# Chapter 13 Tertiary tectonics of Mull and Loch Aline

## Introduction

A series of rather irregular subsidences, in part determined by faulting, has assisted in the preservation of Tertiary lavas and Mesozoic sediments in the west of Scotland and in the north-east corner of Ireland. Mull may be taken as representative of one of the most important of these .subsidences, including in its scope not only Mull itself, but also: on the north-east, neighbouring portions of Morven and Ardnamurchan; on the west, Staffa and the Treshnish Isles; and, on the north, Muck, Eig, and the Loch Slappin district of Skye (*cf.* Sir A. Geikie's Geological Map of Scotland).

The boundary of the Tertiary-Mesozoic outcrop of the Mull district is well-enough defined on the north-east, east, and south, by an emergence of Pre-Mesozoic rocks in mainland and island exposures extending interruptedly from Ardnamurchan (Sheet 52) to the western extremity of the Ross of Mull (Sheet 43).

From the last-named locality, a gentle anticline, running east-north-east, carries the outcrop of Pre-Mesozoic rocks to Inch Kenneth (Sheet 43). Erisgeir lies on the course of this anticline.

North-west of the Inch Kenneth Anticline, there follows an important extension of the Mull depression to which must be referred the lavas of Ulva, Staffa, and the Treshnish Isles, and also, if it be a lava, the columnar basalt of Réidh Eilean off Iona. The northwestward limit of the under-sea continuation of the Treshnish outcrop cannot be fixed precisely; but it lies south-east of the island of Tiree, which just enters the corner of Sheet 43.

Tiree, as may be sufficiently realized on inspection of Sir Archibald Geikie's map of Scotland, is situated on a north-easterly trending anticline responsible for an emergence of Lewisian Gneiss in Tiree and Coll, and of Torridonian Sandstone in Rum, Soay, and, at the head of Loch Seavaig, in Skye. Eig and Muck lie on the Mull side of the Tiree Anticline, while Canna, on the other side, manifestly belongs to the main Skye depression.

Generally speaking, except near the plutonic centres of Mull, Ardnamurchan, and Skye, the Mesozoic sediments and Tertiary lavas of the Mull depression are gently and variously inclined. They are traversed by considerable faults, which, east of Loch Aline, run north and south, and, elsewhere, more or. less north-west and south-east. Apart from this, and the marked subsidence of the region as a whole, the general tectonics of the district present few points of interest. Accordingly, the main part of this chapter will be devoted to the tectonics of the plutonic centre of Mull as illustrated in (Plate 5), p. 165. The outstanding feature, here, is the occurrence of two cauldron-subsidences, or caldera, the more southeasterly of them in large measure surrounded by concentric folds. After the more central tectonics have been disposed of, attention will be directed to a few other points of tectonic interest including the conspicuous Inninmore Fault (Figure 26), and also the Wrench-Fault of Port Donain. Another matter of negative import touched upon is the passive role played by the ancient Great Glen Fault during the development of Tertiary disturbances in Mull and its neighbourhood.

## South-east caldera and concentric folds

In (Plate 5), two confluent tracts of Central Mull are outlined under the title of the Two Main Calderas. The more south-easterly is shown in large part surrounded by a series of concentric folds. The main elements of the tectonic scheme may be grouped as follows from without inwards

- Marginal Tilt, the outer limit of the disturbed country, traceable from near Craignure Bay to beyond Carsaig (M.T. of (Figure 25)).
- Duart Bay Syncline, traceable from near Craignure Bay to near Corra-bheinn.
- Craignure Anticline, traceable by Bàn Eileanan and Craignure Bay to Eilean Trianach (C.A. of (Figure 25)).
- Loch Don Anticline, continuing in relay the Craignure Anticline, and traceable from near Craignure Bay through the head of Loch Don (L.D.A. (Figure 25)). Before reaching Loch Spelve, the Loch Don Anticline split into two, and one

branch can be followed through the Croggan Peninsula and across Loch Buie to Derrynaculen.

- Coire Mòr Syncline, traceable from Coire Mòr to Loch Uisg past the west extremity of Loch Spelve.
- Loch Spelve Anticline, traceable through Sgùrr Dearg and Creach Beinn (L.S.A. of (Figure 25)).
- The South-Eastern Caldera, as indicated on (Plate 5).

These various elements will be considered in the order stated. It has already been argued (Chapter 12) that the folds may have arisen as a sequel to the marginal intrusion of the Glas Bheinn and Derrynaculen Granophyres outside the already established South-Eastern Caldera. Their relatively early date in the history of the Mull complex is demonstrated by the manner in which they are traversed by Early Acid and Basic Cone-Sheets, not to mention the Loch Uisg Granophyre ( (Figure 25)), (Figure 34), and (Figure 35), pp. 174, 231, 237). This feature of the folding is discussed to some extent in the succeeding paragraphs, and is returned to later in connection with the various intrusions concerned (pp. 222, 231, 236).

Before splitting up the subject into its various elements, it is well, to emphasize the opportunity offered by the peninsula south of Loch Don to any one wishing a field-introduction to the more peripheral parts of the fold-system. The two lower sections of (Figure 25) are drawn to true scale across this peninsula, and these combined with the one-inch Map (Sheet 44) wilt serve as efficient guides. Exposures are excellent, and erosion has developed the scenery in diagrammatic fashion, so that structure can be read to singular advantage. This is particularly the case about Loch a' Ghleannain, which lies in a hollow excavated along soft schists ' (slates and limestone), and is flanked by ridges of Old Red Sandstone lavas,- in their turn separated by hollows, worn in Mesozoic sediments, from uplands of Tertiary lavas on either side. The shores of the Firth of Lorne and Loch Spelve help to complete the structural presentation.

The best district to study the relationship of the Loch Spelve Anticline to the South-East Caldera lies about Sgùrr Dearg, and is illustrated in (Figure 30), (Figure 35), pp. 204, 237.

In reading the following descriptions, it is important to bear in mind that, despite the time-intervals involved, there is no appreci able difference of dip between the Tertiary lavas of Mull and the underlying Mesozoic sediments. This fact often greatly simplifies the study of the Tertiary tectonic features of the district.

### Marginal Tilt

The Marginal Tilt, as it is styled in (Figure 25), furnishes the outer limb of the Duart Bay Syncline, and must be held responsible for the preservation of basalt-lavas in the Java Point peninsula as compared with gneiss in Sgeir nan Gobhar, Glas Eileanan, and Eilean Rudha an Ridire, in the Sound of Mull.

From Duart Point southwards, the Marginal Tilt is clearly discernable in the lie of the lavas as shown in (Plate 5). The arcuate trend of the structure is also particularly well-shown in the course of the coast-line between Duart Point and the entrance to Loch Buie; for this gently curved coast marks approximately the line along which the lavas affected by the Marginal Tilt pass through sea-level.

