

EIGHTH REPORT

OF THE
BOULDER COMMITTEE OF THE ROYAL SOCIETY
OF EDINBURGH.

(*To be Presented at Ordinary Meeting on 5th June 1882.*)

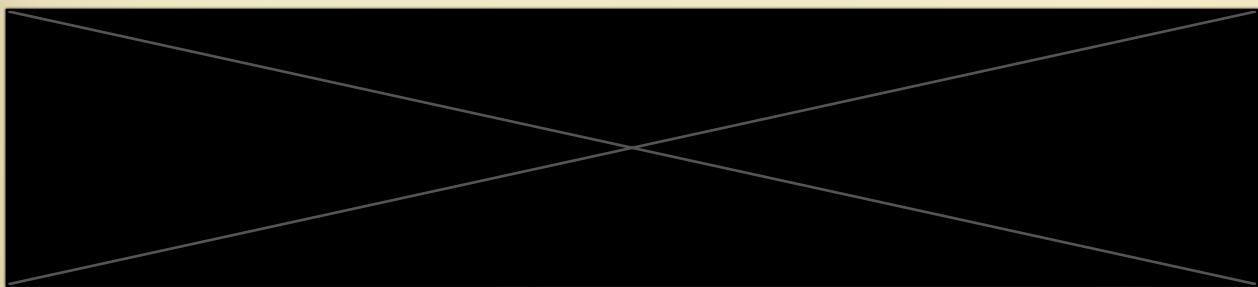
The Convener regrets that, being now no longer able to climb hills, or walk to any considerable distance, his contribution of information to the Committee, is, this year, exceedingly small.

I. CANTIRE.—LOCH TARBERT.

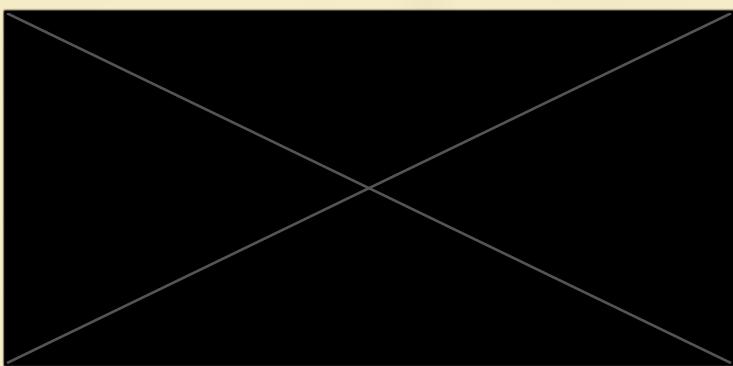
The only place which he visited during last autumn was East Loch Tarbert, Loch Fyne, at the suggestion of Mr. Alexander of Lochgilphead, whose services to the Convener during the two previous years were peculiarly valuable.

Having procured a horse, the Convener, under Mr. Alexander's guidance, rode up two-thirds of a hill, about two miles to the N.W. of East Loch Tarbert, on the property of Mr. Campbell of Stonefield. He omitted to record the name of the hill. The chief object was to examine a boulder bearing the name of "*Capel Cloiche*," meaning "Mare Stone," from its fanciful resemblance, in a misty day, to a mare feeding. The hill was found by aneroid to be 710 feet above the sea.

The summit of the hill is shown by the following diagram, not drawn to an exact scale:—



direction, along the contour line of 690 feet; and about 15 yards between N. and S. at *f*. The largest boulders are represented by the letters *a* to *m*.



The boulder with the name above mentioned (*a* in the diagram) stands on the very highest peak of the hill. It is composed of compact gneiss, whilst the rock of the hill is clay slate, with

numerous quartz veins. The height of the boulder is 8 feet, and its breadth or width each way, near the lower end, is 5 feet.

There are multitudes of boulders near the top of the hill,—chiefly on the S.E. side, *g*, *h*, *k*, *l*, *m*. The largest of these, *k*, is $14 \times 9 \times 8$ feet. There is only one boulder on the north side, viz., *b*, whose size is $9 \times 4 \times 4$ feet. They are all gneiss boulders.

As bearing on the question of transport, it is proper to mention that this hill stands by itself, in a sort of amphitheatre. There are no hills so high as it is, within a mile.

At about that distance towards the north, there is a range of hills somewhat higher,—with openings between. On these hills numerous boulders were descried through the telescope, and regret was felt at the inability to visit them,—especially several seen to be perched on ridges and peaks.

It seemed probable, that if there had been ice floating on a sea from 800 to 1000 feet above the present sea-level, carrying boulders, and stranding on the hill, the position of the boulders on the hill and its sides, might be accounted for.

In this district, with hills not exceeding 1200 feet in height, local glaciers are not likely to have been formed; and if they had been such, they would have passed down the low grounds on each side of the hill along its base.

On his way back to Tarbert, the Convener passed a conical hill, beautifully clad with smooth green pasture. On its N.W. slope two large boulders were observed. But as the access to the hill was difficult, the Convener did not attempt to reach them.

The hills, both north and south of East Tarbert, are well covered

by boulders, and would repay a special visit from any one interested in this subject. Even from the streets of the town, in a clear day, boulders can be seen on the ridges of the surrounding hills on the sky-line.

On the hills adjoining East Tarbert village, on the south, and at a height of from 280 to 300 feet above the sea, there are evident marks of some agent having swept through between the hills from west to east. The rocks are well rounded by friction; and on the east side of many rocky knolls, there are small boulders, and heaps of gravel, which look as if they had been protected by these knolls from a westerly debacle or current.

The Convener, when at Rothesay, walked along the course of the small stream which runs into the sea near the Queen's Hotel. In the lower part of its course, the stream cuts through beds of gravel, from 50 to 60 feet thick. In the upper part of its course he came to a flat about 780 feet above the sea. He found there a number of boulders. The largest $4 \times 2 \times 2$ feet, had its longer axis pointing N.W. and S.E.

Mr. Alexander told the Convener of a large boulder, 9 or 10 feet high, on the Farm of Taynish, at the head of a small arm of the sea, on Loch Sweyn, about 4 miles south of Tayvallock. It is surrounded by a cluster of smaller boulders. It lies on bare rock, which slopes down towards the west. It is about 50 feet above sea-level. On the east side of it, there is an old sea bank, which may have intercepted its transport farther eastward.

II. OCHIL HILLS.

The Convener has received a letter from James Johnstone, Esq., of Alva, referring to the south slopes of the Ochil Hills, mentioning that the boulders in Alva Glen and Silver Glen are all mica schist. In Tillicoultry Glen, he says there used to be many granite boulders; but he thinks they have all been broken up for building purposes.

He adds, that as the rocks of the Ochils are here a species of trap, the boulders in question probably came from the Grampian Hills.

III. ORKNEYS—NORTH RONALDSHAY.

The Convener has received the following in answer to the circular sent out by the Committee during last winter:—

" In this island of North Ronaldshay, Orkney, of which I am proprietor, and the rocks of which consist of Old Red Sandstone flags, there are no boulders that I know of. I have, however, observed a mass of coarse conglomerate like a rock which occurs to the S.W. at Heelabir, in the adjacent island of Sanday. It had been built into a stone dyke, and was of a size too large for most men to carry. The surface was slightly worn, but not rounded like a beach stone. I have also often found smaller blocks of granite and syenite (which may have been transported from the locality at Stromness also to the S.W.); and also a stone resembling coarse jasper, scattered over waste parts of the island; these are often more than half buried in the ground, and most of the blocks are more angular than beach stones. Some of them have their surfaces flattened and smooth, and in one or two instances shining, as if ground and polished. The soil on which they are generally found, is clay, loam, or nearly pure clay of a red colour; and sections in making quarries show that it contains in places rounded pebbles with here and there angular flints, much discoloured, and bits of mica schist mixed with quartz and other extraneous stones. This red clay extends over many acres, and varies from 1 to 4 or 5 feet in depth.

" Wm. TRAILL of Woodwick."

8th March 1882.

IV. SHETLAND.

1. *Parish of Lunnasting.*

In reference to the circular lately received asking for information about boulders, I beg to forward a few particulars respecting four. They are all in the parish of Lunnasting, on the estate of Lunna, and the property of Robert Bell, Esq., sheriff of Falkirk.

No. 1. Height 22 ft. 9 in.; length 36 ft.; breadth 25 ft.; shape, angular; direction of longest axis S.E. and N.W.; height above sea level 150 to 200 ft.

No. 2. Height 19 ft.; length 34 ft.; breadth 14 ft.; angular; direction of longest axis N.E. and S.W.; height above sea level 150 to 200 ft.

No. 3. Height 11 ft. 4 in.; length 8 ft. 7 in.; breadth 8 ft. 2 in.;

angular; direction of longest axis S.E. and N.W.; height above sea 150 to 200 ft.

