

of thin sections or otherwise, can the differentiation of the fossil Spongiadae be satisfactorily made. Occasionally the structure, especially in the silicified sponges, is so admirably preserved as to render this not difficult; but until their true affinities to recent species have been studied from a *strictly zoological* point of view, our knowledge concerning them must be wanting in scientific precision. The result of such inquiries will probably be to reduce many genera to the lower grade of species, and many species to mere varieties or conditions of growth. In common with other forms equally low in the scale of organization, the sponges appear to have endured through a long range of time, subject only to modifications, which scarcely amount to specific distinctions.

IV.—FURTHER REMARKS ON MR. JAMES GEIKIE'S CORRELATION OF GLACIAL DEPOSITS.

By S. V. Wood, Jun.

IN a republication of the papers by him which appeared in successive numbers of this MAGAZINE, Mr. James Geikie has replied to the objections which I offered to his views, and also to the views of sequence which I myself advance, by asserting that the seaward ends of glaciers never float; and that my view that "wherever the ice-sheet rested there no deposit occurred, the material produced by its action incessantly travelling outwards to the ice-edge," is a misconception.

The question whether this flotation does or does not occur is one of the things yet to be solved, and it is difficult to imagine that the continuous Antarctic ice-wall followed without soundings for hundreds of miles by Sir James Ross does not float.¹ Perhaps in thinking that it did, I too readily adopted the view of Mr. Archibald Geikie, the Director of the Scotch Survey; but the question is one wholly beside the main issue, which is—

- 1st. Is unstratified clay or Till deposited under the sea?
- 2nd. Whence does the material of such Till come unless it be a product of land-ice shed out from the sea extremity of that ice?
- 3rd. How, if so shed out, can it be denied that the material is constantly travelling outwards?
- 4th. If so travelling outwards, how can the material shed out under the sea at the commencement of a period be synchronous with the material that was under the sheet at the close of the period.

The Scotch geologists have mostly insisted on a negative to the first of these propositions; and Mr. Croll, in arguing that the unstratified clay of the Holderness cliffs—a clay identical so far as its physical structure is concerned with the Scotch Till—was due to a

¹ In supposing that, so soon as it has a tendency to float, the glacier breaks off into bergs from the rise and fall of the tide, Mr. Geikie seems to me to have overlooked the fact that in such deep water and open sea as that in which the Antarctic ice terminates, the vertical movement of the tide is altogether insignificant. It is to the Antarctic, rather than the Arctic regions, that we must turn to find the ice conditions of our Glacial period.

vast ice-sheet that filled the North Sea, urged that the remains of Mollusca occurring in the unstratified clay or Till of Caithness were due to the ploughing out of a pre-existing sea-bed, by which such remains became incorporated in the unstratified formation produced by this ice-sheet. Now the proof that unstratified Till was deposited under the sea appears to me simple and convincing. When Sir Charles Lyell visited Holderness in 1869, in company with his nephew Mr. Leonard Lyell, and Mr. Thomas M. Hughes of the Geological Survey, they found in the midst of the unstratified chalky clay (or Till, as the Scotch would call it) of the lower part of Dimlington Cliff, a thin streak of greenish sand embedded in the clay, which, according to the description of Mr. L. Lyell sent me by Sir Charles, was "*crammed with perfect specimens of Nucula Cobboldiæ*." Some of these, Mr. Lyell adds, had he believes the two valves adherent, and certainly an *Astarte* was found in that condition.

Now here we have an unequivocal instance of a colony of Mollusca that must have established itself on a sea-bottom formed of unstratified glacial clay, and been afterwards tranquilly covered over with similar material, just in the same way in which with stratified deposits a band of shells is covered by a succeeding stratum of sand or mud. Can it be questioned in the face of this that unstratified clay or Till has been deposited under the sea, which is my first proposition? Further, if this cannot be questioned, then why refer any of this unstratified clay or Till to a deposit on a terrestrial surface? for it is quite a rare exception to find Mollusca in any part of it, no instance of the kind being known to have occurred in all the wide expanse of this chalky clay except at Dimlington.

I have elsewhere pointed out that this wholly unstratified deposit, undistinguishable in its physical character from that Scotch Till which is held to be the terrestrial deposit of land-ice, spreads evenly over large areas of stratified sands that yield Mollusca in places; and that such clay not unfrequently passes down vertically into these sands by a few feet of sandy clay obscurely stratified. Whatever therefore be the cause of the anomaly, I do not see how it can be questioned that by some means a vast mass of material, which is admitted by all to be a product of land glaciation, has been spread out under the sea over an extensive area in a wholly unstratified condition.

