pillars, but they do not think there is room to do much work. The pillars are very sound and strong, and the roof is all coal, and said to be from 6ft. to 8ft. thick. If this be true, it would account for the old workings being in such a good state of preservation.

79—*Fern Hill, Chain Hills.*—(23/8/92): This mine was closed after an output of 1,165 tons during the early part of the year. At the time of my visit I saw that the timber near the mouth of the adit had collapsed, and the mouth of the adit filled up with *debris*. There was no one about the mine. It is not worked out, but I am told it did not pay. It is not known when work will be resumed.

80—*Brighton, Brighton.*—(19/8/92): Some of the old workings have been allowed to cave-in since my previous visit. This caving-in has necessitated a new opening or heading from near the mouth of the main dip-drive, in order to avoid the old workings when the roof is very rotten. Great care has to be taken, and only narrow working-places are considered safe. There is only one man working in the mine.

81—*McColl's, Brighton.*—(19/8/92): I found the old workings closed by the caving-in of the old adit. McColl is now driving a new dip-tunnel a short distance on the north side of the old one, and at a little higher level. This new work will not be completed for some weeks yet, and in the mean-time there will be no output of coal from the mine.

82—*Mosgiel, Mosgiel.*—18/8/92): Inspected all the working-places and find them in good order and carefully worked. The air is good throughout the mine, and the drainage light. The bulk of the output goes to the Mosgiel Woollen Factory.

83—*Salisbury, Tairi.*—(23/8/92): Found a change in the management of this mine. Hunter has left, and Blackie has taken charge for Mr. Donald Reid. Mr. Blackie was engaged repairing the air-way, and making some other alterations and improvements out and inside the mine. There were only two men then.

84—*Bruce No.* 2, *Milton.*—(14/12/92): Examined all the working-places and found them in good order. There was only one man working at the time of my visit, and I was told that the output was always small at this time of the year. The air-current was very strong. The adit is at too high a level to admit of all the coal being taken out to the floor. By this mistake there is from 2 to 3ft. of coal being left under foot, all of which will be lost when the old workings are allowed to cave-in.

85—*Milton, Real McKay.*—(14/12/92): There are three working-places, and two men employed. One of the working-places I considered rather wide. A promise was made to keep it within 14ft. The coal is very solid and stands well. There is a coal roof left from 3 to 8ft. thick. The air is good always, and so strong at times that it was necessary to fix a door in the adit to regulate the quantity to keep the lamps alight.

86—*Wallsend, Lovel's Flat.*—(13/12/92): In this mine there is an open face of about 25ft. of coal, and from three to fifteen feet of stripping, which I am pleased to note is kept well back from, and well in advance of the coal face.

87—*Pllott Hill, Lovel's Flat*—(14/12/92): A new adit, two chains above the old workings, is now being put in to tap the coal south of the old workings, which were abandoned about twelve months ago. Malcom McDougall is doing the work, and will open the mine.

88—*Pastulls, Adams' Flat.*—(13/12/92): This seam has been followed up from the bottom of a gully into a terrace, where the stripping is gradually getting very deep—from 15 to 18ft. of closely packed fine gravel, which stands well, with a vertical face. The output of coal from this mine is very small.

89—*Adams' Flat, Adams' Flat.*—(13/12/92): This is a large open face of bands of coal and clay very much mixed, and from 9 to 20ft. deep. Probably from 8 to 10ft. of the bottom of the seam may be considered passable coal. The surface stripping is from 3 to 6ft. deep. I saw lying in the pit a quantity of earth, which had evidently fallen of its own accord. I afterwards saw Reid delivering coal at a homestead, and told him to give a greater batter to the face of his working-place, which he promised to do.

90—*Benhar Nelson's Mine.*—(15/12/92): Visited all the working-places to the east of the adit, and find a large block of coal immediately below the railway line; this is being left nearly solid. Of

course, a narrow heading has been put through it, to get to the coal on that side of the line, where there is a considerable field of coal. A considerable quantity of the output is used at the brick and drain-pipe kilns at the mine. The pipe-works are very extensive, since that class of goods are being sent by train all over the province. The height of hewn is from 8 to 12ft. The air is good, and the workings are in good order.

91—*Rigfoot Benhar.*—(15/12/92): There are two working-places, but there is only one man hewing coal at present. The height of coal taken out is about 9ft., which leaves about another 9ft. overhead for a roof. Since my last visit a windmill and pump has been erected, at a cost of £60. The mill is 2 h.p., and the pump-pipe is 1½in. in diameter, which were put down into a 3in. hole bored for that purpose. The water is lifted 72ft., and the mill stands some little distance from the mouth of the mine. The pumping-plant does its work well. The air is good, and the mine is in good order. All the fine coal is used in the brick-kiln belonging to the mine, where a considerable quantity of first-class bricks are being constantly made, and sent by train—close to the mine—North and South.

92—*Kaitangata Mine.*—(17/12/92): Went throught all the working-places (39), and tried for gas in places, but failed to get a trace of it. Some parts of the main roadways are very much timbered, in consequence of the crushing-in from the sides and floors. I intended measuring the current of air to-day, but when too late, I learned that the furnace-fin was always damped down at noon on the Saturdays. The usual quantity appeared to me to be passing through the mine. Went to the bottom of the old shaft, which has lately been sunk an additional depth of 300ft., making it a total depth of 700ft. by 13ft. by 5½ft. A chamber is made, and a level-drive to the coal-seam, a distance of 80ft. The dip of the seam is 75deg. to the west, and is 32ft. thick. Went to the end of the heading in the coal and tried for gas in the roof, but failed to find any. A stone-drive is now being put in for an air return, which will be completed in about three weeks. The drainage is being at present lifted by a small tank, till the new pumping-plant and engine are in working order. Preparations are being made to place in position a fly-wheel and pump capable of throwing 15,000 gallons per hour. New proppit-heads have been erected, also a complete plant of coal-screens, which divide the coal into four sizes, all of which at the same time fall into separate railway trucks. A new winding-engine, having direct action on an 11ft. winding-drum, and with 60lbs. pressure to the square inch, is capable of working up to 230 h.p. There is another new engine of larger dimensions to work the air-compressors; the nominal h.p. is 140, but is capable of being worked up to 400 h.p. These two engines are placed on the one floor, in a building 48ft. by 65ft., having brick walls 16ft. high. A third boiler (steel) will be placed in position by the side of the other two, now in use, in about a month's time. The three boilers are much alike in size—viz., 6ft. by 30ft., and capable of generating all the steam required at the mine. In order to complete the new works, now equal to an output very much beyond anything yet attempted, two additional railway-sidings for waggons have been laid at the works at considerable cost. It is thought that all the plant will be completed and ready to work very early in 1893.

93—*Castle Hill, No.* 1, *Kaitangata.*—(16/12/92): There are only two faces working, and in one of these the coal is very thin, but good. This thinning-out indicates a near approach to the outcrop. The pillars are standing well, and are likely to keep good for a long time. The air is good. This mine supplies the engine at the new shaft.

94—*Wangaloa (Smith's) Mine.*—(16/12/92): I did not find anyone about the mine, and I did not see any indications of any work having lately been done.

95—*Lismahagow, Wangaloa.*—(16/12/92): This small mine is in good order, and the output very small. The seam has been opened in another place since my last visit, and dips into the hill from the mouth of the adit, consequently the water which follows the strata at the outcrop gathers in the workings, much to the annoyance of the old man working it. A deep drain would enable Mr. Sewell to work for a long time.

96—*Crofthead, Kaitangata.*—(16/12/92): There are now two working-places, but only one man hewing coal. The seam dips from the mouth of the adit and gets deeper as the work proceeds. The lowest workings are filled with water, and the whole of the high part of the mine is nearly worked out. It is now considered necessary to sink a shaft, or bore for the lowest part of the seam where worked, and erect a pumping plant then. If this be done, it will no doubt open a considerable field of coal that would take some years to work out. The present adit, for some distance into the mine, is very dirty underfoot, and not fit to travel in.

97—*Waikoikoi, Pukerau.*—(23/12/92): The old working-face appears to be abandoned, and a new face openod lower down the gully. A face of coal is stripped, but there does not appear to have been much coal taken out.

98—*Mainholui (Lischmer's) Mine.*—(7/4/92): This is a large open pit on a low flat, where the coal is lying nearly flat, with 9ft. of stripping, which is dumped into the worked-out part. A handy vertical engine is placed on the surface, and does the pumping. The pit is being well worked, and the coal face is safe.

99—*Pukerau (Orchard's) Mine.*—(23/12/92): The edge or outcrop of the seam has been followed up a gully for a considerable distance, and the coal removed to the water-level; but the quantity of coal so taken out did not amount to much, in consequence of it standing at a very steep angle. At a bend in the gully at nearly a right angle with the seam of coal, the stripping was continued into the terrace to a depth of from 8ft. to 14ft., where a pit was made, and the coal is now being taken out below the level of the gully where the thickness of the seam will be tested. The coal is being drawn up an incline by a bullock in harness.

100—*Pukerau (O'Hagan's) Mine.*—(23/12/92): This mine is in the same good order as at the time of my previous visit not long ago, and I think the output must be above the general average. The mine has only a trace of water underfoot.

101—*Pukerau (Dudley's) Mine.*—(23/12/92): There appears to have been very little coal taken out of the pit since my previous visit. Dudley has spent much of his time in cutting a drain up the gully to his pit, and making a passable dray road to take the coal out. When these works are completed, he will be able to put out a quantity of coal at a small outlay of labour, as the stripping is shallow.

102—*Enterprise, Pukerau.*—(23/12/92): All work in this mine was stopped some time ago. A considerable amount of labour will have to be expended in a new tunnel and other works before the

mine can be again opened into a large body of coal. In the meantime, McKenzie is employed in the adjoining mine at wages.

GORE.

103—*McKinnon's Mine.*—(5/4/92): This is a flat seam, with very little stripping, and the coal easily got out. McKinnon does most of the work himself. The water drains off into a still lower flat close by.

104—*Heffernan's Mine, Gore.*—(5/4/92). Mr. Heffernan told me he sold very little coal, and beyond what he used himself, there was little taken out of the pit.

105—*Sarginson's, Gore.*—(6/4/92): This is a new mine just being opened. The thickness of coal could not be seen at the time of my visit. There appears to be considerable drainage into the pit, which was being pumped out while I was there.

