III.—GEOLOGY.

Art. XXXIX.—*On the Age of the Orakei Bay Beds near Auckland.*

By Captain F. W. Hutton, F.G.S.

[*Read before the Philosophical Institute of Canterbury, 27th November*, 1884.]

In his lecture on the geology of the Province of Auckland, delivered to the members of the Auckland Mechanics' Institute, on 24th June, 1859, Dr. von Hochstetter, after describing the brown coals of the Province, and the tertiary strata on the west coast from Waikato to Kawhia, said that "the horizontal beds of sandstone and marls which form the cliffs of the Waitemata and extend in a northerly direction towards Kawau, belong to a newer tertiary formation."* This he considered to be of miocene age, but fossils were obtained only at Orakei Bay, and in an ash-bed at Wangaparoa. Subsequently, on his return to Europe, Dr. von Hochstetter followed Dr. Zittel in placing the "Waitemata series" with the west coast or "Aotea series," but he considered both as older miocene.† Dr. Stache, however, considered the Aotea series to be oligocene,‡ and Dr. Zittel considered it to be eocene.§

The first attempt to ascertain the relative age of these two series by stratigraphical evidence was made in a paper read to the Auckland Institute on 8th August, 1870.‖ In this paper I showed that the Waitemata series can be traced eastward beyond the Tamaki and Howick to Turanga Creek, where it consists of a set of yellow clays and white or pale yellow sandstones, stained in places by iron oxide. It rests here unconformably on a dark green or bluish sandstone, generally showing a concretionary structure, which can, in its turn, be traced nearly to the Papakura River, and on the other side of the valley it reappears, on the north side of the Hunua hills, where it is associated with the Papakura limestone, and, with other beds, forms the "Papakura series," which rests unconformably on the coal series of Drury. Consequently the Waitemata series is separated from the coal series of Drury by two unconformities. The Papakura series was considered to be the equivalent, or very nearly the equivalent, of the Aotea series, and to be of oligocene age, while the Waitemata series was considered as miocene.

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* Geology of New Zealand, Auckland, 1864, p. 26.

† Reise der Novara, Geology, I., p. 34. ‡ Reise der Novara, Palæontology, p. 298.

§ On the Palæontology of New Zealand, Quar. Jour. Geol. Soc., xix. (1863), Misc., p. 20.

‖ Trans. N.Z. Inst., iii., p. 244.

In June 1875, Mr. S. H. Cox, in his report on the Raglan and Waikato districts,* said that the sandstones and clays of Mercer were probably the equivalents of the Waitemata series, and he considered them to form part of Dr. Hector's cretaceo-tertiary formation, now called the "Waipara System;" at the same time saying that "the fossils do not absolutely fix them as such." This is certainly very true, for the only fossil in his list of any chronological value is *Dentalium nanum*, Hutton, which is found in the pliocene beds at Wanganui and Petane. In his further report, however, Mr Cox says that "they are in this locality the higher member of the Leda marls."† In 1879 Mr. Cox was sent to examine the country from Auckland northwards; tracing the Waitemata series towards the Kaipara and Cape Rodney, he found that it gradually changed into greensands mixed with much volcanic ash, and that at Mahurangi and at Komiti Point, in the Kaipara District, it rested unconformably on "chalk-marls and hydraulic limestones," thought to be of cretaceo-tertiary age. This, together with the fossils found at Komiti in the Waitemata series, led him to alter his former opinion, and to consider the Orakei Bay Beds as lower miocene.‡ Dr. Hector in his Progress Report for the same year demurs to this conclusion and suggests that the Waitemata series ought to be divided at the horizon of a volcanic ash bed in the cliffs under Parnell, which he calls the "Parnell Grit;" all below this bed, including the strata at Orakei Bay, being still retained as cretaceo-tertiary: his reason being that *Pecten zittelli*, Hutton,§ and many other Orakei Bay fossils are found at Komiti Point only in sandy marls and grits which underlie tufaceous beds containing a number of lower miocene forms.‖ Mr. Cox, however, who collected the fossils, says distinctly in his report that "these beds [i.e., the marly grits] curiously enough contain, *associated with a great preponderance of lower miocene forms*, the *Pecten zittelli*, Hutton, and *P. fischeri*, Zittel, of Orakei Bay, on the occurrence of which we have ascribed a cretaceo-tertiary age to these beds,"¶ and he does not mention any fossils in tufaceous beds.

