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## Chapter 22 Pleistocene and Recent

### Introduction

The present chapter deals with post-Tertiary happenings, and is virtually a reprint of what appeared on the subject in the 1916 edition of this memoir. For further information the reader may consult two important publications that have appeared in the interval. The first is the Geological Survey memoir by Hinxman and others (1923) on Corrour [NN 400 680] and the Moor of Rannoch [NN 250 550] in Sheet 54 immediately to the east. The second is a comprehensive synthesis by Charlesworth (1956) of glacial retreat phenomena considered consecutively throughout the Highlands as a whole. So far as Sheet 53 is concerned Charlesworth's subject is Late Glacial retreat during what he calls the Moraine or M Stage dating from the maximum of the Loch Lomond readvance. By this time most of the Islands, East Highlands, Midland Valley and Southern Uplands of Scotland had been denuded of glacial cover, the Moor of Rannoch had become a receiver instead of a distributor of western ice and much at any rate of the deposition of the Hundred-Foot Beach had been completed. Charlesworth's local findings in our district are given in his 1956 paper on pp. 826–830 with figs. 6a, 9 on pp. 811, 821; while his general conclusions are set out on pp. 769–781, 891–924 with figs. 21–23 and pl. i on pp. 898, 900, 923, 928.

### Ice-sheet and valley glaciers

#### Striae of the Maximum Stage

All the great valleys of the district afford striated surfaces indicating a down-stream flow of ice. But as one ascends higher and higher, on to cols and ridges, one meets striae with a direction more and more independent of the local inequalities of the topography. It is impossible to disentangle satisfactorily the strim formed at different stages of the glaciation; but in the following paragraphs an attempt is made to indicate the direction of ice-flow during the maximum development of the ice-sheet (Figure 41).

There is good reason to believe that the hollow of Loch Linnhe, even at the maximum of glaciation, controlled a mighty stream of ice flowing south-west, and fed by converging currents from either side.

High-level striae north-west of Loch Linnhe suggest that the ice-sheet reached its greatest elevation along a slightly sinuous north to south line of flow, which enters the map near Meall nan Damh [NM 920 745], and extends southwards through Stob Mhic Bheathain [NM 917 713], Beinn na h-Uamha, Sgòr Mhic Eacharna [NM 928 631], Garbh Bheinn, Meall a' Choirein Luachraich [NM 894 592], and Maol Odhar [NM 885 577]. East of this line of flow the ice-stream was definitely convergent upon the hollow of Loch Linnhe West of it, it found an escape across the low-lying portions of Sheet 52 (Geol.), invading the hollows now occupied by Loch Shiel [NM 900 800] and Loch Sunart [NM 810 610]. This interpretation, and most of the records of striae upon which it is based, are due to Grant Wilson. Where another observer is responsible his name is inserted in brackets in the enumeration given below.

Attention may be drawn more especially to striae on Sgùrr Ghiubhsachain [NM 984 726] and south-east of Meall an Doire Shleaghaich [NM 980 735] on the ridge north of Cona Glen [NM 955 720]; to the fine set between Meall Mòr and Druim Leathad nan Fias [NM 956 703] on the ridge between Cona Glen [NM 955 720] and Glen Scaddle [NM 950 680]; to those on Sgùrr Dhomhnuill [NM 890 679], Sgùrr a' Chaoruinn, Sgùrr na Laire [NM 898 654] (Peach), Meall nan Ruadhlag [NM 924 678], Beinn na h-Uamha and A Bheinn Bhan [NM 947 665] on the ridge between Glen Scaddle and Glen Gour; to those upon and west of Garbh Bheinn (Bailey) and on Sgòr Mhic Eacharna [NM 928 631] between Glen Gour and Glen Tarbert [NM 910 600]; and finally to those west of Maol Odhar [NM 885 577] (Bailey) and east of the same (Maufe), and to those between Meall a' Choirein Luachraich [NM 894 592] and Meall a' Bhraghaid [NM 913 588] on the ridge south of Glen Tarbert [NM 910 600]. E. B. B.

South-east of Loch Linnhe the dominant feature of the ice-flow during the maximum of glaciation was the great Loch Leven current. Numberless striae indicate a convergence of flow-lines upon Kinlochleven. From this point the ice crept

south-westwards to unite eventually with the Loch Linnhe stream. W. B. W., E. B. B.

Some of the other features of the diagram (Figure 41) are more open to question.