West of Loch Buie, there is some difficulty in deciding what to refer to as Marginal Tilt. Near Carsaig Bay, the tilt clearly must form part of the eastern limb of a faint anticline which, assisted by faulting, leads to an important exposure of Mesozoic sediments; but, whereas this anticline is vaguely traceable east-north-eastwards (p. 181) into country unaffected by arcuate folding, the marginal tilt seems to continue as an independent and often well-defined flexure northwards across Loch Beg at the head of Loch Scridain.

### Duart Bay Syncline

The continuity of the Duart Bay Syncline from Craignure Bay to near Corra-bheinn as shown on (Plate 5) is easily verified in the field, except where, for a space south of the entrance to Loch Spelve, the fold is very shallow. Sometimes the lavas are so clearly seen dipping in from either side towards the axis of the syncline that the structure becomes quite a scenic feature, as for instance north of Loch Spelve and in the coastal cliffs either side of Loch Buie.

Comparison of (Plate 3) and (Plate 5) shows that an additional indication of the syncline is afforded by the preservation of relatively late rocks in its embrace; thus in the north-east part of its course, one finds Tertiary lavas flanked by Pre-Tertiary rocks, while north of the Port Donain Fault, and again, both east and west of Loch Buie, there are outcrops of big-felspar basalt, or mugearite, as the case may be, contrasting with the normal unbroken sequence of Plateau Basalts met with either side.

### Craignure Anticline

From the steamers which ply the Sound of Mull, it is possible to detect the Craignure Anticline affecting the Tertiary lavas of the hill-face above Fishnish Bay, though appearances are considerably blurred by numerous cone-sheets. In the lower ground, intrusions are much less abundant, and on foot one can trace the anticline without much difficulty through Cnoc Damh, and so to the sea-shore at Ban Eileanan; in fact, for the last three quarters of a mile, the fold brings Mesozoic rocks to the surface. The inland exposures consist of portions of the Lower and Middle Lias dipping north at 30°. At the coast, only the Lower Lias is found, dipping at 75°.

An interesting feature, both inland and on the coast, is the asymmetrical development of the anticline; the Liassic rocks are exposed only on the northern limb of the fold; on the southern limb they are evidently cut out by faulting. Another feature is the complexity of the folding leading to a double outcrop of the Lias; for a small exposure of Middle Lias Sandstone occurs isolated among basalt-lavas at the road-side 100 yds. north of the main outcrop.

The Craignure Anticline can be recognized again in the Java Peninsula, where its centre is defined by Mesozoic sediments and Moine gneiss exposed in the west shore of Craignure Bay, almost in the condition of a crush-breccia. The Mesozoic sediments of this side of the bay are not fully laid bare; but they seem considerably reduced by crushing, and the only horizon recognized is Trial; conglomerate. A little farther south, Lower Lias is seen cut through by an early acid cone-sheet (aI on one-inch Map, Sheet 44), which makes much of the south-west shore of Craignure Bay. The section at the base of the cone-sheet exposed on the shore (where the letters f and g' are printed on the Map) is particularly interesting for it shows the sheet cutting across obvious crushes affecting the underlying sediments.

Another noteworthy exposure on the south-west side of the Craignure Anticline is afforded by a stream 400 yds. south-south-west of Craignure Church, where basalt-lavas are seen faulted against Triassic sediments. The fault is steep, but with a well-defined reverse inclination towards the north-east. A little north-west of this exposure, it is nearly certain that a tongue from the acid cone-sheet has risen up along the fault as shown in the Craignure Section of (Figure 25).

What is very likely the same fault brings basalt-lava and Lower Lias together at the surface, in the south-west limb of the Craignure Anticline, a little south of Eilean Trianach (*see* one-inch Map). The fault is drawn in the Eilean Trianach section of (Figure 25) as of normal inclination, but the exposure does not show whether such is the case or not.

Similar evidence to that outlined above is met with again on the north-east side of the Craignure Anticline. Thus, the acid cone-sheet at the pier contrasts in its uncrushed condition with adjacent crushed Triassic conglomerate and associated basalt-intrusions. Moreover, a dyke-like branch of this acid sheet occupies a very well-defined fault exposed in the cliff of the raised beach 200 yds. north-east of the pier. This fault brings Lower Lias limestone against a repetition of Trias conglomerate on its north-east side (*cf.* Craignure Section of (Figure 25) and one-inch Map). Farther south-east, what is probably the same fault is responsible for bringing Trias conglomerate against the upper part of the Lower Lias (*cf.* Eilean Trianach Section of (Figure 25) and one-inch Map).

Generally speaking, all the exposures of Mesozoic rocks in the core of the Craignure Anticline, as exposed in Camas Mòr, are greatly shattered. It must not be thought, however, that this condition is universal; in fact, the sediments along the coast between Rudha na Sreine and Duart Bay are not particularly broken.

The Craignure Anticline must flatten out somewhere in the ill-exposed ground south-east of Camas Mòr.

### Loch Don Anticline

The next pronounced element of the structural complex is the Loch Don Anticline which takes on in relay for the Craignure Anticline. Towards the north-east., the Loch Don Anticline passes into a faulted monocline illustrated in the Craignure Section of (Figure 25). The exposures are quite clear and need not detain us.

At Loch Don, and for some distance farther south, the anticline is both symmetrical and compressed, as may be judged from the one-inch Map, and the Loch a' Gleannain Section of (Figure 25). How far faulting accounts for the observed impersistence of some of the rock-groups is uncertain; but it does not seem to be altogether responsible for the inconstancy of the Trias; at any rate, what is taken for an unbroken contact between Lias limestone and Old Red Sandstone lavas is exposed 200 yds. south of Loch Don bridge.

Southwards, the Mesozoic rocks pitch beneath the lavas in a double crested fold illustrated in the Ohm Ben Section of (Figure 25). The more easterly crest is very sharply compressed as is strikingly shown 300 yds. south-west of Cam Ban summit, where Mesozoic rocks are last exposed nipped up between the lavas.

Another interesting feature of the Loch Don Anticline is its bodily horizontal displacement by the Port Donain Fault (p. 183). Still another is the crushed condition of some of the rocks affected by the folding. The slates and schistose limestone are not noticeably shattered, nor are the Mesozoic sediments; but the lavas, both Old Red and Tertiary, and a basalt-sill intruded into the Mesozoic sediments near Cam Ban, are greatly brecciated. The Tertiary lavas only show this crushing in the southern part of the area, e.g. from the centre of the anticline westwards along the north shore of the entrance to Loch Spelve. The Old Red Sandstone lavas on the other hand are very generally crushed, in fact, to such an extent that their original nature is to a considerable extent masked. Quite possibly, in their case, the brecciation is partly of Pre-Mesozoic date and connected with movement along the Great Glen Fault.

