
Chapter 37 Glacial and Recent

Introduction

In one important particular of its glacial history, Mull occupies a position analogous to that of Skye. It includes a sanctuary, within which no mainland boulders have been found; though, beyond its limits, they occur in profusion (Figure 64) and (Figure 65). Dr. Harker's^{<ref>A. Harker, Ice Erosion in the Cuillin Hills, Skye, Trans. Roy. Soc. Edin., vol. xl., 1901, p. 221,</ref>} hypothesis of a local centre of dispersal seems to account satisfactorily for the sanctuary. It is supposed that local snowfall more than supplied the fluxional loss of ice which would have occurred if the surface of the general Scottish ice-sheet had assumed a smooth continuous slope above the mountainous obstruction of Mull. In consequence, a swelling in the ice-sheet always marked the site of the buried massif; and invasion of the sanctuary was prevented by outward flow from this subsidiary centre. The limit of mainland erratics, laid down in (Figure 64) and (Figure 65), roughly corresponds to the most restricted boundary of bottom-currents of ice originating over Mull.

In about half of Mull, the glacial record is entirely of ice-sheet type; and, while there are often plenty of erratics and striae, there is surprisingly little boulder-clay or morainic drift. The story, even in this part of the district, is not a simple one. For instance, granite and gneiss boulders derived from Morven are stranded throughout the country north-west of Loch na Keal, including Ulva, and yet granophyre-boulders from Glen Forsa, or some neighbouring source, have found their way to Dervaig in Sheet 51. This crossing of boulder-tracks corresponds with divergent observations of striae, and there can be no doubt that the currents of the ice-sheet varied greatly from time to time.

In the mountainous central region, in large measure included in (Figure 64), erratics and striae both indicate a phase of valley-glaciation at the close of the glacial history of Mull; and, as usual in the Highlands, the valley-glaciers have left morainic deposits with a hummocky topography.

It has long been known, from faunal and other considerations, that the earlier raised-beach deposits of Scotland are Late-Glacial rather than Post-Glacial, and this is particularly clear in Mull.

It has also been recognized that the lowest well-marked raised beach of Scotland is Post-Glacial, and corresponds to an exceptionally long pause in the relative movement of sea and land, during which was effected most of the marine erosion that has occurred since the withdrawal of the ice-sheet. This low-raised beach is particularly well displayed at Oban and in south-eastern Mull. At Oban, archaeological evidence brings it into relation with the commencement of the human record in Scotland.

Certain landslips are dealt with at the conclusion of the chapter.

Ice-Sheet glaciation

Erratics

In much of its course, the limit of the Mull Sanctuary, within which no mainland erratics are found ((Figure 64) and (Figure 65)), is wonderfully definite.

The hills which face the Sound of Mull, Dùn da Ghaoithe and its neighbours, are littered with foreign boulders, notably Morven granite, Moine gneiss, and Triassic sandstone—the latter probably plucked from the floor of the Sound. Southwards, similar boulders are well-represented on Beinn Fhada, and erratics are conspicuous in the Croggan Peninsula. Westwards, the plateau north of Loch na Keal has scattered upon its surface moderate-sized boulders of Moine gneiss and Morven Granite. There are also a few of quartzite, some of them rounded, but sandstone is virtually absent. In Ulva, granite and gneiss boulders are frequent, and, in the Pre-Glacial Cave (p. 390), fossiliferous Lias limestone was abundantly found along with one fragment of Triassic sandstone. The above statements only hold in a general way, and, where valley-glaciation has succeeded the ice-sheet, foreign boulders are seldom conspicuous, except

along ridges and summits which have escaped cleansing by local ice-flow.

In the Sanctuary (Figure 64) and (Figure 65), foreign boulders are absent. The ridges about Beinn Talaidh, west of the hollow uniting Glen More and Glen Forsa, have not yielded a single fragment derived from the mainland. It is held that this cannot be attributed to subsequent removal of boulders introduced during ice-sheet conditions, more especially as the Sanctuary includes districts, such as Carsaig (Sheet 44) and Gribun (Sheet 43), which were only able to maintain trivial valley-glaciers on the withdrawal of the ice-sheet.

While the limit of foreign erratics is generally well-marked in Mull, in the Ross there is some doubt as to its position. Apparently it follows, approximately, the Bunessan boundary-fault of the Tertiary lavas (Sheet 43). Foreign boulders have not been noticed upon the lava-country north-east of this fault, whereas a few have been observed south-west of it. A good example is a 1 ft. 6 in. boulder of grey hornblende-biotite-granite north-east of Scoor House, on the border of Sheets 35 and 43. The country-rock of the district is gneiss, and, though granite *in situ* figures largely farther west, it is of a different character. There can be no doubt the granite-boulder is of Mainland origin; and, as it is built, with local stones, into a field-wall 200 ft. above the sea, it is not likely to have been carried by man from a point to which it could have been brought by an ice-raft during the 100-ft. Late-Glacial submergence. Mainland boulders of granite are fairly common near Bunessan, but their low stations often render their mode of transport dubious. E.B.B.

A few other interesting cases of ice-sheet distribution of boulders may be cited.

In general, the boulder-carry in the Morven district of Sheet 44 is from east to west. Erratics of Morven Granite are a feature of the basalt-plateaux, even west of Loch Aline; and blocks of quartzite and Lismore Limestone have been found on summits of the granite-area at An Sleaghaeh and Meall a' Chaoruinn. In apparent contradiction with this, a few erratics of Triassic sandstone and Gryphaa-limestone also occur in the granite-area. These, however, cannot be attributed to a distribution from the west; for all the evidence negatives such a suggestion. It points, rather, to a submerged outlier of Mesozoic sediments somewhere along the complicated faultbelt that runs up Loch Linnhe. G.W.L.

In the Oban district, granite-erratics, derived from the Etive complex, are well known. Such as are porphyritic have been derived from the central or Starav Granite of the complex; while the non-porphyritic belongs to the outer ring or Cruachan Granite. E.B.B.

Attention has already been directed to the carry, in Mull, of granophyre-boulders westwards to Dervaig (Sheet 43). Granophyre-boulders are naturally also found well within the Sanctuary of (Figure 65). For instance, they are a fairly marked feature of the country south of Loch na Real, as far as Balmeanach Farm in the Gribun district (Sheet 43). Probably Balmeanach marks the southern limit of ice which, farther east, traversed either the Glen Cannel or Beinn a' Ghràig Granophyres of Chapter 31 and 32. E.B.B., J.E.R.

Another notable carry of boulders is illustrated in Iona, where great erratics of pink Ross of Mull Granite are everywhere conspicuous. Many of them lie above the limit reached by the sea in Late-Glacial times so that there can be no doubt of their transport by land-ice. E.M.A.

Recognizable erratics are scarce in Coll and Tiree, except on the modern and Late-Glacial sea-beaches, where a veritable museum-selection is afforded. There is one very conspicuous black boulder of olivine-gabbro in Coll which must have been carried into position by land-ice. It measures 8 x 7 x 4 ft., and stands on pale gneiss, 200 ft. above sea-level, on the rocky slopes of Ben Hogh, 300 yds. north-west of the head of Loch nan Cinneachan (Sheet 51). As will be shown presently, strife prove that ice passing across Mull must have overridden both Coll and Tiree, so that it is strange how little Mull debris has been left on these islands. The gabbro-boulder may have come from Mull, or possibly from Ardnamurchan.

Striae

Numberless striae have been recorded on the six-inch Field-Maps, especially in that resistant part of Mull which is included within the Limit of Pneumatolysis of (Plate 3) (p. 91). Representative sets are reproduced in the one-inch Map and (Figure 64). On these Maps, striae, occurring side by side, may belong to very different stages of the glacial story.

Thus, (Figure 64) shows how an ice-sheet, flowing parallel to the Sound of Mull, was replaced by glaciers, restricted to valleys draining at right angles into that great hollow.

In what follows, only a few selected instances of the striae shown on the maps are touched upon.

Craignure Divide

(Figure 65) shows the bottom-currents of the general ice-sheet diverging on contact with Mull so as to conform, more or less closely, with the course of the Sound of Mull and Firth of Lorne. The evidence in the field is wonderfully complete and demonstrates that Craignure stands precisely on the parting of the ways:

North-west of Craignure Bay. Striae have been noted directed N.W. at Java Point, and, in succession, W. 5 N., W. 2 N., and W. 10 S., between Java Point and the little stream that enters the west corner of the bay. In each case, the moulding of the glaciated surfaces leaves no doubt that the ice was streaming westwards.

South-east of Craignure Bay. Striae occur directed E. 30 S. 200 yds. northwest of Sgeir Ruadh, S. 30 E. on Eileen Bàn, and S. 28 E. and S. 20 E. on Rudh' Ghuirmein. In all these cases, the moulding of the striated surfaces indicates a south-westwards flow.

The distance between the stripe pointing N.W. on Java Point and those directed E. 30 S. near Sgeir Ruadh is only 1 mile 300 yds. There are no striated surfaces known in the interval; but on either side, whether up the Sound of Mull, or across Duart Bay, there are countless ice-moulded and striated surfaces referable to the general glaciation, and they also agree in putting the parting of the bottom-currents at Craignure. E.B.B.

North of the Sanctuary

The general direction of the main ice-current passing more or less westwards across Mull, north of Craignure and the Sanctuary of (Figure 64) and (Figure 65), is vouched for by abundant striae. At first, the flow is north of west, but, near Salen, a particularly strong current, directed south of west, was concentrated along the valley leading to Loch na Keal. W.B.W.