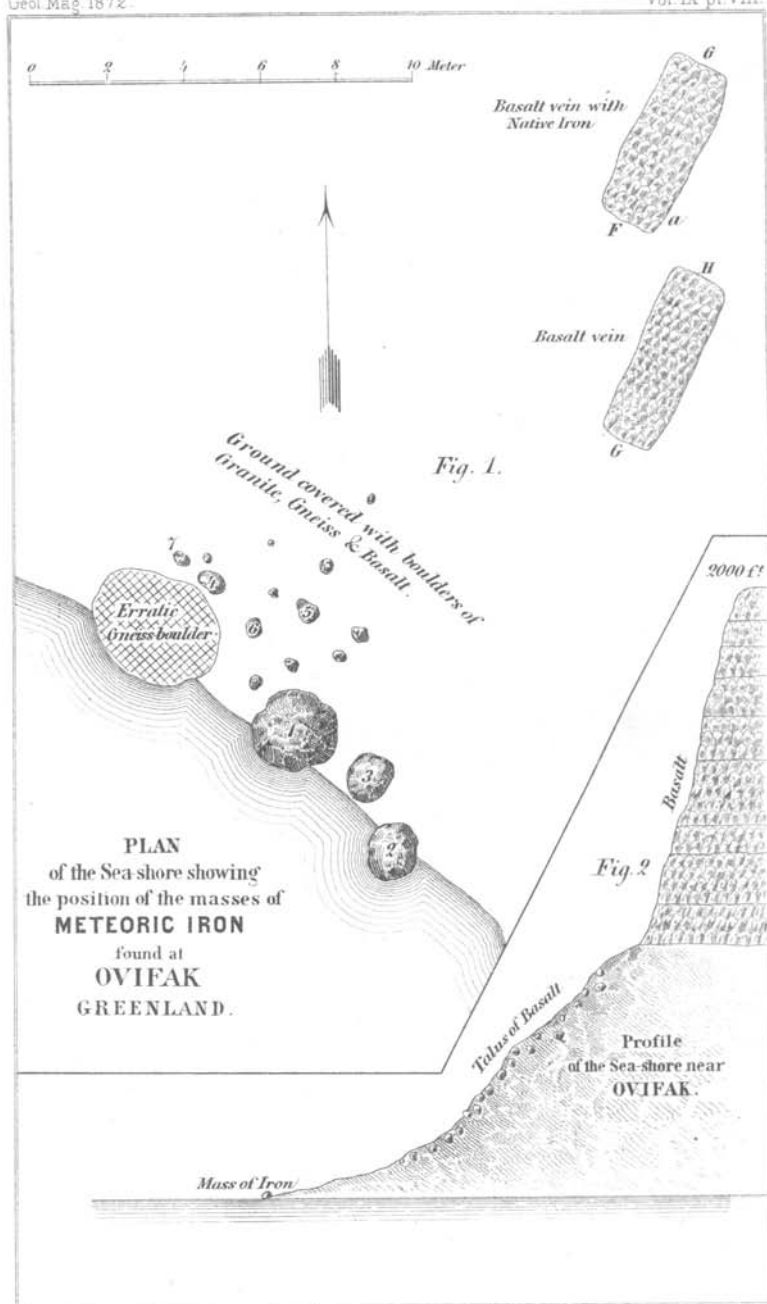
This being so, the second, third, and fourth propositions seem to me to be answered by necessary implication. It will not be denied by Mr. Geikie, or any one, that the material was generated by the action of the land-ice. It could not get out to sea in this vast volume unless its motion was incessantly outwards from beneath the generating ice-sheet; and it could not thus travel outwards without the material generated at the commencement of this action having all found its way into the sea before its termination. If, for instance, we assume the period as 100,000 years—it was probably far more—the material generated in the first 10,000 would have all found its way to the sea before the end of the second 10,000 years, and so on throughout the entire period of 100,000 years.

Mr. Geikie mentions the occurrence on the tops of the Ochils, upon the watershed of the Renfrew uplands, and on the crest of the Pentland Hills, of what he regards as true Till, containing, along with rock debris furnished by these hills themselves, material brought from the Highlands; and as this material, he considers, must have been brought by land-ice, filling the low ground between, he urges this as fatal to my views.

