

Some notes on the distribution of erratics over eastern Moray / by W. Mackie.

Contributors

Mackie, William.
Keith, Arthur, Sir, 1866-1955
Royal College of Surgeons of England

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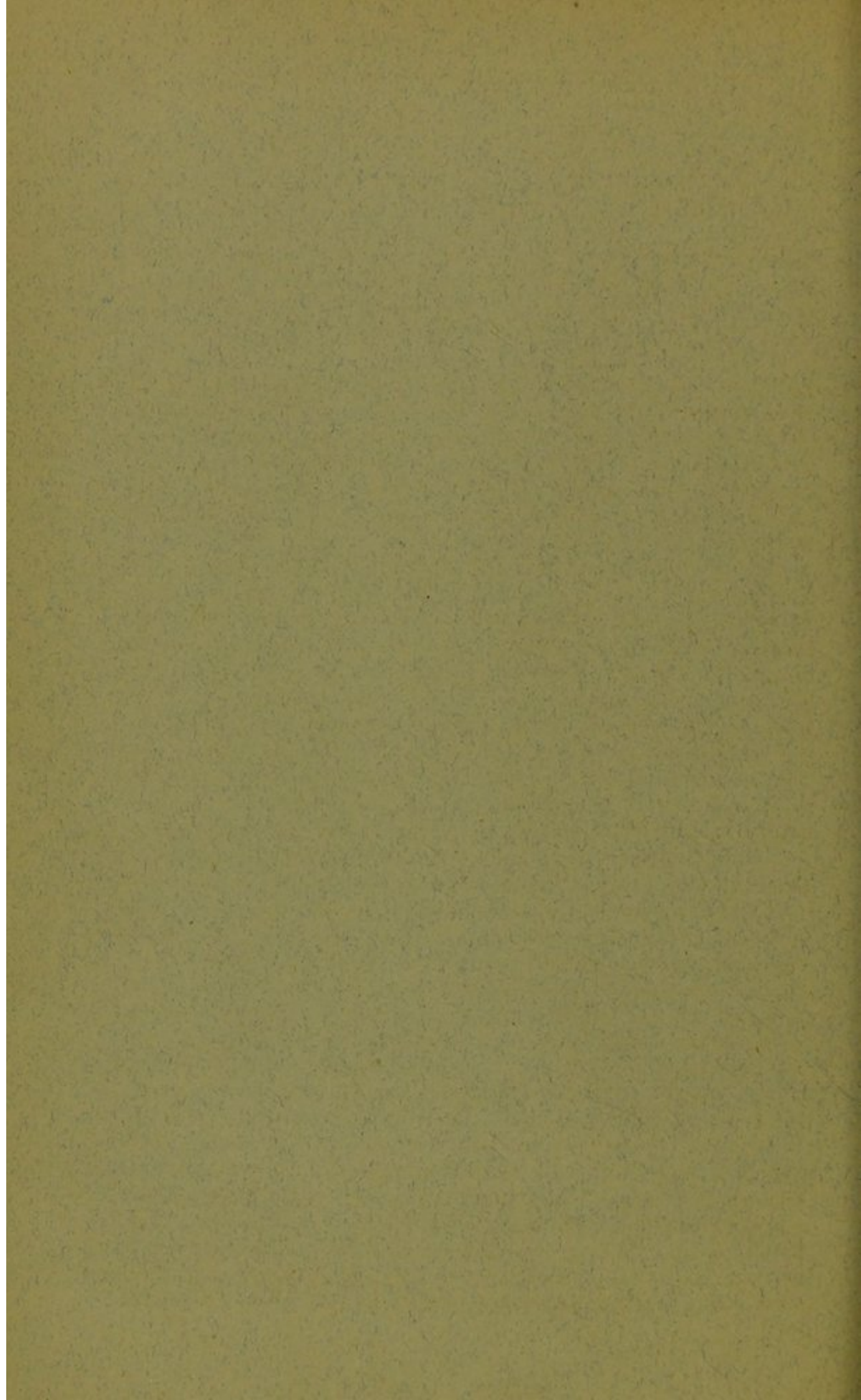
Wellcome Collection
183 Euston Road
London NW1 2BE UK
T +44 (0)20 7611 8722
E library@wellcomecollection.org
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X. *Some Notes on the Distribution of Erratics over Eastern Moray.* By W. MACKIE, M.A., M.D.

(Read 15th March 1900.)

SEVERAL well-marked boulder streams may be traced across the area between the Lossie and the Spey. These streams are found to cut one another's paths at various angles, while over a certain portion of the field there is distinct evidence that the ice-streams that conveyed the erratics must have moved from directly opposite points of the compass. The various boulder streams will now be described in detail.