A remarkable series of little striated hollows and winding grooves is a conspicuous feature of the south shore of Loch na Keal, between Knock and Scarisdale. The depressions have been cut in the rocks, irrespective of geological structure. Where, as is frequently the case, successive hollows are connected by a channel, they furnish miniature examples of rock-basins distributed along a valley. Appearances suggest that the main factor in their production has been running water: the hollows are almost certainly pot-holes; the winding channels stream-courses. Ice has been merely a modifying agent, as in the tortuous grooves on Kelley's Island, Lake Erie, figured in Chamberlin and Salisbury's *Geology*.<ref>T. C. Chamberlin and R. D. Salisbury, *Geology*, vol. iii., 1906, Fig. 485, p. 349. </ref> The clear manner, in which these pot-holes and grooves are exhibited on the shore of Loch na Keal, might suggest a marine origin; but less perfect examples have been noted at various altitudes in Mull up to 1000 ft. Probably, they originated through the operation of subglacial torrents, as suggested by Professor Holmquist in the case of analogous forms observed in Scandinavia, especially in the island of Utö, near Stockholm.<ref>P. J. Holmquist, *The Archean Geology of the Coast Regions of Stockholm*. Guide 15 of the International Geol. Congress, 1910, pp. 112,116.</ref>

The general westward flow of ice across northern Mull was not constant. It has already been pointed out that granophyre-boulders are fairly common near Dervaig (Sheet 51); and, in agreement with this, north-west striae are occasionally met with throughout the district running parallel with the hollows of the Sound of Mull, Loch Frisa, and Loch Tuath. They are well-seen on the coastal platform near Dervaig itself, while, a little farther east, examples of eastward striae are preserved. At Ulva (Sheet 43), close to the ferry, Mr. Burnett has found two sets of striae (N.W. and S.W.) on the same rock-surface; but it is not possible to decide which is the earlier. J.E.R.

The south-westerly striae of Ulva and neighbourhood afford evidence of a closing in of the ice-stream in the rear of the Mull Sanctuary. The same is shown by W. 20 S. striae on moulded surfaces on Erisgeir (Sheet 43), and by S.W. or W.S.W. *roches montonnées* on the Dutchman's Cap and Lunga of the Treshnish Isles. W.B.W., E.B.B.

South of the Sanctuary

Striae, indicating a southward, and then south-eastward, flow of the main ice-sheet between Craignure and Loch Buie, are sufficiently numerous, as may be judged from Sheet 44 and (Figure 64). The reader must be warned, however, that the record of the ice-sheet, here, is more confused by extensive valley. glaciation, than in the more northerly district just described.

In the western part of the Ross of Mull, lying outside the Sanctuary of (Figure 65), very few striae have been observed. Mr. Bosworth, has, however, noted two, one pointing N. 25 W., a little south of Bunessan, and another W.N.W. south of Loch Assapol (Sheet 43). Mr. Cunningham Craig has also recorded striae W. 10–18 N. at Scoor House (Sheet 35). *Roches montonnées* pointing N.N.W. are recognizable between the road and Loch na Lathaich, north of Bendoran Cottage.

In Iona, Professor Jehu<ref>T. J. Jehu, The Archean and Torridonian Formations and the Later Intrusive Igneous Rocks of Iona, Trans. Roy. Soc. Edin., vol. liii, 1922, p. 166.</ref> met with N.W. striae south-west of Cnoc Druidean (Sheet 43).

At the south-west end of Tiree, Mr. Simpson has found many striae on Ben Hynish, which give readings between N. 20 W. and N. 35W. They lie well above the limits of Late-Glacial submergence, and their regularity shows that they are a product of land-ice. These striae are combined with little or no moulding, but taken in conjunction with the north-west glaciation of the eastern half of Coll and of Iona, they presumably indicate an ice-flow towards the north-north-west.

The general north-westerly, or north-north-westerly, glaciation of the Ross, and of Iona and Tiree; seems to be due to something more than a mere closing in of the ice-sheet behind the Mull Sanctuary, namely, the influence of ice proceeding from the north of Ireland. North-westerly striae were long ago mapped by Mr. Wilkinson in the north-west corner of Islay. E.B.B.

Within the Sanctuary

As may be gathered from (Figure 64), the striae of the Mull Sanctuary are in large measure attributable to the action of valley-glaciers in Late-Glacial Times. Thus, valley, glaciers at one time drained down Glen Cannel to unite on the bed of Loch Bà. At an earlier stage, however, there is clear evidence, from the moulding of all the passes leading down to Sleibhte-coire, that ice from the upper portions of the Loch Bà drainage-system escaped south-westwards. (C.T.C)

It would be easy to multiply the records of high-lying striae referable to the ice-sheet, but only one more locality will be cited here. The summit-ridge of Beinn nan Gobhar, above Loch Buie (Sheet 44), carries, at one point, striae pointing S.S.W. on well-marked *roches montonnées*.

In the somewhat lower ground of the Ross extending west into Sheet 43, the striae indicate two main directions of ice-flow. At one time, the peninsula appears to have been covered by ice flowing south from across Loch Scridain. At another, the ice-flow was more from east to west along a curved course leading south-west, then west, then north-west. Particularly complex crossings of striae are a feature of the top of the sea-cliff near Diman na Marchachd (Sheet 44). It will be seen that the evidence of successive openings up and compressions of the lines of ice-flow, met with in this southern part of the Sanctuary, corresponds very closely with what is found north of Loch na Keal. E.B.B.

Local glaciation

The evidence-of valley-glaciation in Mull is threefold: (1) striae and moulding in obvious relation to valley-systems; (2) carry of boulders; (3) moraines.

The contrast between valley-striae and ice-sheet striae is often very marked ((Figure 66), p. 404). This is true also of the carry of boulders. On these two grounds, it is clear that almost every important valley, bordered by ground higher than 1250 ft. above sea-level, was occupied by a glacier in Late-Glacial times; whereas, the outlying plateaux lower than 1250 ft. show little or no trace of anything but ice-sheet glaciation.

Furthermore, hummocky morainic drift is only found where striae and boulders indicate valley-glaciation. This rule is not peculiar to Mull, but is almost universal in the West Highlands, so that the two terms Valley-Glaciation and Moraine-Glaciation have long been used as synonyms. It is sufficiently obvious that the Valley-Glaciation Period must have been marked by some climatic factor that was wanting in the final stages of the Ice-Sheet Period. W.B.W., E.B.B.

The material of the hummocky moraines varies from a boulder-clay, without much striation of the boulders, to a rubble, in the production of which water has had a share. Such moraines are widespread in the district illustrated in (Figure 64), and are particularly impressive in the 'valley of the hundred hills' draining from Loch Fuaran north-westwards into Glen More.

A tendency for the hummocky moraines to assume a linear grouping is not infrequent; and, occasionally definite terminal and lateral moraines are recognizable:

1. The floor of Glen More (Sheet 44) above Craig Cottage is crossed by a series of fine terminal moraines concave towards the north-west.
2. A beautiful boulder-moraine extends for 600 yds. between the 600 and 300 ft. contours on the east side of Ablinn Coire na Febla above Loch Spelve (Sheet 44). This moraine marks a retreat-position of the confluent glacier-systems of Loch Spelve and Loch Don. Other moraines belonging to the same system are discussed later in connection with the Late-Glacial Raised Beaches (p. 406). B.B. B.
3. A well-defined terminal moraine crosses the junction of Sheets 43 and 44 at the mouth of Allt na h-Airidhe Brice, a tributary to Abhuinn Bail' a' Mhuilinn of Gleann Seiliseir. Gleann Seiliseir itself is partly occupied by drift, which has in places been moulded into oval hillocks parallel with the stream. These are probably drumlins; and, if so, must have been produced by a somewhat extensive glacier occupying Gleann Seiliseir prior to the formation of the Allt na h-Airidhe Brice moraine. The Gleann Seiliseir glacier may have descended to sea-level, and was perhaps responsible for the absence of Late-Glacial Beaches at Kilfinichen. E.M.A.

The evidence of valley-glaciers given under (3) is interesting from its situation in regard to the high plateau of the Gribun Peninsula. Most of this plateau bears no trace of valley-glaciation, though its height is often 1500 ft. In the Croggan Peninsula (Sheet 44), an isolated glacier is indicated by moraines towards the head of Glen Libidil, where the neighbouring plateau scarcely reaches 1250 ft. There is little doubt that valley-glaciers thrived increasingly in the eastern part of Mull. The confluent glaciers of Loch Spelve and Loch Don seem to be quite out of proportion to any which have left a record west of Ben More. E.B.B.

Late-Glacial raised beaches

Two of the marine beaches occurring in Mull are of demonstrably Late-Glacial date (p. 402): the older is about 100 ft. above high-water-mark; the younger about 75 ft. In addition, there is a much more prominent Post-Glacial raised beach standing about 25 ft. above high-water-mark. Fortunately, this Post-Glacial beach is often characterized by very pronounced rock-erosion, a feature not found in connexion with the other beaches of Mull. Occasionally, beaches intermediate in height between 25 and 75 ft. (mostly about 45 or 50 ft) are met with in the island. Their date with reference to the glaciers, has not been determined on local evidence, but they will be considered for convenience in the present section.

Some of the beach-measurements cited below have been taken with reference to the upper limit reached by *Fucus caniculatus* on the modern beach, while others, reckoned from 'bench-marks' and 'spot-levels,' have reference to the Ordnance Survey datum. The former will be distinguished by the letters (h.w.m), and the latter by (O.D). The relation between the two sets of readings at the head of Loch na Keal was found to be 0 ft. (h.w.m) = 6 ft. (O.D).