106—*Excelsior Mine, Gore.*—(9/6/92): An old working face with deep stripping on the Waikaka Coal Reserve is being cleaned out by Mr. Fryer, with a view of giving the place a trial. The stripping will be getting deeper as the seam is followed into the rising ground, and I fear the seam will be found to dip into the high ground a short distance ahead of the present workings. It would not be safe to mine it out. The thickness of coal is probably from 7ft. to 9ft.

107—*Dryden's (Gore) Mine.*—(10/6/92): This pit was opened about ten months ago by Peter Hard. He did not send in any returns of output for the past year, stating that he was not aware of any Act requiring him to do so. I promised to send him forms at an early date. I handed him a copy of "The Coal Mines Act, 1891."

108—*Regefsky's (Gore) Mine.*—(10/6/92): This pit was opened for private use close to the farmhouse. There is a 5ft. seam 3ft. below the surface. When the coal is removed, the pit is filled in again with the gravel and waste, and the original top soil, which had been carefully stacked close by, is again spread on top and cultivated as before. The yield of grain, however, is said to be much heavier where the land has been thus treated.

109—*Kirk & Sheddow's Mine.*—(10/6/92): This mine is on the Gore Coal Reserve, and the coal is hewn for private use only. The stripping is shallow and easily removed. A long drain keeps the pit free from water.

110—*Clacloskey's (Gore) Mine.*—(10/6/92): This pit is on land adjoining Regefsky's, and the coal is hewn for private use only. When the coal is removed the hollow is again filled up with the *debris*, and the soil placed on top again and cultivated as before.

111—*Green's (Gore) Mine.*—(18/10/92): There is no further stripping being done at this mine. Two dip-drives were put in from the open face of coal, and will be extended parallel for some considerable distance. The one has been driven about a chain, and the other about one and a half chains. Nine or 10ft. of coal is being taken out, leaving from 3 to 5ft. over head for a roof. The roof is bored with an auger at intervals in order to ascertain the thickness of coal for a safe roof. The haulage of coal and water is done by a horse. The coal is very solid, and air good.

112—*Smyth's (Gore) Mine.*—(11/10/92): The old open face is now very much filled in with slips of clay many feet deep from the surface, which has totally covered the old face of coal out of sight. In consequence of the rapid rise in the surface, and the coal seam keeping nearly flat, the cost of the stripping is getting too great for the selling price of the coal. It is therefore thought to be wise to try to get the coal by underground mining, and preparations are being made accordingly. This mine is close to Green's, on the opposite side of a ridge.

113—*Pacey's, Chatton.*—(22/12/92): The mine in appearance is much the same as it was when visited by me last year. There are, however, some substantial improvements in progress, and well advanced towards completion, by which much labour will be saved to the workmen and the carters taking away the coal. A small vertical Roby steam-engine of 3 h.p. is now on the ground to do the pumping, which was previously done by hand, and to haul the coal-tubs to the top of the bank, where they can be conveniently dumped into the horse-carts. There are supposed to be about 12ft. of coal under foot over the whole of the large open pit that has been made by the output of coal for many years. There will now be no difficulty in lifting the drainage and coal the additional 12ft., and the profit on this large body of coal, already stripped, should more than cover the cost of the plant. It is said the full thickness of coal is likely to be 28ft. or 30ft. As the surface is rising all round the pit, it will in time be too deep to strip at a profit. There are now from 8 to 10ft. of clay on the coal. I think after the removal of the 12ft. on the floor of the pit, the most profitable way to get coal will be to mine it out.

114—*Pemble's, Chatton.*—(5/4/92): This is a vertical seam, showing the outcrop crossing a small gully, from which it has been worked southward for some distance to a considerable depth. There is a deep drain in the gully to the coal, which will render it "comeatable" at a lower level than the present floor. The surface of the seam is still being followed, and may be continued for some distance yet. The sides are sloped, and appear to stand the weather very well. I did not find anyone there.

115—*G. H. Evans, Wendon.*—(22/12/92): The thickness of seam is from 12ft. to 14ft., and the stripping from 12ft. to 25ft., most of which is very hard. This is the heaviest stripping in any coal-mine on my list. I suggested the advisability of mining the coal out, which I thought might be easily done, and at a less cost per ton than by the present method, but Mr. Evans did not agree with me, and said he would go on with the stripping. All his work is very neat, and is carefully done with a view to safety. The open drain to the pit is now being deepened 6ft., in order to follow the dip of the seam.

116—*R. McDonald's, Wendon.*—(22/12/92): This is an open pit in a very steep gully. There has been but little coal taken out yet, and that little was for private use. The stripping, so far, is from 2 to 4ft., and the depth of coal visible is about 4 or 5ft. I sent forms to be filled up and returned, showing his output, but they are not yet to hand.

117—*Waikaka, Gage's Mine.*—(23/12/92): This was my first visit to this mine, which is in an out-of-the-way place, a few miles from Waikaka. I did not find anyone there, and the output at this time of the year, I think, must be very small.

118—*Smith's (Waimea) Mine.*—(10/6/92): This mine is close to, and might have been a part of, Carmichael's old mine at one time. Smith cleaned out some old workings about ten months ago, and

has hardly got the mine properly opened to be worked to advantage yet. I do not think his prospects are very promising for a continuous seam. The stripping is from 10ft. to 12ft. of clay and fine gravel, which will be of greater depth as the work proceeds. The seam of coal is 5ft. thick, and of fairly good quality. The surface of the coal has been much worn away in places, and shows pot-holes from the action of a large stream carrying the gravel now laying on it. The seam appears to be nearly level, and is a considerable height above the Mataura River. Mr. Smith had not sent in his annual returns, but had paid into the Sick and Accident Fund, thinking that was all required of him by the Act.

119—*Mandeville Coal-mine.*—(31/10/92): E. McAlister is the owner of this mine, which is situated close to the railway line, a short distance above Mandeville, and appears to have been worked on a small scale for some years past. The work done has been by an open face part of the time, and by tunnelling when the stripping became too heavy. The seam is very faulty so far as it has been tested, and varies in thickness from 3 to 8ft. Its dip is very uneven and uncertain, and therefore difficult to follow with a tunnel. I have suggested sinking several shafts some little distance apart, to test the thickness of the seam, and the ground dip and depth from the surface. The only coal now being hewn is for McAlister's own use. He did not know anything about the Coal Mines Act, but promised to get a copy at an early date.

120—*Vial's, Waikaia.*—(28/10/92): This is an open face in a high terrace, close to and on the east side of the Waikaia River. The seam was originally found cropping out on the river-bank in several places, a little above flood-level, and in half-a-mile or more in length there are four mines opened and working. The dip in each is to the east, and from the river. The stripping at first was light, but is now from about 30 to 40ft., and consists of fine water-worn gravel and bands of clay, all of which is sluiced off into the river by a stream conveyed to the spot in a water-race from a small creek close by. Small quantities of coal have been removed from this pit from time to time for some years past, but the present proprietors have been mining only about a month. There is about 8ft. of marketable coal, and the output is not likely to be large. The young men did not know anything about the Coal Mines Act, and were much surprised at some of the clauses when read to them. I sold them a copy, and advised them to carefully read it, and comply with its provisions.

121—*McIvor's Mine, Waikaia.*—(28/10/92): This mine is about half-a-mile lower down than Vial's, and on the same side of the river. The stripping is from 30 to 40ft., nearly all of which is fine gravel, which is also sluiced into the river close to the workings. The part of the seam now being stripped appears to have been very much scoured, denuded, and trenched by the action of a rapid stream, and the *debris* it carried with it. In some places nearly all the coal is gone, while in others there is from 8 to 10ft. remaining. The present workings are not much above the river flood level, and the seam dips into the terrace where there is a greater thickness of coal. This mine has been opened and mining carried on on a small scale for several years past. McIvor did not know anything about the Coal Mines Act, but bought a copy from me and promised to comply with its provisions in future. As the work proceeds, the stripping will be much higher, with less fall to the river, and eventually underground mining will have to be started. Suitable timber is plentiful a few miles up the river.

122—*Northcote's Mine, Waikaia.*—(28/10/92): This mine is a little lower down the river than McIvor's, and on the same side. This pit appears to have been worked for some years in the same way as the other two mines above it, and when the stripping became too deep, underground mining was tried for a while, but this is now abandoned for the time being and stripping resumed. The stripping is similar in character and depth to that in the other two mines above it. I examined the underground workings and found that 10ft. of coal was taken out, and was told that 5ft. of coal was left overhead for a roof. This appears to me to be quite sufficient, provided the working-places are not made too wide, and a strong block be left along the open face. No such block was left along the face when underground mining was started, consequently the timber in the workings near the open face shows the crushing weight now resting on it, and the probability of a large block slipping off the face. Northcote had not seen the Coal Mines Act, and did not know such an Act existed. This man works the mine alone when there is nothing to do on his farm.

123—*Hill's Mine, Waikaia.*—(28/10/92): This mine joins Northcote's, and is only now being opened on the same side of the river. The stripping is from six to ten feet, which exposes from four to five feet of coal close to the river and flood-mark. I did not see Mr. Hill. He was not at the mine when I was there.

124—*Argyle, Waikaia.*—(29/10/92): This mine is nine miles above Waikaia township, and is on the east side of the river, and about 25ft. above water-level. It was opened about the time the Waikaia dredge started to work in that locality, and stopped immediately after the dredge stopped mining operations. The depth of the present stripping is from 4 to 10ft., and has been sluiced off with about one sluice-head of water. The seam appears to be from 3 to 6ft. thick at the face, but may be much thicker further into the terrace. Very little coal appears to have been taken out. There is about a mile of very bad road to the pit, which would be unfit to bear a loaded dray in the winter. The mine is not now working, and there was no one there.

125—*Maslin's, Wendon.*—(31/10/92): This mine changed hands quite lately, and is now being worked by Thos. Maslin, who commenced hewing coal on the 20th August last. He knew nothing about the Coal Mines Act, and was surprised at its provisions when read to him. The mine has been opened about five years, during which time several excavations have been made along the line of seam, which stands north and south, and in a vertical position. It is about 15ft. thick and a portion of the top of the seam only taken out where the stripping was shallow. A second seam, about 50 yards to the east of the first, and running parallel with it, was opened by tunnel higher up the gully, and driven on on about two chains. Its thickusss was tested in places, and found to be 20 and 21ft. Although this higher seam is said to be a superior coal to the other, nothing more appears to have been done in it. The reason may be a want of underground mining knowledge. I think the output will be small. The road to the pit will be next to impassable in the winter time.

