Thursday, 4th April 1872.

Professor GEIKIE, LL.D., F.R.S., President, in the Chair.

The following Gentleman was elected a Fellow of the Society :—

JAMES OVEREND, Edinburgh.

The following Communications were read :—

- I. *On Blocks and Boulders lying loose on and imbedded in the Rocks which form the Seaboard of Benholm Parish, Kincardineshire, between High and Low Water-Marks.* By Rev. ALEXANDER SMART MYERS, Minister of the Parish.

Nowhere upon the land of Benholm parish beyond flood-mark does there now remain a block or boulder of notable size which can be considered as “erratic.” One of large dimensions once existed, and gave the name to the farm on which it lay—“Stone o’ Benholm ;” but not a fragment of it is now to be seen. An old inhabitant, however, tells me he remembers seeing several large fragments of it in his younger days. Between high and low water-marks, however, on the sea-board of this parish, there are many blocks and boulders which deserve special notice, and which, I think, would interest the experienced geologist.

Our sea shore trends in a north-easterly direction for fully three miles between the parishes of St Cyrus and Bervie, and the whole of it is low-lying ; while on either side the coast rises—on the south-west, about three miles within St Cyrus, to 150 or 200 feet of trap rock, and on the north-east to about 400 and 500 feet of conglomerate rock in the Hill of Gourdon, on the confines of Benholm and Bervie, and in the Hill of Craig Davie, in the parish of Kinneff. Thence the coast line through Kinneff and Dunnottar consists of precipitous cliffs from 120 to about 200 feet high, including the “Fowlsheugh,” and the rock on which the Castle of Dunnottar stands. The whole of this precipitous range, from Gourdon Hill to Dunnottar Castle, is composed mainly of conglomerate, interspersed by beds of red sandstone, and in places ruptured and overlaid by trap. The sea-board of Benholm is a continuation of this system of rocks, either depressed to nearly the low-water level, or else, perhaps, more probably denuded almost entirely of the conglomerate which overlies the sandstone in the parishes of Kinneff and Dunnottar. At low tide, a margin or border forming our foreshore, about 300 yards broad, is exposed between high and low water-marks.

The whole surface of this margin or border is comparatively flat, in some parts quite level and even, and at full tide not one edge or apex of rock is visible. At its north-east extremity, for about three-quarters of a mile, this margin consists of conglomerate composed of large-sized boulders; then, for about a mile to the south-west, of conglomerate with small bowls, and of sandstone; then onward for a half mile, of large conglomerate; and thereafter, to the south-west boundary of the parish, of sandstone, with occasionally very small conglomerate. Here and there throughout the length of the margin or border there are dykes and overlaps of trap, and in one part a mass of what seems to be quartz rock. When the tide is out, the first and third of the above divisions are seen to be literally bestrewed with what appears to be erratic blocks and boulders, while within the other divisions few, and in some parts none, are to be seen; for a full mile from the south-west end of our shore, the fourth of the divisions above-named, I counted only eight above 2 or 3 feet cube. At the north-east extremity, the first of these divisions, they are far more numerous than at the third, and may be counted there by scores or hundreds. They vary in size throughout the foreshore from 1 or 2 cubic feet to 220 and 729, and in one instance 1080 cubic feet. They are of different kinds of rock—granite, grey and red, but neither the same as the Aberdeen or Peterhead; gneiss, quartz rock, porphyry, greywacke, and what are vulgarly called whinstone and heathen-stone. All are more or less rounded, and are of diverse shapes—oval, cubical, globular, conical, roof-shaped at top, flattish, &c. Mostly they are all pretty smooth, some quite polished; upon none are there any striations or scorings, nor any groovings or ruts which could be pronounced to be the effects of glaciation, except one on which the ruttings are very plain. Upon its top there are two grooves, running the whole length of the stone, $4\frac{1}{2}$ inches deep, and about 8 inches across. This stone measures $5\frac{1}{2}$ feet by 5 feet, and 3 feet high. It is gneiss. I have since discovered another, with decided traces of glacial grating.

