XVI.—*Terraces at Achnasheen, Ross-shire.* By WM. MORRISON,
M.A., *Rector, Dingwall Academy.*

(Read 17th December 1885.)

AT the junction of the heads of Strath-Bran, Glen Docharty, and Glen Carron, and in the immediate neighbourhood of Achnasheen Station on the Dingwall and Skye Railway, are to be seen, on the south-west side of the line, extensive terraces of sand and gravel, rising in three distinct flat-topped tiers resting against the hill Leanach, which forms the abutting angle into the junction of the above straths. The situation of these terraces exactly on the watershed of the country adds an additional interest to them. The base of the terraces rests on the 500 feet contour line, and their highest levels on the 600 feet contour. They run along the railway line, which, indeed, cuts through them in one place on both sides, and are seen to enclose a wide area of meadow land, through which the Bran, issuing out of Loch Chroisg, meanders, until it is seen some two miles to the east of Achnasheen, cutting through and forming a gap in a ridge running across the strath, which coalesces with the terraces on the south side of the valley. The aspect of this basin suggests at once the former existence of a lake, to which these terraces were beach margins. Indeed, if the 600 contour be followed, it will be seen sweeping along that ridge through which the Bran flows, and enclosing to the west the area now partially occupied by Loch Chroisg, Loch Gown, and Loch Sgamhaich, near the head of Glen Carron. At the head of Loch Chroisg, on the Loch Maree road, is seen an accumulation of debris which lies on the rising slope up to the head of Glen Docharty. This debris is also on the 600 contour, and doubtless was caused by the same agency as the terraces of the south-east end of this loch. At or near the confluence of the Bran with the river issuing out of Loch Gown the terraces are seen at their best. In a section of a height of 60 feet, or so, cut into one of them for railway ballast, the deposit is seen to be formed of well-stratified sand and gravel, with lines of false-bedding here and there towards the east, indicating the agency of running water during the time of deposit. The gravel formed of water-rolled pebbles of gneiss of from three inches to a foot in diameter is mixed with clean sand, the pebbles in most instances coated with peroxide of iron. At about three feet from the top of the section may be seen a wavy line of "iron-pan" running in a seam along the entire face of the section.

The slope of the terraces is very steep, resting, indeed, at what must be the angle of repose for such loose stuff. The water-courses cutting into these steep faces give the terraces the appearance of earthworks for an immense fortification, the recesses of the watercourses appearing as so many embrasures in the huge redoubt. The lines of stratification in the mass, on the whole, correspond with the general slope of the hillside on which the terraces rest, thus doubtless showing that the beds are still in their original form of deposit.

On the western side of the line, and on the left bank of the water issuing out of Loch Gown, is seen an exposed surface of rock standing out as a boss in the deposit on that side. This rock is glaciated gneiss *in situ*—the bed-rock on which all the terraces rest. This exposed face—34 yards by 20 yards—is scored and rounded into hummocks, with their general face to the south-east. The weathered appearance of the gneiss makes it difficult to trace distinct scoring; but it may be said that this scoring is mainly, if not altogether, N.N.W. to S.S.E. The gravel and sand of the western terrace extend back from this boss of rock—which acts as a retaining wall to them—to near the edge of the water of Loch Chroisg.

The traveller by the Dingwall and Skye Railway cannot but be struck with the innumerable hummocks to be seen all the way along after he has passed the gorge of the Raven's Rock, near Strathpeffer, until he reaches Achnasheen. At Glen Sgathaich, the surface is one *débaîcle* of huge tables of micaceous rock piled over one another in most admired confusion, and interspersed where open spaces are left by conical mounds and ridges of moraine stuff covered by a skin of turf. Strath Garve presents the same appearance. The lower end of Loch Garve is dammed up by immense heaps of this deposit, mingled with rounded boulders of a porphyritic gneiss foreign to the locality. Near the inn is seen a large glaciated rock surface, with scorings all pointing N.N.W. and S.S.E. At Loch Luichart, the gravel-mounds, where opened, show the highly-polished rock on which the debris rests. In every case the scorings are as clean, deep, and fresh, as if recently done by the chisel, and invariably the same N.N.W. S.S.E. direction is held, whether these mounds are on the sides of the valley or on the hill-tops. I have traced these mounds and rock scorings right up to the head of Loch Fannich. On the rocky face of the "Coileachan" (3015 ft.), which stands to the north of the lower end of Loch Fannich, one may see the rocky walls half way up that precipitous hill, scored by the graving tool of the ice, whether an ice-sheet or rafts is open to conjecture. The uniformity of direction, and the torn-up appearance of the surface along these straths, certainly indicate that whatever the agency, it must have been

