tion of Mr. McKay's arguments in favour of unconformity between the Hutchinson's Quarry beds and the Ototara limestone remains intact, although I now, for other reasons, think his conclusion probable. The only alteration necessary to make in my paper is to erase the words I have italicised in the following sentence:—"Cape Oamaru is formed by an old volcano, *which has broken through the Ototara limestone, and was active when the marine beds of Hutchinson's Quarry were being deposited.*" (*l.c.*, p. 561.)

Art. LV.—*Note on the Geology of the Valley of the Waihao in South Canterbury.*

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

[*Read before the Philosophical Institute of Canterbury, 6th May*, 1886.]

In 1875, Dr. von Haast sent to the Otago Museum a collection of fossils from Whiterock River; Mount Harris; Point Hill, Waitaki; and Waihao Forks, with the request that I would examine them. The results of my examination went to show that the whole collection belonged to the Pareora System.* Dr. von Haast agreed with me as to the age of the fossils from the first three localities, but had doubts about those from the greensands at Waihao. He says: "These greensands are overlaid by calcareous greensands with all the characteristic fossils of the Oamaru formation, on the edges of which the Pareora formation reposes unconformably; consequently a careful study of the more extended collections from these beds is needed to settle this point to my satisfaction."† In October, 1880, Mr. A. McKay examined the district for the Geological Survey of New Zealand. In his report he classes these beds, which he calls "marly greensands," with the cretaceo-tertiary series of the Survey, and in his map he marks them as lower cretaceo-tertiary.‡ He thus agrees with Dr. von Haast that they underlie the Waihao limestone, but he makes no reference to the disagreement between the palæontological and the stratigraphical evidence, and appears to see no difficulty at all in the structure of the district. Last year I examined the collection of fossils in the Canterbury Museum from Waihao, and in December I paid a visit to the district to try to clear up the difficulty.

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* "Trans. N.Z. Inst., vol. ix., p. 594.

† "Geology of Canterbury and Westland, 1879," p. 315.

‡ "Reports of Geological Explorations for 1881," p. 71.

The right bank of the Waihao River, from a little above the Forks down to the bridge by which the road from Arno to Waikakahi crosses the river—a distance of about three miles—is formed by rocks of the Oamaru System. A northerly extension of these rocks, rather more than a mile in breadth, crosses the river about half a mile below the Forks; so that, for this distance, the Oamaru System* forms both banks of the river. On these points all are in agreement. The rocks belonging to the Oamaru System here are—

3. Pale-yellow arenaceous limestone, about 50 feet thick, known as the Waihao limestone.
2. Calcareous sandstone, with green grains, 150 feet.
1. Dark-grey marl, getting more sandy at the top, with ferruginous bands or veins; thickness, 50 feet +; contains *Pecten zittelli*.

No rock is seen to underlie this marl anywhere between the forks of the Waihao and its mouth.

On the left bank of the river, both above and below this northerly extension of the Oamaru System, we find thick (200 feet +) beds of soft dark-green or grey argillaceous sandstone, sometimes with calcareous concretions, and containing numerous fossils (*see* fig.) It was from these beds that Dr. von Haast collected the fossils sent me in 1875. They are also the "marly-greensands" of Mr. McKay's report. The point to be settled is: Do these greensands underlie the marl of the Oamaru System? or do they lie unconformably against the eroded edges of that system?

The palæontological evidence is decidedly in favour of the second of these suppositions, as the following list of fossils from the Waihao Forks will show:—

1. Teeth of crocodile (?).
2. *Aturia ziczac*, Sowb.
*3. *Siphonalia nodosa*, Martyn.
*4. *Ancillaria australis*, Sowb.
5. *Ancillaria hebera*, Hutton.
*6. *Voluta corrugata*, Hutton.
*7. *Pleurotoma fusiformis*, Hutton.
*8. *Pleurotoma buchanani*, Hutton.
*9. *Pleurotoma awamoaensis*, Hutton.
*10. *Clathurella hamiltoni*, Hutton.
11. *Natica gibbosa*, Hutton.
12. *Natica hamiltoni*, Tate.
*13. *Natica suturalis*, Hutton.
14. *Dentalium mantelli*, Zittel.

* For a list of fossils found in these rocks, and a discussion as to their age, *see* "Quar. Jour. Geol. Soc. of London," vol. xli., p. 559.

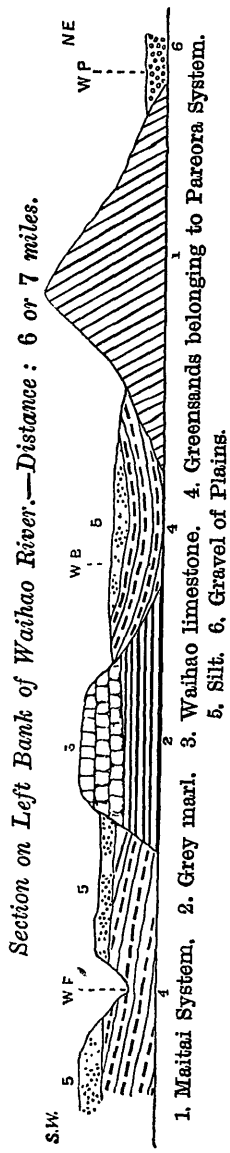
15. *Teredo heaphyi*, Zittel.
*16. *Leda fastidiosa*, Adams.
17. *Pecten hochstetteri*, Zittel.
18. *Flabellum circulare*, Tenison-Woods.