In the following year Mr. Cox was sent to re-examine this point, but he reported that he was more than ever convinced of the correctness of his last year's work, although he thought it possible that the Waitemata series might be of eocene age.** He examined the cliffs from Auckland to Orakei

* Reports of Geological Explorations, 1874-76, p. 9.

† Reports of Geological Explorations, 1876-77, p. 22.

‡ Reports of Geological Explorations, 1879-80, p. 37.

§ Dr. Hector and Mr. Cox often call this shell *Pecten pleuronectes*; it seems therefore necessary to point out that *P. pleuronectes*, L., is a living species which has never been found in New Zealand.

‖ *l.c.*, p. xii. ¶ *l.c.*, p. 17. On page 33 he gives a list of these fossils.

** Probably influenced by his mistake of supposing that nummulites occur at Orakei Bay. (Reports 1879-80, p. 25.)

Bay, and reported that "the sequence between Fort Britomart and Orakei Bay is sufficiently conclusive to make it a matter of certainty that no stratigraphical break occurs above the horizon of the Orakei Bay fossils, which are again seen at Komiti Point."* He also gives a section of Komiti Point, and says, "At Komiti Point, again, a gritty bed occurs at the base of this [older tertiary] series, resting quite unconformably upon the upturned edges of the chalk-marls [cretaceo-tertiary]; and it was from the lowest bed of this series that my collection of fossils was made last year. After passing round the first point and reaching a small bay beyond, a second fossiliferous bed comes in, which is about 100 feet higher in the vertical sequence than the fossiliferous bed first mentioned. This bed corresponds entirely with the fossiliferous deposit at Orakei Bay, Auckland, containing the same fossils, and being of precisely the same character; and these beds pass up again into regularly stratified sandstones and marls, which continue until just before the far point is reached, where beds of consolidated sand come in with lignitiferous deposits and old timber partially carbonized."† It thus appears that Orakei Bay fossils are also found 100 feet above the bed which contains *Pecten zittelli* and *P. fischeri* mixed with miocene fossils; and that there are no tufaceous beds in the locality.

On the 30th June, 1881, Mr. Cox again reported on the position of the Orakei Bay beds. He followed them this time eastward towards Mareitai and found that at Turanga Creek they rested on a green "concretionary tufaceous sandstone" which is underlaid by clay marls and calcareous sandstone.‡ . His section shows the Waitemata series conformable to this green sandstone, but in his report he says that it is unconformable, and his map shows a decided unconformity between the two, as the Waitemata series is made to overstep the green sandstone and to lie on the older slates. I may remark that this map agrees closely with an unpublished one which I made in 1866, and which Mr. Cox had not seen.

In October, 1883, Mr. A. McKay was sent to investigate the question. He reported in favour of Dr. Hector's opinion that the Waitemata series consists of two distinct formations of different ages;§ and Dr. Hector in his Progress Report for the same year, in mentioning the coal at the Whau, speaks of "the lower miocene series that overlie unconformably the 'Waitemata beds' of Hochstetter (taking the Orakei Bay beds as his type)."‖ Mr. McKay's report however has not convinced me that Dr. Hector is right, and I wish to make a few remarks upon it.

Mr. McKay mentions "bands of soft marly sandstone, parted by beds of soft crumbling sandy marl of darker colour," as forming the beds at Point Britomart, which, he says, pass under the Parnell grit; and he describes

* Reports of Geological Explorations, 1881, p. 27. † *l.c.*, p. 23. ‡ *l.c.*, p. 95.
§ Reports of Geological Explorations, 1883-84, p. 101. ‖ *l.c.*, p. xviii.

the beds above the Parnell grit at Parnell as "yellowish sands and sandy clays easily distinguished from the beds underlying the grit bed," and from this he concludes that "there is a marked distinction in the character of the beds overlying and underlying the Parnell grit."* This statement I may be allowed to question. In 1866 I examined these rocks at the typical locality at Parnell and found that at the east point of St. George's Bay the volcanic ash, called by Dr. Hector the Parnell grit—here about 15 feet thick—is overlaid by a bed of yellow sandstone above which comes a set of false bedded sandstones and shales. It is underlaid by another set of yellow sandstones and shales, also false bedded, below which is a greenish sandstone going down to low water-mark. At Resolution Point the Parnell grit, greatly reduced in thickness, rests on a thin bed of clay, below which is a thick stratum of yellow sandstone; the ash of the Parnell grit is much mixed with the clay, and the two beds are certainly quite conformable. Above the Parnell grit comes a set of thin-bedded sandstones and clays, and on the west side of Hobson's Bay these are seen to be covered by a thick stratum of clay. Thus in a distance of 600 yards the series, both above and below the Parnell grit, has altogether changed its appearance. The rocks at Point Britomart do not contain any beds of marl, as stated by Mr. McKay, and they do not correspond exactly with the rocks either above or below the Parnell grit at Parnell, but are more like the beds above the Parnell grit in Hobson's Bay. This, however, is a matter of little importance, for all the rocks of the Waitemata series are so local that lithological evidence cannot be trusted for correlating beds a few hundred yards apart, and I do not understand how Mr. McKay can, in the absence of fossils, "easily identify" the rocks north of Lake Takapuna with those underlying the Parnell grit at Parnell, which are five miles off.