It is doubtful, for instance, whether the Ben Nevis range marked the position of an ice-shed at the maximum stage of glaciation, as suggested in (Figure 41), or whether it was completely overridden from the north-east. The former view has a certain amount of evidence to support it, for whereas striae directed to the S.S.W. have been observed at 3600 and 2500 ft on the summit ridge of Aonach Beag [NN 197 714], others running slightly east of north are met with on the col at the head of Allt Coire Rath [NN 250 713] at 2600 ft (Sheet 54, Geol.); these latter, however, may merely indicate the direction of ice-flow during a somewhat late stage of the period of recession, and one would not be surprised some day to find evidence of an earlier southward carry across this col, and across the range as a whole.

The curving flow-lines drawn farther east in (Figure 41), south-eastwards from Stob Coire Easain across Meall a' Bhùirich, and then south-westwards more or less along Glen Nevis, introduce another doubtful point. An east-south-easterly flow of ice from the Stob Coire Easain range [NN 234 727] is very well attested by striae on the summit of Meall a' Bhùirich [NN 253 706], but it is quite possible that at the maximum stage this current may have been stemmed and indeed reversed. E. B. B.

The glaciation of the eastern part of Mamore Forest [NN 186 630] south of Glen Nevis was affected by a general ice-flow from a centre or centres of accumulation to the east, a little beyond the limits of Sheet 53, modified, either throughout, or only in the later stages of the ice-age, by a local dispersal from the mountains around Binnean Mòr. If the ice ever actually swept from east to west across these mountains we have now no record left of its passage. The conclusion to be drawn from the strike is that the easterly ice divided on the flanks of the Binnein Range, sending one branch down Glen Nevis and another along the valley of Loch Eilde into the head of Loch Leven. The Loch Eilde ice-stream, reinforced by contributions from Binnean Mòr [NN 213 664], joined hands with that coming due west along the Leven valley. There was thus a marked concentration of ice on the head of Loch Leven which, as already stated, must have contained an extremely powerful current.

The convergence of the ice west of Binnean Mòr [NN 213 664] upon the Loch Leven stream is very clearly indicated by S.S.W. striae, running uphill out of the valley of Allt Coire na Gabhalach [NN 202 680], a little below the col leading across to Allt Coire na Bà [NN 190 640]. W. B. W.

A less southerly trend is shown by high-level striae on Am Bodach, a couple of miles west of the col just mentioned.

Three miles further north-west on Sgòr Chalum [NN 128 690] [NN 128 690], which rises above the great bend of Glen Nevis, Grant Wilson found striae indicating an escape of ice out of this glen travelling slightly north of west.

Farther south again Grant Wilson observed striae running N.N.W. on Meall a' Chaoruinn [NN 113 660], not much below the 3000-ft level. It would seem then that the Lairigmòr valley exercised a powerful influence upon the direction of ice-flow. But since it is extremely improbable that the ice at the head of Loch Linnhe ever escaped in any but a south-westerly direction, the flow-lines deduced from these high-level striae on Meall a' Chaoruinn [NN 113 660] are shown in (Figure 41) as crossing the Lairigmòr valley farther on and bending round towards the south-west. That the flow of the ice did carry westwards out of this valley, just as it did in the case of Glen Nevis, is indicated quite definitely by striae directed towards the west on Doire Bàn [NN 092 643] at 1500 ft, and west-south-west on the ridge east of Allt Meurach [NN 085 630] at 1300 ft above sea-level.

We may now turn to the district south of the Leven valley. The convergence of the ice upon Kinlochleven, and the subsequent swinging of the current into parallelism with the loch, are indicated by a profusion of ice-moulded and striated surfaces. Even on the top of the Pap of Glen Coe [NN 125 595] striae have been preserved.

The onward march of the Loch Leven ice over the obstacle of Beinn a' Bheithir [NN 040 555] is particularly well shown by west-south-west striae; found by Grant Wilson on the north spur of Sgòrr Dhearg [NN 056 558] at an elevation of 3000 ft. Across the col at the head of Glen Duror [NN 010 543] the ice-current passed a little south of west.

In Glen Creran [NN 030 480], Grant Wilson and Kynaston have found many striae directed along the course of the glen. It is probable that even at the maximum stage of glaciation the ice more or less followed this great hollow though still tending to some extent to converge upon Loch Linnhe. In the valley of Allt na Muidhe [NN 110 550],

Grant Wilson has recorded south-west striae marking the passage of Glen Coe ice across into Glen Creran.

High-level striae have been scantily preserved on the volcanic rocks and "granites" south of Glen Coe. Still Maufe has obtained striae directed west by south at the 2500-ft level on the south slopes of Bidean nam Bian [NN 140 543]; while on the quartzite of Beinn Ceitlein [NN 176 490] and Stob Dubh, which lie within the "granitic" area, Clough and Maufe have found strike varying between west-south-west and west at elevations of 2500 and 2800 ft. Probably Glen Etive, even in its lower reaches, was crossed, though obliquely, by the main ice-current.

