NOTES ON THE GLACIAL BEDS OF FREE-STONE-BLUFF (SANDY COVE) NEAR WYNYARD. (PL. IX., X., XI., XII.)

By Fritz Noetling, M.A., Ph.D., etc.

(Read October 18th, 1909.)

(1) HISTORICAL SUMMARY.

The first description of the geological features of the coast near Wynyard was given forty years ago by Mr. T. Stephens (1) in a paper read before this Society. In this paper Mr. Stephens drew special attention to the conglomerates at the mouth of the Inglis, and, after mentioning the occurrence of large angular blocks of granite and porphyry, he goes on to say—"These massive blocks of granite and other rocks which are not now found in situ within several miles of their present position, I consider to furnish more conclusive evidence of glacial agency in the geological history of Tasmania than I have met with elsewhere. . . ." As to the age of this conglomerate, Mr. Stephens says:—"It underlies unconformably the tertiary freestone, which has been determined by Professor M'Coy to be of miocene age, and it contains boulders derived from rocks which are certainly not older than the lower carboniferous or Devonian period."

Mr. Stephens was therefore the first to recognise the glacial origin of the "conglomerate" near Wynyard, and, though he does not exactly say so, the inference from the above passages is that he considers these beds to be of carboniferous age. Mr. Stephens, though perhaps not the first who advocated a palaeozoic glacial period, was certainly among the first who did so, and, what is more, he was the first who recognised the palaeozoic glacial period in Tasmania.

(1) Remarks on the Geological Structure of Part of North Coast of Tasmania, with special reference to the Tertiary Marine Beds near Table Cape. Proceed. Roy. Soc. Tas., 1869, pag. 17.

Twenty years later Mr. R. M. Johnston published his Geology of Tasmania. On page 258 of the standard work on Tasmanian Geology, Mr. Johnston gives the following section of the bluff near Sandy Cove, in descending order—

4. Basalt, of palaeogene age.	Eocene.
3. Turritella—group.	
2. Crassatella—bed.	
1. Conglomerate and shale.	Silurian.

Mr. Johnston is of the opinion that the basalt conglomerate and shale are of silurian age, and that the Turritella group, as well as the Crassatella bed, belong to the Eocene. The age of the basalt is not exactly stated, though it is included in the palaeogene epoch. (See also: R. M. Johnstone, Further Notes on the Tertiary Marine Beds of Table Cape, Pap. and Proceed. Roy. Soc. Tas., 1876, pag. 79; a very instructive though somewhat diagramatic section of Freestone Bluff accompanies this paper.)

Montgomery (1) visited this part of Tasmania about seven years later, and he dwells on the peculiar features of the conglomerate, which he terms "Wynyard formation." He thinks that it forms the base of the permo-carboniferous series, and he agrees with Stephens as to the glacial origin. Waller (2), who writes a few years later, fully corroborates Stephens and Montgomery's views.

In 1902 Kitson (3) publishes an exhaustive paper on the glacial beds near Wynyard. If I am not very much mistaken he was the first to recognise that numerous boulders were scratched. Kitson mentions quite a number of different rocks he found in the glacial drift, and from his list it is evident that rocks of the crys-

(1) Report on the Mineral Fields of the Gawler River, Penguin, Dial Range, Mount Housetop, Table Cape, Cam River, and portion of the Arthur River districts. Rep. of the Sec. of Mines, Tasmania, 1895-96.

(2) Report on the Recent Discovery of Cannel Coal in the Parish of Preolenna, and upon the New Victory Copper Mine, near the Arthur River. Rep. of the Sec. of Mines, Tasmania, 1901-02, pag. 77 ft.

(3) On the Occurrence of Glacial Beds at Wynyard, near Table Cape, Tasmania. Proceed. Roy. Soc. of Victoria, Vol. XV. (New Series), Part I., 1902 pag. 28.

talline series preponderate. He also mentions a boulder containing silurian fossils, which had been found by Mr. Stephens, the fossils being described by R. Etheridge, jun. (1). Kitson concludes his paper with the remark that the glacial origin of these beds is beyond doubt. He is, however, less certain as to its age, but it is evident that he accepts Montgomery's view, viz., that these beds form the base of the permo-carboniferous series.

The last who dealt with these glacial beds is Mr. Stephens, who published forty years after the appearance of his first paper another one dealing with the geological features of the North-West Coast (2), in which he still more emphasises the views expressed in his first paper.