Again, Mr. McKay gives no stratigraphical evidence in favour of the Orakei Bay beds being older than the Parnell grit. He commences by assuming, without giving any reason, that the beds at Point Britomart are the Orakei Bay beds, and then says that at St. George's Bay they pass under the Parnell grit. Both these statements may, however, be questioned. I will take the second first. On the east side of St. George's Bay

* *l.c.*, p. 106. Mr. McKay also says that "this is made perfectly clear by Mr. Cox in his report already cited." Mr. Cox, however, says that the beds both above and below the Parnell grit are sandstones and sandy marls "which occur throughout the series,' but the grit represents the commencement of the volcanic outburst which attained its greatest development near the Manukau Heads, the higher beds being notable for the great abundance of the volcanic material which is mixed with the sand and clay. So that, in the absence of volcanic ash, the upper and lower beds, according to Mr. Cox, cannot be distinguished. On page 27 of the same report Mr. Cox also says that the beds *above* the Parnell grit at St. George's Bay have "a similar but more indurated character" to the strata of Fort Britomart.

the Parnell grit dips southerly and reaches the sea-level some distance from the head of the bay, so that all the rocks at the head of the bay must lie above it. On the west side of the bay the Parnell grit is not seen; and, in my opinion, it either thins out or passes below the Point Britomart beds. As, however, the section has two breaks, one in St. George's Bay and the other in Mechanic's Bay, nothing certain can be made out; but it is worthy of notice that the beds above the Parnell grit on the east side of St. George's Bay contain plant remains, as also do those at Point Britomart. Next, with regard to Mr. McKay's first statement: To the east of Parnell, between Resolution Point and Hobson's Point, there is a break across Hobson's Bay, a mile in length, in which nothing definite can be seen. It is, therefore, quite impossible for any one to say, from stratigraphical evidence, whether the beds at Hobson's Point are above or below the horizon of the Parnell grit, and consequently whether they are or are not the equivalents of the Point Britomart beds. It is indeed probable that, on the whole, the rocks of the Waitemata series get younger to the westward; but, although usually nearly horizontal, they are subject to strong local disturbances—as at Cape Horn, Freeman's Bay, Wangaparoa, and Parnell,—and it is as likely as not that the very oldest beds in the series may have been brought up at Parnell.

Neither can Mr. McKay produce any evidence of an unconformity below the Parnell grit. He says, "Respecting the question of an unconformity between the Orakei Bay beds and the higher miocene rocks, I should submit that, when estuarine muds and soft sandstones are suddenly succeeded by coarse volcanic agglomerate, there is, by whatever degree the unconformity is measured, most surely unconformity to a certain extent; and when it is determined that the beds above and below belong to different groups of formations—*e.g.*, the cretaceo-tertiary and the miocene—although no stratigraphical unconformity were apparent, the conclusion that there is such cannot be escaped."* Accordingly in his section from "Auckland north to Wade" he shows the Parnell grit highly unconformable to the underlying beds. The idea that an outbreak of volcanic energy must necessarily mark an unconformity may be passed over in silence; but if Mr. McKay had proved that the two sets of beds belonged to two different formations of very different ages, then all would allow that an unconformity was probable although it might not be apparent. But this is just what Mr. McKay has not done. He recognizes the few fossils found north of Lake Takapuna, above a bed supposed to be the Parnell grit, as miocene, and says that they differ from those found at Orakei; but he makes no reference to the fact that Mr. Cox had found the Orakei fossils mixed with miocene shells at

* *l.c.*, p. 106.