Also, the high-water-mark of ordinary spring tides in the same locality lies approximately at $\frac{1}{2}$ or 1 ft. (h.w.m)= $6\frac{1}{2}$ or 7 ft. (O.D).

W.B.W.

Loch na Keal (Sheet 44)

Deltas belonging to high-raised beaches occur on the rivers of Derryguaig and Scarisdale. There is also a definite gravel-spit, perhaps at the 100-ft. level, above the road south of the last-mentioned river. J.E.R.

At the north-east angle of Loch na Keal, there is a well-marked gravel-terrace extending eastwards for about a mile towards Killichronan House. The following readings were taken for its coastal notch: 75, 80, 75, 70, 65 and 60 ft. (h.w.m.)

A higher terrace at one point gave 95 and 100 ft. (h.w.m) for its notch. Both terraces reappear north-east of Killichronan, the lower largely peat-covered. On either side of Killichronan, the 75-ft. terrace is locally cut in gravels of the 100-ft. terrace, and is therefore of later date. Along the main road, obvious beach-gravel shows through peat south-eastwards from Tòrr nan Clach. Its summit-level reaches 75–85 ft. (O.D), and it appears to form a spit stretching across the valley from Torranlochain on the south-east. Reduced to high-water-mark, the level of the highest shingle of this beach is 78 ft. Behind the gravel spit, is bog at a lower level, 62 ft. O.D. (say 55 ft. above h.w.m), which must have been a marsh at the time of the beach.

Nearer Salen, where the stream of Fèith Bhàn crosses the road, a pit shows 5 ft. of well-stratified gravel with a top at 100 ft. (O.D). There are thus two gravel-spits belonging to the group of Late-Glacial beaches in the pass between Salen and the head of Loch na Beal. These are to some extent obscured by peat, but the upper one was never of any great strength.

Sound of Mull (Sheet 44)

High raised beaches have not been recognized at the mouth of Glen Aros, and are absent at the entrance to Glen Forsa (p. 404).

As Fishnish Bay is approached, little road-metal pits afford exposures of beach-gravels among the rocks. The levels given on the map for the road where it passes over these gravels read, 90, 104, 92, and 76 ft. (O.D). w. S.W.

High beaches are absent at the mouth of the Corrynachenchy stream. They reappear in the Fishnish Peninsula, and a gravel pit, near the bend of the road half-a-mile east of Balmeonach Cottage, is at about 100 ft. (O.D). A little farther on, roadside gravel (on the line of the Bàn Eleauan Felsite) reaches 81 ft. (O.D).

A beach-delta (? at 76 ft) extends up Garmony Burn, but there is nothing corresponding in connection with Allt Achadh na Wine. Between here and Alterich, there are roadside patches of beach-gravel. At Scallastle River, high beaches are conspicuously absent.

In Java Peninsula, beach-gravels extend rather above 90 ft. (O. D); and between Craignure and Duart Bay, roadside pits often show beach-gravels at about 100 ft. (O.D).

Along the Morven coast, little is known of the Late-Glacial beaches. There is, however, a terrace with gravel about 40 ft. above the sea where the coastal road runs north north-west near the edge of Sheet 44. There is also a conspicuous flat of sand and gravel at about the 100-ft. level at the head of Loch Aline (just outside Sheet 44). G.W.L.

Duart (Sheet 44)

The finest development in Mull of the two main Late-Glacial beaches is met with in the Duart Peninsula, north-east of a line of sand and gravel mounds, which will be described in more detail presently as the Loch Don Sand-Moraine (p. 406). The higher Late-Glacial marine gravels of this neighbourhood are preserved in two outliers isolated by a strait floored with the lower gravels: one of these outliers occurs at Duart Point and measures 600 x 200 yds., and is shown on the six-inch map with a 'spot level' reading 99 ft. (O.D.), which means about 93 ft. (h.w.m); the other is at Ardehoirk Farm and measures 1200x 700 yds., and is of the same general level as the Duart Point outlier. The lower beach is more extensive

and is much covered by peat. It can be traced for a couple of miles, and is bounded by a notch of erosion against the Loch Don Moraine (p. 406) and the outliers of the 100-ft. beach. There are sufficient levels' on the map to fix its margins approximately as at 80 ft. (O.D). There can be no doubt that these two main beaches of Duart correspond with the 100-ft. and 75-ft. beaches of Loch na Keal. There is, in addition, a local delta-beach, near Camas Mòr, at a rather higher level than the well-defined Post-Glacial beach of the same locality.

Firth of Lorne (Sheet 44)

A feature of eastern Mull is the absence of Late-Glacial beaches in the hollow connecting Loch Don, Loch Spelve, Loch Uisg, and Loch Buie (p. 405).

The 75-ft. beach of Duart has been traced from the mouth of Loch Don to Port Donain, and its material, as seen in occasional exposures, consists of rather angular gravel.

Another patch is found bordering a stream at Gortenanrue, at the entrance of Loch Spelve.

In the Croggan Peninsula, the 75-ft. beach of Duart is well-developed at a stream south of Portfield; and some high Late-Glacial beach is met with near the mouth of Glen Libidil. E.B.B.

At the north end of Loch Buie, high-lying beach-material is absent up Gleann a' Chaiginn Mhòir, though it forms the basis of the cultivated fields of Cameron Farm. Westwards, little is seen of high beaches, and their absence from Glen Byre is probably significant. G.V.W.

On the Mainland, Late-Glacial beaches have only been recognized near the head of Loch Feochan (p. 407). E.B.B.

Loch Scridain (Sheet 44)

High beach-gravels have been cultivated at Rossal Farm, at the head of Loch Scridain; but extend no farther eastwards up Glen More (p. 407). G.V.W.

About half a mile south-west of Ardvergnish, there is a series of well-defined terraces occupying a small hollow and clearly belonging to the Late-Glacial beaches. They occur at levels of 45 ft., 70 ft., and 90 ft. (h.w.m).

At the mouth of Allt na Coille Mòire, in the same neighbourhood, there are well-marked gravel benches at 45 and 105 ft. (h.w.m), the upper beach continuing for at least a couple of hundred yards west of the stream. Recent shingly gravel occurs at 4½ ft, and an older gravel spit of the modern shore reaches up to 7 ft. (h. w. m.). W.B.W.

High beaches are, however, absent about Kilfinichen Bay in connection with Abhuinn Bail a' Mhuilin draining Gleann Seilisdair (p. 399). E.M.A.

On the south side of Loch Scridain, traces of high beaches are met with at the mouth of Glen Leidle. (B.L.).

Ross of Mull (Sheets 35 and 43)

A little rounded gravel with clayey layers occurs on a platform at 100 ft. (h.w.m).forming Aoneadh Beag, on the south coast (Sheet 43). There is also a terrace-feature at about 60 ft. (O.D) half a mile west of Tràigh nam Beach, on the north coast; and, a little farther west, a gravelly deposit reaches to about the 100-ft. level at Ormsaig Farm. Raised beaches, however, are not well-marked in the Ross, except in the low tract which lies west of a curving line, starting at Eas Dubh, in the south, and passing by Loch Assapol to the northern shore at Bun an Leoib. In this tract, gravel-beaches are so striking a feature that details as to localities would be superfluous. They certainly include representatives of the 100- and 75-ft. Late-Glacial beaches of Duart and Loch na Real, and also of another which lies at 40 or 50 ft., as well as the widespread 25-ft. Post-Glacial beach. As will be emphasized later on, the 25-ft. Post-Glacial beach in this district is only occasionally marked by noteworthy rock-erosion.

There are numerous little pits in the high gravels. It is only necessary to mention a line of roadside pits near Salachran, north of Bunessan, and a couple within a mile of Bunessan along the main road towards Iona Ferry.

A series of measurements was taken on the south coast of Ardlanish Bay (Sheet 35). The 25-ft. Post-Glacial raised beach can here be identified with certainty, since it is backed, at one place, by a cliff in which there is a cave (Uamh Mhòr). Its inner angle lies at 22 ft. (h.w.m). Above this, there are three fairly distinct beach-platforms. The lower two combine to give a sloping surface of gravel extending north to Ardachy House (Sheet 43) with a margin against rock, from 43 to 80 ft. (h.w.m), according to locality. A spit, with a summit at 45 ft. (h.w.m), bespeaks a temporary high-water-level about that height. This is corroborated by the occurrence of a coastal notch cut in gravel at 49 ft. (h.w.m) on the west side of the bay. The gravel, in which this notch is cut, extends to 77 ft. (h.w.m), but appears to correspond to a high-tide-level at approximately 63 ft. (h.w.m). Whatever its exact height, this gravel probably represents the 75-ft. Late-Glacial beach of Duart and Loch na Beal. Above it, in the Ardlanish-Ardachy district, there is a more or less peat-covered flat reaching 95 ft. (h.w.m), which may be interpreted as belonging to the 100-ft. Late-Glacial beach of the localities just mentioned.

One of the first references to raised beaches in Mull is due to A. Stevenson, *A. Stevenson, Notice of Elevated Beaches*, Edin. New Phil. Journ., vol. xxix., 1840, p. 94. who gives measurements from the inlet north-west of Camas Tuath, on the north coast. His readings are 25.3 ft. for the summit of an upstanding gravel-beach, and 40.5 ft. for a higher more doubtful terrace, both measured with reference to present high-water of spring tides. The 25.3-ft. measurement obviously belongs to the Post-Glacial beach; the other to the approximately 49-ft. beach of the Ardlanish series.

