

## EXPLANATION OF PLATES XXVII.—XXVIII.

## PLATE XXVII.

View of southern end of lower moraine looking north-west.

## PLATE XXVIII.

View taken in depression between the upper and lower mounds, looking along the depression in a west-north-west direction.

---

ART. XLIII.—*On the Septarian Boulders of Moeraki, Otago.*

By A. HAMILTON.

[Read before the Otago Institute, 12th November, 1901.]

Plates XXIX—XXXV.

IN the year 1848 Mr. Walter Mantell, as Government Commissioner for the Settlement of Native Land Claims in the South Island, travelled on foot from Kaiapoi to the southern settlements of Otago. An interesting summary of his notes by the way was published by his father, Gideon Algernon Mantell, in the "Proceedings of the Geological Society" for the year 1850 (vol. vi., p. 319).\* On page 320 in that publication is a sketch-map of the geology of the coast-line so far as could be gathered from his daily observations and from information obtained from the natives, who at that time were fairly numerous. Names of rivers and coastal features are given from Kaiapoi to the Molyneux River. On reaching what he calls Onekakara Bay he gives a sketch taken a little south of Hampden, looking to the north, including the coastal features as far as the "White Bluff," and in the foreground is "a group of septarian boulders, called by the whalers 'The Ninepins.'"

Mr. Mantell says, "Midway between the bluff and Moeraki the clay contains layers of septaria varying from 1 ft. to 5 ft. and more in diameter. Hundreds of these nodules, which had been washed out of the undermined clay cliffs by the encroachment of the sea, were scattered along the beach. Some were subglobular, others spherical, many were entire, whilst others were broken and glittered with yellow

---

\* "Notice of the Remains of the *Dinornis* and other Birds, and of Forest and Rock Specimens recently collected by Mr. Walter Mantell in the Middle Island of New Zealand, with Additional Notes on the Northern Island, by Gideon Algernon Mantell, Esq., LL.D., F.R.S., G.S., &c. With Note on Fossiliferous Deposits in the Middle Island of New Zealand, by Professor E. Forbes, F.R.S., &c."

and brown crystals of calcareous spar, with which all the hollows of the septaria were lined or filled. Some of these masses were hollowed out by the action of the waves into regular basins, which at lowtide stand up from the sands full of water, and are 3 ft. or 4 ft. deep."

He then notices the zones or belt of cone-in-cone clay with which they were encircled, and gives diagrams and sections. The diagram is interesting as showing a fragment of bone, not in the centre, as a nucleus, but close to the outer edge. The septarium is a small one in this instance, being 2 ft. in diameter, and the piece of bone enclosed ran straight into the mass. The fragment of bone was flattened,  $1\frac{1}{2}$  in. in longest diameter; "its cancellated structure appears to resemble that of the moa." A note appended by Dr. Mantell (see below) states that slices prepared for examination under the microscope showed the bone to be avian. It would be of great interest to have the fragment re-examined, as neither Dr. Mantell, Mr. Tomes, nor Mr. Bowerbank do more than state that the microscopical characters show that the bone belonged to a bird. Dr. Mantell was not aware at that time of the occurrence of reptilian bones in nodules and boulders at Katiki, the Amuri Bluff, and in similar beds in other places. The probabilities are, I think, more in favour of its being reptilian than moa, more especially as no moa-bone has since been found in beds of equal age. The fragment is, I believe, still in the British Museum.

Since their discovery the remarkable character of these septaria has attracted successive generations of visitors, and nearly all the smaller specimens have been removed to adorn(?) the corners of paths and the grottoes of the suburban villas of the ingenious. Many years ago an attempt was made by the late Mr. J. T. Thomson to manufacture cement from them, a proceeding probably suggested by the analysis given by Dr. Mantell, and made at the Museum of Practical Geology in London, showing 66.7 per cent. of carbonate of lime. Dr. Mantell also compared them with the septaria extracted from the London clay on the coast of Sussex, which are made into first-class Roman cement. They occur in abundance in the Isle of Sheppey, and are dredged for off Harwich and in Chichester Harbour.

Judging from the sketch given by Mr. Mantell, the septaria were at the time of his visit well exposed. At the present time the sand appears to shift very frequently, and at times nearly covers the boulders. My photographs (see plates) were taken at lowtide, and show that at present about half of each stone is visible. There is one well down between tide-marks which is much broken on the landward

side, and has in its hollow a most charming natural aquarium, the sides and bottom of which are thickly lined with Sabellids, sponges, and beautiful sea-anemones (see Plate XXXII.). Mr. Mantell, with the feelings of a weary, footsore, pedestrian explorer, exclaims, "What an excellent footbath!"—a suggestion practical if not poetical. There is one very large specimen still imbedded in the clay cliffs about 50 ft. above tide-mark, but I could not see any of the smaller sizes. The majority of those between tide-marks are encircled with a thick coating of the small blue-black *Mytilus*, and the bare portion is partly covered with a vivid-green *Alga*, which contrasts with the mussels. Those above tide-limits are weathered to a greyish-brown, and in some cases the hard calcite filling the septæ, or cracks, stands out in relief, being less easily acted upon by the weather. Four or five large specimens have fallen to pieces and show the interior to be a hard blue clay or limestone, and numerous exterior layers, which show more and more the cone-in-cone structure as they approach the surface.