He has evidently misunderstood the meaning I attached to the word "deposit" in the expression I used that "where the ice rested deposit occurred." Of course, although no permanent deposit of it occurred, there was always a certain quantity of the material under the ice-sheet, or else it could not be incessantly travelling outwards to the sea; and in protected hollows the temporary accumulation of this might be considerable. Necessarily, therefore, as the sheet wasted back, there was a certain quantity of the material left on the land surface as the ice deserted it, and this would represent the Till which Mr. Geikie thus instances against me; but that material was the product of the ice-sheet just preceding its desertion of these particular spots; and was formed ages after that which occupied the same spot during the earlier part of the period, and which had all travelled out to sea long before these hills were relieved of the ice-sheet. The very circumstance instanced by Mr. Geikie of material from the Highlands finding its way to the Ochils and other isolated hills, proves that the material was thus in motion.

In a footnote to the Introduction to the Supplement of the Crag Mollusca (p. 26), this occurrence of Mollusca at Dimlington near the top of the great Chalky Clay (No. 9 of that Introduction) is noticed; but I had not seen the specimens. Since then Sir Charles Lyell has been kind enough to send them to me, and it is highly satisfactory to me to find this colony of *Nucula Cobboldiæ* occurring at an horizon in the glacial sequence so near to that at which I and my coadjutors had placed the Bridlington bed,¹ with the Mollusca of which, inclusive of this *Nucula*, these Dimlington shells agree identically, as far as they go, both in species and in mineral condition. When it is thus seen that a nest of *Nucula Cobboldiæ* lived in the British sea, after 100 feet of Glacial-clay, teeming with chalk debris similar to that forming the lower part of Dimlington Cliff, had been deposited (for to that depth is it shown by adjacent borings that this clay descends before the uniformly even chalk floor is reached), the prolonged glaciation of the Chalk wold which must have preceded the dying out of that shell will be, I think, better recognized. The existence of another 100 feet of Glacial-clay overlying this *Nucula* seam in actual section shows that a prolonged period of glaciation also succeeded it; and when it is observed that in this overlying 100 feet, the Chalk debris begins to diminish immediately above the shell seam, and

¹ Besides the observations as to the position of the Bridlington bed in the Crag, Supplement Introduction, and in various papers of mine in this MAGAZINE, the respective horizons of the Bridlington bed and of Dimlington Cliff base will be found marked in my vertical section of the Glacial sequence of the East side of England, at page 90 of vol. xxvi. of the Quarterly Journal of the Geological Society.



entirely to disappear in the upper part, the occupation of the districts to the north by the ice-sheet after it had deserted the Chalk, and the connexion of that event with the non-occurrence of *Nucula Cobboldiæ* in Scotch and other Glacial beds, which I assign to a stage in the retreat of the ice-sheet posterior to the desertion of the Chalk, will, I think, be better understood. Nevertheless, according to my view, neither the 100 feet below nor the 100 feet above represent the whole glacial sequence, there being glacial beds anterior to the one and posterior to the other.

I would take this opportunity of adding that the Brick Clays with Mollusca of Scotland, which I thought might, from their resting on the Till, be of Post-glacial age, seem to me on further consideration to belong to the Glacial period, though to the later part of it; and I would ask Mr. Geikie if not merely the Scotch Till, but the clay he distinguishes from it and calls Boulder-clay, and the intercalated and subjacent silt, clay, and gravel, be the equivalents, as he contends, of the East Anglian and Holderness deposits, how it happens that not one of the several shells unknown as living, or as living nearer than the Pacific, which these East Anglian and Holderness Beds yield, has occurred in the many Scotch deposits which yield Mollusca thus grouped by him as equivalents of the East Anglian and Holderness beds—a part of the question which he has avoided encountering altogether.

V.—ACCOUNT OF AN EXPEDITION TO GREENLAND IN THE YEAR 1870.

By Prof. A. E. NORDENSKIÖLD.

Foreign Correspondent Geol. Soc. Lond., etc., etc., etc.

Part II.

(PLATE VIII.)

(Continued from page 306.)

THESE holes in the ice filled with water are in no way connected with each other, and at the bottom of them we found everywhere, not only near the border, but in the most distant parts of the inland ice visited by us, a layer, some few millimetres thick, of grey powder, often conglomerated into small round balls of loose consistency. Under the microscope, the principal substance of this remarkable powder appeared to consist of white angular transparent grains. We could also observe remains of vegetable fragments; yellow, imperfectly translucent particles, with, as it appeared, evident surfaces of cleavage (felspar?); green crystals (augite) and black opaque grains, which were attracted by the magnet. The quantity of these foreign components is, however, so inconsiderable, that the whole mass may be looked upon as one homogeneous substance. An analysis by Mr. G. Lindström of this fine glacial sand gave—

Silicic acid	62.25
Alumina	14.93
Sesquioxyd of Iron	0.74
Protoxyd of Iron	4.64
Protoxyd of Manganese	0.07
Lime	5.09