The continuation of both branches of the Loch Don Anticline can be traced south-westwards hall way through the Croggan Peninsula; but, as indicated in (Plate 5), the lava-dips are very gentle, and finally the more north-westerly branch of the fold fails altogether. E.B.B.

In Glen Libidil, the south-east branch of the Loch Don Anticline, co-operating with a fault, leads to an exposure of Mesozoic rocks (*cf.* (Figure 34), p. 231 and one-inch Map). Westwards, this branch crosses Loch Buie, where it is clearly recognizable in views of the coastal cliffs both sides of the bay. An interesting fault modifies its southern limb as exposed on the west shore. The locality is shown on the one-inch Map under the name An Coileim and occurs 100 yds. south of the axis of the anticline. A steep reversed fault is seen in section with vertical Lower Lias on its southern side. The fault has been traced inland and seems to partake in the curvature so characteristic of the plan of the fold-system. G.V.W.

The Loch Don Anticline can also be followed inland to near Derrynaculen. Comparison of Plates III. and V. shows its effect upon the distribution of the lavas. This is more especially clear in the emergence of mugearite, and associated Plateau Type of basalt, near Derrynaculen. (C.T.C), G.V.W.

### Coire Mòr Syncline

The Coire Mòr Syncline is clearly demonstrable in the Coire Mòr district by observed dips of lavas, and also by the mapping of the Big-Felspar Type of basalt cf. (Plate 3) and (Plate 5).

North of the entrance to Loch Spelve, the syncline is obvious owing to the basalt-lavas along its course being flanked by outcrops of Mesozoic rocks referable to the Loch Don and Loch Spelve Anticlines respectively.

Along Loch Uisg, the syncline is visible in the dips of the lavas (Plate 5). Its northern limit seems affected by a powerful fault near Kinlochspelve Farm, where Triassic sandstone comes in contact with Central Types of lava as shown in (Plate 3).

There is good reason to believe that the agglomerate which occurs along the centre of the syncline at Coire Mòr, and again at the west end of Loch Spelve, rests upon the top of the adjacent lavas. It is shown (p. 196) that very likely it is of later date than the development of the syncline which it occupies.

## Loch Spelve Anticline

Moine gneiss and Mesozoic sediments are exposed as the country-rock of a large triangular region of upheaval which has its apices near Kinlochspelve Farm, Rudha na Faing, and Sgùrr Dearg, situated roughly 5 miles from one another. The individual outcrops of these Pre-Tertiary rocks are quite small owing to an extraordinary profusion of Tertiary intrusions. Another feature of their occurrence is the excessive shattering they have sustained—how far their fracture is due to folding, and how far to explosion cannot be decided.

Triassic sandstone and conglomerate, broken by innumerable dislocations, predominates in the Pre-Tertiary assemblage bordering Loch Spelve; and Moine gneiss near Sgiur Dearg. Only at three localities is any Lias found, and they are all interesting from the structural point of view:

1. On the shore of Loch Spelve, nearly a mile south of Rudha na Faing, fossiliferous Lias limestone occurs between Trias conglomerates and Tertiary lavas. The sediments and lavas are roughly vertical and greatly broken up (Càrn Bàn Section, (Figure 25)). It is uncertain whether the absence of higher zones of the Jurasic should be referred to faulting. Uncrushed Early Basic Cone-Sheets cut the crushed sediments and lavas (p. 236).

2. A little down the north-east slope of Beinn Bheag, three-quarters of a mile east of the summit of Sgùrr Dearg, steeply inclined baked sandy shale, and, at the northern end of the exposure, white sandstone and quartz-conglomerate, are exposed between Moine gneiss and basalt-lavas ( (Figure 30), p. 204). There can be no hesitation in recognizing these rocks as Lower Lies and Trias respectively. The absence of the Lower Lias limestone strongly suggests faulting, as also does the failure to recognize any Mesozoic rocks at all between gneiss and lavas in the mile of reasonably good exposure farther to the south-east. It is a feature of the Beinn Bheag district that its many Early Basic Cone-Sheets are not affected by the conspicuous folding of the Mesozoic sediments and Tertiary lavas which they traverse ( (Figure 35), p, 237).

3. After an interval of a mile, where exposures are mainly of agglomerate, Mesozoic rocks make their appearance in the bed of Abhuinn an t-Sratha Bhain, between North Beinn Bhearnach and Dim da Ghaoithe ( (Figure 30) and (Figure 35)). Trias and Lias are both seen. The former is restricted to patches of white sandstone entangled in brecciated gneiss. The latter is represented by baked fossiliferous concretionary limestones. At the most westerly exposure in the burn, a very impressive section is afforded of vertical limestones cut into thin slices by recurrent Early Basic-Cone Sheets inclined without reference to the folding (Figure 35). The structural complexity of the anticline in this district is brought home by the finding of Lias limestone in the heart of the gneissic area. The limestone is seen on end in the bottom of a gorge, the walls of which consists of gneiss; and, farther along, the same limestone occurs as minute lenticles preserved among cone-sheets. The limestone here is probably bounded by a fault on the south-east (Figure 30).

The Loch Spelve Anticline is markedly asymetrical, and its inner side is furnished by the great boundary-dislocation of the south-eastern caldera, which latter now calls for attention.

## South-East Caldera

Intrusions are so abundant in Central Mull that the piecing together of the scattered tectonic data is a matter of difficulty. The evidence is perhaps most easily presented in a series of rather disconnected paragraphs. The district discussed at this juncture measures 5 or 6 miles across, and it can easily be recognized on (Plate 3) and (Plate 5), where it is shown bounded by a broken line including both Beinn Talaidh and Beinn Fhada in its circuit.

1. All the non-intrusive rocks of the area consist of Tertiary basalt-lavas of Central Types ( (Plate 3), and Chapters 5, 9, 10). This in itself shows that the area belongs to a region of central subsidence; for, in the rest of Mull the prevalent non-intrusive rocks are Tertiary basalt-lavas of Plateau Type, and it has been shown in preceding chapters that the Central Types are, generally speaking, of later date than the Plateau Types. On the other hand, the occurrence of Central Types in the area does not suffice in itself to distinguish it from various synclines outside, where, as shown in (Plate 3), such types are strongly represented. There is, however, satisfactory ground for distinction as will be shown later in paragraph (4).