Mataura.

126—*Beatie's (Sleeman's Mine).*—(21/12/92): This was formerly Beatie's mine. Sleeman is supplying the Mataura paper-mill, which keeps one horse-cart constantly going. The stripping

just now is from 6 to 7ft., and the thickness of coal probably from 10 to 12ft. The drainage into the pit is very heavy, but the little water-wheel manages to keep it down to the floor of the pit.

127—*Town's Mine.*—(21/12/92): This mine is much in the same state as it was on my last year's visit. The output of coal is not as large as could be wished. The standing face of coal and gravel round the pit appears to be quite safe, and in good order.

128—*McGowan's Mine.*—(21/12/92): This mine is close to the township of Mataura, but has a very neglected appearance. I did not find anyone there.

129—*Nicol's Mine, Mataura.*—(21/12/92): This mine had not been visited by any Inspector before. The pit is an open face on private land, on the east side of and a few miles from the Mataura township. The stripping is from 4 to 8ft., and there is from 5 to 6ft. of coal. The seam was first found in a gully, and is now being excavated from the sides, which show that coal has been hewn here for several years past. It is said that it is now being worked for private use only.

130—*Mutch's Mine, Mataura.*—(21/12/92): This pit is on a low flat in the centre of a farm at the head of a drain, by which no doubt the coal was first discovered. The stripping is very shallow, and the coal removed is for his own use only.

131—*Edendale, McDonald's Mine.*—(28/12/92): Since my visit last year a considerable amount of work has been done to find the shallowest stripping and the greatest thickness of coal. In a low flat close to the first workings a pit is now opened, where the stripping is only 2ft., and the depth of coal 6ft. The standing water level in the pit is half-way up the coal face, and is bailed out from time to time when coal is being hewn. The two miles of road to the pit is next to impassable in winter.

132—*Edendale, Shields' Mine.*—(28/12/92): Shields has abandoned his old pits at Menzie's Ferry, and is now opening a pit close to McDonald's, on the Edendale Reserve. This new pit is at the cap of a terrace bordering on a low-lying flat. The stripping is from 3 to 5ft., and the coal seam from 8 to 10ft. thick. A drain has been cut up the flat for a distance of five or six chains, but does not drain the pit by about 6ft.

133—*Edendale, Marshell's Mine.*—(28/12/92): This pit is immediately below McDonald's. The seam of coal is about 3ft. thick, and the stripping from 1 to 2ft. The water stands in the pit nearly on a level with the top of the coal. Marshell takes out coal for his own use only.

134—*Wyndham, Munro's Mine.*—(28/12/92): The stripping is shallow and easily removed. A fair-sized block of coal is stripped, all ready for hewing out. The level of the standing water in the mine is about 2ft. above the floor of the seam. The coal is from 3 to 4ft. thick.

135—*Wyndham, Gauge's Mine.*—(28/12/92): This pit appears to be nearly worked out. As the stripping gets deeper in the terrace, the seam of coal thinned out to only a foot thick. Towards the low-lying flat the coal appears to be cut off. I think Gauge will soon have to do some prospecting for something better than that now exposed to view.

136—*Pine Bush, Trotter's Mine.*—(29/12/92): This pit shows a nearly horizontal floor, and the top of the coal rising slightly with the surface of the gully. Three feet of stripping uncovers 12ft. of coal. The pit is only a few chains from the main Fort Rose Road, to which a road is made with an easy gradient. The output of coal is not great, because of the patches of forest in the district.

137—*Pine Bush, Mrs. Monaghan's Mine.*—(29/12/92): There appears to have been very little coal taken out of the mine since my previous visit. On enquiry, I learned that Mrs. Monaghan took out coal for her own use only.

138—*Nightcaps Mine.*—(16/9/92): Visited all the working-faces, and some other places where two seams were exposed in one perpendicular face of 26ft., with a foot or two of a stone-band in the face. This stone-band varies in thickness, and is as much as 4ft. in places. In a part of this mine the floor of the seam is some feet below the adit level, and makes some water, which is lifted to the adit by a horse and Californian pump, requiring 1½ hours' work every morning. Wherever there are indications of the roof flaking, I find it timbered. The roof in these high places requires careful attention. The output of coal will be very much below that of previous years, in consequence of the company having failed to get the local railway contract, which, I understand, equals 7,000 tons per annum. The air is good throughout the mine, and the spirit of the Act is being complied with.

139—*Wallace Pit, Reid's Mine.*—(16/9/92): This is an open-cast, situated on the low flat, a short distance from the Nightcaps Mine. The coal is from 6 to 10ft. thick, and is exposed by stripping from 6 to 8ft. of soil and clay mixed with gravel, which makes it very hard. The mine—when the depth is considered—makes a considerable quantity of water, which is lifted out by a handy little steam-engine and pumps.

140—*Morley Village, Brazier's Mine.*—(16/9/92): This is an open paddock, and was filled with water at the time of my visit. I learned that there had been no output of coal since the Court case, Brazier *v.* Nightcaps Coal Company, about June last.

141—*Wairio Mine.*—(16/9/92): This is T. Knight's old mine, which is now managed by J. Lloyd. I found only one man in the mine, consequently the output is very small just at present.

142—*Fairfax, Fairfax.*—(16/9/92): This was an open-cast till the stripping became too heavy and expensive. Two tunnels were then driven in the coal from the open-face, and cross-cuts are being put through from one to the other at short intervals, to give good ventilation. The roof is good, and the mine well timbered. The timbering is carefully done.

143—*Isla Bank, Fairfax.*—(16/9/92): An open-work mine of considerable extent, and very heavy stripping of hard material, which appears to be cut down in a safe manner to prevent the sides caving into the paddock.

144—*Hokonui, Winton Mine.*—(22/9/92): Mining operations were resumed here on the 14th April last, since which time an engine-plane has been driven, following the seam down some distance in a solid body of coal of good quality. The mine will soon be in a position to readily supply a large quantity of coal at short notice. There were three faces just opened from the side of the dip at the time of my visit, and preparations were being made to open others when required. There were also some pillars being taken out in the old mine by two or three men. In all, 21 men are employed in and about the mine. The mine drainage is about 1,200 gallons per hour, which is raised by a tank. New pumps are under construction at Invercargill, capable of lifting 3,000 gallons per hour. The little engine now in use is capable of doing all the work till the mine is fairly opened, and there shall be a

very large output of coal. Preparations are also being made to build a brick up-cast stack, to be ready for future ventilation when there are more men employed.

145—*Orepuki Coal-mine.*—(19/9/92): The dip-drive which was being driven at the time of my previous visit was abandoned, and a new one started immediately under the first, but at a steeper gradient. It is now constructed 224ft., at a dip of one in five, and one in three for a distance of 60ft. At this level a rise of one in three for a distance of 50ft. was made, to cut through the kerosene shale, which is proved to be 4ft. thick of good quality, and 6in. of indifferent quality. The depth of coal immediately under the shale is about 30ft. where tested, all of which may be worked in the distant future. At the present time, only 9ft. of the bottom coal is being taken out to supply the local market. The mine makes about 3,000 gallons of water in the 24 hours, and this is pumped out by a steam-engine working a long length of rods in skids down the dip to the pump. The engine is capable of hauling out of the mine from 10 to 15 tons every three minutes. The old motive-power over-shot water-wheel is now put to the one side. The dip-drive is very strongly timbered. The air is good. The signals are painted on a substantial board, framed, and the general rules of 1874 exhibited at the pit mouth. I have requested the manager to put up to view the rules of 1891.

146—*Popham's Mine, Orepuki.*—(18/9/92): There has been no output of coal since last returns were sent in. At the time of my previous visit, a line was being cut through the bush from the pit to the open land, to lay a tramway down. I find now that nothing more than cutting the line was done.

147—*Morrison's Mine.*—(14/12/92): There is nothing doing at this mine, nor is there likely to be for some time.

148—*Waimea, Riversdale.*—(10/6/92): I did not find anyone at the mine, and its general appearance showed clearly that it had not been worked for at least 10 or 12 months. I learned that Carmichael was many miles away rabbiting. The worked faces are very deep, and have fallen in very much.

Accidents in the Otago Coalfields.

I have to make the following report on the several accidents which have occurred during the year ending 31st December, 1892:—

1—*Walton Park Mine.*—On the 15th July, James Hardwick received a slight scalp wound by a fall of coal from the roof of his bord.

2—*Kaitangata Mine.*—W. G. D. Bohning, on the 3rd of October, got his left hand very badly injured on the cuddy-chain pulley, through which he has lost a finger by amputation, and the hand otherwise injured. He says he was, at the time, on the cuddy-chain side, trying to free the chain at the pulley, when his hand was caught. Of course, he had no right to be there while the full box was hanging on the brow.

3—*Kaitangata Mine.*—On 3rd October, Daniel Binnie, while holing his coal face, had a block of coal fall on his hip. Injury slight.

4—*Mosgiel Colliery.*—On the 8th October Peter Sneddon was very much injured by a fall of coal from the roof of one of the main roadways. Three men were taking in their empty boxes to their working-place, when the leading man heard the coal "working" as he passed under it. He immediately called to the others to stop. They did so, and he returned to examine the spot, but it had then ceased to "work." Peter Sneddon, although told to stand back for a while, thought there was no danger, and ventured too near the spot to examine it, and was immediately felled by a block of coal from the roof.

5—*Kaitangata Mine.*—On the 2nd November William Dearly was slightly injured by a blow on the head, caused by slight explosion of gas in the new heading from the bottom of the engine shaft. Just before the change of shift came on to work, Dearly lifted the brattice at a spot some distance back from the working face to do some repairs to the line or sills. The lifting of the brattice of course stopped the air current going beyond that spot, and allowed a little gas to gather at the face. While at his work doing the repairs, he allowed one of the men of the fresh shift to pass him with a naked light and go to the face, and the result was a flash, which caused a stick to strike Dearly's head. Dearly was to blame, and no one else, as he was in charge of the outgoing shift.

Methods of Working.

Worked by shafts—		
Steam-power used	4	
Horse-power used	6	
	—	10
Worked by adit—		
Engine-plane	8	
Horse-power	17	
Hand-power	33	
	—	58
Open		63
Total		131

I have, &c.,
J. Gow,
Inspector of Mines.