Strong support for this view is afforded by Kynaston's observations in Sheet 45 (Geol.) which show that ice passed over the low plateau of Lorne, at the foot of the great granite mountains of Etive, in a direction slightly north of west. The reader may be referred to fig. 16 of the Geological Survey Memoir on Colonsay for a sketch map, compiled by Wright and Bailey, to illustrate the glaciation of the West Highlands south of Sheet 53. E. B. B.

### **Glacial erosion**

The question of glacial erosion has been discussed already in chapter 1. Reference will there be found: to the complex development of hanging valleys, including that of An Steall of (Plate 13), 1; to the example of grinding and plucking illustrated from further down Glen Nevis in (Plate 13), 2; and to the *moutonné* surfaces of the valleys of Allt Coire an Eòin [NN 223 740], flowing north-east from Aonach Beag of the Ben Nevis Group, and of Amhainn Coir ' an Iubhair [NM 920 623], entering Glen Tarbert [NM 910 600] near Loch Linnhe. Instances of *moutonné* surfaces are numerous throughout the district, and a few may be mentioned from more accessible localities. The contact-altered Leven Schists, crossed by the upper path at Glen Nevis gorge, a couple of miles above Polldubh [NN 141 686], are strikingly ice-worn. So, too, are unbaked rocks of the same formation by the roadside and along the shore east of North Ballachulish [NN 052 603]; while further east glacial striping of the slopes, overlooking Loch Leven from the north, is often remarkable, with long gentle ridges and furrows descending at a low angle towards the west-south-west. Ice moulding of Leven Schists by the roadside in Glen Creran, near the southern limit of the map, and of Eilde Flags along General Wade's Military Road, east of Allt Coire Mhorair [NN 195 600], is also particularly impressive. E. B. B.

The massif of Binnein Mòr [NN 213 664] presents a remarkable topographical peculiarity which probably finds its explanation in the glaciation of the district. The northern and eastern spurs of the mountain, which culminate in the summits of Binnein Beag [NN 222 677] and Sgòrr Eilde Mòr, are both trenched by passes with flat bottoms occupied by lakes. The huge valley, Coire Binnein [NN 215 658], that lies between these spurs, was a distributing reservoir for ice during the later stages of glaciation, pouring it out across the passes. The ice-tongue which had its outlet between Binnein Beag [NN 222 677] and Binnein Mòr was tributary to the Glen Nevis ice, while that which escaped over the Sgùrr Eilde Mòr [NN 232 654] pass can be proved by its striae to have swept round and become confluent with the Loch Eilde glacier. To the excavating power of these two glaciers and to their moraine accumulations must be ascribed the flat-bottomed passes and the lakes which occur on them. On the dark mica-schist slopes of Allt Coire na Gabhalach [NN 202 680], below the Binnein Beag [NN 222 677] pass, there is an enormous accumulation of white quartzite debris, distributed by torrents which issued at several points from the front of the northern tongue of ice. W. B. W.

### **Boulder-clay, moraines and erratics**

A small proportion of the glacial drift of the district has been mapped by Grant Wilson as boulder-clay, especially near the southern border of the map, west of Glen Creran. But elsewhere the dominant type is a loose, uncompacted, often more or less gravelly deposit with a hummocky topography, which corresponds with what is commonly designated moraine by Scottish geologists. True glacial gravels also occur, but these will be discussed later.

It must not be supposed that the morainic drift was wholly derived from rock surfaces exposed above the level of the ice. This is most certainly not the case. For instance, the Strontian "Granite" north of Glen Tarbert [NM 910 600] builds a high

plateau, across which the shallow Gleann Feith 'n Amean [NM 870 623] drains, and yet, though the "granite" nowhere rises into a ridge overlooking the plateau, it has furnished the great majority of the boulders occurring in the morainic mounds upon its surface. It is clear, in fact, that the boulders have been derived by plucking, of the type discussed in chapter 1 ((Plate 13), 2). Similarly one can scarcely doubt that the "granite" boulders occurring in the myriad mounds upon the Moor of Rannoch have been derived from below, and not from the insignificant ridge which crosses the moor eastwards from Beinn a' Chrùlaiste [NN 246 566]. E. B. B.

The distribution of boulders of the Moor of Rannoch "Granite", west of the moor, shows the wonderful lifting power of the ice-sheet. Boulders of this rock have been observed on the face of Buachaille Etive Mòr [NN 210 538] at a height of over 2000 ft — one of them, on the col south-west of Stob Dearg [NN 225 543], at about 3000 ft. It may be regarded as fairly certain that these boulders were picked up from the moor at approximately the 1000-ft level. G. W. G.