2. The importance and definiteness of the central subsidence is very clear along its south-east side. Here, outside the limit assigned to the caldera, one encounters the Moine gneiss and Mesozoic sediments of the Loch Spelve Anticline. It is true that only in the Sgùrr Dearg neighbourhood, illustrated in (Figure 30) (p. 204), is the approach of Central Type of lava to gneiss very close; but elsewhere (Plate 5), the two are only separated by Glas Bheinn Granophyre (Chapter 12) and Sgùrr Dearg Vent-Agglomerate (Chapter 16). Of the former, it can be said that its associates are so commonly Pre-Tertiary that it is fair to regard it as an intrusion lying almost wholly beneath the level of even the Plateau Basalts; and of the latter, that it is naturally interpreted as the result of an explosion roughly guided by the marginal fault of the subsidence.
3. The only exposure of the boundary of the caldera occurs north of Sgùrr Dearg, and is illustrated in (Figure 30). At three places, a little crushed gabbro intervenes along the line separating gneiss from lava. A scrap of Triassic sandstone is associated with the most southerly of these outcrops. Otherwise, there is no Mesozoic sediment represented on this side of the Loch Spelve Anticline; and the great group of Plateau Lavas is entirely absent. One of the first lavas met with west of the gneiss is a curious flow-banded basalt, either vertical or dipping south-westwards at 80°. Farther in, away from the gneiss, the dip moderates greatly (north section, (Figure 35), p. 237).
4. When it was said in paragraph (1) that the supposed caldera is occupied by lavas of Central Types, no attention wp.s paid to a feature of the lavas peculiar to the locality. A considerable proportion of the lavas show pillow-structure in the field ( (Figure 18), p. 133); and this peculiarity is combined with a marked tendency towards variolitic crystallization (pp. 98, 149). It is clear, therefore, that something distinguishes the representatives of the Central Lavas found within the caldera from their neighbours in adjacent synclines. The explanation given in Chapter 5 is that the area was frequently the site of a crater-lake, dependent for its renewal upon repeated central subsidence, and that the pillow-lavas acquired their peculiar structure through flowing into the . lake. According to this theory, the caldera was the earliest of the concentric structures, while the surrounding folds developed through subsequent peripheral uprising of the Glas Bheinn and Derrynaculen Granophyres as outlined in Chapter 12.
5. Gneiss-fragments are abundant in vent-agglomerates, outside the supposed calderas, and almost completely absent in vent-agglomerates inside the same ( (Figure 29), p. 201). As explained in Chapter 16, this fits with the view that the calderas are regions of special subsidence, although alternative interpretations are of course available.

If it be admitted that the foregoing arguments prove the existence of a cauldron-subsidence, it will also be admitted that they serve to fix its approximate limits—only the south-eastern caldera is considered here, its north-western neighbour i s very clearly defined as will appear presently. It is stated in paragraph (5) that the margin is actually exposed north of Sgùrr Dearg. Northwest of this, it must turn almost due west if it is to avoid some minute exposures of big-felspar basalt cut by cone-sheets in. Allt nan Clàr (these exposures are not shown on the one-inch Map, but are inserted in (Plate 3). Apart from this, there is no evidence for the exact line chosen for the caldera-margin in a westerly direction, but it probably lies south-west of certain gneiss-laden agglomerates indicated in (Figure 29) (p. 201).

In the other direction, south-westwards from Sgùrr Dearg, the limit of the caldera is pretty definitely fixed, for it must pass between the pillow-lavas of Beinn Fhada and the granophyre of Glas Bheinn. This places it in the belt of agglomerate which reaches past Glas Bheinn from Sgùrr Dearg.

In the Beinn Buie district, it is clear that the limit of the caldera separates the pillow-lavas on the north-east of the Ben Buie Gabbro from the terrestial lavas on the south-west. Accordingly, the caldera-edge must roughly coincide with the smooth concave northeast margin of the gabbro.

A further justification for drawing the caldera-edge where suggested by the evidence just cited is afforded by the concentric grouping of the line, thus- drawn, and many much more easily traced geological features of the district.

The features which most readily occur to the mind in this connection are:

- The arcuate folds discussed above.
- The Early Acid and Basic Cone-Sheets lettered aI and bI respectively on the one-Map, Sheet 44, and described presently in Chapter 19 and Chapter 21.
- The inner edge of the Ben Buie Gabbro ( (Plate 5) and Chapter 22).

- The series of ring-dykes centred on Beinn Chàisgidle ( (Plate 6) and Chapter 29).

E.B.B.

## North-West Caldera

The evidence of the north-west caldera is very much on a par with that advanced above in regard to its south-eastern neighbour. It may be summarized as follows, leaving discussion for Chapter 32, where the encircling Loch Bà Felsite is dealt with:

1. Loch Bà Felsite has risen along a line of fault-brecciation.

2. All basalt-lavas sliced from within the circuit of the dyke are of Central Type (Chapter 9), while those outside, from Ben More to Glen Forsa, belong to the Plateau Group.

3. Apparent faulting of Early Basic Cone-Sheets near Gaodhail ( (Figure 36), p. 238).

4. Apparent faulting of Glen Cannel Granophyre near Beinn Chàisgidle (p. 341).

5. Distribution of gneiss in vent-agglomerates (p. 201).

W.B.W., J.E.R., E.B.B.

There is practically nothing comparable to the ring-system of folding which surrounds the south-eastern caldera. In fact, only at one place has any marked disturbance been noted outside the north-west caldera, and this is at Glac a' Chlaonain south-southwest of Salen: here Liassic sediments emerge dipping at 75° away from neighbouring granophyre.

Inside the caldera, two interior lines of crush-rock have been traced running roughly north-west and south-east across Beinn na Duatharach and Cruachan Beag respectively. W.B.W.

## Structures unconnected with the plutonic centres

Under this heading, a few remarks will be offered concerning folds and faults which have not been sufficiently covered in the introductory statement. As regards folds, it is worth noting that a very gentle syncline runs up Loch Scridain, roughly parallel with the Inch Kenneth Anticline of Sheet 43. This syncline is crossed by the vague Carsaig Anticline, which, starting from Carsaig Bay (Sheet 44), enters Sheet 43 near Tràigh nam Beach, then crosses Loch Scridain to pass a little north-east of Tavool House, and thus, by way of Creach Bheinn, reaches the cliffs between Aoineadh Thapuill and Tòn Dubh-sgairt. The Carsaig Anticline fails to bring Mesozoic rocks to the surface anywhere on the shores of Loch Scridain owing to the effect of the syncline which runs up that Loch. E.B.B.