The Under-Secretary, Mines Department, Wellington.

APPENDIX IV.

ACCIDENTS IN COAL-MINES during the Year ending 31st December, 1892.

No. and Date.	Name of Mine.	Locality.	Cause of Accident.	Above Ground.	Below Ground.	Fatal.	Non-fatal.	Name of Sufferer.	Remarks.
			North Island.						
1892.									
1. Jan. 18	Taupiri Reserve	Huntly ..	Struck by a pick	..	1	..	1	Ben. Houseby	Not serious.
2. „ 22	Kawakawa ..	Kawakawa	Skip fell against him	..	1	..	1	A. Buchanan	„
3. May 16	Taupiri Reserve	Huntly ..	Rail bounced up and struck him on foot	..	1	..	1	W. Patterson	This was not thought serious at time, but he was a good long time off work.
4. July 11	Waikato ..	Waikato ..	Jammed between skip and prop	..	1	..	1	F. Fisher ..	Not serious.
5. Aug. 15	Taupiri Extended	Huntly ..	Struck in eye by a piece of coal	..	1	..	1	Albert Tee ..	„
6. Nov. 3	Kawakawa ..	Kawakawa	Ribs and leg hurt by fall of stone from roof	..	1	..	1	James Sellick	„
7. „ 14	Taupiri Extended	Huntly ..	Scorched at engine-furnace	1	..	..	1	E. W. Coxon	„
8. „ 22	Ditto ..	„ ..	Wrenched his shoulder lifting a truck	1	..	..	1	C. J. Minnett	„
9. „ 23	Kiripaki ..	Ngunguru	Sprained his back lifting a rail	1	..	..	1	J. R. Kitchin	
			Middle Island.						
10. Jan. 20	Coalpit Heath	Greymouth	Leg broken by fall of coal	..	1	..	1	Benj. Newman	A piece of coal came away from side of bord at which he was working and struck him before he could get away.
11. Mar. 14	„	„	Bruised and cut by fall of coal	..	1	..	1	R. Polkinghorn	Not serious.
12. April 7	Coalbrookdale	Coalbrookdale	Returned to an unexploded shot, and had face and eyes hurt by explosion	..	1	..	1	Alex. Senior	He had tamped the hole with paper and scrapings, no clay being about, and then lighted his fuze and retired. He says he heard a report and saw flame, and then returned, when the explosion occurred, and he was seriously injured about the face and eyes.
13. May 20	Coalpit Heath	Greymouth	Leg hurt by piece of coal	..	1	..	1	M. Swinburn	Not serious.
14. July 15	Walton Park	Otago ..	Scalp-wound from fall of coal	..	1	..	1	J. Hardwick	„
15. Oct. 3	Kaitangata ..	„ ..	Left hand badly injured on cuddy chain-pulley; lost one finger	..	1	..	1	W. D. G. Bohning	Was on cuddy-chain side trying to free the chain at the pulley when his hand was caught. Had no right to be there while full-box was hanging on brow.
16. „ 3	„ ..	„ ..	Slight injury to hip through fall of coal	..	1	..	1	Danl. Binnie	Not serious.
17. „ 8	Mosgiel ..	„ ..	Badly injured by fall of coal	..	1	..	1	P. Sneddon	Three men were taking in their empty boxes to their working place when the leading man heard the coal "working," and called to others to stop. Sneddon entered too near to examine, and was felled and badly injured by a block from the roof.
18. Nov. 2	Kaitangata ..	„ ..	Slightly injured by blow on head, caused through explosion of gas	..	1	..	1	W. Dearly	Not serious.
19. Dec. 9	Charleston ..	Charleston	Buried by fall of coal	..	1	1	..	T. Powell	Was buried by a fall of coal in his mine. At time was not thought to be seriously injured, but died same night.

Statistics of Workings in Coal-mines, 1892.

NORTH ISLAND.

Name of Mine and Locality.	Name of Manager.	Number of Years worked.	Quality of Coal.	No. of Seams worked.	Thickness of Seams.	Thickness worked.	Dip of Seam.	System of Underground Working.	Number of Shafts.	Dimensions of Shafts.		Output delivered by	Output for 1892.			Approximate Total Output to 31st December, 1891.	Approximate Total Output to 31st December, 1892.	Number of Men ordinarily employed.			Power used for drawing Mineral.	Pumps.			Means of Ventilation.	Date of Inspector's Last Visit.
										Size of Shaft or Adit.	Depth of Shaft or Length of Adit.		Coal.	Slack.	Total.			Above.	Below.	Total.		Stroke.	Size of Barrel.	Height of Column.		
													Tons.	Tons.	Tons.	Tons.	Tons.									
KAWAKAWA DISTRICT.																										
Kawakawa	Moody, T. P. ..	27	semi-bitum.	1	10′	the whole	1 in 6	bord and pillar	1	350′ length of incline	98′	engine-incline	15,426	..	15,426	765,503	780,929	16	32	48	steam	..	..	..	natural	2/3/92
HIKURANGI DISTRICT.																										
West Bryan	Smith, Charles ..	3	ditto	1	6′ to 8′	5′ to 7′	1 in 9	ditto	1	air-shaft 6′ x 5′	adit 400′	adit	3,089	..	3,089	3,109	6,198	..	4	4	horse	..	..	..	„	14/11/92
Walton and Graham's ..	Graham, T. D. ..	1	„	1	7′	7′	„	open-cast	1	ditto	„	„	..	..	..	1,210	1,210	..	..	..	..	..	..	..	..	..
WHANGAREI DISTRICT.																										
Kamo	Redshaw, William	15	brown	2	4′ to 14′	4′ to 10′	varies	bord and pillar	2	15′ x 6′ and 9′ x 6′	240′	shaft	8,357	1,567	9,924	194,431	204,355	10	58	68	steam	3′ to 7′	11″	268′	natural	17/11/92
Whauwhau	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	70,853	70,853	..	..	..	..	..	..	..	..	..
NGUNGURU DISTRICT.																										
Kiripaka	Armitage, F. ..	..	semi-bitum.	1	4′ to 7′	..	..	..	..	..	..	..	..	..	..	..	..	20	..	20	..	..	..	..	..	..
WAIKATO DISTRICT.																										
Waikato	Wallace, William	5	brown	1	11′	11′	varies	bord and pillar	1	adit 6′ 3″ x 6′ 5″	47′	adit	7,808	241	8,049	127,247	135,296	6	17	23	horse	..	..	..	natural	10/11/92
Ralph's Taupiri	Ord, John ..	16	„	1	20′ to 60′	10′ to 25′	„	ditto	..	10′ x 6′ and 5′ x 4′	185′ and 160′	shaft	8,410	..	8,410	11,177	19,587	6	14	20	steam	2′	4″	185′	„	10/11/92
Taupiri Extended	Tattley, William	17	„	1	21′ to 48′	7′ to 22′	irregular	„	2	10′ diam.	170′ and 204′	„	28,212	..	28,212	378,847	407,059	11	54	65	„	24″ and 9″	10″ 5″	170′ 204′	Ex. fan	10/11/92
Taupiri Reserve	Harrison, Jonath'n	5	„	1	18′ to 24′	10′ to 12′	2 in 9	„	1	9′ x 6′	858′	engine-incline	13,223	..	13,223	58,590	71,813	12	33	45	„	24″	5″	80′	..	11/11/92
Miranda, Bridgewater ..	Snow, Thomas ..	3½	„	1	40′ to 53′	40′	1 in 4	„	2	15′ x 5′	210′	shaft	..	..	..	20,668	20,668	..	..	..	..	..	..	..	..	..
MOKAU DISTRICT.																										
Mokau Mine	Lobb, Joseph ..	8	„	2	3′6″ each	the whole	1 in 24	„	..	air-shaft 4′ x 5′; adit 8′ x 8′	1,023′	horse	1,823	..	1,823	3,961	5,784	..	4	4	horse	..	..	..	furnace	10/6/93
Co-operative Mine* ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	940	940	..	..	..	..	..	..	..	..	..