High-lying boulders of Moor of Rannoch "Granite" have also been met with on Aonach Eagach [NN 160 583], north of Glen Coe, not much below 3000 ft. H. B. M.

It is not only the elevation to which the Moor of Rannoch boulders have sometimes been raised, but also their wide dispersal that entitles them to interest. The northern limit of their distribution has been traced from beyond the eastern limit of the map to near Kinlochleven. It runs approximately east and west, and lies less than a mile north of the river Leven. Its course, shown on Sheet 53, corroborates the evidence afforded by the striae in regard to the westward flow of the ice in this part of the district during the maximum of glaciation. W. B. W.

There remains much useful work to be done in tracing the limits of boulder trails within Sheet 53. Grant Wilson followed kentalenite and augite-diorite boulders south-west along the course of Loch Linnhe from Kentallen and Ardsheal [NM 995 574], and others coming down Glen Creran from Barnamuc [NN 048 499], etc.; but his data have not been preserved. Maufe and Grant Wilson have also drawn attention to the wonderful profusion of boulders of volcanic rocks from Glen Coe, exhibited in the River Laroach [NN 080 560] above Ballachulish Bridge [NN 053 598]. Again, the passage of ice across Glen Nevis during the maximum glaciation is clearly evidenced by numerous boulders of Ben Nevis "Granite" stranded on the north-east face of Bidean Bad na h-Iolaire [NN 112 706]. E. B. B.

As may be imagined, the distribution of boulders is an intensely complicated matter. Whereas the Moor of Rannoch figured, during the height of glaciation, as a centre of dispersal, later it became an area of accumulation. Glaciers from Càrn Ghleann [NN 247 515] and the great valley of the River Bà [NN 240 472] (Sheet 54, Geol.) spread out over the moor in a general easterly direction; and among the erratics thus distributed we may recognise volcanic rocks from the Sròn na Crèisee [NN 240 522] and Meall a' Bhuiridh [NN 250 504] (Sheet 54) group of mountains (*cf.* Hinxman and others 1923, p. 84). H. K.

In keeping with this evidence a succession of particularly clear morainic ridges also occurs on the high ground east of Càrn Ghleann [NN 247 515]. They cross a shallow hollow south of Creag Dhubh [NN 255 523] (Sheet 54), and point to an eastward overflow of ice from Càrn Ghleann [NN 247 515] at the time of their formation. G. W. G.

Further north, striking termino-lateral moraines bulge westwards from the valley of Allt an Eoin Bhinn [NN 230 582] into a col between Beinn Bheag and Meall Bad a' Bheithe [NN 230 595]; and others, more strictly lateral and less well-defined, line the eastern slopes of Beinn Bheag and the western slopes of Beinn a' Chrùlaiste [NN 246 566] opposite. All these morainic terraces slope gently to the north-east. By the time they formed it is quite possible that the hollow now occupied by the Blackwater Reservoir [NN 250 605] had become a receiver of western ice (*cf.* E. M. Anderson *in* Hinxman and others 1923, p. 85). Very clearly marked crescentic moraines at the west foot of Stob Beinn a' Chrùlaiste [NN 232 564] probably indicate a halt at a later stage when the ice-stream had dwindled back to Altnafeadh [NN 222 563].

The crossing of boulder trails mentioned above is repeated again and again. It is well illustrated in Gleann a' Chaolais [NN 040 570] draining into Loch Leven. This glen, even at its head, retains much of the material brought by the main westward ice-flow, including great numbers of boulders of Moor of Rannoch "Granite"; and yet right down to its mouth at Caolasnacón it is strewn with blocks of andesite carried down-valley from the crags of Aonach Eagach [NN 160 583] during the later stages of glaciation. E. B. B.

Since the morainic drift usually presents a hummocky unordered topography, the well defined terminal or lateral ridges mentioned above are exceptional. Additional terminal examples may, however, be cited from the north-east end of Lairig Gartain [NN 200 544], Glen Coe, and from the stretch of Glen Etive between Alltchaorunn [NN 196 509] and Dalness. Two more will be mentioned in the next section. G. W. G.

### **Glacial drainage erosion**

Two fine crescentic moraines occur at the lip of the hanging valley of Allt Coire Giùbhsachan, south-east of Ben Nevis. One of them reaches the col that separates Meall Cumhann [NN 178 697] from Ben Nevis. Across this col there is a typical stream-channel, now dry and deserted. It was cut by waters issuing from a lakelet sustained at this level by the Allt Coire Giùbhsachan glacier.

