

near Dunedin (Park, *op. cit.*, p. 402); Kingston (P. G. Morgan and J. A. Bartrum, in "List of the Minerals of New Zealand," 1913, p. 31); Invercargill district (Col. Lab. Rep. No. 27, 1893, p. 31); Riverton (Morgan and Bartrum, *op. cit.*, p. 31).

Vivianite also occurs in Campbell Island (Col. Lab. Rep. No. 37, 1904, p. 11; and B. C. Aston, in "The Sub-antarctic Islands of New Zealand," vol. ii, 1909, p. 764).

MISCELLANEOUS PHOSPHATE OCCURRENCES.

B. C. Aston records the presence of titanium phosphate in red earth, Antipodes Island. The same material also contains other phosphates. (See 17th Ann. Rep. Dep. Agri., Chemistry Division, 1909, p. 177; and "The Sub-antarctic Islands of New Zealand," vol. ii, 1909, p. 763.) The same chemist also states that the smooth polished crust formed on Bounty Island granite by sea-birds contains 11.77 per cent. of phosphoric anhydride. (See "The Sub-antarctic Islands of New Zealand," vol. ii, 1909, p. 770.)

Guano-deposits are recorded from caves at Akaroa (Col. Lab. Rep. No. 7, 1872, p. 24); Onetana, Collingwood district (Col. Lab. Rep. No. 24, 1890, p. 42); west coast of South Island (Col. Lab. Rep. No. 12, 1878, p. 49); and also occur on Green Island and White Island, near Dunedin; Snares Island; Bounty Islands; Antipodes Island, &c.

10. PROSPECTS OF FINDING STONE SUITABLE FOR HARBOUR-WORKS IN THE OAMARU DISTRICT.

(By J. ALLAN THOMSON, Director of the Dominion Museum.)

SCOPE OF REPORT.

Pursuant to instructions I visited Oamaru in November, 1914, and at once put myself in communication with Mr. C. A. La Roche, Secretary and Engineer to the Oamaru Harbour Board. I ascertained that harbour improvements were contemplated, in the nature of an extension of the breakwater for 1,750 ft., to terminate in 23 ft. of water at low tide, thus enabling a channel of a minimum depth of 22 ft. to be maintained. For this extension it is estimated that 250,000 tons of stone will be required, of which one-half (125,000 tons) is required to be in heavy blocks: 20-ton blocks are desirable, but if the stone is to be transported by the State railways a restriction to a maximum weight of 12 tons is imposed. The estimated cost of these improvements is given as £123,153 by Mr. Cyrus W. Williams, M.I.C.E., of Lyttelton, the consulting engineer. In his report he states, "the critical point in this scheme is the supply of suitable stone."

The points submitted to me for advice were—firstly, the possibility of utilizing the Harbour Board quarry adjacent to the harbour; and, secondly, the possibility of obtaining suitable stone from certain other specified localities in the Oamaru district. I inspected these various localities and the ground adjacent to the quarry and harbour, and have the honour to submit the following report:—

SUITABILITY AND EXTENT OF THE VARIOUS CLASSES OF STONE AVAILABLE.

The following classes of stone are available in the Oamaru district:—

1. *Conglomerates and Sandstones.*

These rocks occur as the basal members of the Oamaru System (under the greensands and limestone) in the interior of the district, but do not outcrop near the coast. I inspected an outcrop near the railway, about a quarter of a mile from the Ngapara Station. The ground at this point is strewn with enormous blocks of fine conglomerate grading down into sandstone. The conglomerates have for the most part a ferruginous cement, which is very variable in consistency, and in no case very strong. There is a band of sandstone outcropping, which has also furnished a large number of the fallen blocks, and which has a hard siliceous cement. This stone would be excellent for the purposes required if it could be obtained in quantity, but it is only 6 ft. thick, being underlain and overlain by poorly consolidated conglomerates and sands. Moreover, the outcrop dies out laterally on each side in a few yards, although the hill-slopes are of such a nature as would yield a prominent escarpment if the rock continued uniform in hardness. The inference is that the siliceous cement which gives the necessary qualities to the stone is irregularly distributed, and quarrying operations at this point could only lead to disappointment. I did not on this occasion examine any other outcrops of similar rocks, as they are too far from the railway to be taken into serious consideration.

2. *Volcanic Rocks, Basalt Lavas or Dolerite Dykes (Bluestones), and Breccias (Rubble Stone).*

These rocks have a wide occurrence in the coastal part of the Oamaru district, being found for the most part immediately below the limestone, and even replacing it more or less completely in places (Target Gully), but there are similar rocks at a lower horizon (below the diatomaceous earth) in the Waiareka valley. Ash-beds (breccias and tuffs) preponderate, and lava-beds are limited in extent, and there are in addition a few dykes known.

The ash-beds are apparently all submarine, and have a calcareous cement. Their volcanic material is more scoriaceous and generally more decomposed than the bluestones, and the rocks depend for their powers of resisting erosion very largely on the nature of the cement. The bluestones are very suitable for the purposes required if they can be obtained in sufficient quantities.

(a.) *Basalt Lava (Bluestone), Oamaru Corporation Quarries, Oamaru Creek.*—This rock, though of good quality, is so thoroughly jointed that very few blocks of even 5 tons are obtained. The same statement applies to the rock farther up the creek where the new Corporation quarries are to be started.