

previous to the deposition of the boulder-clay, the subjacent rock under notice had been completely polished and striated by the passage over it of some heavy, closely-enveloping agent, presumably ice. In the middle of the boulder clay a somewhat singular regular line of boulders occurred, some of greenstone, some of sandstone full of vegetable remains, and some of coarse limestone. About 4 feet of tiring topped the bed of boulder clay.

Another, but much smaller, glaciated rock surface occurred in a bed of limestone about a quarter of a mile to the north of that just noticed. Its surface was polished like the other, and the dip of this bed and the striæ upon its surface corresponded with those of the bed first mentioned. I am glad to say that Mr Linn arranged with the quarrymen to preserve for him the beautiful glaciated specimen of *Lonsdaleia floriformis* above noted. He informs me that, on visiting Petershill in company with our last elected Foreign Corresponding Fellow, Major Brooks of the Geological Survey of Wisconsin, U.S., on 6th July last (our visit had taken place only a week before), he found that the ice markings on the bed first described in this paper had all been quarried away. He secured two fragments, however, from the quarrymen. The rapidity with which interesting geological phenomena often disappear, by human as well as by elemental agencies, proves the desirability of their being observed and recorded without any delay; and this, I think, should be regarded as one of the prime uses and duties of a Society such as ours.

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2d February 1877.

D. MILNE HOME, Esq., LL.D., *President*, in the Chair.

The following Communication was read:—

*Note on a Striated Erratic recently exposed at Granton; with Observations on the Requisites for Determining the Parent Rocks of Erratics.* By RALPH RICHARDSON, F.R.S.E., *Honorary Secretary*.

The portion of an erratic exposed at Granton Harbour by the recent storm is certainly one of the most perfectly striated rocks I ever saw. As an instance of striation it well deserves a visit, and as the tide will probably soon obliterate the striæ upon it, the rock itself should be briefly noticed in this Society. It

occurs on the shore at the foot of the sea-wall not far to the west of Granton pier, and considerably to the east of the western breakwater. The seawall protecting the road along the shore covers what is probably the larger portion of the erratic, only the northern end of which has been laid bare and is now visible. The portion exposed is about 2 yards long by 1 yard broad. The rock is apparently of greenstone, and, as the diagram shows, the portion exposed is of a flat rather than round shape. Striæ in regular long parallel grooves cross the rock in a direction E.N.E. and W.S.W. (true). No cross striæ appear.

Of course, striæ in the case of an erratic prove nothing so far as the direction of the glaciating agent is concerned. But looking to the regularity and length of the striæ on this rock, to the fact that no cross striæ occur, and to the flat shape of the rock itself, I should imagine that the erratic before us may possibly have been at one time a portion of a *roche moutonnée* which had been split off by frost action and laid down here by glacial agencies, without its having been subjected to that tossing to and fro, rounding, cross scratching, and general disfigurement which ordinary boulders have evidently undergone. Another theory to account for the regularity of its striation might be that this greenstone erratic had been deposited here in a rough state, and that it had been planed, polished, and striated by the passage over it of ice entering the sea at this point.

As to the precise locality whence this rock was derived, I do not speculate, as greenstone occurs in many places all round the present site of the erratic under notice. Indeed, this erratic may be said to lie nearly in the centre of a district abounding in detached masses of greenstone. To the north, we find greenstone on the shores of Fife and in the islands Inchcolm and Inchkeith in the Firth of Forth. To the north-west, we find greenstone at Inverkeithing and North Queensferry. Crossing the ferry, we find greenstone again occupying Dalmeny Park and stretching in a long band from Cramond Island as far inland as West Craigs. Further south we find another belt of greenstone extending from Ratho railway station to Bonnington House. The Dalmahoy Craigs are greenstone, Corstorphine Hill is greenstone, Craiglockhart Hill is greenstone, Salisbury Craigs are greenstone. Our erratic at Granton is apparently greenstone also, but you may now judge of the difficulty of ascribing to it a parent rock, and stating definitely whether the rock *in situ* from which it was derived is situated to the north, south, east, or west of Granton.

Unless and until we had a slice of this erratic subjected to minute mineralogical analysis, we could not, I submit, with any thing like scientific accuracy, say whence this erratic was derived. I believe that such analysis, if applied to them, would show that a difference exists betwixt each of the detached greenstone masses

round Edinburgh to which I have referred, and that if they were each analysed and classified, an erratic like that at Granton, when similarly analysed, could be relegated with some degree of accuracy to its parent rock. It has always appeared to me that it would be an all important point in the evidence relative to the direction followed by erratics, in this as in other districts, if we could compare slices of them with slices of known rocks *in situ*; but this kind of evidence implies a knowledge of mineralogy and the use of the microscope with which few are gifted, as also the possession of certain instruments requisite to prepare rock slices for microscopical analysis, of which instruments I have only heard of one (and that recently introduced) in this city.

So far as I am aware, this line of evidence has not yet been systematically followed in connection with the observation of glacial phenomena. Our Foreign Corresponding Fellow, Dr Daniel Hahn, himself a first-rate mineralogist, and a pupil of the famous Zirkel of Leipzig, agreed to send to a German laboratory slices of the trap-rocks of the Edinburgh district, so that we might have them at last carefully and authoritatively analysed and definitely classified; and I furnished him with one or two specimens for this purpose, as also with a chip from a Tynecastle boulder. He left, however, for the Cape of Good Hope (where he still is), shortly afterwards, and I have not since heard from him. So the scheme still rests *in embryo*. A special committee of this Society was formed to take up the subject, but it has as yet made no report.

To show the importance such a scheme of mineralogical microscopical analysis would have upon reading the history of glacial times, I may just cite another practical instance besides that of the Granton erratic. Mr Milne Home and I inspected, in February 1874, the sandpit then newly opened at Tynecastle, and which displayed numerous greenstone boulders. The question, of course, occurred to us, Whence were they derived? Did the ice that conveyed them follow a south-easterly route, say from Corstorphine Hill? or did it follow a north-easterly one, say from Craiglockhart or the Dalmahoy Crag? Or were both of these surmises incorrect, and, as analysis could alone show, were these erratics derived from another, perhaps totally different, quarter? I think you will agree with me that, whilst with our present knowledge we should be exceedingly careful in ascribing to this or that rock mass *in situ* the parentage of erratics, it would be very desirable that, and our knowledge of the district will never be complete till, we have both the trap-rocks *in situ*, and the erratics which lie strewn about in every direction, submitted to mineralogical microscopical analysis, and properly classified.