Iona

The Late-Glacial beaches are well-developed on the east side of Iona. At Dùn Cùl Bhuirg, on the west side of the island, the approximate 50-ft. beach is seen again with its inner angle at 60 ft. (h.w.m), and its coarse storm-beach shingle thrown up to 65 ft., or even 70ft. The gravel on the modern shore reaches to 8 ft. (h.w.m.).

The hollow across the centre of the island has a number of terraces at 65 to 70 ft. (h.w.m); and some less-defined higher ones at 95 ft. W.B.W.

Gribun Peninsular (Sheet 43)

There is a delta-beach intermediate in level between 25 ft. and 100 ft. at the mouth of the stream at Tavool House, north of Loch Scridain. There is also a considerable spread of gravel, reaching 60 ft. or so above sea-level, at Balmeanoch Farm, four miles farther north. The farm-road north of Allt na Teangaidh runs along a spit of this beach. B.B.B.

Ulva Ferry and Loch Tuath, (Sheet 43)

There is a good development of beach-gravels up to 100 ft. (O.D) on the mainland side of Ulva Ferry. G.V.W.

At the mouth of the streams which enter the sea south of Beinn Duill, near Haunn, there is a fair amount of wave-worn shingle belonging to the Late-Glacial beaches. It reaches a height of 70 ft. (h.w.m), whereas the shingle on the modern shore is thrown to 10 ft. This indicates an elevation of the beach amounting to 60 ft., or perhaps a little more. W.B.W.

Northern Mull (Sheets 51 and 52)

The only other conspicuous terrace of high. level beach-gravels in northern Mull skirts the coast for a mile and a half southwards from Quinish Point. G.V.W.

Interplay between the valley-glaciers and Late-Glacial Sea

The account of the Late-Glacial beaches of Mull, that has just been given, shows that they have a somewhat sporadic development. Except in the Ross of Mull, where, as in Iona, Coll, and Tiree, extensive rocky platforms have been exposed to the fury of the Atlantic surf, these beaches seldom show any appreciable accumulation of gravel, unless in the vicinity of river-mouths. Moreover, they are, under no circumstances, backed by rocky cliffs peculiar to themselves. They are manifestly the records of comparatively brief periods of stability in the relations of land and sea; and caution must be exercised in interpreting the vagaries of their distribution. It has long been realized that, in the highlands, the sea of the earlier raised beaches was often prevented by contemporary glaciers from extending into the more important glens of the country. Evidence of this sort is nowhere clearer than in Mull; and a perusal of the descriptions given below will show that it is only to a limited extent of a negative character. Four principal Mull examples of valley-glaciers, continuing down to the sea-level of their day, are selected for discussion; and their consideration is supplemented by a short account of glacial gravels in Glen Euchar, Lorne. All the instances dealt with are situated in sheet 44. W.B.W., E.B.B.

Loch Bà, Mull

Striae on the shore and by the roadside, east of Rudha Ard nan Eisirein, show that a glacier from Loch Bà once reached as low as present-day sea-level, travelling about W. 15 N., in marked contrast to the W. 25 S. flow of the main ice-sheet across the same rock-surfaces. For three-quarters of a mile south of the River Bà, a strip of ill-defined moundy moraines stretches from the Post-Glacial raised beach, near the burial ground, eastwards past Knock House to unite with the main morainic belt of the Loch Bà valley (Figure 64), p. 393). These mounds carry felsite-blocks which have come from a mile farther up the valley. North of the river at Knock, there is an undulating flat of gravel, sometimes sinking into kettle-holes. Near the Post-Glacial raised beach, its height is about 35 ft. (O.D), or about 6 ft. less above high-water mark; but, at Loch Bà, it reaches to about 75 ft. (O.D). A little east of Knock House, the River Bà, crosses the gravel-spread, part of which extends south-eastwards as a peninsula with Benmore Lodge standing upon it. Its general height, near the Lodge, is about 70 ft. (O.D), though it rises into mounds some four feet higher. A pit east of the Lodge shows 7 ft. of coarse sub-angular clean gravel with traces of steeply dipping stratification. Its included boulders are up to 1½ ft. in diameter; and blocks of felsite lying on neighbouring mounds measure as much as 4 ft. across. From Benmore Lodge northwards, the general level of the gravel sinks. Almost due north of the Lodge, close by the shore of the Loch, there is a remarkable bouldery ridge rising to 58 ft. (O.D.), some 10 ft. higher than the adjacent gravel-spread, and 17 ft. higher than the surface of Loch Bà.

It is obvious that the Loch Bà gravels are a fan discharged from a glacier which halted with its front standing where the Loch now finishes to the west. It is also clear, from its retention of its glacial form, that this fan must have been developed after the withdrawal of the sea responsible for the raised beaches already described at the mouth of the Scarisdale River, on the south-west, and at the head of Loch na Keal, on the north. Measurements of the latter show definite marine accumulations at 100 and 75 ft. above present high-water mark. In other words, the 100 and 75 ft. raised beaches of Loch na Keal were already elevated when the Loch Bà, Glacier stood facing the site of Benmore Lodge.

When one thinks of the exclusion of the 100-ft. sea from the Loch Bà valley, it is well to remember that the 100-ft. contour includes the valley-bottom for four miles south-east of Benmore Lodge.

Glen Forsa, Mull

Similar evidence is furnished in Glen Forsa (Figure 66): there are crossings of striae belonging to the general and valley stages of glaciation; there are hummocky moraines restricted to the valley; and, near the mouth of the river, there is a gravel-fan reaching from a little over 45 ft. (h.w.m) downwards with uniform slope till cut into a bank with its top at 34 ft. overlooking the Post-Glacial raised beach.

It is possible to lay down a line on (Figure 66), marking the position occupied by the glacier-front while this fan accumulated. There remains, in fact, a hollow cast of the glacier, now floored by the peat of Blàr Mòr and Dail Bhàite. Though this cast is not nearly so striking as that occupied by Loch Bà, a particularly beautiful feature is the occurrence within it of several little mounds and eskers rising to the same general level as the neighbouring fan. One of them, at Calachally Farm, terminates in the fan; and they all clearly mark the courses of subglacial streams connected with the formation of the frontal spread. The longest of these little eskers lies close to the river, and can be followed for quarter of

a mile.

The hummocky moraines of Glen Forsa do not extend to the Post-Glacial raised beach, as at Loch Bà, but start at Killbeg Cottage, and continue thence for many miles through the valley-system of east-central Mull (Figure 64); and it is important to realize that, for three miles east of the gravel-fan, the moraine-strewn bottom of Glen Forsa lies below the 100-ft. contour.

The gravel-fan, when considered in detail, is found to be composite, for its surface shows accumulation from two points of discharge. One of these coincides with the confluent-esker at Callachally Farm; the other is situated near Pennygown Farm. In both cases, a regular outward slope of the gravel bespeaks accumulation on dry land. The wonderfully clear definition of this composite fan, and also of its inner scarp, its tributary eskers, and the hummocky moraines behind, proves the further point that it can have suffered no submersion comparable in duration with those responsible for the 100-ft. and 75-ft. beach-gravels, found towards Loch na Keal, on the south-west, and Fishnish Bay, on the east. Accordingly, the Glen Forsa Glacier stood with its front near the sites of Callachally and Pennygown Farms, at some date later than the upheaval of the 100-ft. and 75-ft. beaches of the neighbourhood.

The halts of the Loch Bà, and Glen Forsa glaciers, dealt with above, were probably synchronous. Presumably, both glaciers reached beyond the modern shore-line during the Late Glacial submersion-period. W.B.W.

Loch Don and Loch Spelve, Mull

Valley-glaciers of eastern Mull were particularly strong in their development, and they combined in the low tract, which to-day is partially occupied by Loch Don and Loch Spelve, to yield a veritable piedmont glacier, the most considerable of its kind for many miles around.

The contrast between the direction of striae referable to the piedmont and ice-sheet glaciations is pronounced in the Loch Don district: near the head of Loch a' Ghleannain, the piedmont glacier has left striae running E. 17–15 N.; while, at Àird a' Chròtha on Loch Don, the ice-sheet striae are directed rather south of S.E., and across the north-eastern corner of Loch Spelve they run almost due south.

Hummocky moraines, belonging to the piedmont glacier, are a very pronounced feature of the low ground skirting the road between Loch Don and Loch Spelve; and they continue recognizable as far east as Gualachaolish Farm, east of Loch Spelve.

Under these circumstances, the Loch Bà and Glen Forsa evidence would lead us to anticipate a widespread exclusion of the 100 ft and 75 ft. raised beaches from the low tract of Loch Don and Loch Spelve. As a matter of fact, this anticipation is realized under circumstances so well-defined that one can locally point to the actual position of the ice-front when the 75-ft. beach was raised.

For almost two miles, a row of sand and gravel mounds, the Loch Don Sand-Moraine, continues with little interruption from the roadside near Camas Mòr to Gorten Farm, at the mouth of Loch Don. The ridge is shown on the one-inch Map ornamented by a stipple. It rises occasionally to about 140 ft. (O.D); and its irregularity of outline is in striking contrast to the platforms of the 100-ft. and 75-ft. beaches, spread out in front of it towards Duart Point. There are very few sections showing the inner construction of the ridge: at the north-east end, a road-side pit at 85 ft. (O.D) exposes evenly-bedded gravel (probably beach-gravel), partly covered by boulder-clay; along the road leading to Kilpatrick Farm from Lochdonhead, sand can be seen at one place passing steeply under boulder clay, and at another with bedding conforming in a general way to the shape of the ground and dipping under morainic rubble; south of Kilpatrick Farm, big boulders occur on the surface of the sand and gravel, which, in a neighbouring pit, are seen to be flatly bedded; and, at intervals along the Gorten sector of the ridge, the following notes have been taken:

- Irregular sands and clays and stony layers.
- Steeply dipping sand passing under morainic rubble.
- False-bedded gravel with morainic appearance.