No. 4. Height 7 ft. 10 in.; length 8 ft. 7 in.; breadth 3 ft. 2 in.; wedge-shaped; direction of longest axis S.E. and N.W.; height above sea 300 to 400 ft.

Nos. 1, 2, and 3 stand all near each other in the northern part of the parish, and not far from the sea. Nos. 1 and 2 are separated only by a distance of 10 or 12 feet, the intervening space being filled with large masses of stone which appear to have fallen from No. 2. No. 4 stands by itself, surrounded by deep moss, within a few yards of the highest point of a hill about four miles to the south of the other three. Its longest axis runs parallel to the face of the hill. It is known by the name of the "standing stone" of the south hill of Lunna.

No. 3 has no special designation.

Nos. 1 and 2 are known as "the stones of Stofas." "Stofas" is said to be a corruption of *stay fast*, and the legend accounting for the name is that it was given to the stones from the circumstance that they were originally two giants passing through Lunnaness, and converted into stone by some superior power who arrested their progress by pronouncing the words "stay fast."

All the above stones look something like pale granite.

Note by Convener.—These stones of "Stofas" are referred to by the late Dr. Hibbert in his volume on Shetland, and a diagram of them is given. He describes them as "enormous detached masses, which do not seem to have undergone any very distant removal, since they repose on rocks of precisely a similar kind" (p. 173).

Dr. Heddle of St. Andrew's informs the Convener that he, some years ago, examined these stones, and formed an opinion that they had, by some unknown natural agency, been detached and wrenched off from other rocks, and moved in a direction towards E.S.E. They are micaceous gneiss.

These blocks are referred to in the 2d Report of the Boulder Committee.

2. Parish of Fair Isle.

The Rev. William Laurence, catechist and teacher, reports as follows:—

"There are no boulders above 10 tons, but there are several small ones of the pudding-stone description, quite different from the rocks *in situ*. There was one very remarkable large stone—a huge

block of sandstone—quite similar to the Eday* sandstone, but it was blown up by gunpowder last year for building purposes. There was nothing like it in the whole island.

“ It and the other small ones probably are glacial deposits.”

V. CAITHNESS.

The Rev. Hugh Mair sends the following answers to a circular from the Committee :—

“ Boulder in Keiss parish ; estate of Freswick ; farm of Mr. Peter Gunn ; proprietor, Wm. S. Thomson Sinclair, Esq.

“ Length 9 ft. ; breadth 5 ft. ; height 7 ft.

“ Rounded, but rather broader at base.

“ Longest axis W. by N. and E. by S., or W. and E.

“ Different from any rock in locality ; none similar in locality so far as known.

“ Conglomerate or pudding-stone of a most remarkably pronounced character.

“ Popular name, “ Greystone ” ; no legend, save that it is called one of the Kirk stones,—origin of name unknown.

“ 200 ft. above sea-level ; and $\frac{1}{4}$ mile from sea on east coast.

“ Marks the boundary between the old parishes of Wick and Canisbay, and between the lands of Nybster and Aukingill.

“ I am sorry to say the answers refer to the stone *as it was*. Some utilitarian individuals blasted it ; and part has been carted away ; but three large portions remain. When whole, it must have been a most remarkable stone.”

GEO. CHRISTIE.

The Manse, Lunna, Lerwick, Shetland,

18th March 1882.

Notes by Mr. Ralph Richardson (a member of the Committee) of a Visit by him to Strathnairn, in the Autumn of 1881.

I drove last August (1881) from Inverness *via* Druids Temple and General Wade's military road to Strathnairn, crossing the

* Note by Convener.—The Island of Eday is about 13 miles to the S.S.W. of Fair Isle.

River Nairn at Daviot, and proceeding down its right bank to the celebrated "Tom riach" boulder, returning *via* Clava and Culloden Moor,—a distance of about 20 miles. Shortly after passing Craggie Burn, Strathnairn, I was struck with the number of boulders dotting eminences throughout the valley, and with the depth of sand which covered the hills,—the whole pointing to a period of submergence in Post-Pliocene times.

To make this still more evident, I may cite the interesting discovery last summer by Mr. James Fraser, C.E., Inverness, of Arctic marine shells at the height of 500 feet above the sea, at Drummore of Clava in this district, being the second highest discovery of the kind made in Scotland. Several of the shells discovered here being now only found in Arctic regions, the sea which once covered this district must have been of a decidedly glacial type.

I examined the section at Drummore, and found that it exhibited a considerable depth of sand, beneath which the shells occurred in a bed of blue clay. Similar shells in similar blue clay are found near the sea coast at Ardersier, Fort George, about 8 miles due north from Drummore of Clava, and at an elevation of about 50 feet. It is evident from the occurrence of these shells in two separate localities, that this part of Scotland had once been covered by a sea of a temperature similar to that now washing the coasts of Arctic America, Finmark, and Spitzbergen. I also inspected the two famous boulders of the district, both of them huge conglomerate blocks, "Tom riach" (the stone of the grey hill), measuring 27 feet \times 22 feet \times 15 feet, near Croygorstan, and the "*Duke of Cumberland's stone*" on Culloden Moor.* Probably neither of these are far travelled, Conglomerate rocks being found *in situ* in proximity to them. The valuable papers by Messrs. Thomas D. Wallace and James Fraser of Inverness, in volumes III. and IV. of the *Edinburgh Geological Society's Transactions*, treat fully of the Boulder phenomena and geology of this interesting district.

* The "Tom riach" boulder is between 300 and 400 feet above the sea-level; and the "Cumberland stone" is 487 feet above the sea.

*List of Boulders in the Neighbourhood of Inverness, sent by
Mr. Wallace, High School, Inverness.*

1. Split conglomerate boulder, in the burn below Mid-Lairg Farm, in Upper Strathnairn.
2. Clach-a-nid (stone of the nest) lies on the N.E. shoulder of Meal-Mor, a hill 1207 feet high. The boulder is 950 feet above sea-level. It is composed of gneiss, and measures $28 \times 24 \times 14$ feet.
3. Brownie Stone. A very large conglomerate boulder lying on the moor, half a mile north of Bunachton.
4. Clach-na-h-ulaidh (stone of the hidden treasure). A large block of gneiss, $12 \times 12 \times 5$ feet, resting on the brink of a cliff of Old Red Sandstone, overhanging the east bank of the Nairn River, a few yards from Nairnside House. It is about 40 feet above the river, and 400 feet above sea-level.
5. Gneiss boulder, measuring $6 \times 5 \times 4$ feet, much rounded, lies on limestone, interbedded with the Old Red Sandstone, at Dalroy, on the Nairn. It is composed of ordinary gneiss.
6. Conglomerate boulder in a field, a little to the N.E. of "Tom Riach" boulder, measures 95 feet in circumference, and 35 feet in length. It lies about 350 feet above sea-level. Same kind of conglomerate as the "Tom Riach," which would show that it came from the S.W.
7. Conglomerate boulder (same as other), lies in the bed of the River Nairn, to the East of Daviot House. Measures about $6 \times 7 \times 8$ feet.
8. Four conglomerate boulders, same as last, on the moor, north of Nairnside School House, at a height of 590 feet above sea-level. One measures 14×8 feet, one 13×15 feet, one 9×9 feet, and one 9×8 feet. These may have come from west. They do not rest one upon the other.
9. In Cran-More Wood, Nairnside, there is one boulder measuring $9 \times 6 \times 3$ feet, which is stratified conglomerate, similar to that found at Failie, about 5 miles to the west. This boulder lies at a height of 600 feet above sea-level. In the same wood there is a gneiss boulder, 5×6 feet, slightly rounded, and resting on Old Red Sandstone.

10. Conglomerate boulder, on south shore of Loch Duntulchaig, opposite Achnabat, a few feet above the loch and 720 feet above sea-level. It measures $4 \times 5 \times 3$ feet. There are several others of the same rock lying along the shore of the loch. These can easily be identified with the rock on Dunchae, which is about a mile to the W. There is no other similar rock in the whole neighbourhood. It is composed not of rounded pebbles, but of thin pieces of rock.

11. Granite boulder on the west shoulder of Dalcromlin Hill, which lies S.W. by S. of Inverness. This boulder rests on conglomerate rock, 1200 feet above sea-level, and measures $5 \times 3 \times 3$ feet.

12. Clach-an-abau is a conglomerate boulder, lying in Petty Bay, to the E. of Inverness. It was moved by the tide. The waters round it had frozen, and thus served as a means of floating it. It is not large, perhaps about 4×3 feet. The underlying rock is Old Red Sandstone.

13. Boulder of Dirrymore granite lies on the shore, a few feet above sea-level, to the E. of Kessock Ferry. Dirrymore lies N.W. by N. from Inverness. Boulders of this granite are found scattered over the shores of the Moray Firth as far east as Buckie. This boulder is lying on the gravel of the shore.

14. There are two boulders in Findhorn Bay; one of Granite, measuring $4 \times 3 \times 3$ feet, and the other of gneiss, measuring $5 \times 3 \times 3$ feet.