COLLINGWOOD.																											
Wallsend, Collingwood ..	Walker, James ..	24	bitum.	2	2′ 6″	all	N. 60° W. 1 in 6	longwall	..	..	..	adit	1,688	273	1,961	39,704	41,665	4	6	10	hand		siphons		natural	13/12/92
Motupipi, Takaka	Harley, Thomas..	3	brown	1	3′	″	..	open-cast	..	..	..	″	..	..	..	360	360	..	..	..	..	..	..	..	..	..
Brownville, Takaka ..	Charles, Edward	2	″	1	4′ 6″	″	..	..	..	..	..	″	20	..	20	50	70	..	..	..	..	..	..	..	..	..
WESTPORT.																											
Mokihinui, Mokihinui ..	Straw, M. ..	12½	bitum.	1	32′	15′	varies	bord and pillar	..	9′ x 6′	..	″	3,056	..	3,056	12,037	15,093	4	14	18	engine	..	..	..	furnace	12/9/92
Westport-Wallsend, Ngakawau	Broome, G. H. ..	4	″	1	16′	all	W. 35°	ditto	..	9′ x 6′	180′	..	..	..	..	3,441	3,441	..	..	..	..	..	..	..	natural	17/5/92
Coalbrookdale	Cameron, John ..	14	″	2	4′ to 20′	″	varies	″	4	8′ 8′ 8′ 6′	48′ 90′ 146′ 148′	engine-plane	171,508	26,958	198,466	1,074,464	1,272,930	64	253	317	engine	12″ 8″ and pul	4″ 6″ som	130′ 120′ eter	furnace and steam-jet	18/11/92
Granity Creek	Brown, Thomas ..	..	″	..	..	..	..	..	..	..	..	..	..	..	..	..	..	40	..	40	..	..	No. 7	..	..	13/9/92
Waimangaroa	Elliott, Robert ..	4	″	1	7′ to 20′	6′	W. 1 in 3	bord and pillar	..	..	..	adits	5,290	..	5,290	12,017	17,307	2	4	6	hand	..	..	..	natural	30/5/92
Wellington	Elliott, Robert ..	..	″	1	7′ to 20′	6′	W. 1 in 3	ditto	..	..	..	″	1,264	..	1,264	1,035	2,299	1	3	4	″	..	..	..	″	30/5/92
Whitecliffs	Mace, F. G. ..	1	glance	1	8′	8′	W. 1 in 2½	* ″	..	..	..	..	..	..	..	173	173	..	..	..	..	..	..	..	..	..
REEFTON.																											
Murray Creek	Sara, James ..	9	″	1	18′	12′	1 in 3	″	1	4′ x 2′ 6″	40′	adits	530	229	759	6,502	7,261	..	2	2	hand	..	..	..	natural	10/10/92
Golden Treasure	Reargh, Robert ..	21	″	1	20′	16′	level	″	1	4′ x 4′	20′	″	320	..	320	4,050	4,370	..	2	2	″	..	..	..	″	10/10/92
Inkermann	McCallum, James	7	″	1	8′	all	45°	stoping	..	6′ x 4′ 6″	350′	″	195	..	195	2,470	2,665	..	..	..	″	..	..	..	″	3/10/92
Lankey's Gully	Lamberton, W. ..	15	″	1	8′	7′	varies	bord and pillar	..	..	..	″	195	..	195	5,129	5,324	1	1	2	″	..	..	..	″	6/10/92
Phœnix	Fox, John ..	8	″	1	12′	10′	N.E.	ditto	..	..	..	″	928	..	928	4,250	5,178	..	2	2	″	..	..	..	″	10/10/92
Inglewood..	Collings, W. G. ..	5	″	1	5′	5′	varies	″	..	..	..	″	20	..	20	294	314	..	..	..	″	..	..	..	″	10/10/92
Progress	Radcliffe, W. ..	12	″	1	5′	5′	S.E. 1 in 8	″	..	5′ x 5′ 6″	190′	″	918	..	918	2,769	3,687	..	1	1	″	..	..	..	″	29/9/92
Sir Francis Drake	Casley, George ..	5	″	1	6′	6′	1 in 4	″	..	6′ x 6′	110′	″	216	..	216	830	1,046	..	1	1	horse	..	..	..	″	6/10/92
Devil's Creek	Metcalf, George..	2	″	1	7′	7′	W. 1 in 3	″	..	..	..	dip drive	203	..	203	140	343	..	2	2	hand	..	..	..	″	19/8/92
Inangahua	Rutherford, E. J.	2	″	1	7′	7′	W. 1 in 3	″	2	6′ x 3′ 6″	40′	ditto	56	..	56	15	71	1	1	2	horse	..	..	..	″	19/8/92
Murray Creek No. 2 ..	Butler, John ..	2½	″	1	8′ to 14′	varies	1 in 2	″	..	..	..	adit	..	..	..	450	450	..	..	..	..	..	..	..	″	10/10/92
Coghlan's, Boatman's ..	Coghlan, Patrick	4	″	1	8′	6′	W. 1 in 3	″	..	..	..	″	82	..	82	218	300	..	1	1	hand	..	..	..	″	4/10/92
Archer's, Boatman's ..	Archer, D. ..	1	″	1	8′	6′	N. 1 in 2	″	..	..	..	dip drive	140	..	140	..	140	..	..	1	horse	..	..	..	″	4/10/92
Burke's Creek, Boatman's ..	Walker, F. D. ..	2	″	1	7′ 6″	7′	S.W. 1 in 3	″	3	3′ x 5′	30′	shaft	..	..	..	300	300	..	..	..	..	..	..	..	..	..
Cumberland	Adams, William..	1	″	1	10′	8′	N.E. 1 in 8	″	..	..	..	adit	300	..	300	..	300	..	..	1	hand	..	..	..	natural	30/9/92
Supreme	Waylin, B. ..	18	″	1	8′	6′	S. 20° E. 1 in 6	″	..	..	..	″	36	..	36	..	36	..	..	1	″	..	..	..	″	30/9/92
Reefton	Joice, George ..	2	″	1	2′	2′	N.W. 1 in 5	″	..	..	..	″	..	..	..	..	..	..	2	2	″	..	..	..	″	7/10/92

* Not worked for eighteen months.

Statistics of Workings in Coal-mines, 1892—*continued.*

Middle Island—*continued.*

Name of Mine and Locality.	Name of Manager.	Number of Years worked.	Quality of Coal.	No. of Seams worked.	Thickness of Seams.	Thickness worked.	Dip of Seam.	System of Underground Working.	Number of Shafts.	Dimensions of Shafts.		Output delivered by	Output for 1892.			Approximate Total Output to 31st December, 1891.	Approximate Total Output to 31st December, 1892.	Number of Men ordinarily employed.			Power used for drawing Mineral.	Pumps.			Means of Ventilation.	Date of Inspector's Last Visit.
										Size of Shaft or Adit.	Depth of Shaft or Length of Adit.		Coal.	Slack.	Total.			Above.	Below.	Total.		Stroke.	Size of Barrel.	Height of Column.		
													Tons.	Tons.	Tons.	Tons.	Tons.									
Greymouth.																										
Blackball	Lindop, A. B. ..	..	bitum.	2	4′ 6″ and 12′	..	S.W. 1 in 5	bord and pillar	..	9′ x 6′	1,232′	adit	..	..	..	30	30	..	..	..	..	..	..	..	furnace	..
Wallsend	Bishop, James ..	..	″	1	16′	..	S.W. 1 in 4	ditto	2	11′ and 14′	670′	shaft	..	..	..	205,539	205,539	..	..	..	..	..	..	..	..	..
Tyneside	Bishop, James ..	..	″	1	16′	..	S.W. 1 in 4	″	2	10′ and 6′ x 6′	116′and 25′+12′	″	..	..	..	18,398	18,398	..	..	..	..	..	..	..	..	..
Brunner	Hodgson, J. W. ..	28	″	1	8′ to 10′	all	S.W. 1 in 4	″	..	10′ x 7′	3,000′	engine-plane	58,527	22,088	80,615	868,072	948,687	22	143	165	steam and electricity	..	..	..	Schiele fan	20/10/92
Coalpit Heath	Hodgson, J. W. ..	16	″	1	16′	″	S.W. 1 in 4	″	2	10′ x 6′ and 6′	280′ and 75′	″	84,764	12,865	97,629	429,991	527,620	33	167	200	engine	4′ 3′ 3′ 2′ 2′ 10″ 10″	10″ 9″ 6″ 9″ 9″ 6″ 6″	250′ 170′ 250′ 170′ 170′ 250′ 250′	ditto	7/11/92
Malvern.																										
Springfield, Springfield ..	Lindop, A. B. ..	16	brown	1	4′ 6″	″	S.E. 1 in 6	bord and pillar	1	12′x 5′ 2″	246′	shaft	380	431	811	70,172	70,983	1	2	3	engine	1′ 10″	8″	246′	steam	6/3/92
Kawi Pass, Springfield ..	Smith and Taylor	..	″	1	3′ 6″	″	..	ditto	..	..	..	incline	330	..	330	..	330	..	2	2	hand	..	..	..	natural	6/3/92
Sheffield, Canterbury ..	Austin, J. ..	30	″	2	2′ 3″	″	S.70°E. 21°	narrow bord and pillar	1	5′7″diam	160′	shaft	1,760	15	1,775	37,399	39,174	3	6	9	horse	1′	6″	140′	″	8/3/92
Snowdon, Rakaia Gorge ..	Gerard, W. (owner)	..	″	1	14′	6′	N. 80° E.	narrow	1	4′ x 4′	90′	″	100	..	100	340	440	1	..	1	″	..	..	..	″	7/3/92
Acheron, Lake Coleridge ..	Murchison, J. ..	23	anthracite	1	5′ 3″	all	S.W. 18°	″	..	..	adit	adit	32	..	32	225	257	..	..	..	hand	..	..	..	″	7/3/92
Rockwood	Levick, H. ..	7	brown	1	7′ to 10′	″	S. 12°	″	1	3′ diam.	12′	″	..	..	..	1,143	1,143	..	..	..	″	..	..	..	″	10/10/90
Homebush, South Malvern ..	McIlraith, J. A. ..	20	″	1	7′	″	E. 10° S. 1 in 3	bord and pillar	2	5′ x 6′ 3′ 6″ x 3′	40 ch'ns 60′ & 20′	″	3,329	..	3,329	89,626	92,955	2	7	9	″	..	..	..	″	10/3/92
Whitecliffs, South Malvern ..	Leeming, W. ..	12	″	1	6′ 6″	″	E. 5° S. 30°	narrow	1	incline	195′	incline	2,356	..	2,356	20,855	23,211	1	5	6	engine	2′	4″	..	″	10/3/92
South Brockley*	Smart, Wm.	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10/3/92
Mount Somers	Harris, A. E. ..	28	brown	1	40′	8′ to 12′	S. 60° E. 10°	bord and pillar	..	5′ 6″	..	incline	1,200	1,100	2,300	15,808	18,108	4	3	7	hand	..	..	..	natural	12/1/92
Duke's, Kakahu	Duke, James ..	..	″	1	30′	10′	..	..	..	9′ x 8′	..	adit	..	..	..	900	900	..	..	..	″	..	..	..	″	1/8/90
Albury, Canterbury ..	Hodson, Jno. ..	1	″	1	16′	..	..	..	..	6′ x 5′	50′	″	68	..	68	..	68	1	4	5	″	..	..	..	″	..