The Maori has localised the tradition of the loss of the celebrated canoe "Arai-te-Uru" in the neighbourhood by pointing out the long reef just south of Port Moeraki as the canoe, and the cargo may still be seen strewn on the beaches, a huge elongated concretion being the *hinaki*, or eel-basket, of Hape-ki-taurake and the slave Puketapu.\* The globular septarian boulders are the calabashes which held the supply of water for those in the canoe, and a number of strangely shaped ferruginous concretions which occur to the south of the headland at Katiki are the kumaras washed ashore from the wreck. Mr. Mantell speaks of these "kumaras" as "nodules containing a far larger amount of iron and less lime than those before mentioned. The spot is known to the whalers as 'Vulcan's Foundry.'"

These Katiki Beach boulders are also much in request for garden ornamentation. The natural red-brown colour is often improved(?) by a coat of white paint or white-wash.

Mr. Shortland visited this part of the coast in the early days and notices the story of the canoe and the kumaras, but does not seem to have seen the larger groups of septaria to the north.†

From the geological or stratigraphical point of view the boulders have been frequently referred to in the Reports of the Geological Survey. In 1862 Sir James Hector indicated the position of the Moeraki septaria beds in a paper on the

---

\* Canon Stack: "Traditional History of the Southern Maoris" (Trans. N.Z. Inst., x., 61).

† Shortland. "Southern Districts of New Zealand," p. 190.

geology of the Manuherikia Valley, and also in 1864, when he determined the succession of the beds in the Shag Point district. Sir Julius von Haast reported on the Shag Point coalfield in the Geological Reports for 1873-74, page 25, and Captain Hutton, describing the Waipara formation in the geology of Otago, refers to the septaria of Moeraki. Another colonial geologist, Mr. Cox, in his report of 1877, refers to their stratigraphical position in connection with the Shag Point series of beds. Still later Mr. McKay examined the geology of the coast-line from Moeraki Peninsula to Kakanui,\* and states that "overlying the lower greensands are some dark muds or carbonaceous clays more than 100 ft. thick, which in these lower beds contain the celebrated Moeraki boulders, which, whether spheroidal or flattened, are usually enveloped in a coating of cone-in-cone limestone."

Flattened boulders covered with cone-in-cone limestone are seen in the bed of the Little Kini Creek, opposite Hampden Railway-station. The beds containing boulders reach the beach at the mouth of the creek; but there they are mostly flattened, and it is only when seen further south within tide-marks that they take the perfectly spheroidal form. There are also spherical and elliptical ferruginous concretions on the Katiki Beach, on which a few saurian remains have been found.

In the report for 1890-91, page 47, Mr. McKay has a humorous and lucid description of the difference between the grey and the brown "boulders."

Sir James Hector also refers to them in his appendix to the same report (page 173). Captain Hutton, in his "Sketch of the Geology of New Zealand,"† includes the beds in his Pareora system.

#### *Analysis of Moeraki Boulder.*

Carbonate of lime	...	...	66·7
Silica ...	...	...	16·2
Alumina ...	...	...	10·4
Peroxide of iron	...	...	4·7
Organic matter ...	...	...	2·0
			100·00

Contained when received 2 per cent. of water.

#### *Note on the Fragment of Bone referred to above.*

The external form of this fragment conveys no idea of its nature; but slices carefully prepared for the microscope

\* Rep. of Geol. Survey, 1886-87, p. 223.

† Quart. Journ. Geol. Soc., May, 1885.

present, under a moderately magnifying power, a structure which shows that the bone belonged to a bird. There is, however, no proof that it can be referred to the *Dinornis*. Mr. Tomes and Mr. Bowerbank, who have obliged me by examining the specimen, concur in this opinion. Insignificant as this fact may appear, still, in these early pages of the palæontological history of our antipodean colonies, it is worthy of remark that the first-discovered fossil relic of the terrestrial Vertebrata in the Tertiary strata of New Zealand should belong to that class which, in later periods, constituted the principal types of the warm-blooded animals of the fauna of that country, to the almost entire exclusion of the Mammalia.—G. A. M.

## DESCRIPTION OF PLATES XXIX.—XXXV.

Plate	XXIX.	Moeraki Beach, with septaria.	
Plate	XXX.	"	"
Plate	XXXI.	"	"
Plate	XXXII.	"	" weathered.
Plate	XXXIII.	"	" decomposed.
Plate	XXXIV.	Cone-in-cone limestones.	
Plate	XXXV.	"	"

ART. XLIV.—*Note on an Artesian Well at Aramoho.*

By J. T. STEWART, C.E.

[Read before the Wellington Philosophical Society, 6th August, 1901.]

ABOUT three miles above Wanganui, on the Wanganui River bank, a 4 in. bore has been made by Mr. John Walker, jun., in search of water. There is, of course, much speculation as to where the water comes from. It is struck under a layer of papa (280 ft. thick), and water was struck at bottom of this layer, at 540 ft. below the surface, in a layer of sand intermixed with pumice sand. The surface here may be 30 ft. to 40 ft. above the sea. Perhaps the water gets under the main papa stratum where it has been pierced by the volcanic heights about Ruapehu and Tongariro and follows down under the papa formation to where found. I found the temperature of the water coming out of the pipe at the surface to be  $70\frac{1}{2}^{\circ}$  Fahr., while the adjoining river-water was  $42^{\circ}$  at 6 ft. under the surface. The temperature in the shade at the time was  $45^{\circ}$ .

A few years ago a 2 in. bore was put down at the same