In company with Mr. Stephens I visited Wynyard in February, 1908, and during my examination of the strata at Sandy Cove Bluff I made an observation, which may be of far-reaching consequence not only for the interpretation of this outcrop, but for the geology of Tasmania on the whole. I intended to visit Wynyard again before publishing my notes, but as it is not very probable that I shall find time during the coming summer, and as others may visit Sandy Cove Bluff in the meantime, I wish to draw the attention to the peculiar features I observed, with a view to have them either confirmed or refuted. Before discussing this particular point, I will briefly describe the sequence of beds.

2. THE SEQUENCE OF BEDS AT FREESTONE BLUFF (SANDY COVE). (PL. IX.)

In descending order we see—

(c) Basalt.
(b) Sandstone with fossils.
(a) Clay with scratched boulders.

---

(1) Description of Remains of Trilobites from the Lower Silurian Rocks of the Mersey River, and Brachiopoda from the Conglomerate of Table Cape. Pap. and Proceed. Roy. Soc., Tasmania, 1882, pag. 158.

(2) Notes on the Geology of the North-West Coast of Tasmania from the River Tamar to Circular Head. Proceed. Linnean Soc., New South Wales, 1908, Vol. XXXIII., pl. 4, pag. 752 ft.

These three divisions represent the primary natural subdivision of the series exposed at Freestone Bluff (Sandy Cove), and I think that there cannot be the slightest doubt about this. Difference of opinion enters only when we discuss the age and the relations of these three divisions, but before touching this intricate point it will be well to describe shortly their main features:—

(a) Clay with scratched boulders. (Glacial drift or Wynyard formation.)

The glacial drift is well exposed along the outlet of the Inglis, and thence it can be followed in western direction past Freestone Bluff along the shore almost as far as Table Cape, where it disappears underneath the overlying sandstone. In eastern direction it can be followed close up to Woody Hill Point; the total length of exposure along the coast being about six miles (1). From Freestone Bluff towards Table Cape there is a decided dip towards west, but this dip does apparently not continue across the Inglis river, because if it did the glacial drift ought to be at a much higher level near Woody Hill Point than it is. Here it appears at sea level exactly as at Freestone Bluff, and we must therefore assume that the eastern portion from Woody Hill to Freestone Bluff is fairly level, and that the dip commences only west of the last-named point. It is prtety certain that it extends for a considerable distance in northern direction, because at low tide the boulders can be traced far to the north.

How far towards north the moraine extends is difficult to say, but I feel inclined to think that it extends at least as far as the 20-fathom line, about 10 miles from the shore.

At Freestone Bluff at least 20 to 25 feet of thickness are exposed, but for the present it is impossible to state the entire thickness, which must be considerably more.

We do not know the strata on which the moraine rests, but there is every reason to assume that it rests on schists of pre-cambrian age, which form the larger portion of the North-West Coast.

---

(1) See also Stephens' Notes on the Geology of the North-West Coast, etc. Lin. Soc., New South Wales, 1908, Vol. XXXIII., pag. 752.

The character of this boulder clay is that of the glacial drift, so well known in Northern Europe and Northern America (see Pl. X. and XI.). More or less rounded sub-angular blocks of rocks, many of which are striated, are irregularly embedded in an argillaceous matrix. This feature is particularly well seen from Freestone Bluff towards the Inglis River, but on turning round the corner of the bluff it loses its character as a boulder clay; the boulders are almost absent, and, what is more, the clay becomes stratified, strangely contrasting in appearance with its former characteristic development. The boulders appear again further towards west, and this certainly proves that the character of the moraine locally changes considerably. Further investigations of this point are very desirable.

Unfortunately my time was too short to make a complete collection of the different kinds of rocks occurring, but I noticed that crystalline rocks form far the majority. Sedimentary rocks are very scarce; I found a boulder of greyish limestone without fossils, and though I searched very carefully I did not find any trace of permian fossiliferous rocks. On this point apparently all observers agree; neither Mr. Stephens, nor Mr. Kitson, nor myself found boulders of rocks of permian age. Kitson enumerates quite a number of different kinds of rocks, and I have no doubt that if a systematic collection is made, and the rocks correctly determined, we will be able with great certainty to fix the geological features of the country whence they came, and thus probably locate their origin.

Most of these boulders are strongly striated and scratched. On the whole these ice-worn boulders are not very common, but I succeeded in finding two perfect specimens of considerable size.