15. The little burn to the west of Inches House, about $2\frac{1}{2}$ miles S. of Inverness, is full of boulders. One interesting group of three may be mentioned. They lie one against the other. The one to the west is Granite and measures $7 \times 4 \times 2$ feet. The one in the middle is Old Red Conglomerate and measures 6×3 feet. The one to the east is gneiss and measures 3×2 feet. They lie at a height of 200 feet above the sea-level.

16. There is a fine specimen of a striated stone, fixed in boulder clay, in the burn below Muckovie Quarry, about 3 miles S. of Inverness. The striae when seen by me, when the stone was fixed in the clay on the bank of the stream, ran E. and W. It has now fallen from its original position.

17. *Porphyry Boulder*.—In wandering over Strathnairn and the

district to the S.E. of Inverness, I was puzzled to know where the numerous specimens of porphyry could come from. While pursuing my investigation in the upper part of the Strath, I found the rock *in situ* between Loch Ruthven and Loch Duntilchaig. I have also, since that time, seen the same rock in other two places in Strathnairn, nearer the mouth of the river.

18. *Boulders of hornblende* are to be seen lying along the shore between Inverness and Culloden Station, as well as along the west shores of Loch Ness. There are two places on the west shore of Loch Ness, where hornblende rock is *in situ*. One of these about two miles to the west of Loch End Inn, has been known to me for a number of years. The other which is about two miles further to the west was pointed out to me by Dr. Aitken, Medical Superintendent of the Inverness District Asylum, who discovered it.

19. One of the stones in the so-called Druidical circles at Stoneyfield, about one and a half miles E. of Inverness, is quite unlike anything I have seen within a radius of 20 miles of Inverness. I have not been able exactly to identify this rock, but from descriptions in mineralogical books, I am of opinion that it is a diorite. The stone has every appearance of being waterworn and rounded, but whence it came I cannot say.

20. One of the stones in the "circle" at Culloden Railway Station is a serpentine. There is serpentine in Glenurquhart, which is about 12 or 14 miles W. from Inverness. I do not think the builders of these circles would have gone so far for building material.

21. A friend of mine in Glenurquhart tells me that there are granite boulders in that district, differing from all the granites surrounding the Glen. He is investigating the matter, and I expect to have exact information regarding them soon.

*Extracts by Convener from Notes supplied by Mr. William Morrison,
Secretary to Field Naturalists' Club, Dingwall, Ross-shire.*

1. On the south slope of Tulloch Hill, the following boulders occur:—

(1) At the height of 550 feet above sea, an irregularly rounded

boulder of granite-gneiss, supposed to be one of those mentioned by Mr. John Campbell in *Frost and Fire*, vol. ii. p. 152, as consisting "of a peculiar kind of pink granite, resting on slate," and of which he gives a diagram at page 167.

Its girth is 29 feet; greatest length 11 feet; height 7 feet, and breadth 7 feet. Its major axis is N.N.W. and S.S.E., with sharpest end to E. The felspar in the boulder is pale red, and the mica so arranged as to produce a laminated appearance.

(2) About a quarter of a mile S.W. of No. 1, on Upper Docharty Farm, at 400 feet above sea, another boulder of same rock $8 \times 5 \times 5$ feet; and major axis N.N.W. and S.S.E., with sharp end to west.

(3) To N.W. of No. 1 boulder, at a height of 620 feet above sea, a flat block of mica schist, $11 \times 7 \times 2$ feet; major axis W. and E. The west end pointed, and appears as if scoured by running water.

The upper surface is scored by natural ruts, grooves, or striae, 2 and 3 inches broad, and from $\frac{1}{8}$ to $\frac{1}{4}$ inch deep. These run in a direction from N.W. to S.E., and cross nearly at right angles the lines of lamination of the stone.

Over the upper surface of the boulder, there are about thirty-six artificial "*cup markings*." These marks are faint where scorings are deepest and most frequent. The cup marks are well defined at the N.E. end of the upper surface of stone, and also at the S.W. end. One seen well marked at S.E. side, about half an inch from top surface.

(4) On Drynie Farm, S.W. of No. 3, at height of 600 feet above sea, a mica schist boulder $12 \times 8 \times 4$ feet; major axis N.N.W. and S.S.E.

On the surface of boulder there are six striations or groovings (not artificial), running N. and S.

There is one cup mark at south end.

(5) On Tulloch Hill, at 900 feet above sea, a boulder of same rock as No. 1 and 2, $8 \times 6 \times 4$ feet, with major axis N.W. and S.E.

The prevailing rock on Tulloch Hill is a bluish grey indurated sandstone shale.

Where the outcrop stands upon opposite side of valley, the strata (dipping south at angle of 45°) have been rubbed and smoothed on their north faces by some natural agency, in many lines bearing N.W. and S.E.

The prevailing soil on Tulloch Hill is a pale reddish till, derived possibly from the rocks of red sandstone and conglomerate, which exist towards the west.

To the north of Tulloch Hill a Moor stretches to a uniform height of 1100 feet, on which are many smaller boulders similar to those on the southern slope of the hill. They occur also to the east of the hill, all the way down to the Cromarty Firth; and (as reported) even to the Black Isle. In most cases of the boulders having one axis longer than the other, the direction of the former is E. and W.

2. Thinking it probable that these Tulloch Hill boulders came from the westward, Mr. Morrison states that he lately set out, accompanied by a few friends, on an excursion in that direction.

At *Garve* (about eleven miles west of Dingwall), rock was found with surfaces rounded, smoothed, and striated; the *striæ* running E. and W.

The Strathgarve district is covered with multitudes of boulders of granite and mica slate, chiefly the former. For miles along the Ullapool Road on to *Inchbae*, there are *torrents* of such blocks.

At *Achnaclerach*, there is a gigantic mass of the same kind of granite as the Tulloch Boulders, $25 \times 23 \times 12$ feet above ground, about seventy feet in girth, and weighing probably about seven hundred tons; evidently an erratic, the kind of granite composing it being different from the rock on which it rests.

Farther along the road towards *Inchbae*, several other boulders of the same kind, and not much less in size, were seen.

At *Inchbae Lodge*, the ground is much covered by these *boulders*.

At the confluence of the rivers *Glascarnoch* and *Strathvaich* near the schoolhouse, rock appears *in situ* identically the same as that of the Tulloch Hill boulders. The felspar of the rock has the same pink colour, and the mica is segregated in bands. The bed of Strathvaik river is entirely composed of the rock, and it appears to break naturally into huge cubical masses, among which the river rushes and foams violently.

In proceeding further west no boulders were to be seen. We seemed to have at length reached the parent rocks; for to the N. of *Garbad*, a place about a mile S.E. of Inchbae Lodge, no more boulders were met with.

The boulders in this district occupy the valley, through which the *Blackwater* River flows.

The *schoolhouse* above mentioned (about seven hundred feet above sea-level) is at or near the base of a hill called *Druim Buidhe*, 1080 feet above sea, which presents naked cliffs of granite rock facing W.N.W.

"We examined the pass of the Bealach, situated between *Big Wyvis* and *Little Wyvis*, which reaches to a height of about 1250 feet, and runs in a direction N.W. and S.E., to see if any granite or other boulders were lying there; but we found no travelled blocks. The Bealach itself is full of gigantic blocks of mica schist detached from the side of the Pass."

"It appeared to us, therefore, that the *Tulloch Hill* boulders had made a detour eastwards over the south shoulder of *Little Wyvis*, a hill which reaches to a height of 2497 feet. On the south side of the Blackwater Valley, the hills rise to the height of 1500 feet above the sea."

Of course it is most improbable that the boulders on *Tulloch Hill*, at a height of about 1000 feet above the sea, could have been derived from the rocks forming the channel of the Black Water, at a height of only 500 feet above the sea. The parent rocks must have been at an elevation above that of the boulders. It only remains therefore to examine the adjoining hills, exceeding 1000 feet in height, to see whether they contain granite rocks of the same variety, or in the channel of the Black Water at Inchbae.

"I found granite boulders in large numbers, and of huge size, in the bed and on the banks of *Alt nan Cuirach*, four miles west of *Tulloch Hill*, and on move to E. conglomerate ridge, ending at *Cioch Mhor*. The river has washed out many of these boulders from the base of scours of yellow boulder clay of a depth of from 40 to 60 feet. These boulders were traced at heights from 1000 to 1200 feet above the sea from river bed at a spot due S. from *Loch Glass*. They probably came from *Carn-Cuineag*, through the opening occupied by *Loch Glass*. Both *Alt nan Carioch* and the river *Glass*, of which the former is a tributary, cut all the way down to *Evanton* through deep cliffs of boulder clay, resting on hard sandstone strata dipping S.E. The granite boulders are imbedded at the very base of the clay deposits."