steady, heavy, and irresistible in its march from the high grounds to the low. This uniformity of direction is remarkable. In Easter Ross, the Black Isle, and generally to the south-east of Wyvis, the number of huge erratics of the peculiar pinkish "Augen-gneiss"¹ or porphyritic gneiss of "Cuinneag" attracts attention. In a report which I made for the "Boulder" Committee of the Royal Society, Edinburgh, at the instance of our President, Mr Milne-Home, I stated that the nearest parent source of these boulders—several of them hundreds of tons in weight—was "Carn Cuinneag," in Glen Diebidale, in the centre of Ross-shire. That granted, this hill of 2700 feet, and some 12 miles to the N. of Wyvis, must have furnished the blocks found scattered over the south-east of the county, and even into Morayshire. I found one of these porphyritic blocks on the east flank of Wyvis, on the 1800 feet contour. No glacier could possibly have brought that block from "Carn Cuinneag" to its present resting-place, unless it slid along an incline of about 1 in 100 from the very summit of "Carn Cuinneag." This argues submergence, then, to at least 2000 feet when "Carn Cuinneag" sent out its rafts loaded with boulders. If so, Achnasheen must have been some 200 fathoms down in that ancient ocean bed—too deep, then, for the formation of these terraces. The period of ice rafts must have been before or after that of the ice which caused the glaciation on the rock surfaces on these hills and in these straths. That a submergence took place, we have—in addition to the evidence of boreal marine shells having been found in the boulder-clay of N.E. Lanarkshire at 500 feet above sea, and still higher at Moel Tryfaen, in North Wales, at 1350 feet, marine shells of northern origin found in the sands and gravels on that hill—evidence of local interest. As had been communicated to you by Mr Fraser, C.E., Inverness, two years ago, marine shells were found by him in boulder-clay at Clava, near Nairn, at a level of 450 feet. That level would have sent the tides up to the terraces at Achnasheen. It seems strange that this blue tenacious clay, with imbedded northern and recent shells, should not be found in this neighbourhood at a higher level than 25 feet, as it is found at Dingwall. Here the very same boulder-clay, with marine shells, is found overlaid by sand and gravel interstratified with a peaty deposit, in which I found numerous bones of some ruminants. The subsidence at Nairn, on the Moray Firth, some twenty miles or so from the head of the Cromarty Firth, lagged behind to form differential levels of about 400 feet. Instances on a larger scale of such differences are known to have taken place in Greenland and the Scandinavian peninsula. The 50 feet raised beach may be seen round the head of the Beaully Firth,

¹ The felspar crystals are large and pinkish.

about six miles from the head of the Cromarty Firth. At Loch Carron again, on the west, raised beaches may be seen in one terrace, extending from near Plockton to near Loch Kishorn, leaving the entrance at Strorne Ferry free. These are the only evidences, with the exception, perhaps, of the upper line of pigeon caves at Cromarty referred to by Hugh Miller in his famous "Schools and Schoolmasters," that I know of in this part to prove elevation since the glacial epoch of ice rafts.