Oamaru.																										
Kurow, Kurow	Wade, J. E. ..	13	„	1	19′	all	N.E. 45°	pillar & stall	1	6′ x 2′ 6″	53′	incline	200	30	230	3,975	4,205	2	2	4	„	..	..	..	„	28/2/92
Phillips's, Kurow	Phillips, J. ..	4	„	1	indefinite		..	„	1	8′ x 6′	50′	shaft	170	..	170	513	683	1	1	2	„	..	..	..	„	28/2/92
Wharekuri, Wharekuri ..	Cairns, W. B. ..	26	„	1	8′	all	S. 60° W. 60°	narrow	1	4′ x 3′	80′	adit	512	..	512	8,403	8,915	1	2	3	„	..	..	..	„	29/2/92
Collins's, Wharekuri ..	Collins, Jno. ..	1	„	1	8′	„	S. 60° W. 60°	..	1	6′ x 5′	75′	„	442	92	534	..	534	1	3	4	„	..	..	..	„	29/2/92
St. Andrew's	Nimmo, John ..	14	„	1	8′	7′	E. 15°	bord and pillar	1	4′ x 2′ 6″	60′	„	1,440	..	1,440	15,248	16,688	1	5	6	horse	..	..	..	„	1/3/92
Prince Alfred No. 1 ..	Willetts, J. M.	23	„	2	9′	all	N. 50° E. 12°	ditto	1	4′ x 4′	90′	„	1,420	..	1,420	32,682	34,102	2	5	7	hand	..	..	..	„	1/3/92
Prince Alfred No. 2..		16	„	2	9′	„	E. 10° S. 1 in 5	„	1	4′ x 4′	50′	„														1/3/92
Ngapara, Ngapara	Nimmo, G. S. ..	14	„	1	18′ to 25′	7′ to 8′	N. 5° E. 1 in 4		1	6½′ x 4½′	15ch.	„	657	..	657	11,127	11,784	1	2	3	„	..	..	..	„	4/8/92
Rosebury, Otepopo.. ..	Love, Alex. ..	9	„	1	5′	all	..	„	1	..	..	„	330	..	330	292	622	1	2	3	„	..	..	..	„	4/8/92
Early Bank, Otepopo ..	Willetts, J. M. ..	2	„	1	3′ 9″	„	E. 1 in 9	„	1	4′ x 2′	50yds.	„	50	..	50	150	200	1	1	2	horse	..	..	..	„	4/8/92
Shag Point.																										
Shag Point	Irvine, Jas. ..	29	pitch	2	2′ to 12′	„	E. 1 in 4	„	3	16′6″ x 6′ 6′8″ x 5′	200′ going to 450′	shaft	2,828	158	2,986	228,242	231,228	28	38	66	engine	2′	6″	200′	steam	4/10/92
Allendale	McIntosh, A. ..	5½	„	1	7′	6′	..	„	1	5′ 6″ x 5′	350′	engine-plane	9,458	2,230	11,688	22,143	33,831	11	28	39	„	5′ 6″	6″	..	natural	4/10/92
Central Otago.																										
Kyeburn, Kyeburn.. ..	McCready, D. ..	19	brown	1	10′	10′	S. 45° W. 40°	narrow	1	3′ x 2′	60′ & 45′ 500′	adit	97	46	143	14,575	14,718	..	2	2	hand	..	..	..	„	14/11/92
Commercial No. 2, Kyeburn	Archer, C.	9	„	1	14′	8′	S. 45° W. 70°	open	1	6″ x 4′	25′	shaft	334	..	334	8,018	8,352	1	1	2	„	..	..	..	„	14/11/92
Perseverance, Kyeburn		13	„	1	8′	all	S. 45° W. 40°	„	1	„	500′	adit														
Commercial No. 2, Kyeburn		3	„	1	5′	„	..	narrow	1	„	200′	„														
Hill's Creek, Hill's Creek ..	McKnight, J. ..	28	lignite	1	10′	„	E. 25°	open	..	..	..	..	25	..	25	779	804	1	..	1	..	..	..	..	..	7/11/92
Rough Ridge	Beck and McLean	6	„	1	30′	„	N. 5°	„	..	..	..	..	1,692	..	1,692	4,356	6,048	3	..	3	..	..	..	..	..	10/11/92
Rough Ridge, Idaburn ..	White, Jno. ..	22	„	1	23′	„	N. 30° W. 3°	„	..	..	..	..	1,257	..	1,257	23,819	25,076	2	..	2	..	..	..	..	..	10/11/92
Border Colliery	Turnbull, G. ..	22	„	1	20′	„	N.W. 20°	„	..	..	..	..	62	..	62	2,113	2,175	1	..	1	..	..	..	..	..	28/4/91
Blackstone Hill	Dunsmuir, A. ..	26	„	1	8′	„	N. 70° W. 5°	„	..	..	..	..	223	..	223	515	738	1	..	1	..	..	..	..	..	7/11/92
Welshman's Gully	Jones, J. R. ..	31	brown	1	40′	30′	W. 10°	„	..	..	..	..	1,942	..	1,942	13,898	15,840	3	..	3	..	..	..	..	..	5/11/92
Cambrian	Dungey, C. ..	8	„	1	20′	all	N.W. 3°	„	..	..	..	..	1,121	..	1,121	5,811	6,932	2	..	2	..	..	..	..	..	5/11/92
Alexandra, Alexandra ..	Thomson, W. ..	13	„	1	14′	5′ 6″	N. 20° E. 1 in 7½	bord and pillar	1	5′ x 2½′	60′	shaft	1,129	..	1,129	13,039	14,168	..	2	2	horse	..	..	..	natural	14/4/92
Macqueenville, Alexandra ..	Lett, Robt. ..	6	„	1	14′	5′	S. 75° W. slight	ditto	2	3′ x 4′ 9″	62′	„	648	..	648	6,122	6,770	2	1	3	„	..	..	..	„	14/4/92
Waikerikeri, Clyde ..	Holt, W. J. ..	11	„	3	20′	..	S. 1 in 1	stoping	2	6′ x 3′	160′	„	442	..	442	18,850	19,292	1	1	2	„	..	..	..	„	20/1/91
Dairy Creek, Clyde ..	Marie, T. C. ..	21	„	1	unknown	..	S. 45° E. 45°	bord and pillar	1	4′ x 3′ 6″	60′	adit	..	..	..	3,730	3,730	..	..	..	„	..	..	..	..	20/1/91
Excelsior, Cromwell ..	McNully, E. ..	11	„	1	17′ to 18′	12′	E. 6° S. 60°	stoping	1	4′ x 6′	40′	„	521	..	521	3,412	3,933	..	2	2	„	..	..	..	..	15/4/92
Nulli Secundus	Parcell, W. ..	3½	„	1	10′	6′	S. 40° W. 5°	bord and pillar	1	6′ x 4′	50′	„	..	..	..	632	632	..	..	..	..	..	..	..	..	15/4/92
Kawarau, Cromwell ..	Pryde, J. ..	15	„	1	8′	all	N. 1 in 4½	„	1	6′ x 6′	34′	incline	1,300	..	1,300	13,374	14,674	..	3	3	horse	..	..	..	natural	15/4/92
Bannockburn, Cromwell ..	Wilson, T. ..	3	„	1	6′ to 7′	„	flat	„	1	6′ x 4′	20′	shaft	86	..	86	109	195	1	1	2	„	..	..	..	„	15/4/92

* Cannot send out coal till a passable dray-road is made to the mine.

Statistics of Workings in Coal-mines, 1892—*continued.*

Middle Island—*continued.*

Name of Mine and Locality.	Name of Manager.	Number of Years worked.	Quality of Coal.	No. of Seams worked.	Thickness of Seams.	Thickness worked.	Dip of Seam.	System of Underground Working.	Number of Shafts.	Dimensions of Shafts.		Output delivered by	Output for 1892.			Approximate Total Output to 31st December, 1891.	Approximate Total Output to 31st December, 1892.	Number of Men ordinarily employed.			Power used for drawing Mineral.	Pumps.			Means of Ventilation.	Date of Inspector's Last Visit.
										Size of Shaft or Adit.	Depth of Shaft or Length of Adit.		Coal.	Slack.	Total.			Above.	Below.	Total.		Stroke.	Size of Barrel.	Height of Column.		
													Tons.	Tons.	Tons.	Tons.	Tons.									
Central Otago—*continued.*																										
Gibston, Gibston	Cowan, J.	25	pitch	4	5′ each	all	W. 22½°	narrow	1	6′ x 5′	80′	adit	952	..	952	15,883	16,835	..	2	2	hand	..	..	..	natural	6/5/91
Saddle, Gibston	Macale, M.	6	"	1	7′	"	S. 60° W. 35°–40°	"	..	7′ x 7′	420′	"	203	..	203	1,274	1,477	..	1	1	"	..	..	..	"	6/5/91
Cardrona, Cardrona	Robson, W.	8	"	1	20′	"	W. 35°	open	..	..	..	..	1,254	..	1,254	2,740	3,994	3	..	3	..	..	..	..	..	18/4/92
Jones's, Roxburgh	Jones, James	22	lignite	1	unknown	20′	W. 1 in 7	"	..	..	..	..	1,560	..	1,560	6,771	8,331	3	..	3	..	..	..	..	..	22/7/91
Perseverance, Roxburgh	Craig, James	5	"	1	"	10′	..	"	..	..	..	..	813	..	813	2,740	3,553	2	..	2	..	..	..	..	..	22/7/91
Mrs. McPherson's, Roxburgh	Kirkwood, R.	22	"	1	"	18″	..	"	..	..	..	..	1,090	..	1,090	1,805	2,895	3	..	3	..	..	..	..	..	22/7/91
Otago.																										
Saddle Hill (Christie's)	Christie, J.	18	brown	1	19′ 6″	10′	E. 1 in 10	bord and pillar	3	5′ x 2′	50′	adit	1,748	1,588	3,336	75,591	78,927	1	4	5	horse	..	..	..	natural	18/8/92
Glenochiel, Saddle Hill	Bryce, D.	11½	"	1	16′	7′	varies	"	1	8′ x 4′	43′	"	1,786	..	1,786	7,154	8,940	1	2	3	"	..	..	..	"	18/8/92
Walton Park, Green Island	Shore, Thomas	22	"	1	17′	8′	E. 1 in 9	"	3	11′ x 4′ 12′ x 4½′ 6′ x 4½′	175′ 173′ 25′	shaft	14,620	5,129	19,749	406,102	425,851	9	39	48	engine	4′	93″	170′	furnace	19/8/92
Fairfield, Green Island	Harris, A.	1	"	1	4′	all	..	"	..	5′ x 4′	..	adit	216	482	698	..	698	1	2	3	hand	..	..	..	natural	20/8/92
Abbotsford, Abbotsford	Green, E. R.	11½	"	1	6′ to 10′	6′ to 8′	E. 10° N. 1 in 10	"	5	4′ x 4′ 4′ x 4′ 5′ x 3½′ 6′ x 4′ 10′ x 4′ engine-plane 15 chains	45′ 80′ 120′ 140′ 140′	engine-plane	9,503	4,171	13,674	163,501	177,175	8	36	44	engine & horse	12″	5″	161′	steam	22/8/92
Chain Hills	Allen, A. G.	1	"	1	6′ to 8′	6′ to 8′	..	"	..	6′ x 5′	100′	adit	842	..	842	..	842	1	1	2	horse	..	..	..	natural	23/8/92
Fernhill, Chain Hills	Gray, James	15	"	1	19′ 6″	7′	N. 10° E. 1 in 10	"	1	4′9″x4′6″	..	"	650	515	1,165	90,053	91,218	2	7	9	"	..	..	..	"	23/8/92
Brighton, Brighton	Walker, Jos.	6	"	1	6′ to 8′	6′	S. 80°	"	1	3′ x 2½′	20′	"	524	27	551	1,969	2,520	1	1	2	"	..	..	..	"	19/8/92
McColl's, Brighton	McColl, Wm.	4	"	1	5′	all	E. 12° 1 in 12	"	1	6′ x 4′	30′	"	30	..	30	268	298	..	1	1	hand	..	..	..	"	19/8/92
Mosgiel, Mosgiel	Sneddon. Jas.	9	"	1	15′	7′	S. 1 in 10	"	2	4′ x 4′ 6′ x 4′	27½′ 32′	engine-plane	2,406	3,105	5,511	30,716	36,227	3	7	10	engine	siphon	..	..	"	15/10/92
Salisbury, Taieri	Reid, David	2	brown	1	10′	6′	..	"	1	5′ x 6′	264′	adit	930	240	1,170	1,421	2,591	2	2	4	hand	..	..	..	"	23/8/92
Bruce No. 2, Milton	Hardwick, N.	18½	"	1	20′	6′ to 7′	N. 30° E 10°	"	1	4½′ x 4½′	25′	"	1,194	419	1,613	19,887	21,500	1	3	4	horse	..	..	..	"	13/12/92
" "	" "	17½	"	1	12′ 6″	6′	varies	"	1	4′ x 3′	20′	"														
Real McKay, Milton	Young, A.	24½	"	1	20′	10′	N.E. to E. 1 in 8	"	1	4½′ x 3′	34′	"	789	..	789	16,211	17,000	2	..	2	"	..	..	..	"	14/12/92