Of faults, by far the most arresting is the north and south fault which brings Tertiary lavas, and underlying Mesozoic and Carboniferous sediments, against Moine gneiss at the angle of Inninmore Bay, almost at the entrance to the Sound of Mull. Mr. Manson's sketch ( (Figure 26)) of this well-known dislocation illustrates the marked contrast of scenery on the two sides: the trap-featuring of the lavas on the west, and the amorphous slopes of gneiss on the east. Although this fault completely alters the face of the country by bringing into conjunction highly contrasted rock types, it does not lead to any significant change of level: the down-thrown lavas on the west rise to an elevation of 1573 ft. in Glais Bheinn; while the gneisses, less than a mile and a half away, reach 1517 ft. in Màm a' Chullaich. It is impossible to gain an accurate knowledge of the throw of the fault, but the 1000 ft. contour in the gneiss-country just east of the dislocation approaches so closely the head of Inninmore Bay, where Carboniferous sandstone extends below sea-level, that 1000 ft. may be safely assumed as a minimum. Inland, there is less chance of judging, for the gneissic floor rises gently northwards under its sedimentary and lava cover, and emerges, at the base of the Glais Bheinn escarpment, at about 1000 ft. above sea-level. This does not necessarily mean that the fault diminishes in throw when followed towards the north; but it certainly becomes a less conspicuous tectonic feature. G.W.L.

On the other side of Mull at Bunessan (Sheet 43), a west-north-west fault serves as the boundary of the Mull lavas for a distance of 5 miles measured across the Ross. The Bunessan Fault is never exposed, but its course is easily followed, since it is marked by a continuous hollow, with Moine schists, or gneisses, on the south-west, and basalt-lavas on the north-east. These latter belong to the lower part of the Tertiary sequence, but not to its base; and it is quite clear on the ground that their linear termination is determined by faulting. (O.T.C)

The course of this fault after reaching the bay at Bunessan is not very clear. Probably it continues up Loch Caol and across the Ross of Mull Granite to Dearg Phort, while at the same time it sends a branch up Loch na Lathaich, skirting the north-east shore of Eilean Bàn It is certain, at any rate, that a fault intervenes between the gneisses of Eilean Bàn and the lavas of Ardtun; whereas the gneisses of Na Liathanaich may very well form part of the floor upon which the Ardtun lavas rest. E.B.B.

Before leaving this district, it is worth while noticing certain north-westerly faults conspicuous in the cliffs of the Gribun Peninsula (Sheet 43). The most obvious bounds Tòn Dubh-sgairt on the north-east, and has a throw of about 400 ft. An interesting feature of the north-westerly faults of both the Gribun and Ross Peninsulas (Sheets 43 and 44) is the clear manner in which they cut the sills and sheets of the Loch Scridain district described in Chapter 23. E.B.B., E.M.A.

It is often impossible to decide how far there has been lateral movement along a steep fault. In the case of some of the north-west faults of Mull, there has certainly been a considerable amount. The best local instance of a wrench, or tear-fault, or flaw, as dislocations of this type are variously styled, is afforded by a well-marked west-north-westerly fault which runs from Loch Spelve across to Port Donain (Sheet 44). In its course, it cuts through the Loch Don Anticline, and displaces this structure bodily for more than 100 yds., measured horizontally. The Port Donain Fault is easily recognized westwards in a crush-line followed by the Lussa River, while on the mainland it is possible continued by a fault passing Kilninver; but in neither of these directions is there a chance of seeing whether it maintains its wrench-character.

E.B.B .

## Quiescence of the Great Glen Fault

One of the most interesting features of the Tertiary Tectonics of Mull is of a negative character. The north-east fault known as the Great Glen, or Loch Linnhe Fault, is generally regarded as chief among Scotland's high-angled fractures. It passes through the foundations of Mull, where, as explained in the Memoir dealing with the Pre-Tertiary geology of the district, its course can be followed fairly accurately by paying attention to the extremely contrasted metamorphism of certain Pre-Devonian inliers showing among the Tertiary lavas: on the one side of the fault, are the gneisses of the west shore of Loch Spelve and Sgùrr Dearg, evidently belonging to the same gneissic complex as is exposed in Morven and the Ross of Mull; on the other side, are the roofing slates and limestones of the Loch Don Anticline, the obvious continuation of similar rocks occurring in Lismore and. Lorne, and, like the latter, accompanied by Old Red Sandstone lavas. In striking contrast with these observations, there is clear evidence that no important displacement of Tertiary date has taken place along the northeast line. A trivial fault has indeed been traced from Lochan an Doire Dhairaich to Camas Her, but that is all. The arcuate folds of (Plate 5) have been developed boldly across the line of the Great Glen Fault. In fact, it is almost certain that this fault, instead of controlling the development of Tertiary structures, has been involved in them, and deflected outwards from the centre of the island; it is difficult otherwise to account for finding a gneiss outcrop so far south-east as Balure, on the shore of Loch Spelve.

The quiescence of the Great Glen Fault in the Mull district is of old standing, for the preservation of Jurassic strata does not seem in general affected by it. An interesting exception to this rule is discussed in the Memoir dealing with the Pre-Tertiary rocks, where it is suggested, on Dr Buckman's determination of fossils, that some group of strata (? Callovian), otherwise unknown in the district, has here been preserved from early Cretaceous erosion by slipping down into a fault-fissure along the line of the stream leading north-east towards Camas Mòr. This is the same line, which, in Tertiary times, showed a slight movement, so that it is quite reasonable to imagine that .a gaping fissure may have locally opened along it in Cretaceous times (see also p. 395). E.B.B.

