light oil, and hence may be of economic value for their distillation products. Associated with the carbonaceous shales are blue marls containing numerous Lamna teeth, generally blue with an incrustation of vivianite.

On the other side of the range, as shown in the accompanying plan, the limestones, clays, and coal-seams outcrop at about the same height (600 ft. to 700 ft.) as in the Tawhetarangi Creek. The most important coal-seam was about 5 ft. thick when first opened up, with an average north-east and south-west strike, and a flat dip to the east. On further working the seam soon diminished in size to a mere carbonaceous parting. The coal-measures, moreover, are here but a short distance above the slaty shales—a fact which, of course, precludes the possibility of a payable coalfield being developed.

The following is an average of several analyses of these coals made by the author :—

| | |
|---|---|
| Fixed carbon ... ... ... ... ... ... | 56·66 per cent. |
| Hydrocarbons ... ... ... ... ... ... | 2·81 " |
| Water... ... ... ... ... ... ... | 4·77 " |
| Ash ... ... ... ... ... ... ... | 35·76 " |
| | 100·00 |

Evaporative power: $56{\cdot}66 \times {\cdot}13 = 7{\cdot}36$ lb.

The fossils enumerated above assign to the sedimentary beds a position at the base of the Tertiary rocks, and they may hence be grouped with the Oamaru series of Hutton or the Cretaceo-tertiary series of the New Zealand Geological Survey.

Recently, however, the author has discovered a hitherto unknown outcrop of these beds at Waiaro, about four miles to the north of Cabbage Bay. It is situated at an elevation of 1,200 ft. above sea-level, and consists, so far as could be seen—for the dense bush renders investigation very difficult—of blue clays and shales, together with several seams of coal, the largest of which is 5 ft. in thickness. The lowest member of the series is a bed of blue shaly clay, which rests directly on the Palæozoic clay slates, here weathering to a white friable rock. At 40 ft. above the Palæozoic rocks is the main coal-seam, striking north to south, and dipping east at a fairly high angle. Above the main coal-seam are clays similar to those underlying, and containing small coal-seams and carbonaceous bands, and also a fine band of slate conglomerate corresponding to and closely resembling that occurring at Torehine, but differing in being composed of finer pebbles. The line of outcrop is approximately horizontal, and was traced for a distance of nearly a mile along the western slope of the range. The approximate thickness of the beds is 150 ft. (See Fig. 3.)

The coal in the large seam is highly carbonaceous, analysing as follows :—

| | |
|---|---|
| Fixed carbon ... ... ... ... ... | 82·47 per cent. |
| Hydrocarbons ... ... ... ... ... | 6·53 " |
| Water ... ... ... ... ... ... | 0·50 " |
| Ash ... ... ... ... ... ... | 10·50 " |
| | 100·00 |

The remarkable percentage of carbon in coal from this horizon seemed at first to indicate the presence of a dyke, metamorphosing the brown coal into its present anthracitic state; but on further investigation nothing of the sort could be found. It is therefore probable that the alteration is due to thrust movement along the coal-seam, and this is the more probable as the coal is parted by parallel layers of graphite which may represent the planes of movement.

Associated with the coal, and in dark carbonaceous shales, are well-preserved plant-remains, with the following characteristics: Fronds pinnate, probably of considerable length. Pinnæ narrowly lanceolate or obovate, some acutely pointed, some rounded at the ends. Texture probably coriaceous. Edges entire or finely toothed. Two distinct forms of pinnæ, possibly barren and fertile. Secondary nerves fork at an acute angle. (See Fig. 4.) This form I consider identical with the *Blechnum priscum** of Ettingshausen (*Alethopteris* of Hector?), allied to the living *B. occidentale* indigenous to Central America, and to the fossil *B. atavium* (Sap.) from the Sezanne beds. Forms also occur which may be referred to *Flabellaria sublongirachis* (Ettingsh.) and *Bambusites australis* (Ettingsh.). In a carbonaceous band found near the top of the series numerous dicotyledonous leaves occur which may be referred to *Fagus*. (See Fig. 5.)

On the whole, the above forms resemble markedly the fossil flora of the Pakawau beds, Nelson Province. Von Ettingshausen very strongly insisted on a Cretaceous age for these Pakawau beds, which are placed by the New Zealand Geological Survey at the base of the Cretaceo-tertiary. These land-fossils at Waiaro therefore contradict somewhat the evidence of the Torehine marine fossils, which are undoubtedly Lower Tertiary in age. Still, the Waiaro beds are certainly lower in horizon than the calcareous sandstones and limestones that furnish the Torehine fossils if these outcrops may be correlated by the bed of slate conglomerate—the lowest member at Torehine, and yet occupying a fairly high horizon at Waiaro.

## VIII.—Upper Eocene Volcanic Rocks.

This series is by far the most important in the Coromandel area, containing as it does the principal auriferous reefs. It consists of lavas, tuffs, and breccias, for the most part highly decomposed, but in places solid and unaltered. Dykes of this age are absent, or at any rate have not been recognised; the "dykes" of the miners consisting merely of zones of unaltered lavas. When fresh the andesites are dark-coloured, in places almost black, with no porphyritic constituents. A

* Ettingsh: Transl. Beitrage zur Kentniss der Fossilen Flora Neueeslands, Wien, 1887.