Of these 17 species, all have been found in rocks of Pareora age except *Leda fastidiosa*, which is a recent species, only known fossil at Wanganui, and *Flabellum circulare*, which, however, occurs in both the Oamaru and Wanganui Systems. The nine species marked with an asterisk are not known anywhere in rocks older than the Pareora. *Ancillaria hebera*, *Natica gibbosa*, and *Dentalium mantelli*, are common Pareora species, but rarely found in the Oamaru System. *Aturia ziczac* occurs in Europe and in North America in the upper eocene and lower miocene only; in Australia it is found, according to Professor McCoy, in the oligocene, the miocene, and the pliocene. Consequently the palæontological evidence is decidedly in favour of these greensands belonging to the Pareora System.

The stratigraphical evidence is not so satisfactory, for no clear sections exist. It is possible—from a stratigraphical point of view—that these greensands might pass under the marl of the Oamaru System, although they occur at a higher level than the marl; because there is some evidence that the northerly extension of the Oamaru System lies in a flat syncline. But in no case are they seen either to pass below the marl or to lie upon it; consequently the palæontological evidence must be taken as proving the superior position of the greensands.

Mr. McKay, in making out his case, says (*l.c.*, p. 72) that at Elephant Hill these greensands are succeeded directly by the Pareora System, which would be quite in accordance with the view that they themselves belong to that system; but Mr. McKay, in his section, shows an unconformity between them. This unconformity, however, does not appear to have been directly observed by Mr. McKay; and his section is evidently a hypothetical illustration of his views, and not a simple record of observed fact. This is at once seen by looking at his section, which is an impossible one. Mr. McKay says: "In the section above sketched, the marly greensands terminate at a peculiar fucoidal band, which in the Waihao River is seen to occupy the middle part of these greensands; the succeeding beds are the characteristic marine part of the Pareora formation, and unconformity *is therefore manifest at this point.* Not half a mile distant from the point of unconformity represented above, the lower part of the section is complete as high in the series as the Waihao limestone, which is overlaid unconformably by the Pareora beds. On the south side of the Maerewhenua River the marly greensands and coal rocks underlie in direct sequence the Maerewhenua limestone, and at no point do they come in contact with marine tertiary rocks" (*l.c.*, p. 73).

I have elsewhere examined Mr. McKay's statements as to the age of the greensands at Maerewhenua and Wharekauri,* and I will here only remark that he gives no evidence to show that they are the equivalents of the greensands at Waihao. Indeed, unless his *Nautilus danicus* is *Aturia ziczac*, he does not mention a single species common to both. For the present, therefore, the position of the Maerewhenua greensands cannot be taken as furnishing any evidence of the age of the greensands at Waihao.



Section on Left Bank of Waihao River.—Distance: 6 or 7 miles.

1. Maitai System. 2. Grey marl. 3. Waihao limestone. 4. Greensands belonging to Pareora System. 5. Silt. 6. Gravel of Plains.
W.F. Waihao Forks. W.B. Waikakahi Bridge. W.P. Waimate Plains.

With reference to the first part of the paragraph I have quoted, not much weight can be attached to the position of the "peculiar fucoidal band," which is not mentioned elsewhere by Mr. McKay, and if unconformably overlain, could not always form the top of the greensands here. The evidence for the unconformity really rests on the absence of the Waihao limestone at this place, although found half a mile off. This, however, proves nothing; because it is the relative position of the limestone and the greensands which is the doubtful point; and to introduce an unconformity into the section because the limestone is absent, is to assume as true the very point which it is wished to prove.

Another exposure of the Oamaru System occurs on the right bank of the Waihao River just before it enters the plains. The rocks here are much obscured, and I failed to make out the section given by Mr. McKay. To me it appeared more like an inlier, surrounded unconformably by the Pareora System. According to Dr. von Haast, the Pareora System fills up valleys denuded out of the Oamaru System north of Elephant Hill,† and there is no difficulty at all in supposing that these Pareora rocks cross both the south and north branches of the Waihao, and wrap round the rocks of the Oamaru System as far as the Waimate Hills. The annexed woodcut illustrates my view of the relation of the rocks, but it is of course to some extent hypothetical, as no positive stratigraphical evidence is available.

* "Quar. Jour. Geol. Soc. of London," vol. xli., pp. 558 and 562.

† "Geology of Canterbury and Westland," Sheet of Sections No. 5, Section No. 4.