The late Mr John Campbell of Islay, in his interesting book, "Frost and Fire," vol. ii., pp. 148, 149, and 150, in referring to the Achnasheen terraces,—the only published reference I am acquainted with, adopts the marine theory to account for them, as he elsewhere does for the "Parallel Roads" of Lochaber. I may be pardoned if I quote his words, which are—"Five miles off," from the head of Loch Chroisg, "at the lower end of the lake, near Achnasheen, are flat terraces of stratified water-worn gravel and sand, resting on a large lateral moraine, and the moraine is on grooved rock. Beyond the glen towers Sgur-a-Mhulin, and a range of high hills. The grooves point along Strath-Bran at Ben Wyvis and Loch Carron, so ice did not come from the high hills.

"The terraces stretch far up along the road which leads to Torridon, and they are very large.

"Tides surely flowed through this strait at about 700 feet, for no small streams could do such heavy work."

I demur to his observation as to the direction of the groovings. Those I saw indicated a N.N.W. and S.S.E. direction, running obliquely across Strath-Bran.

I traced the striæ from the lower end of Loch Fannich through the moraine stuff where it was cleared for gravel-pits, and found that they pointed in the direction of the length of Loch Liuchart, into which the ponderous agent must have ploughed, gouging up probably the very trough of the present loch, for where the mass entered that trough in its silent march the loch is deep; at its upper end it is comparatively shallow. Possibly this shallow end may be due to the gradual silting up caused by the inflow of the Bran. The moraine heaps scattered in these straths are not of pronounced water-rolled pebbles, but are largely composed of till or lower boulder-clay—the "bottom moraine" of the ice-sheet. I take it that this is the same stuff which overlies the blue tenacious clay with imbedded marine shells, referred to as found at the lower end of the Strathpeffer Valley. In this valley itself, at Fodderty, is to be seen a deposit of sand and gravel similar in all respects to that of the Achnasheen terraces. The lower end of the Strathpeffer Valley, about half a mile from the sea, shows the remains of a terminal moraine which ran across the

valley, and must have effectually dammed up the waters of the Peffery, converting the broad expanse of the strath at the foot of Knock-Farril into a lake. The gravel terraces of Fodderty can thus be accounted for. A similar explanation by the law of parcimony, that is to use the better known for the less known cause, is probably the best for the formation of the Achnasheen terraces. There a barrier is seen running on the 600 feet line across the strath, and cut through by the Bran as already mentioned. The debris at the head of Loch Chroisg points also to the same explanation. The flat tops of the terraces, three of which may be seen on the slope of Leanach, can be satisfactorily accounted for only by an *abrupt* lowering of the general level of the water in which the terraces were formed. An abrupt and permanent lowering of sea level is not common, or rather, the uplift of the land is generally slow. The secular uplift of the land may, indeed, account for one terrace above the other, but the surface of these must, in the nature of things, slope more or less downwards.

It is difficult to account for the presence of banks of sand and gravel in such a tideway as is supposed to have formed the Achnasheen terraces. If there were not meeting tides at this point, and hence eddies or comparatively still water, these banks must have been exposed to the full scour of tidal currents, and thus would soon have been swept away.

Again, the presence of peroxide of iron in the deposit as a bottom of "pan," and beneath that "pan" more or less of this peroxide coating the pebbles throughout the mass, is not compatible with the tide-theory. [Peroxide of iron as a deposit requires not only still water—fresh or salt, no matter—but the water must be shallow enough to allow vegetation to grow in or near the water. This "pan" is seen *within a yard* of the top of the highest terrace and *in the deposit*. A shallow lake marginal shelf at that level can alone give the explanation for the presence of this "pan." Altogether I find it difficult to accept the marine theory in the face of such evidence as I have adduced. In conclusion, I accept the lacustrine theory as that which meets all the elements of the problem. These terraces then come under that period referred to by Geikie (page 892 of his "Text-Book on Geology") as belonging to the period of Second Glaciation, or re-elevation of land, and geologically contemporaneous with the period of raised beaches—in short, to the "Champlain period" of American geologists, when vast quantities of water were discharged over the low grounds from melting glaciers. A visit to the terraces will amply repay any one interested in the question of their origin.