The channel just mentioned is one of the few in the district that can be referred to glacially diverted waters. In this respect there is a marked contrast between the West Highlands and the East. The West, owing to its greater snowfall, has suffered more from direct glacial erosion than the East; its rocks are fresh and hard right up to the surface, and do not readily yield to water erosion.

In addition, the West was the true home of glacial conditions during the valley-glacier stage. The main glaciers were constantly joined on either side by tributary glaciers and by slopes of *névé*, and so did not afford an opportunity for marginal drainage. In the East the main glaciers invaded a district where local conditions of climate were not, strictly speaking, glacial at all, and there it is that marginal drainage phenomena have been developed in perfection.

While dealing with the subject of glacially directed water-erosion we may note another example furnished by Meall Cumhann [NN 178 697], though of a different category from the last. The cliff face of Meall Cumhann [NN 178 697], a little beyond the upper end of the Glen Nevis gorge, is beautifully water-worn, with hollow surfaces, and even gigantic semi-pot-holes, into which sheep have been known to scramble ((Plate 13), 1). The water-worn face is perhaps 200 or 300 ft high, and clearly marks the position of a marginal crevasse down which a torrent was wont to plunge, drilling great pot-holes, half in rock, half in the ice. Now, of course, only the rock half remains. E. B. B.

### **Fluvio-glacial gravels**

Fluvio-glacial gravels deposited by the melt-water of the glaciers in the form of cones, fans and terraces are found in some of the glens, generally in association with hummocky moraines. These gravels vary in character from a tumultuous assemblage of boulders, pebbles and sand, not easily distinguished from the loose and gravelly forms of the morainic drift, to well-stratified clean gravel and sand, closely resembling normal river deposits. All this is readily understood. A part of the material dumped by a glacier at its snout is deposited as moraine, some of it being more or less washed by the melt-waters; whilst other parts, carried forward and rearranged by the escaping stream, may eventually give rise to terraces similar in every way to ordinary river terraces. With the exception of the Corran gravels, discussed below, none of the fluvio-glacial gravels of the district has been specially indicated on the map. Many small patches have not been separated from the morainic drift with which they occur, while larger stretches, such as high-level river terraces and deltaic cones, have been grouped as alluvium. Thus the flood-gravels forming the plain in Glen Coe between Clachaig Hotel and the rock-barrier below Loch Achtriochtan are shown merely as alluvium on the map, although probably deposited at the same time as the morainic drift which rests on the rock barrier and extends laterally along the hill-slope north of the loch.

At the mouth of Fionn Ghleann [NN 124 550], tributary to Glen Coe, there is a conspicuous series of terraces, banked one above the other, and heading up to a morainic mass, which lies near the "granite" boundary where the glen contracts. These terraces appear to have been deposited as steeply sloping deltas which were successively eroded on the melting away of the ice. Even the lowest terrace, reaching close down to Achnacon [NN 119 566], is considerably denuded by the stream, which has cut a deep channel for itself in the Leven Phyllites. H. B. M.

A fine fluvio-glacial cone descends into Glen Nevis from a terminal moraine near the foot of Allt a' Choire Dheirg.

The Corran gravels referred to above stand quite apart from the other fluvioglacial phenomena of the district. They form a conspicuous terrace on both sides of Corran Narrows [NN 0183 6342] at about 75 ft above sea-level. This terrace looks extremely like a raised beach, but although well characterised in this one locality it is definitely absent elsewhere in Sheet 53 along the shores of Loch Linnhe and Loch Leven. Grant Wilson suggested that it marks the site of a lake between two glaciers, the one coming down upper Loch Linnhe, the other issuing from Loch Leven. This view has been accepted by Maufe and Peach.

It is quite probable that the water-level of the glacial lake was determined by that of the sea farther down Loch Linnhe. On this hypothesis Peach and Horne (1910, pp. 495–6) have suggested that the two largest lochs on the Corran peninsula are "kettle-holes in fluvio-glacial deposits of the 100-ft Beach". These two lochs are quite remarkable considering their situation. James Murray (*in* Murray and Pullar 1910,2, pt. ii, p. 261) found them to be 74 ft and 43 ft deep respectively (the surface levels given by the Ordnance Survey are 14 ft and 6 ft). The names under which they are described by Murray, Peach and Horne are Lochan Eoin Mhic Alastair [NN 007 637] and Lochan na h-Eaglais [NN 008 640]. In calling them kettle-holes Peach and Horne imply that they mark the sites of great buried masses of ice which persisted during the formation of the Corran gravels, and then melted, leaving holes behind. E. B. B.