Komiti Point; and he makes no attempt to prove that the Orakei Bay beds are of cretaceo-tertiary age. He certainly says that the Mercer beds, which are generally thought to be the equivalents of the Waitemata series, "close the sequence of rocks succeeding the cretaceo-tertiary coal formation;" but this is a pure assumption unsupported by any evidence and abandoned by Mr. Cox as disproved.*

Mr. McKay also ignores altogether the opinion of the European palæontologists who have examined the fossils from Orakei Bay. Professor Rupert Jones examined the *Foraminifera*, and thought that they indicated a late tertiary period.† In the Palæontology of the Voyage of the Novara Herr Karrer says that these *Foraminifera* are probably of the same age as the Vienna Basin—*i.e.* miocene,—and Dr. Stoliczka thinks that the *Bryozoa* indicate a miocene or perhaps older pliocene age; while Professor Martin Duncan thinks that the Orakei Bay beds are probably the equivalents of the Mount Gambier series of South Australia, which he calls middle cainozoic,‡ and which are considered by all Australian geologists to be miocene. So that four well-known palæontologists all agree that these beds are not older than miocene.

The reason why the Orakei Bay beds were considered by the Geological Survey to be of cretaceo-tertiary age is stated by Mr. Cox. He says it was because *Pecten zittelli* and *Pecten fischeri* occurred in them; and he further says that "we have always considered *P. zittelli* to be a typical fossil in the cretaceo-tertiary series—indeed, to be almost confined to the *Leda* marls; and now to find it associated with a large number of Pareora fossils is apt to throw discredit on those fossils which we have considered as distinctive of any special horizon."§ But I am not aware that either of these species of *Pecten* has ever been found associated with cretaceous fossils. Both were described from rocks at Papakura, considered by Dr. Stache to be oligocene, and by Dr. Zittel to be eocene. *P. zittelli* also occurs at Cape Kidnappers|| in beds acknowledged both by Dr. Hector¶ and by Mr. McKay** to be miocene, and the finding of both species by Mr. Cox, in 1880, with acknowledged miocene fossils at Komiti Point, proved decisively that neither species can be taken as characteristic of cretaceo-tertiary rocks.

But there is still another point altogether omitted in Mr. McKay's report. If the "marly grits" containing Orakei Bay fossils at Komiti Point belong to

* Reports of Geological Explorations, 1881, p. 36.

† Quar. Jour. Geol. Soc., xvi., p. 251 (1860).

‡ Quar. Jour. Geol. Soc., xxvi., p. 316 (1870).

§ Reports of Geological Explorations, 1879-80, p. 17.

|| Cat. Tertiary Mollusca of New Zealand, 1873, p. 32.

¶ Reports Geol. Exp., 1877-78, p. 190.

** Rep. Geol. Exp., 1874-76, p. 49, and Rep. Geol. Exp., 1878-79, p. 70.

the Waipara System, what is the age of the "chalk-marls and hydraulic limestone" which underlie them unconformably? These are also considered by Dr. Hector and Mr. McKay to be cretaceo-tertiary, and certainly they are not like any rocks in New Zealand that are older than the Waipara System. Again, if the Orakei beds belong to the Waipara System, what is the age of the green sandstones of Turanga and Papakura, which both Mr. Cox and myself have shown to underlie the Orakei Bay beds unconformably? Dr. Zittel considered the Papakura series to be of eocene age, that is, to belong to the Oamaru System, and if this be correct the Waitemata series must belong to the Pareora System. This conclusion is quite in accordance with the evidence, both stratigraphical and palæontological, at Komiti Point, and at Mahurangi, and is not contradicted by the fact that the Mercer beds are apparently conformable to the underlying marls, for it is quite possible that two systems may be conformable at one place although unconformable at other places.

It appears then (1.) That there is no evidence that the Orakei Bay beds are older than the Parnell grit; they may or may not be so; (2.) That there is no evidence of any unconformity in the Waitemata series between Auckland and the Tamaki; and (3.) That the evidence, both stratigraphical and palæontological, is altogether in favour of the Orakei Bay beds belonging to the Pareora System.

ART. XL.—*Descriptions of new Tertiary Shells.* PART I.

BY CAPTAIN F. W. HUTTON, F.G.S.

[*Read before the Philosophical Institute of Canterbury, 27th November*, 1884.]

Plate XVIII.

DURING the past year I have received several collections of fossils from Mr. S. H. Drew, of Wanganui, and from Mr. A. Hamilton, of Petane, near Napier, and I now offer descriptions of the new species so far as I have made them out. There are, in addition, a few species which, although not known in New Zealand, are living in Australia or Polynesia, e.g. *Drillia alabaster*, Reeve.

Ringicula uniplicata.

Shell minute, ovate, transversely finely striated. Whorls 4, those of the spire small and smooth. Aperture narrow, obliquely notched in front; the outer lip thickened, varicose; columella with a strong anterior plication.

Length, ·08 inch.

Locality. Petane.