A. The most important stream came from the west. It is characterised by a large and varied category of boulders, some of which are traceable to well-known origins, but to a large number of them no definite locality can with certainty be assigned. Conspicuous among them, however, are blocks of the (1) porphyritic granites of Ardelach and Kinsteary. These granites are by no means easy to distinguish by the naked eye. For this reason, microscopic examination of sections from such blocks as were found in unexpected positions has been resorted to as a means of diagnosis. The Ardelach rock is somewhat lighter in colour, and usually shows finely-marked zonings of its porphyritic feldspars, a characteristic which is entirely absent in the Kinsteary rock. Microscopically, the former granite shows muscovite in parallel intergrowth with the ordinary black mica in almost every mica cluster; while the Kinsteary only shows this arrangement—and then not very typically—in perhaps a single cluster out of several slides. The inclusions in the quartz grains of the two granites are also markedly different. Blocks of Kinsteary granite have been observed in the following unexpected positions:—(α) on the front of the Blue Hill south-east of Craigellachie; (β) near Benrinnes Distillery; (γ) in the wood below the Distillery there is a large block which has been cut for a lintel; (δ) two blocks built into walls of houses in Dufftown; (ε) near Whitehills, Banffshire; (ζ) in the valley of the Isla east of Keith. Dr Milne has observed them in the parish of King Edward east of Banff. The highest elevation at which they have been observed would be about 800 feet on Benrinnes and the Blue Hill. Boulders of Ardelach granite occur much more rarely. One has been observed near the Poorhouse,

Bishopmill; another large one lies at one of the street corners in Elgin.

(2) In the western stream are also a large number of grey granites, the localities of origin of some of which are unknown; but conspicuous among them are boulders of the Stratherrie granite characterised by the presence of abundant hornblende and sphene. Blocks of this rock are particularly plentiful about the village of Urquhart, five miles east of Elgin; but I have seen them as far east as Whitehills. At that point they would be over sixty miles from the parent rock. The line of this particular boulder stream is crossed between Lochs Ruthven and Duntelchaig, Inverness-shire. Blocks of the grey granite which occur *in situ* near Loch Moy, Inverness-shire, are also to be found over the area, but are not very plentiful.

(3) Blocks of the Inchbae augen-gneiss from the centre of Ross-shire are also to be found in well-rounded blocks at different points between Elgin and the sea, and also, I believe, much further to the east. In the positions noted by me these blocks would be over sixty miles from the parent rock. I have also observed blocks of the same rock at intermediate positions as near the east end of Loch Garve, and repeatedly also in Strath Conon, near Urray.

(4) Conglomerate boulders from Strath Nairn and Stratherrie occur in large numbers, and often of large size, over the area. It may be noted in passing that the eastern conglomerates do not give origin to boulders. They are either entirely devoid of cement, or their cement where present is calcite, which readily yields to the weather. For this reason all conglomerate boulders which are observed may safely be referred to a western origin. The Stratherrie variety is largely made up of fragments of the local granite embedded in a paste formed by the debris of the same rock. The Strath Nairn is characterised by the presence of red or liver-coloured quartzites, fragments of red granites, pegmatites, and gneisses of various kinds. Boulders of this sub-division have been seen in the following positions:—(a) a very large one in the burn just west of Rothes; (β) in the hollow to the south of Ruthrie Linn, Aberlour; (γ) within 200 feet of the top of the hill of Buchrumb, near Dufftown, that is to say about 900 feet above sea level.

(5) Quartz-porphry of several varieties, quartz schists, diorites, and gneisses of many varieties, also occur as members of the western stream; but it is impossible to assign a definite origin to by far the greater number of them.

(6) There is another class of boulders which may or may not belong to this stream; but which are sufficiently interesting to

deserve notice. These are of barytes. Two of these—one a large one—have been observed in the Rothes Burn. Veins of barytes occur in the neighbouring quartz schists and quartzites; but I know of no vein that could possibly have yielded the blocks observed.

B. Again, to the south-west of the area there exists an important centre whence boulders have radiated in directions the extreme lines of which would meet at an angle of something more than 140 degrees. The parent rock is a diorite, which is found in place at Netherly about four miles west of Rothes. On its eastern side the rock is a quartz-diorite, the quartz grains of which teem with innumerable rutile needles. To the west, in place of hornblende it shows augite, hypersthene, and occasionally, I think, a little diallage; and though there is usually still a little free quartz, it contains no needles. In either case the rock is very characteristic, and boulders from this area, many of which have been identified microscopically, have been carried away in great numbers to the north-east, in which direction they are to be found often of large size over the north-eastern slopes of the Brown Muir and Findlay Seat. On their way they must have crossed the hollow of Glen Rothes as if it had no existence. They are particularly plentiful near the northern opening of that glen, and have been met with nearly as far north as Longmorn Station, particularly near the farm of Rashcrook, where, however, they begin to be buried under the post-glacial sand and gravels which from this point seaward become such an important feature in the surface geology of the country. They have gone due north, but in rather sparing numbers, and are seen from time to time along the old road over the Mannoch Hill from Knockando to Birnie. They have gone directly east into the valley of the Spey at Conrock. They have gone round the shoulder—more likely right over the top—of the granite protrusion of Hunt Hill, and one large boulder, ascertained by microscopic examination to belong to the eastern side of the parent area, is found across the Spey built in four pieces—each of which is not much under three feet in diameter—into the dyke by the roadside just west of Craigellachie. Fragments of the same rock have been observed at least 1000 feet up the northern face of Benrinnes, and on the same aspect of the Blue Hill at elevations not much less. That debris from the same area has been carried much further in the same direction we have evidence in the numbers of its characteristic quartz grains that are to be found in the boulder clays and river sands collected in the Fiddich Valley some distance to the south-east.