There is another feature connected with these boulders which, if I am not mistaken, was first noticed by Kitson. Almost all the boulders are intersected by a number of parallel cracks running approximately north-south. These cracks are indicative of a great lateral pressure, which did not affect the softer matrix, but broke the more rigid boulders (Pl. XII.). It is very probable that these cracks or joints indicating a pressure from north are the result of the subsidence of the earth's surface when Bass Straits was formed.

At several places I noticed towards the top of the glacial drift lenticular masses of hard quartzite sandstone. Mr. Kitson is inclined to consider these as transported blocks. I rather think them to be solidified aranaceous concretions, which were eventually subjected to the same process of pressure as the boulders (Plate X.).

I am, further, not quite certain whether the apparent stratified condition of the moraine may not also be due to pressure. However that may be, it is certain that the moraine was subjected to an enormous pressure.

(b) Sandstone with Fossils.

Immediately above the moraine follows a layer of coarse conglomerate, which was unquestionably derived from working up the top part of the moraine and redeposit of the more larger blocks. These boulders are cemented by a sandy matrix containing numerous fragments of shells, sometimes also a more complete specimen. About 2 feet above this occurs a very constant bed of fossils about ½ to 1 foot in thickness (Pl. X. and XI.), which has been called Crassatella-bed by Mr. Johnston. This Crassatella-bed is rather peculiar; though very constant in level and thickness, it is not separated by planes of bedding from either the lower or upper portions of the sandstone. It looks as if the fossils had been more concentrated at a certain time during the deposit of the sandstone than either before or afterwards. When we closely examine the fossils we see that they consist for the greater part of broken and rolled fragments, while complete specimens are not very common. It is obvious that the Crassatella-bed forms an old sea beach—in fact, there is not the slightest difference between it and a modern beach along our coasts. Mixed with the fossils, and immediately above the bed, there are numerous rolled small pebbles of whitish or yellowish quartzite, such as I have seen in the tin-bearing deposits on the North-East Coast (1).

Above the Crassatella-bed follows a series of about 80 feet of thickly bedded sandstone, of yellowish white

(1) This is one of the observations hitherto apparently unnoticed.

colour. This sandstone is rather calcareous, and pretty hard. The most common fossil is a small Curritella, which has been called T. Warbartonii, and from which the whole series has appropriately been called Turritella sandstone. The fossils, which are exactly the same as those occurring in the Crassatella-bed, are more sparsely distributed, but now and then they occur in heaps, just as we find them along our shores at the present day.

Besides these marine fossils leaves of terrestrial plants in particular Sapotacites oligoneuris, Etting. and others were found (1), but the most interesting is a nearly complete skeleton of the marsupial Wynyardia bassiana Spencer (2). It may perhaps seem somewhat surprising to find the remains of terrestrial plants and animals in marine deposits, but a little consideration will show that this is not surprising at all. In fact, it would be more surprising if these remains had not been found. The Turritella-sandstone represents a typical deposit formed along the beach, where the land was not far away; leaves from the trees growing close by were frequently blown into the water, and the strand was also frequently visited by animals (3), whose remains became now and then embedded in the sandstone.

The Turritella-sandstone dips slightly towards west, and the higher beds, which are inaccessible at Freestone Bluff, descend more and more towards the sea level the further we move towards west.

I am unable to say whether a subdivision of the Turritella-sandstone is possible or not. If we distinguish the Crassatella-bed as a special palaeontological horizon, we must of course distinguish the strata above and below it. It will perhaps be possible to establish a certain subdivision, particularly if it could be proved that the terrestrial remains occur only in the upper portions, but a good deal of work remains still to be done before we can say something definite.

---

(1) Pap. and Proceed. Royal Soc. Tasmania, 1886, pag. xx.

(2) Proceed. Zoolog. Soc., London, 1900, pag. 776-795.

(3) At the mouth of the Ringarooma River I noticed numerous tracks of the native cat (Dasyurus viverrinus) among the sand dunes and along the beach, showing that this animal is in the habit of frequenting the sea shore.

(c) Basalt.

The last of the series is a cap of basalt, having a thickness of about 80 feet. Mr. Johnston is of the opinion that this basalt is of very recent age (1). I am unable to say anything with regard to the relations of the Sandy Cove basalt and the Trachy-dolerite of Table Cape. Mr. Stephens thinks that the Turritella-sandstone was deposited against the Trachy-dolerite of Table Cape. This would imply that the Table Cape rock is much older than the Turritella-sandstone—in fact, that Table Cape already formed a promontory as to-day at the time when the Turritella-sandstone was deposited. I do not agree with Mr. Stephens on this point, because if this were so the beds ought to dip away from Table Cape, but not towards it; besides, I think that the Turritella sandstone is somewhat altered nearing Table Cape. I think that there is not much reason to assume that the Sandy Cove basalt and that of Table Cape are of such widely different age as they would be if Mr. Stephens' view were correct.