[The Convener being struck with the account given of the striae and cup marks on Boulder No. 3, wrote to Mr. Morrison, to ask whether any idea existed in his mind as to the possibility of the striae having been formed after the cup marks had been formed. His answer, dated 24th April 1882, is—"The suggestion forced on the mind unquestionably is, that the cups were partially obliterated by the scoring agent, and hence were made before the natural striae."

If this suggestion is supported by further examination and study, it would indeed be a very marvellous discovery.

As Mr. John Campbell, in his *Frost and Fire*, refers to this district, the Convener gives the following extracts from his work:—

Page 149.—“Above the Inn at Garve, at about 600 feet, grooves on a rib of white quartz, turn with the glen. They do not point at Wyvis, or up into Strath Bran. They coast round a hillside, carefully avoiding the high hills, as rivers do at a lower level. They point S. 45° E.

“At the end of Loch Garve, beside the road, grooves on contorted gneiss take another turn with the glen. At about 150 feet above the sea, the marks point N. 70° E., and aim at the shoulder of Wyvis, which bars the way. On this hill side are piles of drift.

“If Strath Bran held a glacier which flowed N. and E. towards Ben Wyvis, stones left by it ought to be blocks of white and grey quartz and gneiss, fragments of rocks in Strath Bran and near it. But there is no such collection of native drift here.”

Page 153.—“At 1000 feet up the side of Wyvis, the rock is laid bare in a small burn. It is a soft slate, dipping 10° south.”

“There are blocks of granite on the hill, and a moraine in the glen. But the granite is foreign.

“At 1650 feet is a conical hill *Cloch Mor*,—a lump of hard coarse conglomerate. The sides are scored, the steepest end is down stream towards the west. In the supposed “ice” are large blocks of mica schist, bits of grey quartz rock, and a big boulder of gneiss.

“At 3000 feet, the ground on a shoulder of Wyvis is smooth and flat, the rock shows in the edge of a deep corrie. It is a coarse gritty sandstone, which splits into thin flags. On this high shoulder are blocks of gneiss.”

Page 255.—“At 3000 feet on Beinn Wyvis, mica schist (boulders lie) upon slate.”]

In company with Mr. MacLean, factor for Ardross, Dr. Sutherland, Invergordon, and Mr. Joass, Dingwall, I visited Carn-Cuinneag (2744 feet) in Ardross. The hill has two peaks, from each of which enormous shoots of granite blocks have fallen, many of which weigh about 400 tons. In Strath Ruasdale we saw on roadside a block of granite $22 \times 21 \times 12$ feet. Major axis N.W. and S.E., and weighing about 462 tons. We observed to the W. on the sky-line on the ridge forming west flank of *Glac-an-t-Seilich*, at 1600 feet above sea, a huge cubical block. Further, to the W. on the sky-line, on ridge close by north end of Loch Glass is to be seen an immense erratic block, cubical, said to be the largest in Ross-shire. Carn-Bhren to N.E. of Cuinneag, reported to be granite. These two hills of granite are probably part of the same belt, which to S.W. crops up at Strathvaich. The country to S.E. of this belt is full of boulders, chiefly granite. Many hills on their N.W. faces denuded and sown over with blocks.

The gravel of the road from Ardross to Diebidale is granitic. We observed under banks, washed by streams, beds of till yellowish red. The felspar of the Diebidale granite is generally paler than that of the Strathvaich granite, but many blocks were found, in which the felspar had same pale red appearance. The hill, Carn-Cuinneag, is entirely composed of granite. The saddle between the two peaks appears like a shingly beach; rounded stones of about 10 lbs. weight are seen packed on edge here and there in crevices, with longer axis of stones lying all in same direction. The east peak has shot down its fractured masses on the N.E. slope, whereas the west peak has sent its broken masses down on the N.W. side. Carn-an-Lochan (2000 feet) to N.E. of Carn-Cuinneag is also a hill of granite. Carn-Cuinneag being the highest hill in Easter Ross, commands a magnificent panoramic view of hills and deep glens to the N. and E., and hills rising on wide moors to S. and W. Many of these latter are rounded or dome-shaped and much denuded, hence the Gaelic name for such ("Creachan"), as may be seen by Ordnance Map, is frequent.

It was suggested that Carn-Bhren, said to be granite, Carn-an-Lochan, Carn-Cuinneag, all nearly in line N.E. to S.W., were but prominences in a belt of granite running S.W. to Strathvaich. To determine that point is to be our next work.

The road up Strath Ruasdale, and on through *Glac-an-t-Seilich* (Gaelic Glen of Willows—none, however, there now), passes through

numbers of boulders chiefly on the north side of the road, and resting on slope of the valley. Many of them evidently were carried from Carn-Cuinneag without losing much of their angular form, others had their angles well rubbed off by the grinding action of some heavy agency passing over them. These rocks were probably rounded by their fellow boulders, for where accumulations of these boulders appear largest, granite gravel and sand are associated with them indicating that these huge blocks struck against each other, and that the hammering and grinding produced the gravel and sand found in their neighbourhood.

The prevailing rock passed over on way to Carn-Cuinneag is quartzite, of hard, compact, and flaggy structure, some of it is flecked by ferric oxide. Indeed, in Strath Ruasdale, is found so large a quantity of good hematite, that a Birmingham firm offered Ardross £2000 a year for the mining of one huge rock. Another kind of rock prevailing to N. of Cuinneag is a hard blueish-grey quartzite (?), with a slabby structure.

Boulders were seen in the distance, perched on the sky-line of ridges to the west, of from 1600 to 2000 feet above sea.

W. MORRISON,
Secretary to Ross-shire Field Club.

Mr. Morrison, in sending the foregoing notes, writes to the Convener a letter (dated 8th May 1882) from which the following extracts are given, as they supply information of interest:—

“Carn-Cuinneag, in company with Mr. MacLean, factor for Ardross, Dr. Sutherland, Invergordon, and Mr. Joass, Dingwall, I visited on Saturday last. The weather unfortunately was extremely unpleasant; sleet and snow with driving mists prevented more thorough work being done. However, we satisfied ourselves as to the parent source of most of the travelled boulders in Easter Ross. Carn-Cuinneag and its lesser neighbours, Carn-Maine and Carn-an-Lochan, we saw were granitic. Carn-Bhren to the N.E., the keepers told us, is composed of the same rock as Cuinneag.

“The rock of the hills to the N. in the immediate proximity of Cuinneag was found to be of a flaggy or slabby structure. Under the microscope it shows grains of quartz. The appearance of the rock is uncommonly like limestone, but the acid test (hydrochloric)

decided it was not limestone. I am not enough of a geologist to determine what this rock is. The description given in Rutley's *Petrology of Quartz-Trachyte* answers well to what I found the rock to be under the microscope. Carn-Cuinneag is a remarkable hill. Its two lugs (hence the Gaelic name) are pinnacles of granite; the slopes descending from these peaks are covered with immense numbers of huge oblong blocks to within a short distance of the base of the hill. On the N. and W. slopes are to be seen shoots of stones of all sizes besides.

"Kildermore to the S.E. is strewn over with boulders, evidently from the Diebidale hills.

"I shall report result of our investigation of the hypothetical belt, extending from Carn-Bhren over Carn-Cuinneag and on to Inchbae, where the granite or gneiss was found *in situ* at Druim Buidhe as reported before, when we get to work.

"The granite of Carn-Cuinneag, in the main, is like that of Inchbae. We saw blocks of pure granite of the Peterhead pattern on the slopes of Cuinneag, but the granite characteristic of this district is that which I have described in my previous reports. The summit of Carn-Cuinneag must have been splintered by some terrific agency, to account for the overthrow of such gigantic masses as are found on both sides (N.W. and S.E. sides) of the hill. The blocks descend in perfect cataracts on both these sides.

"If we had an experienced geologist with us, it would add very much to our pleasure in exploring these regions; but in lack of one, queries from you for further information will do much to direct our observations.—Faithfully yours,

"WM. MORRISON."

Extracts from a Memoir by Professor Duns of the New College, Edinburgh (a member of the Committee), on the Surface Geology of Mid Luchaber, read in the Royal Society of Edinburgh on 6th February 1882.

"Boulders forming heaps or clusters are met with in the low grounds and also high up the sides of the mountains. Those in the low grounds contain sand and gravel; while in the heaps on the heights

there are boulders alone. The explanation most likely is, that those in the upland slopes have had the sand and gravel washed away by heavy rains.

A typical boulder heap occurs near the foot of the S.W. slope of "*Meall an t' Suidhe*," on the farm of Ashantee. So far as examined, all the blocks composing it differ from the mica schist rock on which they lie. They consist of different sorts, as granites and porphyries. The blocks near the heap are also granites and porphyries. One is of immense size, $13 \times 12 \times 6$ feet. A large piece has been broken off, in the line of cleavage, by another large boulder which had fallen against it, and been pushed partially over the part thus separated. To the N.W. of this heap, are other great clusters, which look like little hills.

The granites here are of various kinds, and frequently form boulders of great size. Some bear a close resemblance to the light red-coloured granite of Aberiachan, near Loch Ness.