## **Raised beaches**

In this district, as along much of the west coast, raised sea-beaches, or corresponding rock-platforms subtending a cliff, are found on both sides of Loch Linnhe and Loch Leven. The raised beaches consist of coarse and fine bedded gravel, sometimes mixed with sand, and are generally found in bays and at the mouths of streams, where they form broad flats, here and there ridged with low bars of gravel representing old storm-beaches. The rock-platforms make a continuous terrace connecting beach with beach along the coast. They vary in breadth according to the exposure of the site, the resistance offered by the rock to erosion, and the steepness of the slope into which the platform and cliff are cut.

This natural terrace, being the easiest route to follow, has determined the line of most of the main roads. Even where the hills rise abruptly from the sea there is a terrace sufficiently broad to carry a road, or at least to reduce the necessity for rock-cuttings to insignificance.

In neighbouring districts beyond the limits of Sheet 53 it is common to find two or three sea-margins at different heights, but one of these generally known as the "Twenty-Five-Foot Beach" is almost always more strongly developed than the others. In this district there is one well-developed sea-margin, corresponding as we shall see to the "Twenty-Five-Foot Beach", and some evidence for a lower beach in a few places, but nowhere is there undoubted evidence of the shore-line of the "Hundred-Foot Beach", or indeed of any sea-margin above the level of the so-called "Twenty-Five-Foot Beach".

### **"Hundred-Foot Beach"**

In spite of the great development of the gravels of this beach about the mouth of Loch Etive [NN 000 330], only a few miles to the south, no corresponding terraces either of accumulation or of erosion have been recognised within Sheet 53. It is perhaps not surprising that such terraces are not preserved on many parts of the coast where the hills rise sharply from the sea, but it is noteworthy that, in the low, open ground, which lies north-east of Fort William, there is no trace of a shore-line above the limits of the "Twenty-Five-Foot Beach". This low ground is covered with hummocks of loose morainic drift, which would certainly show signs of re-arrangement, if it had ever been acted on by the sea.

Although the shore-line of the beach is not recognisable, what may be its sub-littoral deposits are represented by green clays. One of these deposits, according to Gwyn Jeffreys (1863) contains a marine fauna, characterised by a great number of boreal forms, which is not unlike that of the "Clyde Beds". This clay-bed, but not the layer containing shells, is exposed at the bridge half-a-mile south of Fort William pier. The section when examined showed 4 ft of green clay, laminated with silt seams, and containing a few pebbles of red granite and local schists. The gravel of the "Twenty-Five-Foot Beach" overlies it.

Other green clays, which may belong to this period, are found at Cilmaliu [NM 898 557] and Glengalmadale [NM 867 532], on the western border of the map. A short distance above the mouth of the stream at Cilmaliu [NM 898 557], about

10 ft of stiff greenish clay is overlain by river-gravel, and in a roadside section, about 400 yd south of the house, a similar green clay, 3 ft in thickness, is overlain by gravel of the "Twenty-Five-Foot Beach", 4 ft in thickness. Just below Glengalmadale [NM 867 532] Bridge the gravel of the "Twenty-Five-Foot Beach" overlies a thin bed of peat which in turn rests on a stiff green clay in which the plate of a large *Balanus* was found. These clays rise not more than 16 ft above present high tide-mark, and were it not for the thin layer of peat one might think that they belonged to the "Twenty-Five-Foot Beach" period; but it is evident that they are older.

The relation of the "Hundred-Foot Beach" to the morainic drift is perplexing. In this district and in Loch Eil [NN 000 780] the latter comes down to the "Twenty-Five-Foot Beach" where it is eroded and its material re-arranged to form beach-gravels. The absence of the shore-line of the "Hundred-Foot Beach" at once raises the question whether in this district the morainic drift is contemporaneous with or later than the "Hundred-Foot Beach".

If the Fort William clay with its boreal shells belongs properly to the "Hundred-Foot Beach" period, it must be looked upon as a relic which has escaped erosion during an advance of the glaciers responsible for the moraines. We should have to suppose: that the sea of the "Hundred-Foot Beach" extended up Loch Linnhe at least as far as Fort William; that the glaciers which formed the morainic drift increased again and reached down Loch Linnhe beyond the limits of Sheet 53, sweeping out most of the deposits of the "Hundred-Foot Beach"; and that the sea-level was lowered before the ice had again retreated very far. It must be admitted that this suggestion does not rest on a very sure foundation, but it is in keeping with the relations subsisting between the morainic drift and the "Hundred-Foot Beach" in other parts of the Highlands, for instance in south-east Mull and at Loch Lomond [NN 330 090].