The actual observations of the strata as exposed near Wynyard can therefore be summarised as follows:—

"There exists a fairly thick glacial drift unconformably overlaid by an arenaceous littoral formation with fossils capped by basalt."

The question now arises, what is the age of these deposits? Before discussing this problem, I wish to mention another observation I made, which, though of the greatest importance, has apparently never been noticed by previous observers. When I examined the top part of the glacial drift, with a view to ascertain the relations between it and the Turritella-sandstone, I noticed small lenticular layers of fossiliferous sandstone, each showing the small quartz pebbles embedded in the boulder clay, and later on I found rather a long layer of this sand (Pl. XI. and XII.). There is no question that these fossiliferous layers, undistinguishable from the standstone above, were embedded in the moraine, but the problem is to decide whether they are moraine, but the problem is to decide whether they are primary deposits contemporaneous with the moraine or

(1) Geology of Tasmania, pag. 259.

secondary infiltrations so to speak, which were formed long after the deposit of the moraine. It will be seen that it is of the utmost importance with regard to the age of the moraine as well as the Turitella-sandstone to decide this question one way or another.

(3) AGE OF THE BEDS AT FREESTONE BLUFF (SANDY COVE).

Montgomery, Waller, and Kitson believe that the glacial drift belongs to the palaeozoic area, and forms part of the permo-carboniferous, or, as we would say, permian formation, whose lowest or basal bed it represents.

Above the palaeozoic moraine rests a fossiliferous sandstone supposed to be of eocene age (1). I have never been able to find out on what palaeontological proofs the view of the eocene age of the Turritella-sandstone has been based. If the list of fossils described from this formation is carefully studied (2), it will be seen that practically all species are new. Not one of them could be identified with species from true eocene rocks either in Asia or Europe. Further, that characteristic fossil of the eocene, the genus nummulites, is entirely absent, though in Europe it occurs under the same latitude in large numbers. I rather feel inclined to think that the proofs for the eocene age are negative, and not positive. In the older geological manuals we find Sir Charles Lyell's rather fetching percentage theory being accepted as an absolute certain guide for the subdivision of the tertiary formation. This theory assumes that the percentage of living forms decreases in descending order; that is to say, there are a smaller number of living species in the Miocene than in the Pliocene; and, again, they are far less in the Pliocene than in the Miocene; and the smallest number of all occur in the Eocene. More modern investigations have, however, proved that the percentage theory must be

(1) I may state here that Prof. M'Coy was originally of the opinion that these beds are of Miocene age. (See Johnston Geology of Tasmania.)

(2) Reference List of the Tertiary Fossils of Tasmania. Pap. and Proceed. Royal Soc. of Tasmania, 1886, pag. 124 ft. (See also Johnston Geology of Tasmania.)

used with the greatest discretion only, and unless supported by other evidence it is at times completely misleading.

This certainly applies to the fauna from the Wynyard sandstone. There is not the slightest reason to assume that it would be of Eocene age because none of the species could be identified with specimens living nowadays. The fauna of Bass Strait is a very modern one; it can have only migrated to its present habitat after the formation of Bass Strait, and it is a priori very probable that it has very little in common with the much older fauna from the Turritella-sandstone.

But let us assume for the sake of argument that the Turritella-sandstone is of Eocene age. The inclusions of fossiliferous sand in the upper part of the moraine seem to indicate a close connection between the glacial drift and the overlying fossiliferous sandstone. This being so, we have established the existence of a Tertiary, that is to say Eocene glacial period. Now, however, different the opinions of geologists may be, there is not one dissenting voice with regard to the climate of the tertiary period. They all agree that the Tertiary was a period of warmth, but not of cold. The establishment of a tertiary glacial period in Australasia would be so much in opposition to all accepted views that it required much better and stronger proofs than we have now before we could accept this theory.

Now, let us presume that the moraine is of palaeozoic—that is to say, of Permian age. In that case, the fauna of the Turritella-zone would also be of permian age, a theory whose absurdity must even strike a beginner in palaeontology. Whatever the age of the Turritella-sandstone may be, its fauna is of such a modern habitus that anything else but a tertiary or post tertiary age is out of question.