Several of the heaps have a covering of peat. They lie in the course of a long line of single boulders referred to below.

Some large blocks are met with in association with many much smaller. Thus opposite to Lochy Bridge, at a height of 1500 feet, there is a porphyry boulder $7 \times 6 \times 5$ feet. The rest of the heap is made up of small granite blocks.

Not far from this heap, there are several boulders lying in line to the N.W. * * * *

Boulders which occur singly.

Near the old military road between Fort William and Stirling which leaves the drove road at the S.W. end of the former, there is a large boulder near the top of a hill, about 400 feet above the sea, and looking down on Loch Linnhe. Standing by this great stone, and looking to the N.E. in the direction of "*Meall an t' Suidhe*," one sees a series of boulders in line in the same direction, though the line is not so well marked as in some other cases. The boulder is a coarse grey granite, that next to it in the line is a fine felstone. Two others are quartzites, the rest are mainly of the rock of the hill,—mica schist—much rubbed and rounded. On the east of the road again, is a boulder of a fine-grained pinkish granite, with a close resemblance to the Aberiachan granite. * * * *

Coming now to the area lying N. of the River Nevis, including both low grounds and mountain slopes, granite, granitic porphyry, and porphyry blocks lie for the most part in a line of their own, while schists, micaceous gneiss, and some porphyrites, lie in either side of them.

The mica schists are nearest to the mountain; the granites and porphyries next, and the others lie between them and the River Nevis.

The line is a diagonal of the area referred to, running in a N.W. direction.

Looking from near Claggan Cottage along the steep slopes of *Meall an t' Suidhe*, granite boulders are seen lying on the mica schist rocks, where the side of the mountain slopes down so steeply as to make it a puzzle to understand how they can remain in position.

Some on the lowermost slopes and in the plain are of great size, and present distinct marks of polishing and well-defined striæ;—viz., (a) Syenite, $17 \times 5 \times 6$ feet, larger axis N.N.W. and S.S.E., with a deep conchoidal hollow at the broad end; (b) micaceous gneiss, $15 \times 9 \times 6$ feet; two other large boulders of the same mineral lie in front of this, one to the N.W., the other to the S.W. of the line.

On the north aspect of one of these blocks, are several round hollows, so very like the cup markings of the archaeologist, that at first sight they seemed artificial; but in another block, a bit, having been noticed protruding from the surface, on being struck with the hammer, fell out, leaving the cup marking on the stone; (c) micaceous gneiss, $11 \times 7 \times 7$ feet; (d) mica schist (*the rock in situ*), 11×7 feet. * * * *

Slopes of Meall an t' Suidhe, from 100 up to 1500 feet.—On these, the size of the boulders and their "lie" to the horizon varies. (a) Porphyry, $7 \times 5 \times 4$ feet, angle of its site to horizon 35° , longer axis N.N.W. and S.S.E. This boulder is poised on an edge, which towards the mountain is 1 foot 7 inches broad, and towards the plain only 5 inches. (b) Porphyry (triangular shaped), $9 \times 7 \times 5$ feet, apex towards the hill, as if the point of the boulder had been violently driven into it, larger axis N.N.W. and S.S.E. On west side, a cup and ring mark. These oval or round marks are numerous,

and occur chiefly on the N.W. side of the boulders ; —angle of site to horizon 20° . (c) Micaceous gneiss, $13 \times 8 \times 13$ feet, angle to horizon 20° . The heavy end rests on the mountain. At the point which stands out from the face of the hill ; the depth is only $3\frac{1}{2}$ feet ; it lies mainly on three small rounded granite boulders, and is so poised as to suggest, that the slightest push would send it down the hill.

* * * *

At a point 1060 feet above the sea-level, a considerable part of the surface has been laid bare, and the rock is distinctly striated, the direction of the striae being apparently N.W. and S.W., but partly obliterated by cross-hatching. * * * *

On the area to the N. of the rounded crest above Suidhe lake, and to the W. of the great corrie between Ben Nevis and Carn Dearg, there is, (a) an enormous boulder of mica schist, lying on porphyry *in situ*; (b) large block of grey granite; (c) large block of porphyry. These lie in a mass, associated with smaller boulders of mica schists, and stretching from this heap, are two rows of boulders lying nearly direct W. The first block is grey granite, $7 \times 4 \times 6$ feet, angle of site to horizon 40° ; the others are grey granites, porphyries, and mica schists, their larger axis being N.N.W. and S.S.E.

The most noticeable feature is the "lie" of these blocks to the hills ; they appear in long lines sometimes far apart, but there is no mistaking their place in the lines, which are W.N.W. and E.S.E. The larger axis varies so much, that from it no inference can be drawn."

Towards the conclusion of his paper, Professor Duns remarks that the gravels of the district consist mainly of rolled and water-worn fragments of granite, porphyry, quartz, mica schist, bits of arenaceous rock, and at one part of a mineral (malacolite) nowhere found massive in the locality. In the rare instances, in which large boulders are met with *in* these gravel heaps, they are sub-angular blocks of the rocks of the immediate neighbourhood. The *erratics* occur *on* the heaps.

"On nearly all the mountain slopes, and even at the tops of some, blocks abound ; many of enormous size and weight, for whose positions, no explanation can be found in any of the forces at present existing in the locality.

The position of boulders in the plain may have as great significance as the position of those high up on the mountain.

Thus, if a granite erratic be found at a height of 1000 feet, and one of the same rock in the low ground, at a height of 50 feet above the sea-level, in a place to which it could not have rolled, assuming the face of the country to have been the same as now, when the boulder on the high level was laid down, it will follow, either that one and the same force put them contemporaneously in their respective positions, or that the valleys, river courses, and little hills which now intervene between the high and the low blocks were formed since both were deposited. There is only one other alternative. Each may have been dropped by an agent, on which inequalities of surface could have no bearing.

A careful examination of the deposits within the area described, so far as they bear on Arctic conditions of climate and a glacial surface, leads to the belief that the bulk of the phenomena may ultimately find their explanation in the recognition of two movements,—one outwards from Ben Nevis as a centre, the other a force travelling from the W. the N.W. or the N.N.W."

Extracts by the Convener from Notes on Boulders and Striated Rocks situated to the W. of Fort William, by Colin Livingston, Teacher of Public School, Fort William.

The places mentioned by Mr. Livingston (Plate) are shown on the map reduced from the Ordnance Survey.

1. *Meall nan Cleireach*,* the height of which above the sea is 1651 feet, composed mostly of micaceous gneiss and clay slate. About 60 feet below the summit, is a boulder called "Clach an Acras"† or the "Hunger stone" $8\frac{1}{2} \times 6 \times 3\frac{1}{2}$ feet. Its longer axis is N. 5° W., with heavy end to north, resting on clay slate. It bears from the summit of the hill N. 10° E. It might have come to its present position through Glen Nevis, or Glen More, or (but less probably) Glen Scaddle, on the W. side of Loch Linnhe.

A second boulder, $17 \times 6 \times 3$ feet, lies N.E. of the former at a distance of 24 yards. Its axis is N. 8° W., and about 70 feet below summit level of hill.

* Mr. Livingston explains that this word means "Hill of Clerks or Clergy," implying that it belonged to the church.

† When the people at "Blar-mach-foldach" saw the sun over this boulder, viz., at 2 P.M., they went to dinner.

Both of these boulders are of mica schist with garnets. A third boulder $15 \times 7 \times 6\frac{1}{2}$ feet to the E. of the first mentioned, and distant about 40 yards, is mica schist without garnets.

These three boulders, being in sight of and near each other, are spoken of by Mr. Livingston as forming a triangle.

Mica schist with garnets is a rock not known in the neighbourhood. Dr. Heddle found it *in situ* on *Aonach Beg*, a hill to the E. of Ben Nevis, about 4060 feet above the sea, where it is open to Glen Spean and Glen More.

2. Other boulders with garnets occur at the following places:—¹

(1) A large mass about 200 yards above where the road from Fort William crosses the river *Abhainn Bheag*, $18 \times 10 \times 7$ feet.

(2) A similar block $11 \times 7 \times 5$ feet at a short distance.

A line connecting these bears almost on *Clach an Acrais* boulder.

(3) A small boulder nearly in same line about a mile from Fort William to the W.

(4) At nearly same distance from Fort William on the E. side of the town a similar boulder of larger size on the hill face above Nevis Bridge.

If a glacier came down *Glen Spean* and along *Glen More* it might have brought the above boulders.

The idea of such a glacier is favoured by the existence of a remarkable *trainee* of boulders to the E. of *Blar-mach-foldach*,* partly above road on left, and partly on right at first house in township.

3. A more striking indication of ice movement in this direction is an immense collection of boulders on lower slopes of same hill, *Meall nan Cleireach*, called *Blar nan Cleireach*. The shoulder of the hill which projects so as to cause the bend of the river *Kiachnish*, is littered with boulders. The boulders are mostly granite. There are also boulders of porphyry and mica schist. The largest in size are mica schist.