### **"Twenty-Five-Foot Beach"**

This beach and its associated rock-notch form a well-marked feature along the shores of Loch Linnhe and Loch Leven. The deposits consist of more or less well-rolled gravel and sand, sometimes as much as 15 ft in thickness. The pebbles in the gravel consist of local rocks mixed with far-travelled stones derived from the neighbouring drifts. From its position and from the size of many of its boulders Grant Wilson concluded that the spread of raised beach north of Ballachulish Ferry [NN 053 598] is in large measure a resorted moraine. No fossils have been recorded from the gravels of Sheet 53, though Gwyn Jeffreys says that the beach overlying the fossiliferous clay at Fort William contained littoral species and shells which must have been thrown up by the tide.

In two instances the gravels rest on peat layers. In one of these, already mentioned, the raised-beach gravels just below Glengalmadale [NM 867 532] Bridge on the western margin of the map are separated by a thin layer of peat from underlying green clay. In the other, coarse stratified gravel and sand, about 15 ft in thickness, on the right bank of the River Lochy [NN 113 758] (Sheet 62, Geol.), a mile and a half north of Fort William, and 1000 yd west of the Lochy Suspension Bridge, rest on a bed of sandy peat containing prostrate tree-trunks up to 1 ft in diameter. The mosses in the peat-bed have been examined by H. N. Dixon (1910), who found nearly forty species, and showed that the conditions under which these grew indicate "a stream of some magnitude — not a mere rivulet — tumbling over boulders, and flowing, at times at any rate between wet rocky cliffs, down a wooded mountain side or valley". He further concludes that the flora is "indicative of a mild and equable climate", and believes "its presence may be taken as fairly conclusive that the climate of the period was at least in no degree more boreal than at the present time". The presence of the peat shows further that the sea-level before "Twenty-Five-Foot Beach" times was lower than it is at the present day; that is to say, the lowering of sea-level from "Hundred-Foot Beach" times to the present day was not a simple lowering accompanied by halts, but was interrupted by at least one oscillation of appreciable magnitude.

The altitude of the shore-line of the "Twenty-Five-Foot Beach" is in this district always above the 25-ft contour line. The beach has, in fact, sometimes been called the "Fifty-Foot Beach". The inner angle of the rock-shelf lies at about 35 ft above O.D. H. B. M.

### **Peat and alluvium**

Peat is widely developed, but in subordinate amount. It is constantly found in the hollows between moraines, and is a very valuable source of fuel for the crofters and gamekeepers.

The most important moss is situated on the gravel flats at Clovulin [NN 000 630], southwest of Corran Narrows [NN 0183 6342].

There are considerable stretches of alluvium in several of the main valleys, notably Glen Gour, Glen Coe [NN 120 570], Glen Creran [NN 030 480] and Glen Etive [NN 190 510]. As pointed out already, it has not been found possible to distinguish with precision between normal alluvium and fluvio-glacial gravels.

Some of the alluvium has accumulated in lochs. At the present day Loch Achtriochtan [NN 145 566], Glen Coe, is obviously in process of extinction. E. B. B.