It is to be noted that other diorites occur in this area. These,

however, even to the naked eye are quite distinct, while the microscope reveals important differences. On the other hand, specimens of diorite blocks occurring to the north of Elgin—one in particular which was sent me by the late Mr Grant of Lossiemouth, and which had been unearthed during the excavations in connection with the harbour works there—and all of which might have been taken on a naked eye examination as having been derived from the Netherly area, were uniformly found to be from other and probably western origins. Apart from this examination, the position that ice from the Netherly area reached the seaboard as far west as Lossiemouth might have legitimately been maintained.

(6) Another boulder stream seems to have taken place mainly in the line of, but to have spread somewhat beyond, the limits of the present Spey valley. It is characterised mainly by blocks of (1) Benrinnes granite; (2) blocks from a small but distinct area of diorite just west of Dandaleith Station; (3) blocks from an area in the quartzite zone near Conrock, and (4) by blocks of diorite from another area at Conrock, which may or may not be connected with the Netherly boss. The two rocks are certainly very different lithologically. The parent rock in this case occurs in juxtaposition to if not in actual contact with (3). The Dandaleith diorite is characterised by large crystals of hornblende or its alteration products, bright red feldspars and quartz grains showing as inclusions, numerous apatite prisms and occasional rutile needles. Fragments of an identical rock have been found in the L.O.R. conglomerate on the Auchinroath Burn. The Conrock diorite, on the other hand, is found to differ from all the other local diorites in showing numerous well-formed crystals of sphene and abundant white, rather limy-looking feldspars, some of the smaller of which are occasionally seen to be included in the sphenes.

The quartzite at Conrock (3), bordering on the fore-mentioned diorite, is quite characteristic. At this point the rock has been shattered by a local intrusion, and the fragments, which often show concentric rings, have been subsequently cemented together by the infiltration of bricky-red quartz, giving the rock a brecciform appearance, as is well shown in the polished fragments exhibited. Some distance back the red veining ceases, but the fragments are still found to be surrounded by alternate and sometimes differently coloured rings of crystalline and chalcedonic quartz.

All the members of this group have been observed over the area lying due north of the parent rocks. In particular large blocks of both varieties of (3) have been observed in both the Rothes and Glengrant Burns, also intermingled with large num-

bers of the western series, (*A*) in the valley of the Auchinroath Burn, and, still further north, Mr Taylor, of Lhanbryde, reports that they are of frequent occurrence in fragments up to a foot in diameter on the shore to the east of the Binn of Urquhart. Considerable fragments of (*4*) have been found in the boulder clay of the Baron's Craig, west of Rothes.

D. There was yet another stream which carried up from the Laich of Moray fragments of Old Red sandstone, the Cornstone of New Elgin and Mayne, and the Reptiliferous sandstones of Quarrywood and Spynie, and scattered them over the schist area to the S.E. in a broad belt, the axis of which would run from about Lossiemouth S.E. towards Dufftown. I have extracted fragments of Cornstone, of Newtown and Spynie sandstones from the Baron's Craig, while I have in my possession a microscopic section cut from a block of sandstone, probably referable to the Reptiliferous of Quarrywood, which was extracted from the boulder clay overlying the Netherly diorite, and which was found to contain quartz grains showing the large straight rutile needles characteristic of the quartz grains of the diorite, over which it was found to lie. U.O.R. and Reptiliferous blocks have also been observed as far south as Craigellachie, and, I dare say, if search was made, they would be found still further to the S.E. in the valley of the Fiddich towards Dufftown, while the microscope actually shows that their characteristically rounded, iron-coated, or quartz-encrusted grains are of not infrequent occurrence in the surface debris collected from that area. We have also evidence of this movement in the occurrence of fragments of the Conrock quartzite, of which one or both varieties have been noted at the following localities: (*a*) in the wood near Benrinnes distillery; (*β*) near Ruthrie Linn; (*γ*) the northern front of Blue Hill; (*δ*) the valley of Fiddich, near Dufftown station. The large block of Netherly diorite to the south of the Spey, at Craigellachie already referred to, would also bear witness to a movement in the same direction, while north of Elgin the occurrence of fragments of the cherty rock of Lossiemouth at Bishopmill and at intermediate positions in direct line from the parent rock would also point to a like conclusion.