Most of these boulders are below the contour line of 800 feet. The following are the sizes of the largest mica schist boulders: $10 \times 8 \times 5\frac{1}{2}$ feet, $8 \times 7 \times 4$ feet, $10 \times 6 \times 3$ feet, $11 \times 4 \times 5\frac{1}{2}$ feet, $7 \times 5 \times 3\frac{1}{2}$ feet.

The granites are grey and purplish. The pink colour is owing to

* This Gaelic word means "Green spot, outlying, hospitable."

the predominance of felspar. In some, the felspar crystals are large, in some, small.

Of the boulders with large felspar crystals, one may be mentioned $10 \times 8 \times 3$ feet, one with small felspar crystals $8 \times 5 \times 4$ feet. Fine grained grey granite $4 \times 2 \times 5$ feet. There is one called "agglomerate," $7 \times 5 \times 3$ feet. Among this collection, there are one or two small quartzite boulders.

This large assemblage of boulders is on the N.E. shoulder of the hill. It could be reached by an arm of Glen More passing down over the col between *Achintore Hill* (940 feet) and *Bein Riabhach* (1300 feet), the watershed between which is from 400 to 450 feet, and by an arm of the Glen Nevis glacier through the transverse valley of the Riasgaig. *Achintore* hill has *striæ* N. and S. at 590 feet.

Mr. Livingston observes that the lower boulders could hardly have come from the westward, as the only opening in that direction is the channel of the river *Kiachnish*.* To have come by it would imply their having crossed the supposed ice stream of Glen More, here flowing along the bed of the present Loch Linnhe.

4. Showing that ice has moved in this direction from Glen Nevis, we have on a ridge separating that glen from the valley of the Riasgaig—a feeder of the Kiachnish—the remarkable boulder called *Clach a Sgrogaidh* or "The tilted Stone" (1790 feet), between the summit of *Sgor Chalum* and *Glas Chreag*. This boulder is $10\frac{1}{2} \times 6\frac{1}{2} \times 9\frac{1}{2}$, axis W. 10° S. It is of compact mica schist, indurated, finely laminated with quartz veins, and contains chlorite and ilmenite. The rock on which it rests is of somewhat similar material, but differing considerably in structure, containing neither of the two latter minerals, which occur in Aonach Beg rock.

Within a few yards of it, and nearer the Glen Nevis edge of the ridge, is another boulder of the same kind of rock, $12 \times 7 \times 5$ feet.

Above these, on the shoulder of *Glas Chreag*, at a height of 1930 feet, *striæ* occur, their direction being N. 20° W., apparently formed by an agent from Glen Nevis towards the glen of the *Kiachnish*.

Proceeding further south along the skyline, a small angular perched block is seen at an elevation of 2170 feet, with its axis N. 25° E. It is quite angular, and might not have been carried far.

* This word means "Stream from a marsh."

At about the same elevation, on the Kiachnish side of Glas Chreag, there are *ten* blocks all of considerable size, the two largest $7 \times 7 \times 4$ feet, and $7 \times 4 \times 4$ feet. They also are angular, and lie on the surface of detrital matter. They are open to *Glen More* and lower *Glen Nevis*, but more probably were brought from upper *Glen Nevis* by a glacier winding round the shoulder of the hill—Glas Chreag—through Glen Riasgaig.*

5. In *Coire-a'-Mhiulinn*, farther round the shoulder of Glas Chreag, there is a large angular block $8 \times 6\frac{1}{2} \times 5$ feet. The rock is mica schist, indurated and thick bedded. It rests on native rock—mica schist also, but much softer and more fissile. Rock identical with it is found at the head of *Coire Riabhach*, which looks in to *Glen Nevis*.

6. Another feature of the locality is that while there are few or no boulders on the W. side of *Meall a' Chaoruinn*,† they are very numerous on the E. side, which is open to *Glen Nevis* through the glen of the Riasgaig.

Another large boulder of indurated micaceous schist occurs at the foot of *Meall an-t-Snidhe*, on the opposite side of *Glen Nevis* near its mouth.

7. On the east side of the streams forming the Riasgaig, at an elevation of 600 feet and under, there are boulders of the following sizes : grey granite $8 \times 6 \times 3$ feet, two granite boulders with pinkish felspar $15 \times 9 \times 9$ feet and $10 \times 6 \times 5$ feet, and smaller ones. They may have come from *Glen Nevis*, or *Glen More*.

8. Mr. Livingston, under the head of "General Conclusions," suggests that the boulders mentioned by him may have come by two glaciers, one descending *Glen Nevis*, the other *Glen Spean* and *Glen More*.

(1) With regard to the former, Mr. Livingston observes that from the confined nature of *Glen Nevis* in its upper part, and the height of the mountains enclosing it, the glacier would probably be of great depth, reaching to a high level. After passing the spur of Ben Nevis, opposite Achriabhach, the lower portion would turn to the right, but

* Note by Convener.—It is difficult to understand how the supposed glacier could wind round the shoulder of the hill here referred to. The position of the ten boulders on the surface of *detrital matter*, seems rather to suggest the agency of floating ice.

† This name means "Hill of Rowan trees ;" though there are none there now.

the upper and much larger portion would continue straight on, through *Glen Riasgaig* towards Linnhe Loch. Hence (he says) the accumulation of boulders upon *Blar nan Cleireach*.

As the boulders on *Meall nan Cleireach* are at a height of 1630 feet, *Clach a Sgrogaidh* at 1790, and *strice* at 1930, the glacier must have reached at least 2000 feet.

Mr. Livingston observes that a portion of the Glen More glacier may have united with the Glen Nevis glacier, and added to the boulders upon *Blar nan Cleireach*. He says that the general character of the boulders brought by the two glaciers differed. Granites of various kinds were brought down by the left flank of the Glen More glacier, and by the right flank of the Glen Nevis glacier. Mixed with these granites are occasional blocks of mica schist with garnets.

The left flank of the Glen Nevis glacier, he says, seems to have brought mica schists of various degrees of hardness, in some cases passing almost into quartzite. With these is mixed an occasional small block of true quartzite from *Sgor a Mhaim* and *Stob Bàn*.

Occasional blocks of porphyry are also met with. One or two fragments of actinolite, which is found *in situ* above Glen Nevis House, may also indicate the course of the *Glen Nevis* glacier. They were found on the road near Blarnachfaoldach.

On the left of the river Nevis, above Glen Nevis House, innumerable blocks, mainly of mica schist, occur. They have probably come partly from *Coire Riabhach*, partly from the shoulder of Ben Nevis above *Achriabhach*.

At the entrance into Glen Nevis, on the E. slope of the *Cow Hill*, above a small burial-ground, the stream called *Allt Eas an l-Slinein* cuts through detrital matter consisting mainly of granite boulders. It has long formed quite a quarry for building stone. One large granite block, found on the opposite side of the Nevis, furnished stone for the whole front of the Belford Hospital, Fort William.

On the right of the lower Nevis also, towards Inverlochy and Torlundy, there are immense mounds and ridges of detrital matter, the material of which, Mr. Livingston says, has "an imperfect stratification"—"such as might be produced if it fell from some height." He therefore supposes that the detritus was brought down by surface streams on the Glen Nevis glacier, and by others flowing on to that of Glen More.

He says there are also "remarkable lines, undoubted moraines, occupying great part of the area stretching towards Spean Bridge. One of these begins at the foot of the hill on the left of the Lundy, and may be traced almost continuously to *Bldr Odhar*, a distance of eight or nine miles. The part near Glen Nevis appears to have been formed by a glacier moving up in the direction of the Spean, while the further part, and the three similar lines nearly parallel with it, have apparently been formed by a glacier descending the Spean valley."

*Extracts from Notes sent to the Convener by Dr. Heddle,
St. Andrews.*

1. On descending the west slope of East Lomond Hill, Fife, at a height of 1075 feet, overhanging Greenwalls, found a large number of dolerite blocks, from 4 to 7 feet in length, much rounded. They lay closely together on the brow of "a fall-over of the ground to the west."

About 40 vertical feet from the highest, and 20 from the lowest of the boulders, and at a distance of about 200 yards, a quarry of the same kind of dolerite was met with, in jointed pillars, the joints being somewhat open or loose.

"Concluded that ice, sweeping from the west," had struck the west slope of the hill, where the dolerite rocks protruded, and pushed before it some of the loose pillars.

2. On descending Auchluisky Hill (one of the Ochils), into Glenquay, at a height of 1025 feet, found a small red granite boulder weighing about half a cwt. The slope on which it lay, faced W.N.W.

On ascending Benty Knowe, directly opposite, at height of 905 feet, found another red granite boulder, rather smaller. The rocks of the Ochils here are trap,—a "rotting clinkstone."