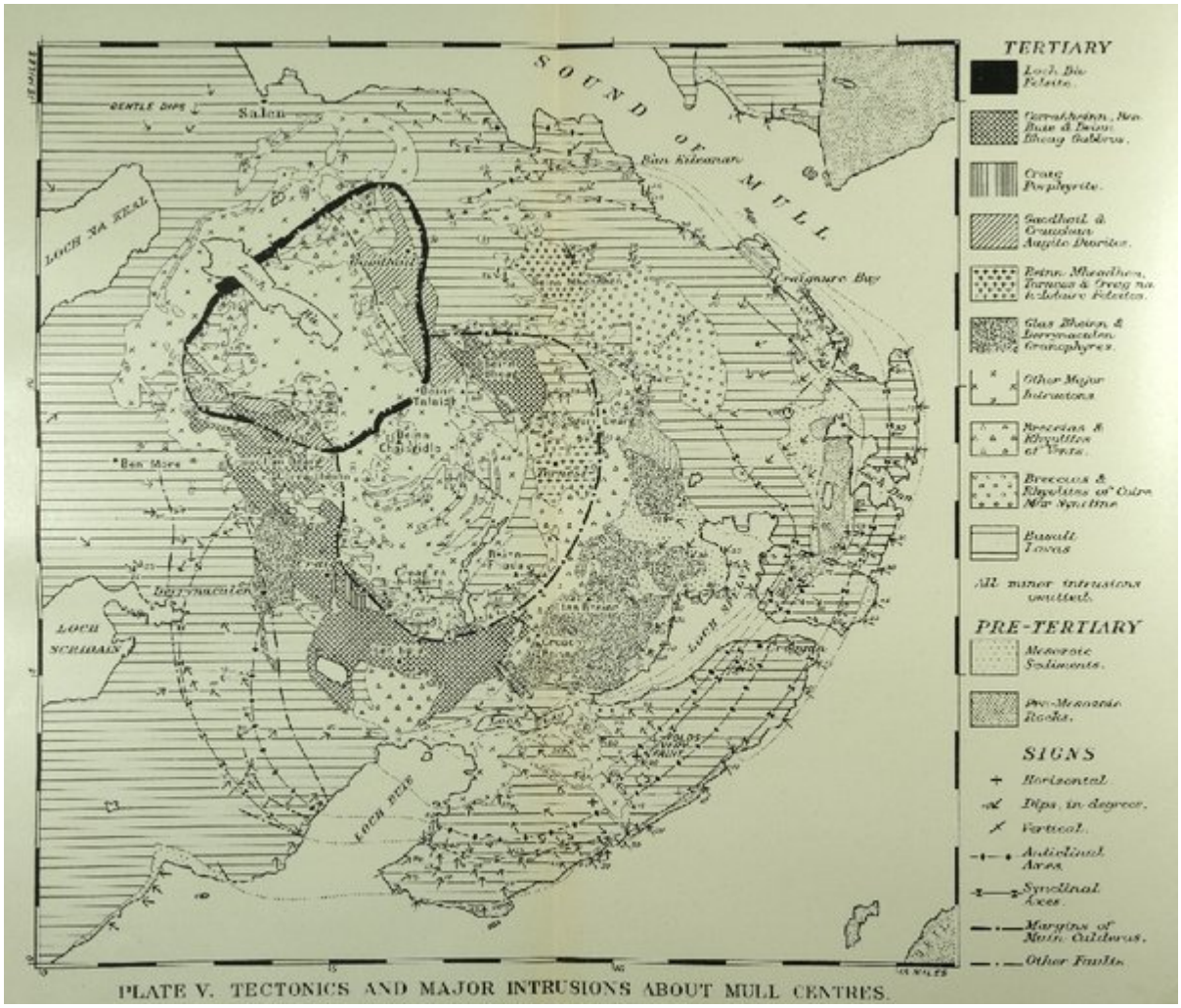



PLATE V. TECTONICS AND MAJOR INTRUSIONS ABOUT MULL CENTRES.