Further evidence of a movement in the last-mentioned direction is found in glacial striæ on rocky surfaces at the following points: (*a*) S.E. of Burghead; (*β*) west of Hope-man; (*γ*) near Lossiemouth; (*δ*) at Quarrywood at a height of 200 feet above sea level. The first two sets are indicated on the Survey map (sheet 95). Set (*γ*) was observed by the late Mr Grant at the old quarry near the schoolhouse, and the appearances, as reported by him, were such as left no doubt in his

mind that the ice-sheet, improbable as it seemed, moved up out of the sea and across the land surface in a direction slightly to the east of Benrinnes. Set (δ) takes the form of somewhat superficial scratches over deep groovings and flutings, the earlier of which are directed a few points north of east. These appear to have been succeeded by a series verging round to a position considerably south of east. Some doubt might be expressed regarding the direction of movement of the ice mass that caused the superficial scratches, but as the scorings are always deeper at the northern end, a movement from that quarter is doubtlessly indicated. These markings are directed towards a point just to the west of the peak of Benrinnes.

The whole of the phenomena which have just been described can easily be explained on the theory of a prolonged Ice-age, subject to exacerbations or ameliorations, or it may be to actual interruptions from time to time, but during which there were many long marked changes in the direction of movement and volume of the ice-masses as conditions varied.

The first phase is indicated by a movement of the ice-masses, both here and further west, from the central high-ground outwards to the N.E.

In the broad valley of the river Nairn and Caledonian Canal glaciers, from different mountain systems, met and became confluent. Still advancing and meeting with other glaciers streaming out from the Northern Highlands, they finally came to fill the Moray Firth with a broad sheet of ice. The advance of the ice from the Northern Highlands, gradually increasing in volume, began at length to hamper the out-flow from the Great Glen, as well as over eastern Moray; and gradually, as conditions became more urgent, to deflect it from its natural course down the centre of the Moray Firth, causing it first to hug the southern shore of the firth, and to veer round from N.E. to N. by E., then finally to a direction which may be put down as approximately 25° S. of E. At a later stage the Scandinavian ice, advancing far into the Moray Firth, caused a deflection of the Scottish ice through quite a right angle, and gave rise to the particular distribution of erratics indicated under *D*.

As a similar deflection of the Scottish ice has also been demonstrated on the northern side of the firth, where the movement of the ice was found to be from the seaboard across the Caithness plain to the north-west,¹ we are thus enabled to fix, with more or less exactness, the position of the front of the Scandinavian ice at this period. A line drawn from Lossiemouth to the opposite shore of the Moray Firth at Dunbeath

¹ Messrs Peach & Horne, "Proceedings" Royal Physical Society, Edinburgh, 1880-81, pp. 316-352.

might be taken as roughly tangential to the western face of the Scandinavian ice. At this period the Scotch ice, thrown off by its advance on the south side, both as regards volume and thickness, was, I think, comparatively insignificant. It has left only superficial raspings on the rocky surface at Quarrywood, at a height of 200 feet, while on the same surface the eastward bearing ice is represented by deep flutings and groovings that must have been produced by a mass probably many times its thickness.

A rough estimate of the different masses may also be made by comparing the relative number and size of the erratics distributed by the respective streams. It may, therefore, be concluded that the Scotch ice had become very much attenuated before the advance of the Scandinavian ice into the centre of the Moray Firth.

The grouping described in *C* is, no doubt, due to a local glacier, probably having its rise in Benrinnes during the decadent phase of the glacial period.

In the case of some of the boulders of Kinstearry granite there has been an apparent up-lift of about 600 feet; that is to say, there is a difference in level of 600 feet between the highest known out-crop of the rocks, *in situ*, and the highest placed boulders derived from it. From the number of boulders of this granite scattered over the land surface to the east, to say nothing of what may be under the sea, it is manifest that immediately preceding, and probably far into the Ice-age, this boss of rock stood much higher than it does now. Its *rochés-moutonnés* surface also shows that the last operation on its surface was executed by land-ice. If, by chance, icebergs had anything to do with the observed up-lift, they must have most obligingly waited around while the sea rose, or rather the land sank, 600 feet. Another position, however, which might be taken up in the interests of land-ice, is that boulders detached by one ice-stream during a particular phase of the Ice-age may have been carried up to their present positions by another ice-stream during another phase. It is no doubt also possible that icebergs might have carried off blocks which had previously been detached by other agents, but the entire distribution of erratics over eastern Moray may be quite satisfactorily explained without once calling in their aid.