It is therefore certain that neither the eocene age of the Turritella-sandstone nor the palaeozoic age of the glacial drift satisfactorily accounts for the intimate relationship between the two as indicated by the fossiliferous inlayers. This could only be explained if we were to assume that the moraine is of diluvial age, or, as it is generally called out here, pleistocene age.

The pleistocene glacier deposited its debris in a sea, which became later on inhabited with the Turritella fauna. Gradually the sea encroached on the land, the upper parts of the moraine were worked up and re-deposited as a conglomerate bed, while small inlayers of fossiliferous sand became mixed up with the upper parts of the moraine.

The Turritella-sandstone would therefore be of post glacial age, and the basalt would be younger still.

As far as I can see there could be two objections to this theory, viz., the cracks in the boulders and the supposition that the inlayers of fossiliferous sand are secondary infiltrations.

I have shown above that almost all the boulders are intersected by a series of parallel fissures. If sandstone and moraine belonged together, one would assume that the cracks continued into the sandstone, and that the larger fossils were broken in a way similar to the boulders. If my memory does not deceive me, I never noticed such a feature, though I must confess I did not pay much attention to it at the time. However that may be, even if the cracks did not extend to the Turritella sandstone, we might assume that the subsidence of land which caused the pressure also opened an inroad for the sea, in which the younger Turritella sandstone was deposited. Though the boulders in the older moraine were therefore broken, the same pressure did not affect the younger Turritella-sandstone.

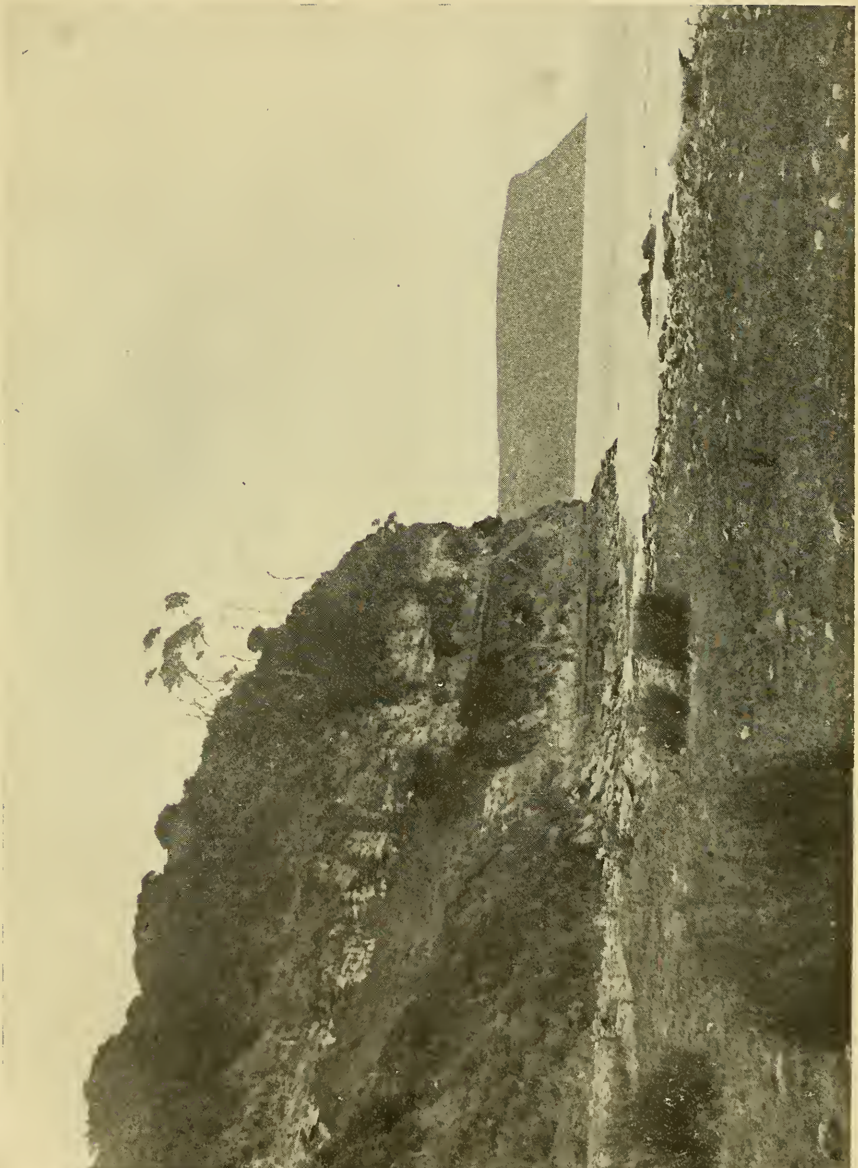
The other objection is the more serious of the two. In order to make it fully understood, we will accept for the moment the old theory that the moraine forms the base of the permian rocks, and that the Turritella-sandstone is of tertiary (eocene) age. We would then have one of the most stupendous discordances known in the history of the earth. The whole of the mesozoic formation, viz., triassic, jurassic, and cretaceous periods, even a part of the younger palaeozoic (middle and upper permian) would be missing.