*(Plate 5) Map showing calderas, major intrusions, and folds*

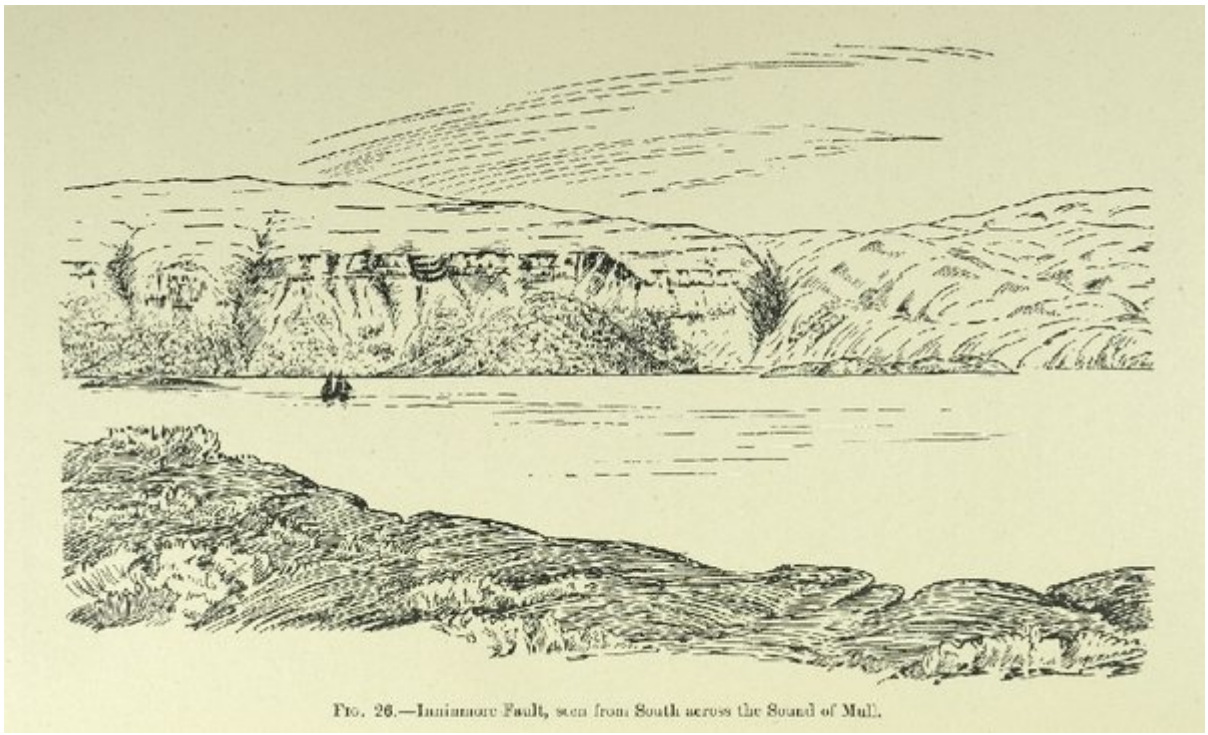
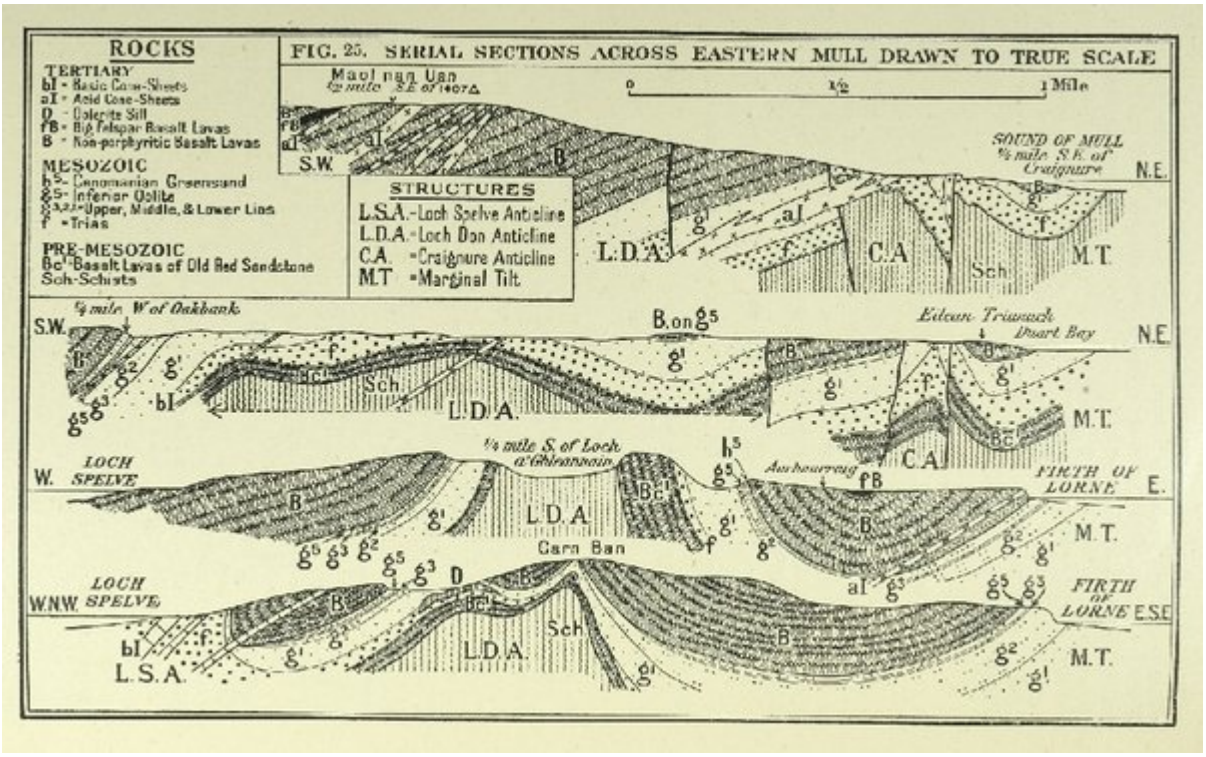
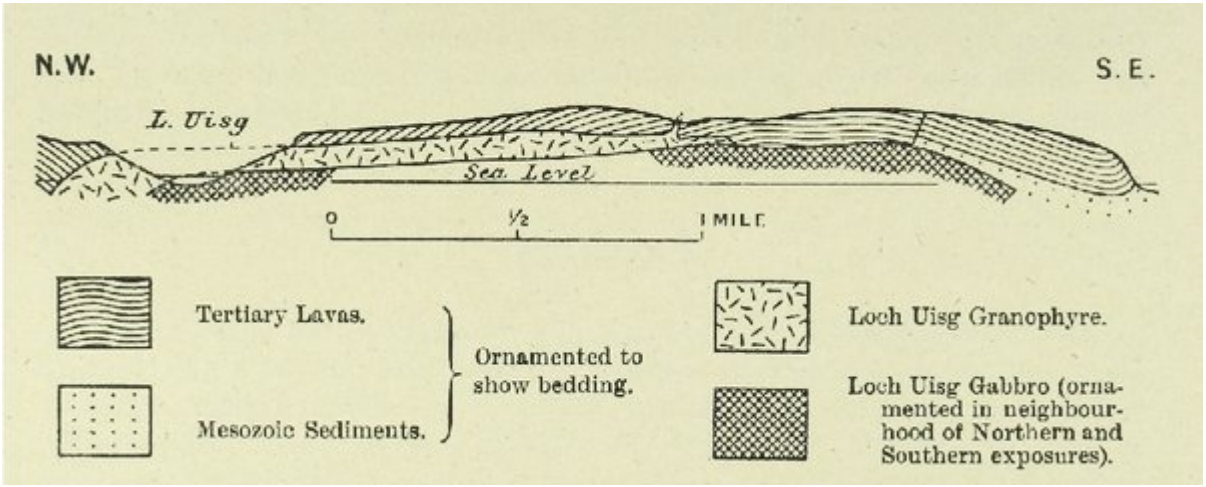


FIG. 26.—Inninmore Fault, seen from South across the Sound of Mull.

*(Figure 26) Inninmore Fault, seen from South across the Sound of Mull.*




*(Figure 25). Serial sections across Eastern Mull drawn to true scale. Rocks, Tertiary: bI = Basic Cone-Sheets aI = Acid Cone-Sheets D = Dolerite Sill fB = Big Felspar Basalt Lavas B = Non-porphyritic Basalt Lavas. Mesozoic: $h^5$ = Ceitomanian Greensand $g^5$ = Interior Oolite $g^{3,2,1}$ = Upper, Middle.& Lower Lias f = Trias. Pre-Mesozoic: $Bc^1$=Basalt Lavas of Old Red Sandstone; Sch=Schists. Structures: L.S.A.=Loch Spelve Anticline. L.D.A.=Loch Don Anticline. C.A. =Craignure Anticline M.T. =Marginal Tilt.*