- Irregularly bedded silt and sand.

There can be no doubt that the Loch Don ridge is a moraine, heaped up during an advance of the piedmont glacier over the sand-strewn bottom of the Late-Glacial sea.

For a distance of a mile, in the neighbourhood of Kilpatrick Farm, the notch of the 75-ft. raised beach is cut in the outer face of the Loch Don Moraine. On the other hand, nowhere inside the moraine, is a vestige of this beach to be found. It is obvious then, that the piedmont glacier stood at the Loch Don Moraine when the elevation of the 75-ft. beach actually occurred.

Similar evidence is met with six miles farther south-west, at the other side of the piedmont glacier. Between Loch Spelve and Loch Uisg, there is a fan of glacial gravel, overlying disturbed Shelly clay, save where the latter protrudes in well-formed morainic ridges. The disposition of these ridges indicates that they are the terminal moraines of a glacier which, for a time, occupied Loch Spelve; and their material is obviously a marine clay derived from the bottom of the loch. The contained shells (mostly fragmental) belong to a glacial marine assemblage. A small collection was kindly determined by the late Mr. W. Evans:

Nuculana minuta (Müll.).

Nuculana tennis (Philippi).

Astarte sulcata (Da Costa).

Astarte sulcata var. *elliptica* (Brown).

Astarte compressa (Mont).

Astarte compressa ribbed—var *striata*

Cyprina islandica (Linné)

Cardium sp.

Natica alderi (Forbes) or possibly *N. Pallida* (B. & S).

Balanus porcatus (Da Costa).

These shells and their matrix indicate that the Late-Glacial sea had access to Loch Spelve for a time. The readvance of the ice, responsible for the transport of the bottom marine clays and their rearrangement as moraines at Kinlochspelve, was very likely contemporaneous with the readvance that drove before it the sand-moraine of Loch Don.

The glacial gravel-fan, through which the Kinlochspelve moraines emerge, varies in height between about 100 ft. and 50 ft. (O.D). A pit, by the main road north-west of the church, shows that, at their lower levels, the gravels were dropped with pronounced delta-bedding into standing water. This water evidently lay as a pool between the snouts of the Loch Spelve Glacier and a minor glacier occupying Loch Uisg. It cannot have been a branch of the sea connecting Loch Spelve through Loch Uisg with Loch Buie, for Loch Uisg has not been invaded by the sea since the ice melted; one can make this assertion, because no trace of a high-level delta faces any of the tributary gorges, which empty into the loch, although low-level deltas are prominently developed. E.B.B.

Loch Scridain and Glen More, Mull

For about two miles east of the high beach-gravels of Rossal Farm, the bottom of Glen More is a spacious flat lying below the 100-ft. contour, but nowhere is there any further trace of high beach-accumulations. The Coladoir River is so considerable a stream that it could not have failed to furnish a delta, had it issued into the Late Glacial sea responsible for the gravels at Rossal Farm. Under these circumstances, it is clear that the Coladoir Glacier must have extended to

near Rossal Farm until after the withdrawal of the Late-Glacial sea. (C.T.C).

Glen Euchar, Lorne

While the mountainous part of Mull, during the Late-Glacial period of submersion, nourished glaciers, that extended down all the more important glens right out into the sea, the remainder of the district, included in Sheet 44, presented a very different appearance. There was scarcely a glacier to be met with, and the sea bathed the coast-line uninterruptedly. The circumstances of the mainland are best illustrated in:

1. The development of 100-ft. beach deposits at the head of Loch Aline in Morven (p. 400).
2. The high-level fluvio-glacial terraces met with along the River Euchar.

Where the River Euchar approaches the coast at Kilninver, there are two well-marked terraces of fluvio-glacial gravel, sand, and clay preserved above its low-lying alluvium and its deep rocky gorges. The highest of these terraces continues up Glen Euchar (markedly avoiding Glen Gallain) to Loch Scamadale (Sheet 45), altogether a distance of 5 miles. It ends about half way along the shores of Loch Scamadale, standing some 30 ft. above the loch, that is approximately 255 ft. above sea-level. Quite obviously, the terrace-gravels originated as an outwash-product of a tongue of ice, protruded, along Loch Scamadale, from a piedmont glacier occupying the low ground at the foot of Ben Cruachan. Near the coast at Kilninver, this terrace is still about 100 ft. above the sea; and, accordingly, it seems necessary to suppose that one is dealing with a merging of fluvio-glacial gravel into 100-ft. beach deposits, a claim already advanced by Dr. Peach and Mr. Kynaston. <ref>B. N. Peach and H. Kynaston in The Geology of the Country near Oban and Damally, Mem. Geol. Surv., 1908, p. 165.</ref> Half a mile north-east of Kilninver, a high terrace of unrounded gravel continues parallel with the coastal road for about a quarter of a mile, and undoubtedly represents one of the high glacial beaches of Mull.

Only one point of importance need be added to the brief statement published by Dr. Peach and Mr. Kynaston. At Kilninver, there are two high fluvio-glacial terraces. The lower one has not been developed for more than half a mile back from Kilninver, It probably corresponds with the 75-ft. Late-Glacial beach of Mull. The subsequent erosion of rocky gorges, and deposit of low-lying alluvium, were almost certainly initiated in Late-Glacial time, but the local evidence does not throw any particular light on this question. E.B.B.

Post-Glacial raised beach

This raised beach is very much better marked through the greater part of Scotland than any of its companions. Its main distinguishing features, at first sight, are its comparatively low elevation, and the frequently pronounced wave-erosion which has accompanied its formation. Evidence, collected in other Scottish districts, shows that it was separated from its Late Glacial predecessors by a period of elevation allowing of extensive peat and forest growth on situations since depressed below sea-level ('submerged forest' of to-day) and that its shells possibly indicate a rather warmer climate than that which characterizes the modern sea. The chief points emphasized in the following account are:

1. The beach's striking development in the South-West Highlands, in which for this purpose we may include Oban and the south-eastern half of Mull; and its comparative obscurity in the North-West Highlands, to which the other half of Mull, along with Coll, Tiree, Ardnamurchan, and Skye may be assigned.
2. Its variations of elevation.
3. Its archaeological connections.

Before entering into detail, it is necessary to state that this particular beach has been differently elevated in different parts of Scotland. From this fact, there has arisen a certain amount of confusion in regard to nomenclature. Thus, in recent Geological Survey Memoirs on Sheets 19, 27, 32, 33, 35, and 53, the beach is spoken of as the 25-ft. raised beach, while in others dealing with Sheets 36 and 45 it is called the 50-ft. raised beach.

W.B.W., E.B.B.

(1) Contrasted development of the beach in the south-west and north-west Highlands

South-west of a line laid down in (Figure 65), the Post-Glacial beach, now under consideration, is generally represented by a fairly continuous rock-platform, often from 30–100 yds. in breadth. This line, continued north-eastwards beyond the limit of (Figure 65), crosses the north-western shore of Loch Linnhe, of which the greater part, perhaps, belongs to the, south-western province. Southeastwards, the boundary-line must pass outside Jura and Islay, and near to Colonsay; the exact position of Colonsay in this classification is a matter of opinion; for, while it has spacious caves belonging to its Post-Glacial raised beach, it has scarcely any coastal cliff. This vagueness of definition is characteristic of the boundary zone all along its course. A gradual deterioration in the amount of rock-erosion is noticed on crossing the line from south-east to north-west. If this were merely local, it could be referred to local circumstances, for instance, to a variation in country-rock, or to a difference of exposure. It is only after experience has shown that the deterioration is definitely regional that one is driven to propound a regional explanation. It is suggested, on this basis, that the South-West Highlands enjoyed a more prolonged period of constant sea-level during the Post-Glacial submergence than the country farther north-west.

Very characteristic marine erosion-forms are to be encountered in the vicinity of Oban. Many of the roads, and the older part of the town, are situated on the coastal platform, cut in rock, with a high cliff behind it and an irregular covering of shingle on its surface. The platform is met with in Kerrera and all the other islands of the neighbourhood. Two of these are, indeed, named the Dutchman's and Shepherd's Hats, respectively, on account of their possessing central crowns surrounded by brims constituted of the Post-Glacial platform. (A quite different Dutchman's Cap has already been described; p. 389).

Let us contrast all this with what is found on the present-day shore. Glacial striae are retained on some of the modern coastal rocks of Oban Bay. They are preserved from frost owing to their situation, but they have been exposed to wave-action ever since the upheaval of the Post-Glacial raised beach. This post-upheaval period of important wave-attack is long according to human standards. How much longer must have been the period of successful assault responsible for the Oban platform, which, as already stated, often ranges from 30 to 100 yds. in breadth.

Apart from the platform itself, and the conspicuous cliff behind, there are many other interesting features. For instance, a stack, reminiscent of the Old Man of Hoy, stands in front of the raised coastal cliff between Oban and Dunollie Castle; and, in the other direction, beautiful undercutting is exhibited at the road-side, south-west of Dungallan House. The corresponding eaves of the Oban district are chiefly remarkable for their archaeological interest, which will be considered separately. At the present juncture, it is only necessary to refer to Uamh nan Columan, a cave above Rudha Tolmach, on Kerrera Sound, which is very commonly inhabited even to-day.