Wallsend, Lovell's Flat ..	Hewitson, R. ..	22	lignite	1	20′	all	S. 20° W. 1 in 4	open	..	..	..	..	700	..	700	6,090	6,790	2	..	2	..	..	..	..	〃	13/12/92
Gibson's, Lovell's Flat ..	Gibson, Jas. ..	2	pitch	1	20′	6′	..	..	2	11′ x 4′ 8′ x 4′	320′ 250′	shaft	..	..	..	89	89	..	..	..	engine	tank	..	..	〃	13/12/92
Elliot Hill, Lovell's Flat ..	McDougal, M. ..	4	brown	1	25′	7′	E. 15° to N. 5°	bord and pillar	1	6′ x 4′	90′	adit	100	..	100	1,328	1,428	..	1	1	hand	..	..	..	〃	13/12/92
Paskell's, Adam's Flat ..	Paskell, Jno. ..	28	lignite	1	8′	all	N.E. 1 in 6	open	..	..	..	..	12	..	12	323	335	1	..	1	..	..	..	..	〃	13/12/92
Adam's Flat, Adam's Flat ..	Reid, Jno. ..	10	〃	1	14′	10′	S. 45° E. 12½°	〃	..	..	..	..	144	..	144	1,243	1,387	1	..	1	..	..	..	..	..	13/12/92
Benhar, Benhar	Nelson, Jno. ..	29	brown	1	30′	8′	S. 17°	bord and pillar	..	4′ x 4′ 8′ x 6′	48′ 462′	engine-plane	3,500	518	4,018	65,731	69,749	1	4	5	engine	..	..	..	natural	14/12/92
Rigfoot, Benhar	Aitkin, Thos. ..	6	〃	1	18′	10′	S. 12°	ditto	..	6′ x 8′	240′	adit	554	135	689	2,537	3,226	1	1	2	horse	tank	..	..	〃	14/12/92
Kaitangata (No. 1), Kaitangata	Watson, W. P., Gen. Manager	16	pitch	1	30′	10′ to 25′	W. 45°	〃	1	13′ x 5′ 6″	392′	shaft	33,632	17,383	51,015	629,051	680,066	26	140	166	engine	2′	5″	250′	furnace	17/12/92
Kaitangata (No. 2), Kaitangata	Shore, W., Mine Manager	9	〃	1	10′ to 30′	25′	W. 1 in 4	〃	1	6′ diam.	210′	engine														
Castle Hill (No. 1), Kaitangata	Carson, M. ..	5½	〃	1	12′ to 14′	8′	N. 20° E. 14°	〃	1	3′ 9″ x 2′ 6″	54′+4′	adit	1,444	1,187	2,131	4,163	6,794	1	4	5	horse	..	..	..	natural	15/12/92
Wangaloa, Kaitangata	Smith, Joseph ..	12	〃	1	10′ 6″	10′	E. 1 in 6	〃	..	8′ x 6′	..	〃	10	3	13	925	938	..	1	1	hand	..	..	..	〃	16/12/92
Lismahagow, Kaitangata ..	Sewell, R. M. ..	11	〃	1	4′	all	N. slightly	〃	..	..	..	〃	144	..	144	1,238	1,382	..	1	1	〃	..	..	..	〃	16/12/92
Crofthead, Kaitangata ..	Mackie, E. ..	6	〃	1	12′	8′	N. 20° E. 10°	〃	..	6′ x 5′	396′	〃	1,140	..	1,140	4,332	5,472	2	3	5	〃	..	..	..	〃	16/12/92
Waikoikoi, Pukerau ..	Cullen, J. ..	5	lignite	1	4′	all	N. 50°	open	..	..	..	..	..	..	..	62	62	1	..	..	..	..	..	..	..	23/12/92
Mainholm, Waipahi ..	Lischmer, F. ..	6½	〃	1	15′	〃	E. 30°	〃	..	..	..	..	3,478	..	3,478	4,300	7,778	4	..	4	horse	..	..	..	..	7/4/92
Valley Road, Pukerau ..	Orchard, E. C. ..	3	〃	1	12′	10′	..	〃	..	..	..	..	148	..	148	356	504	1	..	1	..	..	..	..	..	23/12/92
O'Hagan's, Pukerau ..	O'Hagan, C. ..	12	〃	1	16′	10′	W. 1 in 10	bord and pillar	..	6′ x 7′	496′	adit	1,085	..	1,085	18,110	19,195	..	3	3	horse	..	..	..	natural	23/12/92
Dudley's, Pukerau	Dudley, J. D. ..	3	〃	1	16′	16′	..	open	..	..	..	..	30	..	30	350	380	1	..	1	hand	..	..	..	..	23/12/92
Perseverance, Pukerau ..	McKenzie, J. ..	6	〃	1	16′	..	N. 20°	bord and pillar	..	8′ x 4′	330′	adit	220	..	220	1,832	2,052	1	2	3	〃	..	..	..	natural	23/12/92
Frank's, Pukerau	Mapp, R. ..	2	〃	1	6′	4′	level	ditto	..	..	..	〃	18	..	18	15	33	..	..	..	〃	..	..	..	〃	..
McKinnon's, Gore	McKinnon, A. ..	11	〃	1	5′	all	〃	open	..	..	..	..	615	..	615	1,936	2,551	1	..	1	..	..	..	..	..	5/4/92
Heffernan's, Gore	Heffernan, P. ..	14	〃	1	12′	〃	N. 15°	〃	..	..	..	..	156	..	156	776	932	1	..	1	..	..	..	..	..	5/4/92
Sarginson's, Gore	Sarginson, J. H. ..	6½	〃	1	9′	8′	N. 20°	〃	..	..	..	..	276	..	276	580	856	2	..	2	..	..	..	..	..	6/4/92
Excelsior, Gore	Fryer, H. ..	1	〃	1	8′	all	..	〃	..	..	..	..	499	..	499	..	499	1	..	1	..	..	..	..	..	9/6/92
Dryden's, Gore	Dryden, Wm. ..	1	〃	1	10′	〃	..	〃	..	..	..	..	438	..	438	..	438	1	..	1	..	..	..	..	..	10/6/92
Hoffmann's, Gore	Hoffmann, J. ..	9	〃	1	10′	〃	N. 12°	〃	..	..	..	..	40	..	40	2,415	2,455	1	..	1	..	..	..	..	..	10/6/92
Regefsky's, Gore	Regefsky, A. ..	1	〃	1	3′	〃	..	〃	..	..	..	..	18	..	18	..	18	1	..	1	..	..	..	..	..	9/6/92
Kirk and Sheddor's, Gore ..	Kirk, J. ..	1	〃	1	6′	〃	..	〃	..	..	..	..	50	..	50	..	50	..	..	..	..	..	..	..	..	10/6/92
Cluckoskie's, Gore	Cluckoskie, J. ..	1	〃	1	3′	〃	..	〃	..	..	..	..	8	..	8	..	8	..	..	..	..	..	..	..	..	6/9/92
Green's Mine, Gore ..	Stark, J. ..	4	〃	1	19′	10′	..	bord and pillar	..	7′ x 9′	100′	adit	1,263	..	1,263	3,428	4,691	2	3	5	horse	..	..	..	..	18/10/92
Smyth's, Croydon	Smyth, W. ..	3½	〃	1	12′	all	S. 60°	ditto	..	..	..	〃	62	..	62	636	698	1	..	1	〃	..	..	..	..	18/10/92
Pacey's, Chatton	Pacey, W. R. ..	16	〃	1	30′	20′	S.E. 1 in 6	open	..	..	..	..	900	..	900	5,803	6,703	2	..	2	engine	..	..	..	..	22/12/92
Pemble's, Chatton	Pemble, H. ..	15	〃	1	16′ to 26′	16′ to 18′	90° strike	〃	..	..	..	..	479	..	479	10,530	11,009	1	..	1	..	..	..	..	..	5/4/92
Leitze's, Chatton	Leitze, M. ..	13	〃	1	6′ to 7′	6′	S.E. 5°	〃	..	..	..	..	33	..	33	1,025	1,058	1	..	1	..	..	..	..	..	6/12/89
Irvine's, Knapdale	Irvine, J. F. ..	7	〃	1	35′	25′	vertical	partly open	..	..	..	adit	906	..	906	..	906	..	1	1	hand	..	..	..	..	..
SOUTHLAND.																										
Hunter's, Otama	Hunter, Thos. ..	7½	〃	1	2′ 8″	all	N.E. 5°	ditto	..	..	..	..	142	..	142	796	938	1	..	1	..	..	..	..	..	7/12/89
Edge's, Wendon	Evans, G. H. ..	14	〃	1	8′ to 12	〃	N. 60° E.	〃	..	..	..	..	380	22	402	1,225	1,627	1	..	1	..	..	..	..	..	22/12/92
No. 14, Waikaka	Edge, W. H. ..	5½	〃	1	8′ to 7′	4′	W. 35°	〃	..	..	..	..	28	..	28	340	368	1	..	1	..	..	..	..	..	23/12/92
Waimea, Waimea	Smith, John ..	2	〃	1	5′	all	flat	〃	..	..	..	..	624	..	624	100	724	2	..	2	..	..	..	..	..	10/6/92