3. On ascending Bencleuch from the east, at a height of 2200 feet, found two boulders, each weighing about 4 tons, in a line with each other E. and W. One of the boulders is a variety of graywacke, which may be called "almond conglomerate," from its containing nodules of white quartz of the shape of almonds, but now to four times larger. Recognised the rock of this boulder to be

the same as a rock at the foot of the north spur of Ben Lomond, mentioned in last year's Report, page 28, at a height of from 2230 to 2240 feet above the sea. The Rev. Mr. Peyton (who has frequently accompanied Professor Heddle in his excursions, and is a good geologist) mentioned having seen the same rock *in situ*, about 8 miles to the east of Ben Lomond.

The other boulder was of gneiss, laminated and convoluted in structure;—much resembling rocks *in situ* in the district of Loch Earn and Glen Falloch.

4. Walked in the Lewis from Stornoway to Tarbert, in Harris. The north part of the district, where not covered with peat, consists of glaciated rock, with ill-defined striae running in almost every direction except N. and S. The general flatness is the more remarkable as the strata are nearly vertical, so that their edges have been ground down by some agent passing over them.

This flat district of course terminated on the south at the base of the Harris Hills. One or two of these reach a height of about 2600 feet, and glaciers were no doubt formed in some of their valleys; but the levelling of the district to the north cannot be attributed to them.

The trench between the two Lochs Tarbert, where, in the previous year's Report, boulders were reported to have been seen, was again visited. There is evidence here of two independent glaciations. "In the main trench, there is evidence of ice rising on the hill sides to a great height, as if squeezed up, when moving through the pass from the west." In Glen Skeaudle, again, which joins the main valley at an obtuse angle, there is evidence of a small glacier, which pressed seaward to the west.

5. Morvern.—Walked for about ten days over the hills on the Glen Sanda property.

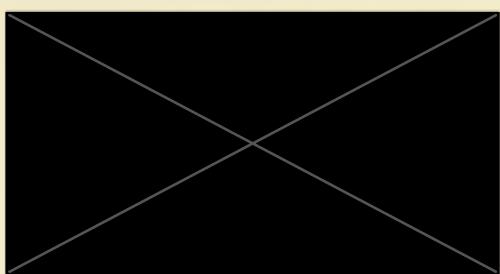
The shores of Loch Corry are much glaciated on both sides—in the same direction, namely towards the east.

A knoll or boss of red granite at the mouth of the loch attracts notice, from the way in which, on its W.N.W. side, the rocks on a slope reaching up to 150 feet were all rounded, smoothed, and scratched. The opposite, or S.E. side of the knoll, was rough and craggy.

On the north shore of Loch Corry, near its mouth, an angular block $27 \times 27 \times 10$ to 13 feet was observed; about 28 yards from

it, a hollow in the rocks was discovered, which, in dimensions and shape, exactly fitted the boulder; this hollow was situated N.W. of the boulder. The boulder was about a foot lower in level than the hollow it came out from. A thick mass of floating ice was probably the transporting agent.

Several of the hills on this Glen Sanda property reach to a height of 1800 feet and more. They show glacial action to their very summits,—by the rounded surfaces of the rocks where hard. But

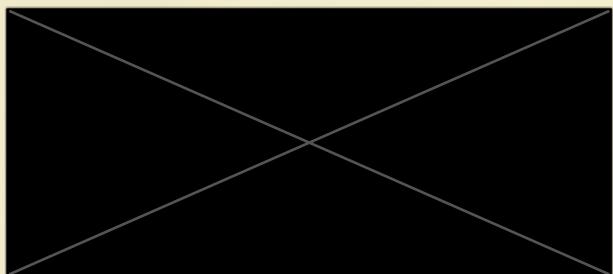


at one place a series of grey granite and red granite strata were seen to alternate thus:—the strata marked *g*, representing the soft grey granites, formed as it were trenches between the red granite strata marked *r*.

Most of the boulders on the hill slopes were grey granites.

6. From Stage House, on Loch Shiel, examined a valley leading to the west. Ascended double-peaked hill of Fraoch Bheinn, 2680 feet; on approaching each summit, found many blocks apparently torn from their natural beds, and carried very short distances eastward. In some of the belts of rock, sockets or hollows were observed, from which the blocks had been detached. These were from 20 to 40 feet below the east summit on its west side, and had manifestly been pushed up hill. These blocks weighed from about a ton to 10 tons. The top of the hill is pointed in a remarkable manner by a block of about 6 tons, “which is nearly turned up on end. It did not seem to have been moved more than a yard.”

7, (1) *Fort-William District*.—In company with Mr. Livingston, went up Glen Finnan, then over a hill of 2419 feet (name unknown). Much glaciation in the col between it and the east top



of Sgor - nan - Coireachan (2718 feet). A great white granite vein or dyke cuts right through the col running N.N.E. and S.S.W. This dyke (8 to 10 feet thick)

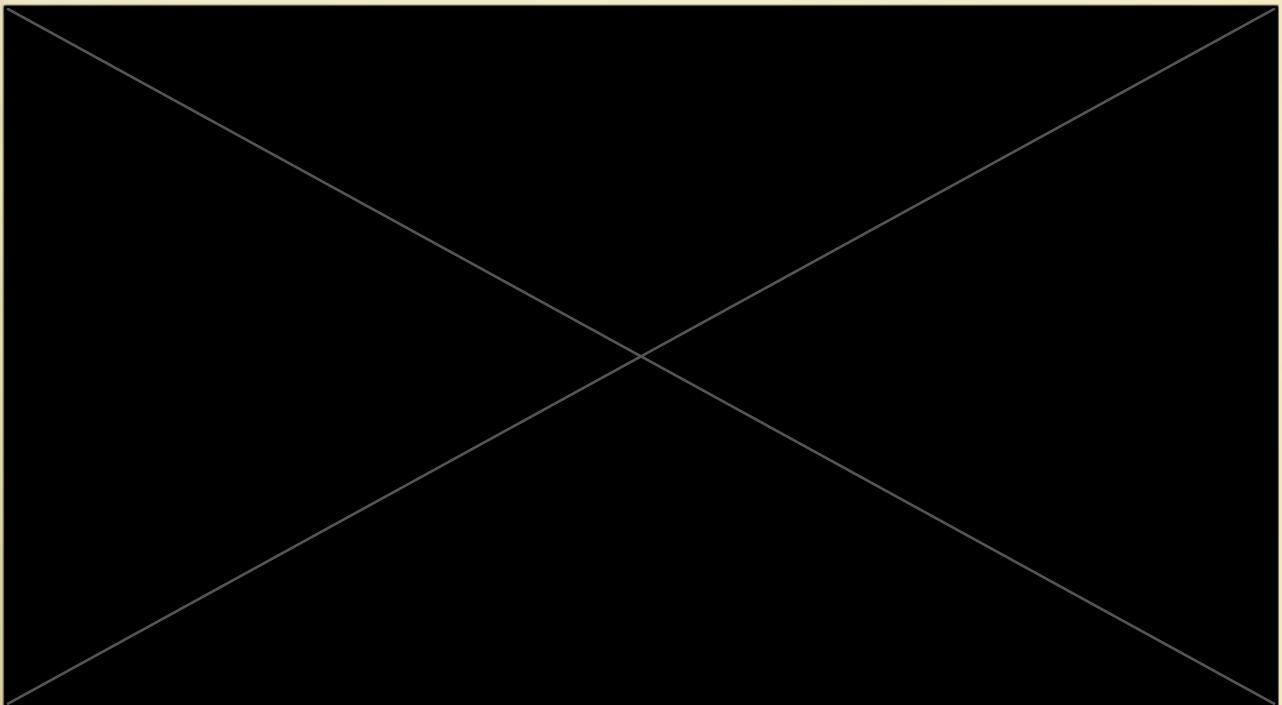
is a few feet below the summit-level of the col on the west side, thus:—*a e f* being the outline of the hill, *d* the granite dyke, and *e* blocks from the dyke, lying to the east of the dyke. The outcrop of

the dyke was quite rounded; some of its blocks were found one-third of a mile to the east,—none to the west.

The summit of the hill (3136 feet) showed no glaciation. Ice, however, had gone over the col (2600 feet) between this hill, and that to the west (not named in the map).

From the 2500 feet contour line, to within almost 200 feet of the bottom of Glen Oban, there is one of the most tremendous scenes of glaciation probably to be seen in Scotland.

The sides of the glen abound in shallow corries, with large portions scooped out in some places, and smoothed over in others. There are precipices at many places rounded from top to bottom, some of them more than 100 feet in height. Local glaciers may have done the work.



The scooped-out parts of the Glen face the north, at right angles to the trench of Glen Oban.

The central parts of the Glen are nearly blocked by enormous masses of rock, fallen from a cliff on the north side, about 700 feet above.

At the mouth of Glen Oban, looking eastward, there are fine examples of perched blocks. These blocks in two cases rest on glaciated knolls or nobs of rock, situated in the centre of the Glen, as shown in the foregoing rough sketch. These knolls are from 300 to 400 feet high, and cannot be climbed, their sides being so steep.