Caves are a common feature of the Post-Glacial raised cliff, wherever a fair amount of rock-erosion has been accomplished. The largest cave in Mull, Mackinnon's Cave, Gribun (Sheet 43), lies rather outside the limit assigned to the south-west district in (Figure 65); but it is presumably in large measure attributable to the same sea as cut the Oban caves, for, though it is inaccessible -at high tide, much of its bottom remains unsubmerged. Fingal's Cave, in Staffa, has its bottom submerged even at low water; and it would be pure speculation to assign any of its excavation to other than modern conditions. E.B.B.

(2) Elevation of the Post-Glacial beach

The Post-Glacial raised beach is the only one of the series, for which even an approximate estimate of variation in altitude has been made. The deformation of this beach over its wide area of distribution in Scotland, Northern England, and Ireland is on the whole fairly well-known. It reaches its greatest height above the modern shore somewhere to the south-east of Loch Linnhe, and descends gradually on every side, reaching sea-level in a northward direction a little north of Caithness, probably in the Orkneys, and towards the south along the coast of the Wexford in Ireland. It decreases in altitude rather slowly towards the east and stands 10 or 12 ft. above high-water on the coast of Aberdeen, but on the north-west it drops more rapidly and is absent in Lewis and Harris. The average gradient is not more than an inch or two per mile, but in the last-mentioned direction it may be as much as four inches. It will be readily seen that, generally, within the limits of an Ordnance Sheet, very little change in altitude is observable. Moreover, determination of the change of

level presents peculiar difficulties, and is liable to quite a number of errors. Ordnance altitudes, even in the rare instances where they are available, are of little use for the purpose, and the only reliable method is actual levelling. Even then, it is necessary to try and find localities where the conditions on the ancient and modern shores have been comparable, and, in such, to level from one shore to another, because individual gravel-deposits and rock-notches are found to have very varying relations to high-water-mark.

In the area dealt with in this Memoir, the beach exhibits quite an exceptional tilt, averaging as much as four inches to the mile from east to west. It has been elevated approximately 30 ft. at Oban, and only 20 ft. in the north and west of Mull and in Iona. Unfortunately, no measurements are available between Oban and Loch na Keal and Loch Scridain, in Mull.

Oban

In Ganavan Bay, north of Oban (Sheet 44), a rock-notch and accompanying shingle-spit afford a very fair chance of estimating the elevation of the beach. The rock-notch is at 29 ft. (h.w.m), and the shingle-spit, which is very large, reaches 40 ft. The recent shingle is only thrown to a height of 6 ft., but, being less abundant than that on the old shore, is hardly comparable. The raised rock-notch, on the other hand, may have been cut below high-water-mark, so that on the whole an elevation of from 30–32 ft. is indicated here.

South of Port a' Bheanaig, at the north end of Kerrera (Sheet 44), there is a very well-marked rock-shelf backed by cliffs 20 to 40 ft. high and lying at from 25 to 27 ft. (h.w.m), while a possibly comparable recent notch occurs at 1½ to 3 ft. below the same datum. An actual elevation of 27 to 30 ft. is thus indicated.

Loch, na Keal

At the head of Loch na Keal (Sheet 44), at the time of the 25-ft. beach, a massive shingle-spit was, as at the present day, built out from the southern shore confining behind it the River Ba, as far north as Drumlang Cottage. Later, the river broke through the spit, about a quarter of a mile north of the Burial Ground; but the modern shingle-spit has again deflected its outlet, so that it now enters the sea at the extreme northern corner of Loch na Beal, over a mile to the north of the temporary breach. Another break-through, however, is threatened at much the same point as before.

North-west of the Burial Ground, a shingle-beach, backed by a cliff of moraine, affords conditions comparable with those of the present shore, and thus gives an opportunity for an estimate of elevation. The top of the beach is at 27 to 28 ft. (h.w.m), and the recent shingle is thrown to 5 to 6 ft., and occasionally goes a couple of feet higher. The amount of elevation thus indicated is 22 ft.; it is certainly not more than 23 ft, or less than 20 ft.

Loch Scridain

Near Dererach, at the head of Loch Scridain (Sheet 44), the inner edge of the raised beach-gravel lies at 25 ft. (h.w.m). The conditions appear to have been fairly comparable with those of the modern shore, the shingle on which is thrown up to 7 ft. Comparison therefore gives 18 ft. of elevation, but, as the raised beach-gravel is finer than that on the modern shore, this may be an underestimate.

At Pennyghael, two miles farther south, several observations confirm the estimate of 18 ft. of elevation from this area, suggesting that the beach is a couple of feet lower here than on the western coast. These observations, however, hardly allow of deductions regarding a change of level of such small magnitude. Moreover, another measurement in the immediate neighbourhood gives a slightly higher reading, for, at Ardvergnish, the beach is preserved in a little stack and attains a level of 22 ft., while the gravel on the modern shore is thrown about 2i ft. This would indicate an elevation of 19 or 20 ft.

Ross and Iona

At Ardalanish, on the south coast of the Ross of Mull (Sheet 35), a very fair estimate of the elevation of the beach was obtained, with sand and gravel at the inner angle occurring at 21 to 22 ft. (h.w.m). The equivalent elevation might be 20 to 23 ft.

In Iona (Sheet 43), the beach is fairly well developed as a terrace of deposition, and approximate estimates of the amount of elevation have been made. At Clachanach, the inner angle of the beach lies at about 20 ft. (h.w.m), and south of the Free Church, and north of Dùn Cùl Bhuirg, similar readings were obtained. Near Calva, an opportunity of comparing shingle-accumulation on the raised beach and modern shore presented itself. The recent shingle reaches 5 ft. (h.w.m), and that of the raised beach 26 or 27 ft. As the older shingle was more abundant than that of the modern shore, it was probably heaped to a greater height on the shore, so that a comparison would indicate an elevation of 18 to 22 ft. The shingle of the raised beach is ungrassed.

In Port an Fhir-bhrèige, at the south end of the island, there is another rather remarkable deposit of ungrassed shingle which rises to 31 ft. (h.w.m). The highest shingle-banks of the modern shore here reach 10–12 ft., and are comparable to those of the raised beach, thus indicating an elevation of 19 to 21 ft. Iona may therefore be regarded as lying approximately on the 20 ft. isobase of the Post-Glacial raised beach.

Gribun

In the Gribun district (Sheet 43), the beach is very irregularly developed, being largely controlled by the hard and soft beds of the Trias sandstones. The inner angle at the foot of the old cliff varies from 18–26 ft. (h.w.m).

Northern Mull

Several observations of level taken between Burg and Haunn, to the west of Kilninian (Sheet 43), show that a rock-shelf, with local gravel, along this coast, lies at a fairly uniform level of 20 to 21 ft. (h.w.m). Though no comparable notch is available on the modern shore, an elevation of from 19 to 22 ft. is indicated.

In Quinnish and Mornish (Sheet 51) the beach is poorly developed, and determinations of elevation are difficult. At the head of Calgary Bay, the inner angle of the beach lies at a height of 20 ft. or so (h.w.m). Dùn Bàn, on Mingary Àrd, is connected by a spit of gravel rising to 39 or 40 ft. (h.w.m), and having an angle of erosion at its base at about 25 ft. It is not clear whether this spit is a product of the Post-Glacial shoreline. The amount of gravel on the modern shore is small. The beach may have an elevation of anything from 18 to 20 ft. in this district.

W.B.W.

(3) Archaeology of Oban caves

The platform of the Post-Glacial raised beach has furnished an excellent site for much of modern Oban, and excavations connected with the growth of the town have revealed five small but interesting caves, which had long lain sealed by fallen debris. Important accounts of these caves have been published between 1872 -and 1898, notably by Sir William Turner and Dr. Anderson; and references to their papers will be found in the Bibliography, p. 423. Only the very briefest *resume* of their results is here attempted.

The five caves are cited below in such fashion that they may be located by anyone visiting Oban; but their interesting features have, of course, disappeared, even where the caves themselves remain recognizable.

1. Mackay Cave, at north end of Oban Bay, near Burn Bank House, where Nursery Road enters Stratbaven Terrace.
2. Gas-Works Cave.
3. Distillery Cave.
4. MacArthur Cave, near St. Columba's Church.
5. Druimgarvie Cave, facing away from sea, near Railway Station.

All these caves were occupied by man unacquainted with the use of metals. The first four originated through direct sea-erosion, so that their occupation, in itself, denotes a withdrawal of the sea. In the case of the MacArthur Cave, there

is suggestive, but debatable, evidence that this withdrawal had not proceeded very far before the cave was claimed by man. Accordingly, this particular cave is of special interest. The summary given below is based upon Dr. Anderson's account published in 1895.

The cave is 25 ft. long, and 16–20 ft. broad. Its bottom-deposits, from above downwards, were:

- Black vegetable mould, largely washed in from outside.
- Shells with patches of ashes, wood-charcoal, and charred splinters of bones, the whole free from admixture with black mould or gravel, and extending over all the floor; thickness, 2 ft. 3 in. to 3 ft.
- Gravel, composed entirely of small water-rolled stones; thickness, 6 in. to 1 ft. 6 in.
- Partial layer of shells, thinning out towards sides and mouth of cave, and in several places presenting an irregular and patchy appearance in section, as if the shells had been deposited in heaps or pockets in the gravel; maximum thickness, 2 ft. 2 in.
- Gravel, mixed with rock-fragments towards its bottom; thickness, 4 ft.

Human bones occurred in association with the black earth, along with quantities of small bones, presumably belonging to bats, rodents, and birds, and a few larger ones suggestive of cattle. There seems no reason for claiming a close connection between these remains and the shell-layers below.