Statistics of Workings in Coal-mines, 1892—*continued.*

Middle Island—*continued.*

Name of Mine and Locality.	Name of Manager.	Number of Years worked.	Quality of Coal.	No. of Seams worked.	Thickness of Seams.	Thickness worked.	Dip of Seam.	System of Underground Working.	Number of Shafts.	Dimensions of Shafts.		Output delivered by	Output for 1892.			Approximate Total Output to 31st December, 1891.	Approximate Total Output to 31st December, 1892.	Number of Men ordinarily employed.			Power used for drawing Mineral.	Pumps.			Means of Ventilation.	Date of Inspector's Last Visit.
										Size of Shaft or Adit.	Depth of Shaft or Length of Adit.		Coal.	Slack.	Total.			Above.	Below.	Total.		Stroke.	Size of Barrel.	Height of Column.		
Southland—*continued.*													Tons.	Tons.	Tons.	Tons.	Tons.									
Mandeville, Riversdale ..	McAlister, E. ..	1	lignite	1	3′ to 8′	all	..	open	..	..	..	..	10	..	10	..	10	..	..	..	..	..	..	..	..	31/10/92
Vial's, Waikaia	Vial, Edw. ..	1	"	1	6′ to 7′	"	E. 1 in 6	"	..	..	..	..	40	..	40	..	40	1	..	1	..	..	..	..	..	28/10/92
McIvor, Waikaia	McIvor, W. ..	1	"	1	5′ to 8′	"	E. 1 in 6	"	..	..	..	..	48	..	48	..	48	1	..	1	..	..	..	..	..	28/10/92
Northcote's, Waikaia ..	Northcote, T. ..	1	"	1	10′ to 15′	"	E. 1 in 5	adit	..	..	..	..	193	..	193	..	193	..	2	2	..	..	..	..	..	28/10/92
Cosgrove's Argyle, Waikaia ..	Cosgrove, J. B. ..	1	"	1	6′ to 7′	"	..	open	..	..	..	..	64	..	64	..	64	1	..	1	..	..	..	..	..	29/10/92
Maslin's Wendon ..	Maslin, Thos. ..	1	"	1	20′	18′	..	"	..	..	..	..	103	..	103	..	103	2	..	2	..	..	..	..	..	31/10/92
Mataura, Beattie's Old Pit ..	.. ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	17,612	17,612	..	..	..	..	..	..	..	..	..
Mataura (Beattie), Mataura..	Sleeman, C. P. ..	17	lignite	1	16′	all	N.W. 4°	open	..	..	..	..	3,500	..	3,500	4,245	7,745	4	..	4	water-wheel	5″	6″	26′	..	21/12/92
Mataura (Town), Mataura ..	Town, C. ..	5	"	1	16′	"	N. 70° W. 5°	"	..	..	..	..	826	..	826	5,884	6,710	1	..	1	..	..	..	..	..	21/12/92
McGowan's, Mataura ..	McGowan, F. ..	4	"	1	4′	"	N. 70° W.	"	..	..	..	..	12	..	12	113	125	1	..	..	..	..	..	..	..	14/8/81
Townshend's, Mataura ..	Townshend, E. ..	9	"	1	12′	8′	level	"	..	..	..	..	20	..	20	263	283	1	..	1	..	..	..	..	..	21/12/92
Nicol's River View, Mataura	Nicol, L. D. ..	1	"	1	..	..	..	"	..	..	..	..	120	..	120	..	120	1	..	1	..	..	..	..	..	21/12/92
Mutch's, Mataura	Mutch, J. C. ..	2	"	1	4′	all	"	"	..	..	..	..	31	..	31	35	66	1	..	1	..	..	..	..	..	21/12/92
Edendale, Mataura ..	McDonald, A. ..	2	"	1	5′	"	"	"	..	..	..	..	655	..	655	204	859	1	..	1	..	..	..	..	..	28/12/92
Shields's Edendale, Mataura	Shields, Wm. ..	12	"	1	6′	"	"	"	..	..	..	..	219	..	219	4,820	5,039	1	..	1	..	..	..	..	..	28/12/92
Marshall, Edendale, Mataura	Marshall, H. ..	1	"	1	3′	"	"	"	..	..	..	..	30	..	30	..	30	..	..	..	..	..	..	..	..	28/12/92
Munro, Wyndham, Mataura	Munro, E. ..	5	"	1	5′	"	"	"	..	..	..	..	831	..	831	2,350	3,181	2	..	2	..	..	..	..	..	28/12/92
Genge, Wyndham, Mataura	Genge, J. ..	15	"	1	2′	"	"	"	..	..	..	..	151	..	151	1,988	2,139	1	..	1	..	..	..	..	..	28/12/92
Robin Hood, Pine Bush ..	Trotter, R. A. ..	11	"	1	15′	"	"	"	..	..	..	..	162	..	162	162	324	1	..	1	..	..	..	..	..	29/12/92
Monagan's, Pine Bush ..	Monagan, A. ..	1	"	1	8′	6′	"	"	..	..	..	..	8	..	8	..	8	..	..	..	..	..	..	..	..	29/12/92
Nightcaps (No. 1), Nightcaps	Handyside, W., Gen. Manager	12	pitch	1	15′	all	N.E. 1 in 7 to 1 in 2½	bord and pillar	1	6′ x 4′	adit	130′	6,302	..	6,302	109,441	115,743	8	9	17	engine & horse	..	..	..	furnace	16/9/92
Nightcaps (No. 2), Nightcaps	Loyd, J., Mine Manager	10	"	1	8′	"	N.E. to E. 1 in 4 to 1 in 6	ditto	1	5′ x 4′	engine-plane	55′														
Nightcaps (No. 3), Nightcaps		4	"	1	12′	"	S. 80° E. 50°	"	1	5′ diam.	..	60′														
Wallace Pit, Nightcaps ..	Reid, William ..	7	"	1	3′ 9″	"	S. 80° E. 5°	open	..	..	open	..	1,448	..	1,448	2,465	3,913	4	..	4	engine	8″	5″	18″	..	16/9/92
No. 1, Morley Village ..	Brazier, J. ..	5½	"	1	10′	"	S. 80° E. 5°	"	..	..	"	..	515	..	515	1,581	2,096	2	..	2	..	..	..	..	..	16/9/92
Reliable No. 2, Morley Village	Brazier, J. ..	3	"	1	4′	"	N. 60° E. 5°																			
Wairio, Nightcaps	Lloyd, Jno. ..	11	"	1	9′	"	N.E. 50°	bord and pillar	..	6′ x 6′	3 ch.	adit	450	..	450	3,002	3,452	1	1	2	horse	..	..	..	..	16/9/92
				1			E. 10°																			
Annandale, Annandale ..	Chalmers, N. G...	2	"	1	10′	8′	S.W.	open	..	..	..	..	60	..	60	62	122	1	..	..	..	..	..	..	..	9/10/91
Fairfax, Fairfax	Graham, P. S. ..	14	lignite	1	5′ 6″	all	N. 60° W. 4°	bord and pillar	..	5′ 6″ x 7′	..	adit	499	..	499	8,135	8,634	..	2	2	..	..	..	..	..	16/9/92
Isla Bank, Fairfax	Slattery, M. ..	12	"	1	8′	"	N.W. 5°	open	..	..	..	..	460	..	460	1,950	2,410	2	..	2	..	..	..	..	..	16/9/92

Hokonui, Winton	Hays, Jno. ..	5	pitch	1	8′	all	W. 14°	bord and pillar	..	7′ x 8′	..	engine-plane	3,042	951	3,993	8,649	12,642	5	11	16	engine	..	..	..	natural	22/9/92
Orepuki, Orepuki	Love, Alex. ..	7	″	1	22′	9′	S.E.	stoop & room	1	7′ x 8′	120′	ditto	159	179	338	5,008	5,346	2	3	5	″	16″	..	..	″	19/9/92
Cluny, Orepuki	Popham, J. ..	4	″	1	10′	5′	S. 12½° W. 80°	open	..	..	..	..	..	..	..	156	156	..	..	..	..	..	..	..	..	19/9/62
Morrison's, Benhar ..	Morrison, J. ..	4	brown	1	15′	7′	S. 12°	bord and pillar	1	8′ x 8′	100′	adit	..	..	..	646	646	..	..	..	..	..	..	..	..	14/12/92
Riversdale, Waimea ..	Carmichael, J. ..	6½	″	1	12′	all	N. 10°	open	..	..	..	..	..	..	..	3,711	3,711	..	..	..	..	..	..	..	..	10/6/92
Owaka, Catlin's	Copan, W. ..	1	pitch	..	..	..	..	..	..	..	..	..	..	..	..	95	95	..	..	..	..	..	..	..	..	..
Nightcaps	Alley, Jesse ..	1	″	1	4′	all	..	open	..	..	..	..	49	..	49	..	49	..	..	..	..	..	..	..	..	..
Kawai Pass	Taylor, — ..	1	″	1	3′ 6″	″	..	..	1	..	..	adit	..	..	..	229	229	..	..	..	..	..	..	..	..	..
													568,938	104,377	673,315	6,820,216	7,493,531									
Add output of Waikaka, Adam's Flat, and Waimea Mines, inserted twice in last year's statement													..	..	..	6,518	6,518									
																6,826,734										
Output of mines included in statement for 1890, but whose operations were suspended prior to 1890, less three which are again included in body of statement, namely—Hill's Creek, 779 tons; Lovell's Flat, 323 tons; and Wyndham, 1988 tons: total, 3,090 tons																132,723	132,723									
																6,959,457	7,632,772									
Output from mines included in former statements, and whose operations were suspended prior to 1889																..	172,529									
																	7,805,301									

HENRY A. GORDON, M.A. Inst. M.E., Inspecting Engineer.

By Authority: SAMUEL COSTALL, Government Printer, Wellington.—1893.