(2) Walked from Fort William to top of *Ben a Gueaig* (2017 feet) (to connect the traverse of a former year) along ridge to *Meall na Cleireach* (1626 feet). Found near Corunanan House several small boulders of the same syenitic granite, which I found last year in a *trainee* on the top ridge of *Stob Choire a Chearchaill* on the north side of Linnhe Loch (*Seventh Boulder Report*, p. 36), and on *Bein Bhan* on the south side of the loch. The felspar was not so red in these boulders; no other difference.

Found on south spur of *Meall nan Cleireach* a boulder, $4 \times 6 \times 4$ feet, of a peculiar rock, which I learned afterwards had attracted much attention from Mr. Livingston and Professor Duns. The material of the boulder looks like a very vitreous hyaline quartz rock —the grains running into each other. The large amount of felspar in it, has cemented the grains of quartz. Many examples of this boulder were afterwards discovered. The parent rock I have never met with. I named it, for identification, after Mr. Livingston.

The ridge between *Bein na Gucaig* (2017 feet) and *Meall nan Cleireach* (1626 feet) consists of an igneous dyke, and is sprinkled with very small boulders, (1) of the red binary granite (felspar and quartz, almost a porphyry) of the hill *Mullach nan Coirean* (3077 feet) lying nearly due E., (2) of the above mentioned syenitic granite, (3) of the Livingston rock, (4) of a fine grained diorite, not found *in situ* by any of us, and (5) two small boulders of quartzite.

The top of *Meall na Cleireach* I found "intensely interesting." Three boulders lay on its N.W. side about 20 feet below summit. They lie about 50 feet above the three which are mentioned in Mr. Livingston's notes as forming the points of a triangle. The hill showed bare clay slate rocks on its W. side. Every other part had a thin cover of turf over it, and for about 50 feet down; from which point to the summit, but only on the N.E. side, there was a deep deposit of angular masses of rock, tossed in confusion as if rolled from off a glacier. They were thinly covered over with turf; but on clearing the turf off, the boulders were found to consist of micaceous gneiss and red granite.

On descending the hill towards the stream, and about 400 feet above it, I "came on a clump of three boulders." Two of these are of interest; one $13 \times 4 \times 4$ feet being of grey granite with a little red felspar;—the other $5 \times 3 \times 2$ feet, a mass of matted fibres of

amianthus.* We afterwards found a similar rock (but far from identical) 3 miles N.E., near limestone, overhanging Glen Nevis.

(3) On following day, went up to *Mullach nan Correan* (3077 feet). It forms a great round dome, all of red granite, tending to porphyry. On its summit there are several small angular blocks of pure white quartz rock, the nearest locality of which is the peak of *Stob Bhan*; others had been built into the cairn.

The ridge from this hill to *Stob Bhan* (3274) is one of exceeding interest. It is narrow, falling and rising five times, forming so many little hills.

In the second of the depressions, at an altitude of 2904 feet, the rock is of red syenitic granite, apparently the same as that of the boulders before mentioned on Ben Guraig and Ben Bhan, and also as forming a trainee on *Stob Coire Chearchaill*.

We afterwards found the same rock in abundance near the great precipice of Ben Nevis, at an altitude of 2200 feet.†

At another part of the ridge, the ground falls from 3004 feet to 2904 feet; and there "for about 100 yards, the ridge consisted of a bank of loose material." Whether a glacier which had been pouring through, or rather sending a delta-branch through the hollow, showered down the heaps of stones which form the ridge, or whether it had been deposited by aqueous agency, may be matter of opinion. By going down the S. slope, and by peering over the precipices of the next height, so as to see the N. slope, we inferred that this bank was about 40 feet deep. It was quite "like the patch on the N.E. top of *Meall nan Cleireach*; only, in addition to angular blocks, it contained much gravel and small rounded stones." Its ridge was broad enough for three persons to walk abreast. The heap is made up of many kinds of rock,—micaceous gneiss, Livingston rock, and quartzite being common. "I hope I have made it clear that the forementioned bank is the connecting ridge between the 3004 feet hill and the next hill (2995 feet). This last mentioned hill

* I found no other grey granite boulder on the S.W. of Nevis, though many on the N.E. The amianthus boulder may fairly be referred to the lime locality near Glen Nevis.

† This discovery of a rock *in situ*, identically the same as the rock composing boulders seen on *Stob Coire a' Chearchaill*, alters the opinion I had formed last year as to the direction from which these boulders had come.

rises out of it in plumb precipices of say 30 to 60 feet,—a deep-red burnt-like porphyry, rudely columnar."

Stob Ban (3274 feet) and *Sgor a Mhaim* (3601 feet) are both of them quartzite; but the connecting ridge was found to be in some places almost a clay slate.

(4) On following day, drove up Glen Nevis to *Achriabhaich*, and from that walked up past Steall, and thereafter climbed the quartzite ridge to the N.E. The first half of the walk astonished me on account of the absence of boulders, in this part of Glen Nevis,—considering the thousands which lie at and about the mouth of the Glen. Above the narrow part of the glen at *Meall Cumhann* (2000 feet) the whole surface seemed swept clean. We saw only one boulder (micaceous schist) about a yard square. It lay on the S. side of *Sgùr-a-Choinnich Beg* (3108 feet) at an elevation of 1830 feet. We went, in an easterly direction, over seven other hills from 3600 to 3858 feet in height, and then descended the N.W. slopes of *Stob Coire Chalaerie* to *Corrie Coillzie*. Until we came near this last named place, we saw no boulders. Between the heights of 1740 and 1260¹ feet on the N.W. slope, we came upon eight boulders lying rudely in a line, "as if part of a lateral moraine." They were all much of one size, about $6 \times 6 \times 5$ feet; and they were of two kinds of rock only, viz., the Livingston rock, and a grey granite rather fine in grain;—the site of neither rock is known to me.*

(5) Another excursion was made with Mr. Livingston to *Craig Dhu*, a hill near the mouth of Glen Roy. We found a number of huge boulders at 1780 feet, and extending to within 20 feet of summit, (which is about 2200 feet above sea). They lay on S. and S.S.E. side of hill. There was well-marked glaciation, with much rounding of rock-surfaces at 2050 feet, in a line N.N.W. and S.S.E.; and it seemed to us that the movement had been from the last point, but we had not time to satisfy ourselves on the point. All the boulders seen on this hill are of the same two rocks as those seen above Coire Choilzie (*i.e.*, on the slopes of *Stob Coire Chalaerie*, at the height of 1740 feet), over which we had passed two days previously.

* Professor Duns having read these notes, informs the Convener that boulders of the kind of rock here mentioned, were observed by him on the slopes of *Meall an t Suidhe*, near the mouth of Glen Nevis.

"This hill should be thoroughly explored." *

Professor Heddle in concluding his notes, states that—"Looking to what I saw on and of the ridge which forms the S. side of Glen Nevis;—the patch of matter on the N.E. side of the summit of *Meall nan Cleireach*; the quartzite blocks on the summit of *Mullach nan Correan*; the red felspar syenite *in situ* to the E. of this; a detrital bank at an altitude of 2904 feet; and the quartzite and gneiss hills to the E.,—no doubt remains on my mind of there having been a glacier, which, sweeping down Glen Nevis, overtopped the hill of 3077 feet, on which, when decreasing in bulk, it may have left the quartz blocks; that when it dwindled somewhat more, it carried off blocks of the syenitic granite from somewhere near its 2904 feet locality; then, overflowing all the lesser heights to the W., crossing the Linnhe Loch, and sweeping into the directly opposing *Sroin a Chreugain* glen, it was finally stopped by the precipice of *Sroin Coire Chobarceail*, upon the ridge of which (2300 to 2500 feet) it left the boulders, as a kind of terminal moraine." "That while still further dwindling, it laid down the patch on the N.E. top of *Meall au Cleireach* (1580 to 1626 feet). Lastly when its bulk was no longer great enough to pass in a direct westerly course over 1600 feet hills, it was deflected by them into the N.W. bend of Glen Nevis."

He is also of opinion that another great glacier, of nearly equal spread but lesser depth, was cradled in the gorges which lie between the lofty ridge of Aonach Beg and Aonach Mor, and the nearly equally lofty quartzite ridge which stretches from Sgor-Choinich Beg to Stob Coire Chlaurie;—and that this glacier had sent a tongue of ice northwards across the scoop of Lochaber. Before committing himself, however, to such a view, he would require many more days exploration of the district.

* [Note by Convener.—There is the greater reason for the more thorough exploration here suggested, because *Craig Dhu* has been examined by several other geologists,—Professor Nicol, Mr Jameson (Ellon), Mr Jolly (Inverness), and the Convener. The opinions formed by several of these, were that the agent which transported the boulders and glaciated the rocks on the hill came not from the eastward but from the westward. *Royal Society of Edinburgh Trans.*, vol. xxvii. p. 640.]