The upper layer of shells was the refuse of cave-dwellers. The species represented were for the most part limpet, razor-shell, scallop, *tapes*, cockle, mussel, oyster, and periwinkle, and, occasionally, the larger and smaller whelk. Broken and splintered bones were interspersed among these shells; and it is obvious that bone-implements, many of which occur in the deposit, were actually made in the cave.

The gravel is described as a whole, in Dr. Anderson's account; but even its upper part is designated as clean-washed.

The lower layer of shells was in every way like the upper as regards its contained shells, bones, ashes, and implements; except that the shells and bones were more weathered.

The bones were found to belong to large red deer, roe-deer, ox, large pig, dog, badger, otter, and cat, and also fish. Crabs were represented by great claws alone, so that Dr. Peach suggests that the cave-men did not consider the rest of this creature fit for human food.

A few stone-implements were found, most of them fashioned from flint; bone and horn-implements were much more common; and included pins, awls, rubbers, and harpoons. Regarding the source of the flint, it is possible that flint, or silicified chalk, from Carsaig, Mull, may have been used; but it should be remembered that serviceable flint pebbles are characteristic of some of the beaches of the west, for instance those of Tiree and Iona.

In 1898, Dr. Anderson summed up his archaeological researches thus:

"It is evident that these three shell-mounds in Ornsay [Sheet 35] and the MacArthur and Druimgarvie Caves at Oban belong to the same archaeological horizon,—a horizon which has not heretofore been observed in Scotland, but closely corresponding with the intermediate layers in the cavern of Mas d'Azil, on the left bank of the Arize in France, explored and described by M. Piette, and which he has reason to claim as filling up the hiatus that has been supposed to exist between the palaeolithic and the neolithic." He continues by pointing out that the Azilian implements, in their home region, are " associated with existing fauna and with abundance of red-deer remains."

It is unnecessary, in this Memoir, to discuss whether a close resemblance of culture bespeaks actual contemporaneity in sites so distant as Mas d'Azil and Oban. We turn rather to what Dr. Anderson has styled the pertinent question whether the sea had wholly and finally left the cave when man first took possession. Dr. Anderson confessed himself very loth to admit an elevation of the Oban shore of 20 or 30 ft. since some stage of the Neolithic Period; and accordingly he put forward an alternative interpretation of the observed interstratification of human refuse and gravel. He suggested that the inhabitants, at first, occupied a saucer-shaped hollow in the cave-gravel, until this shingle eventually came to be trodden

over the earlier part of the refuse. It is very difficult, however, to suppose that the refuse originally collected as a widespread, though incomplete, covering of the cave-floor, only at some later stage to be completely hidden by mere down-treading of the same gravel, as had long stood heaped about it in unstable equilibrium; and, accordingly, we do not accept Dr. Anderson's argument. In fact, he himself acknowledges that some of the associated investigators thought that the upper gravel must have been washed in over the deposit of food-refuse which was found beneath it; and, consequently, that the occupants of the cave must have been, for a time, driven out by the sea, soon afterwards to resume possession. Dr. Anderson points out that the buried refuse is not wave-sorted, and even retains its ashes; so that those who disagree with him, and attribute the spreading of the upper gravel to sea-action, cannot lay claim to evidence of a period of resubmergence. It appears, rather, that the sea had withdrawn a little from the mouth of the cave, but was able, during an exceptional storm, to throw its shingle forward over the litter of refuse that had gathered on the floor.

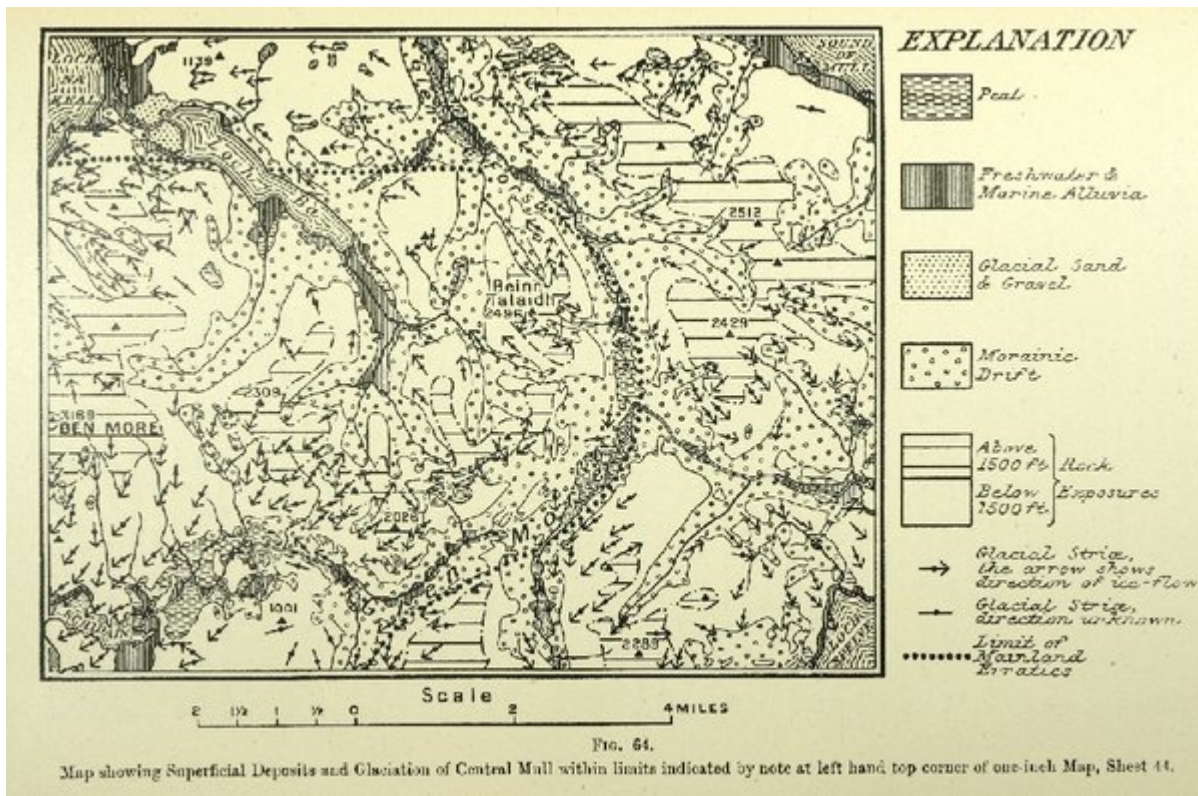
Dr. Anderson's *a priori* objection to a Neolithic date for the final withdrawal of the Oban Post-Glacial sea to its present shoreline does not seem to carry much weight. There is, at any rate, abundant evidence that the shores of the extended Post-Glacial sea carried a Neolithic population in the Forth and Clyde districts of Scotland, and in the neighbourhood of Larne in the north of Ireland. W.B.W., E.B.B,

Landslips

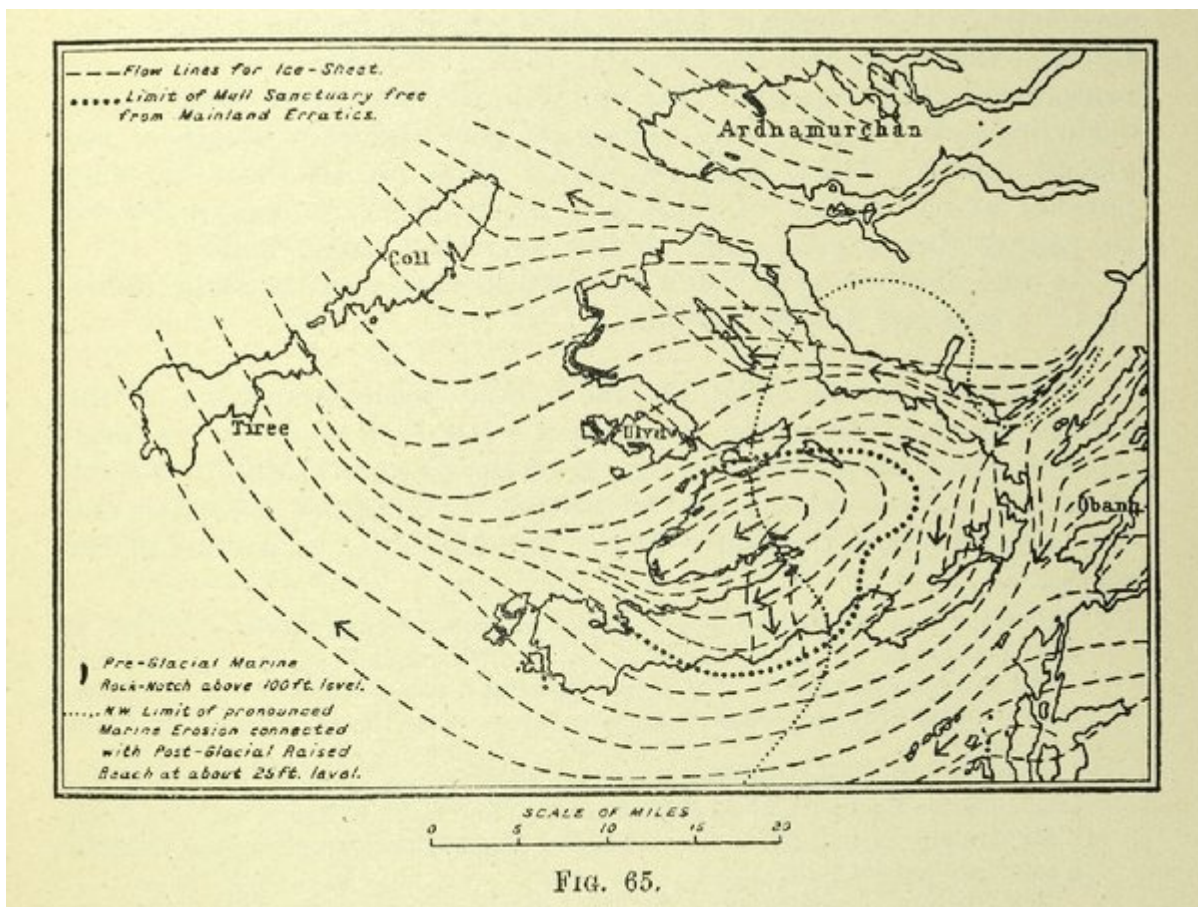
The steep coastal cliffs of Mull have been a source of many landslips, the more important of which are shown by ornament on the one-inch Map. A landslip of Pre-Glacial date near Gribun has already been discussed (p. 391); and a few words may here be added regarding a Late-Glacial landslip of the same district (Sheet 43). This particular landslip is about half a mile long parallel to the cliffs, and its irregular surface serves as the southeastern boundary of the cultivated fields of Balmeanach Farm. Its Late-Glacial date is shown by the distance it lies in front of the great lava-escarpment; for it is almost certain that the angle of this escarpment must have been choked by snow and ice to allow of so considerable a forward movement. This particular landslip is of the completely disintegrated type, and, accordingly, might be claimed with some propriety as a moraine. E.B.B.