I do not wish to enter into the discussion whether the strata representing these periods were always missing or have been removed by subsequent denudation. All I wish to point out, that if the views hitherto held regarding the age of the strata at Freestone Bluff (Sandy Cove) be correct we have Eocene resting immediately on the basal bed of the Permian.

Now, all throughout Tasmania the permian formation above the basal glacial drift is represented by a series of great thickness, consisting of mudstones, limestones, and coal measures, the latter being followed by those of younger, probably mesozoic age. Now, we must either assume that not a foot of this great thickness of strata had been deposited near Wynyard, or that they all were removed by subsequent denudation.

It is impossible to assume that they were not deposited near Wynyard, because if the glacial drift, i.e., the basal moraine, had formed the surface of the earth ever since the early Permian, it would probably be disintegrated to such an extent that it would be hardly recognisable. We cannot measure yet the absolute time that lapsed between the beginning of the permian and that of the tertiary epoch, but whatever it may have been it must represent an immense period. Is it imaginable that during this almost immeasurable time the boulder bed forming the surface all the while became so little disintegrated that it remained as fresh as it appears today? I think not, and we must therefore assume that the younger strata, mostly of permian age, were removed by denudation. This at once raises another difficulty—why was the denudation so energetic just near Wynyard that it removed practically all traces of the permian beds, and why was it not so eneregtic in other parts of Tasmania?

Presuming this strange phenomenon did take place; the younger strata disappeared and the surface of the glacial drift was laid bare; about that time a great subsidence of land took place to the north of Wynyard; the pressure thus created broke the boulders and opened fissures in the moraine which became subsequently filled up with fossiliferous sand from above. There is no doubt that this theory is a very fetching one, and it would be possible to reconcile the palaeozoic age of the moraine with the kainozoic age of the Turritella-sandstone. There is, however, one drawback; so far I have not seen a single instance where cracks of the kind required were connected with the Turritella-sandstone.



FREESTONE BLUFF, NEAR WYNYARD (TABLE CAPE IN THE BACKGROUND)

LENTICULAR MASS OF SANDSTONE IN THE MORAINE, OVERLAID BY THE CRASSATELLA BED.

GLACIAL MORAINE SHOWING A LAYER OF FOSSILIFEROUS SAND IMBEDDED IN ITS TOP PORTION.

THE CENTRAL PORTION OF THE LAST PLATE ENLARGED. THIS SHOWS THE FOSSILIFEROUS LAYER MORE DISTINCTLY.

These cracks should be vertical, or at least nearly so, such as shown in the boulders. Though I searched hard, I could not find a single instance. The fossiliferous inlayers in the moraine were all more or less horizontal and disconnected with the Turritella-sandstone. Further examinations would be required to prove conclusively that the fossiliferous inlayers are later infiltration, and not contemporaneous with the moraine. For the present the evidence goes more in favour of the latter than of the former view.

The strongest point in favour of a palaeozoic age of the moraine is the seemingly entire absence of boulders of younger than permian age. We know for certain that the moraine must be of post silurian age, because boulders containing silurian fossils have been discovered in it. The absence of permian boulders does, however, not necessarily mean that it must be of pre-permian age, though it is, I admit, a very strong point in favour of this view. We know, however, so little about the boulders contained in the moraine, that we cannot say with certainty that they do occur; and, further, if they do not occur, we have always to consider the probability that the glacial debris was derived from places where there were no permian strata.

At present the case stands therefore like this: Unless it be conclusively and without the slightest doubt proved that the fossiliferous inlayers in the glacial drift are subsequent infiltrations, we must assume that the moraine and the Turritella-sandstone belong to one and the same epoch. As no sane geologist would consider the fauna of the Turritella-bed to be of palaeozoic age, and as the assumption of an eocene glacial period would be contrary to all experience, we must assume that both the moraine and the Turritella-sandstone are of diluvial (pleistocene) and post diluvial age.