

the anticlinal axis has an upward pitch, but from the summit of Mount Buckley the downward pitch to the south is resumed, so that the coal-measures speedily disappear beneath younger rocks. The western limb of the anticline dips on the average about 16° . The eastern side has a much steeper dip, in places approaching 90° .

The coal-measures of the Grey district are traversed by numerous faults. Some of these are of considerable magnitude, and add much to the difficulty and expense of opening out and working the coal-mines.

Age of Coal-measures.—The facts mentioned on a later page indicate that the coal-measures are separated by an unconformity from overlying beds of known Miocene age, and, on this account, they are considered to be of pre-Miocene age. The palæontological evidence has not yet been fully worked out, but so far as it has been determined is consistent with the view that a moderate time-break intervenes between the coal-bearing strata and the unquestionably Miocene beds.

Conglomerate.—The basal conglomerate of the coal-measures has been observed in a small creek on the south side of the Grey east of Brunnerton, and on the Paparoa Range near Mount Sewell. Other localities in which it is known to occur have not yet been visited. The constituent pebbles are grauwackes, occasional argillite or slate, and a little quartz. They are of large size towards the base of the conglomerate, but become smaller in the upper layers. Their derivation from the Greenland rocks on which the conglomerate unconformably rests is sufficiently obvious.

Grits and Sandstones with Coal-seams.—Grits and sandstones of probable fresh-water origin conformably succeed the conglomerate just described, which indeed to some extent is interbedded with them. The rocks under consideration are seen on the slopes of Mount Buckley, in the Brunner Gorge, and on the higher slopes of the Paparoa Range. The sandstones consist almost entirely of quartz grains, with a little mica. They graduate into grits, which again are often coarse enough to be more correctly termed fine conglomerates. The coal-seams associated with the beds just mentioned will be described under the heading of *Economic Geology*.

Island Sandstone.—Above the coal horizon comes a thick band of slightly calcareous yellowish-grey sandstone, well seen in the high cliff-faces near Brunnerton and Dobson. Owing to its forming a low rocky island in the Grey River opposite the Dobson Quarry, Sir James Hector gave this bed the name of Island Sandstone. The marine origin of the Island Sandstone is shown by its containing remains of echinoderms and molluscs, together with numerous imperfect casts of fucoid stems.

Dark-coloured Mudstones (with Minor Sandstones).—The mudstones of the coal-measures are usually dark bluish-grey rocks that weather to a dark-brown, buff, or purplish colour. They are often of a sandy character, and in places pass into a dark impure sandstone. They seldom exhibit distinctive strike or dip. As developed on the eastern side of the Paparoa Range, the mudstones have a great thickness, probably well over 3,000 ft.

MIOCENE BEDS.—The unquestionably Miocene strata of the Greymouth Subdivision have an estimated thickness of 3,600 ft. They are decidedly folded, and exhibit fairly well-marked anticlines and synclines with a general north and south trend. In the case of the anticline running southwards from Mount Buckley (a continuation of the Paparoa anticline previously mentioned), a quick downward pitch to the south has a considerable influence on the strike, and in other localities notable irregularities may be observed. The dip is usually gentle, but occasionally reaches 50° and 60° , and may even approach 90° . From the horizon of the Cobden Beds downward the Miocene strata may be correlated with the Oamaru Series of Hutton. The upper or Blue Bottom horizon is probably equivalent to Von Haast's Pareora Series.

So far as can be judged, there is no marked structural unconformity between the coal-measures and the Miocene strata, but the presence in the lower beds of the latter of numerous waterworn fragments of coal almost certainly derived from the known coal-measures indicates a marked break between the two sets of strata. It is therefore evident that in order to allow of the denudation of the coal-measures there must have been very decided elevation of some part of the land immediately preceding Oamaru times. Probably a certain measure of folding took place also, but proof of this is lacking.

Mudstones with Grit and Pebble Bands; Sandstones and Grits with Fragments of Coal.—In Rocky Creek (on the east side of the Paparoa Range) the almost uniform mudstones of the coal-measures are succeeded by another class of mudstones with grit and pebble bands. Of these beds there appears to be a thickness of not less than 1,100 ft. From their nature and on stratigraphical grounds they are thought to correspond in age with the beds next to be mentioned.

On the south side of the Grey, in the valleys of Kaiata, Racecourse, and Omotumotu Creeks, there are sandstones, grits, and mudstones that contain in many places numerous fragments and even bands of water-worn coal, a feature commented on above. The occurrence of waterworn pieces of coal in the Miocene rocks of this locality was noted by Mr. Alexander McKay as far back as 1873.*

Kotuku Conglomerate.—Two of the Lake Brunner Oil Company's bores at Kotuku, after passing through Miocene mudstones and limestone, entered conglomerate. In one of their bores (No. 9) this rock was penetrated for 256 ft. without being passed through. The diamond-drill cores obtained show that the conglomerate consists of pebbles of grauwacke, argillite, or slate, and granite. It is in general fairly fine, but towards the bottom of No. 9 bore boulders of some size were encountered. The Kotuku conglomerate may be correlated with a fault-involved bed of grit and conglomerate seen at the base of the Hohonu Range near the Teremakau Settlement.

Blue Mudstones.—Above the horizon of the beds last described comes a thick band of bluish mudstones, that often closely resemble typical Blue Bottom. They are well exposed on the west side of the Omotumotu Valley, and are seen also along the main road from Omotumotu to Greymouth. In the

* Geo. Survey Reports for 1873-74, Vol. viii, 1877, pp. 78, 79. See also "Report on Supposed Coal-seams in Kaiata Range, Greymouth," C.-10, 1901, p. 7; and *New Zealand Mines Record*, December, 1900, p. 203.