Other landslips of Mull and its neighbourhood, while perhaps of Post-Glacial date, are earlier than the Post-Glacial upheaval responsible for the raised beach of the previous section. A good example of this sort occurs at Inninbeg, east of Loch Aline (Sheet 44). It involves basalt-lavas and Liassic sediments, including the exposure of the low-tide reefs opposite the Keeper's Lodge. The notch of the Post-Glacial raised beach has been cut into it. G.W.L.

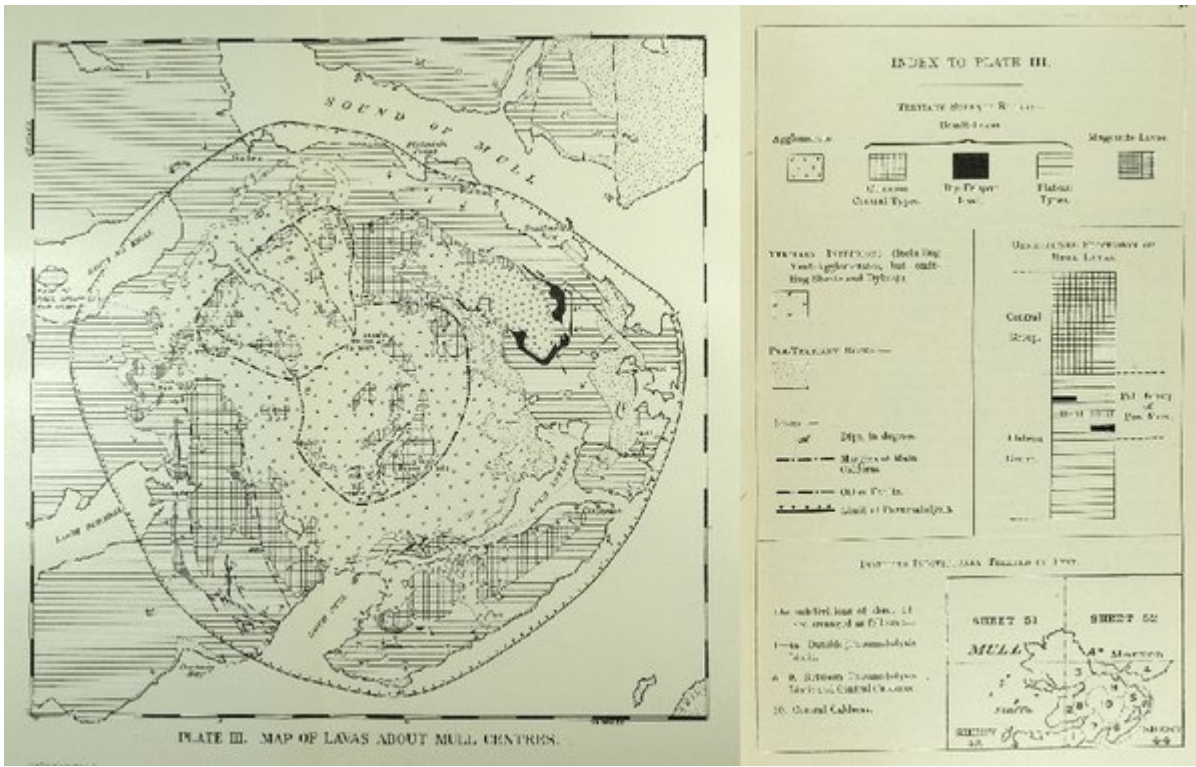
Landslips, obviously of our own day, are very prominently exposed in the Wilderness (Sheet 43). E.B.B.



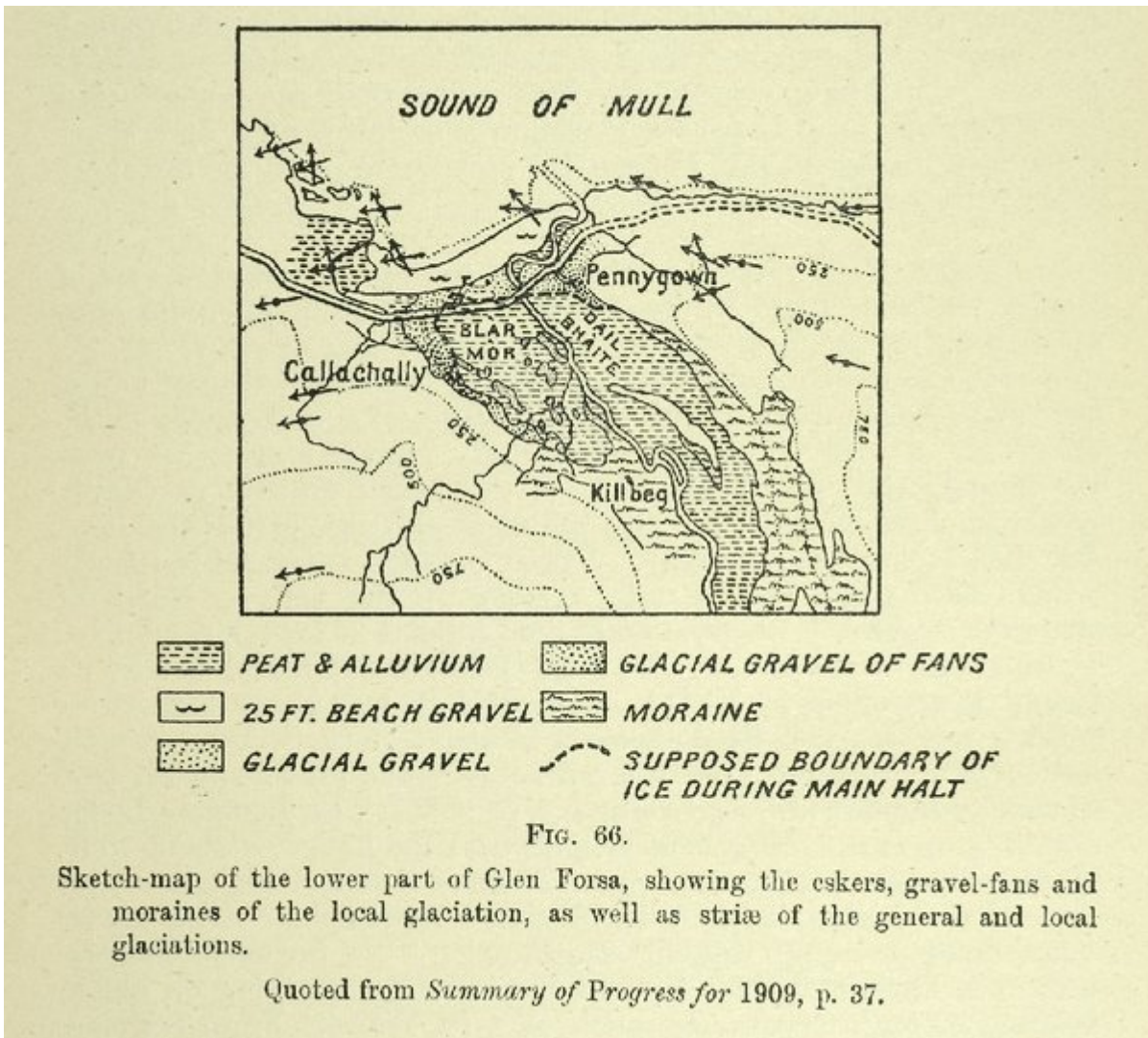
(Figure 64) Map showing Superficial Deposits and Glaciation of Central Mull within limits indicated by note at left hand top corner of one-inch Map, Sheet 44.



(Figure 65) General Glaciation of District, and some Raised-Beach phenomena.



(Plate 3) Map showing the distribution of lava-types and the limit of pneumatolysis



(Figure 66) Sketch-map of the lower part of Glen Forsa, showing the eskers, gravel-fans and moraines of the local glaciation, as well as striae of the general and local glaciations. Quoted from *Summary of Progress for 1909*, p. 37.