For long I was of opinion that the whole of these blocks and boulders had been brought and laid down where they now lie, during the last glacial period, by glaciers partly, and partly by icebergs. I was led to ascribe these boulder-deposits to both these agencies—first, in respect to the former, because from the glacial scoopings and gougings on the ridges of hills, and the striae and groovings on the surfaces of rocks in this parish and neighbourhood, it is evident that the enormous ice-cake which passed to the north-eastward over Kincardineshire, south of the Grampians, must have taken our sea-board edgeways, and upon a decline, and hence would drop on our sea-margin the blocks with which its south-east side was loaded; and second, with respect

to the latter, I have been induced to believe that icebergs must have been, during part of last glacial period, floated on upon our land in considerable numbers, because (a), either from an inset of an ocean current, or from the effect of prevailing east and south-east winds at some seasons of the year, many ships have been driven and wrecked, and even bodies of persons who had been drowned in the Firth of Forth (three cases I can give) have been cast in upon our shore; (b), there are some beds of glacial clay in the parish that had been formed by the grounding and grinding of icebergs, and from one of these I took, when it was exposed, some pieces of chalk which was evidently Scandinavian; and (c), many of the boulders and blocks on our sea-margin are of kinds of rocks not found in this country, as far as I am aware. But I have lately observed reasons for modifying this opinion. For on examining our boulders and blocks more narrowly, I have discovered that not a few of them are still partly imbedded hard in the underlying solid rock. One of these, which is gneiss, lies imbedded in trap, and the part exposed measures 12 feet by 6 feet, and $4\frac{1}{2}$ feet standing out; another of gneiss, imbedded in conglomerate, is 9 feet by 6 feet, with about 3 feet protruding; one like greywacke, is 18 feet by 12 feet, and is 3 feet out of the imbedding rock, which is trap; one of granite, imbedded in conglomerate, shows about 3 feet every way; another of granite is 10 feet by 5 feet, with only a few inches jutting out.

My conjecture, therefore, now is, that most, if not all of the blocks and boulders lying loose within flood-mark on our sea-margin or border, had not been deposited during the *last* glacial period, but have been liberated from the rocks in which they had been imbedded by the action of the sea in storms, aided by frost at low water in winter, and that such as are of some size remain on the spot where they had been imbedded. For very many of them rest curiously poised on three, four, or five round stones protruding from the conglomerate, the vacant interspace below, which had been washed out, being of such depth that one can not only pass easily a walking-stick, but sometimes one's arm, through beneath the propped-up boulder or block, and I have seen one below which a child could creep through. This conjecture as to the source whence, and the way how, these loose boulders have been derived in their present position, is supported by the facts that they are only found in numbers on the conglomerate where similar ones are still fast imbedded, whereas few or none are found where the conglomerate is made up of moderate-sized stones, and where the rock is sandstone, as before was stated. This conjecture is also confirmed by what seems a peculiarity in some parts of our conglomerate. In places its bowls are cracked and indented, and its boulders and blocks are

cracked, as if by heavy lateral pressure and by heat. The loose boulders and blocks are also cracked and split—many of them, and from several large fragments have fallen off. If I am right in this conjecture, may not many of those erratic boulders about which your Society is so properly and so much interested, have been derived at the last glacial period from the same source, and been then expressed by glacial action out of the conglomerate in which they were imbedded, as were the bowls of the boulder clay? Doubtless many are found in situations at the surface of the land, which had been carried and laid down there during the last glacial period; but there are others which must have been deported from far, and deposited on our island ages before. I have seen such blocks in the boulder clay. One such, which is both rutted and striated, was lately taken from the boulder clay at the sandstone quarry of Lauriston, in St Cyrus parish, and has been preserved by the proprietor, Alexander Porteous, Esq.

My idea further is, that these blocks and large boulders imbedded in the rocks on our sea-margin, together with most or many of what are lying loose, and of such as are occasionally found in boulder clay, being evidently all “erratic” or “travelled,” had been carried by glaciers and icebergs during some of the former glacial periods, and having been dropt on stony beaches, became subsequently fixed in the conglomerate, and that most or many of the blocks and boulders now found loose, were afterwards detached in the ways I have suggested. The large ones on our sea-board still imbedded in trap, had evidently been forced up out of the conglomerate by the eruptive trap; and I have seen trap dykes with smaller boulders of quartz, &c., sticking fast on the surfaces, which had been brought up in the same way.

I may add, that in this parish there are some deposits of glacial moraine which have been rearranged by water, and that the glaciation of the last period has left a very marked and decided impress on the whole parish.

II. *On some Points in the Geology of the Neighbourhood of Edinburgh deserving further Investigation.* By Professor GEIKIE, LL.D.

III. *Notice of a Fault in the Carboniferous Rocks on the Water of Leith, above Currie; with some Observations on the Geology of the District.* By JOHN HENDERSON, Curator of the Museum.

The operations at present going on, in the process of making the Balerno branch of the Caledonian Railway, afford many