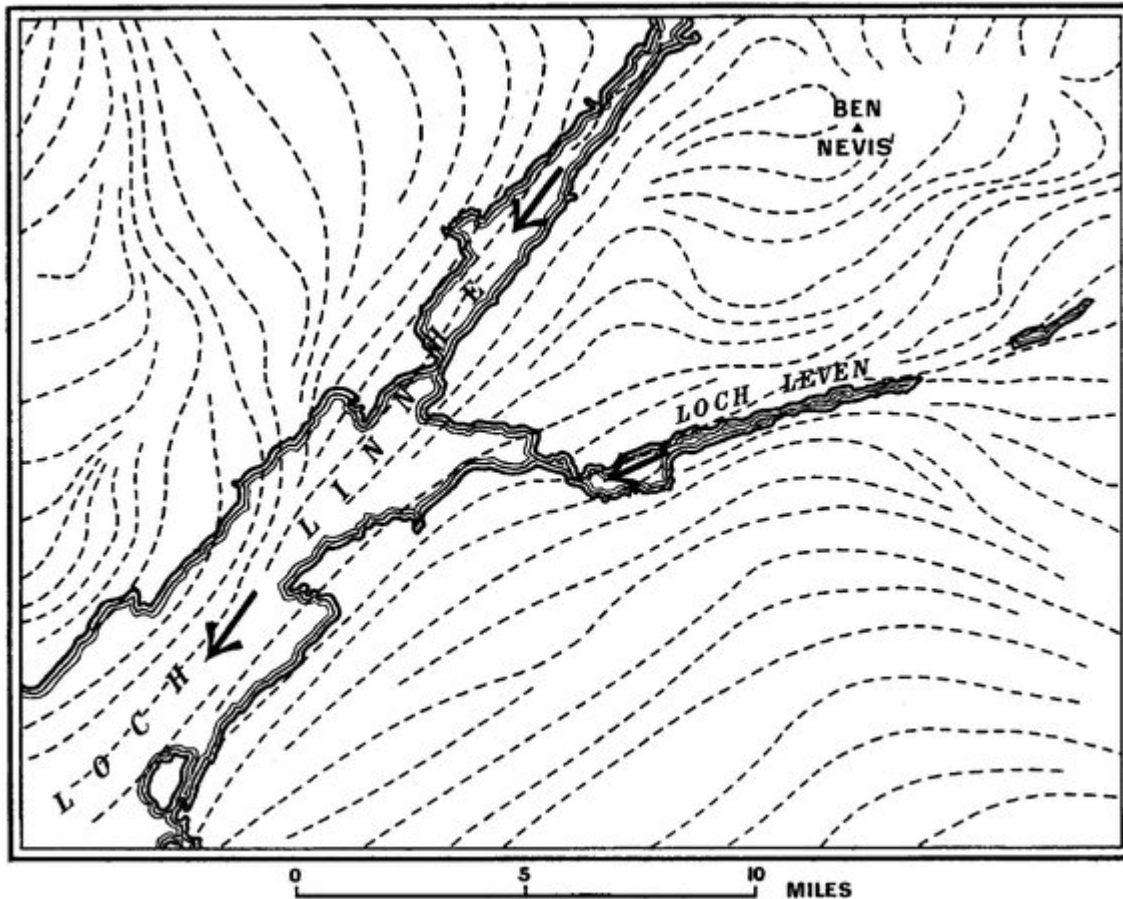
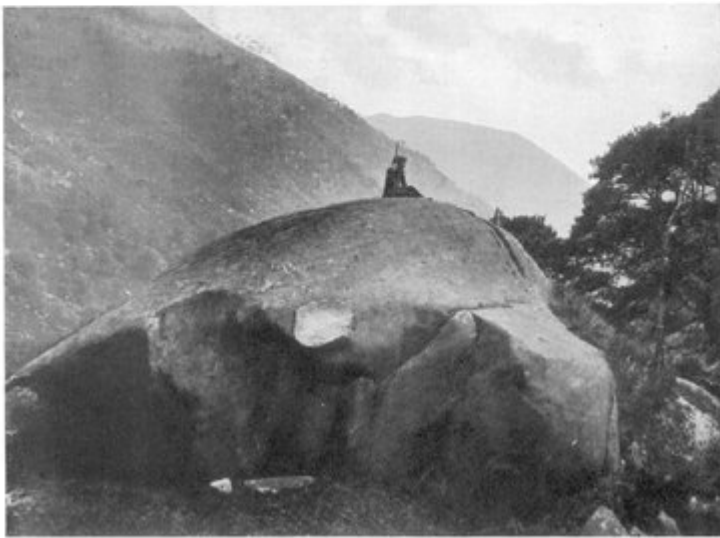
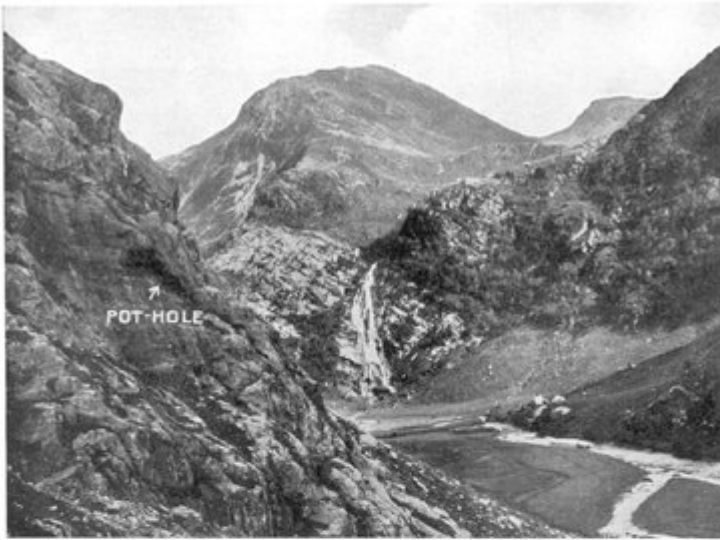


FIG. 41. Map of glacial flow-lines during the maximum stage of glaciation

*(Figure 41) Map of glacial flow-lines during the maximum stage of glaciation.*





*(Plate 13) An Steall, The Waterfall of a valley hanging to Glen Nevis Water-worn crags on left due to stream cascading down marginal crevasse; Roche moutonnee, Glen Nevis, by roadside above Polldubh [NN 141 686] Note gap on "sloss" side due to plucking.*