*(Figure 34) Section showing Loch Uisg Granophyre cutting folded lavas.*

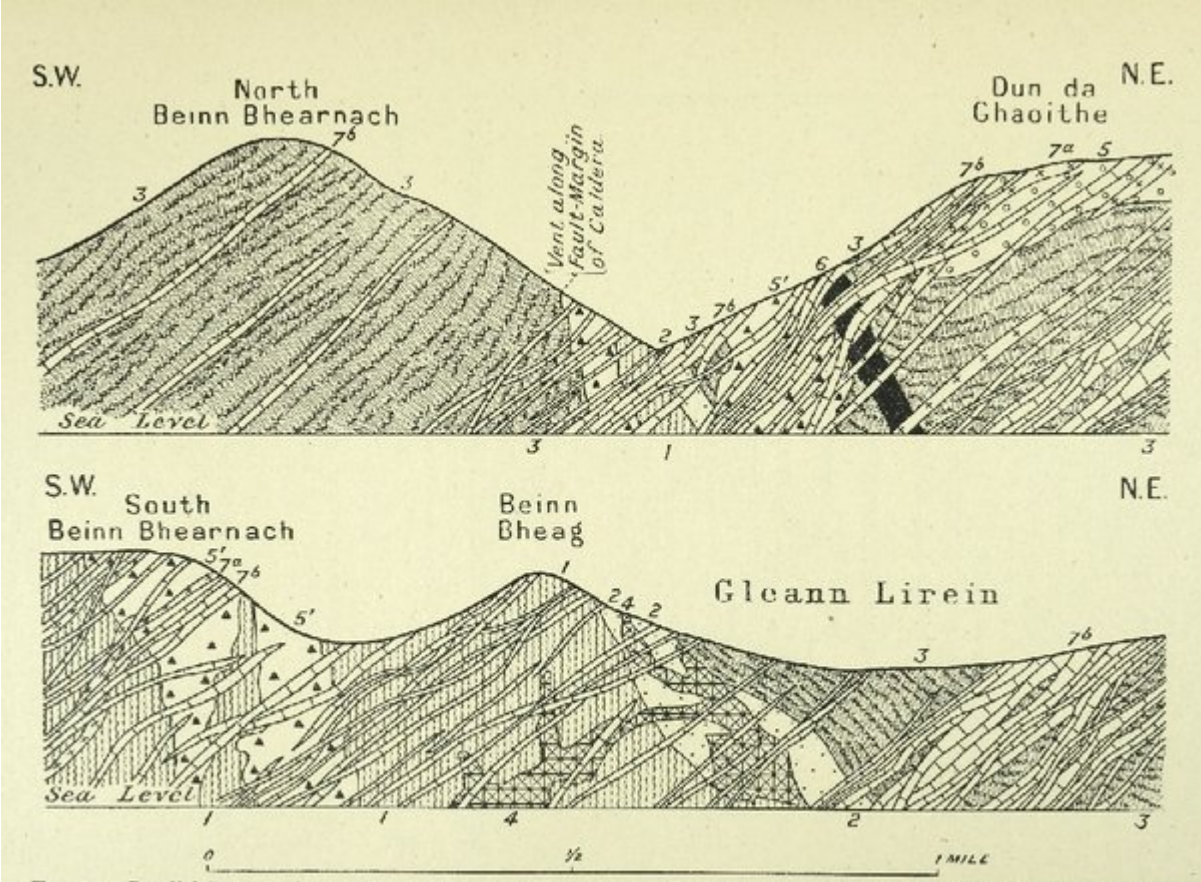



FIG. 35. Parallel Sections showing Early Basic Cone-Sheets cutting Loch Spelve Anticline, North-West and South-East of Sgùrr Dearg. 1 Moine Gneiss. 2 Mesozoic Sediments. 3 Basalt-Lavas. 4 Big-Felspar Gabbro. 5 Surface-Agglomerate. 5' Vent-Agglomerate. 6 Beinn Mheadhon Felsite. 7a Early Acid Cone-Sheets. 7b Early Basic Cone-Sheets.

*(Figure 35) Parallel Sections showing Early Basic Cone-Sheets cutting Loch Spelve Anticline, North-West and South-East of Sgùrr Dearg. 1 Moine Gneiss. 2 Mesozoic Sediments. 3 Basalt-Lavas. 4 Big-Felspar Gabbro. 5 Surface-Agglomerate. 5' Vent-Agglomerate. 6 Beinn Mheadhon Felsite. 7a Early Acid Cone-Sheets. 7b Early Basic Cone-Sheets.*

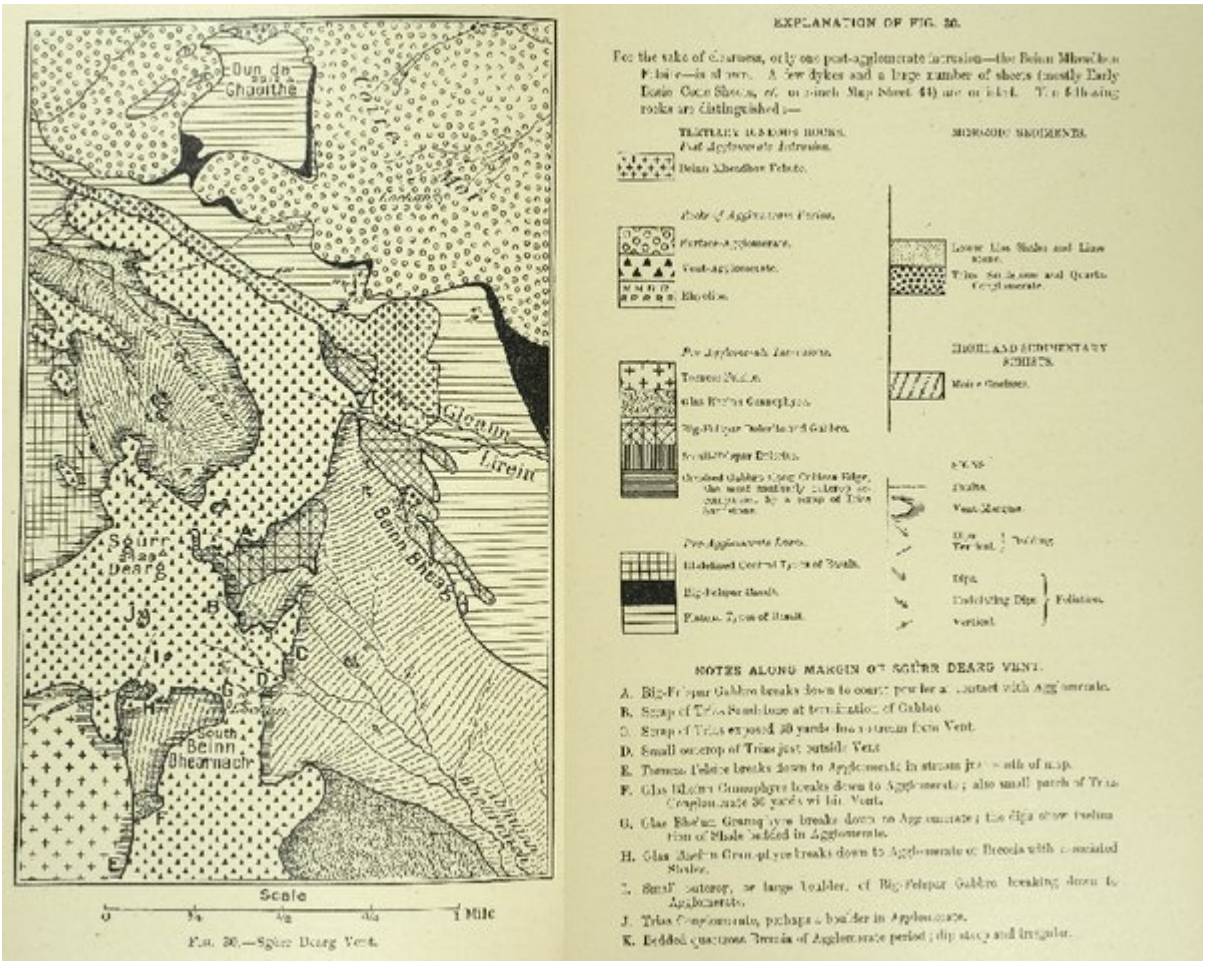
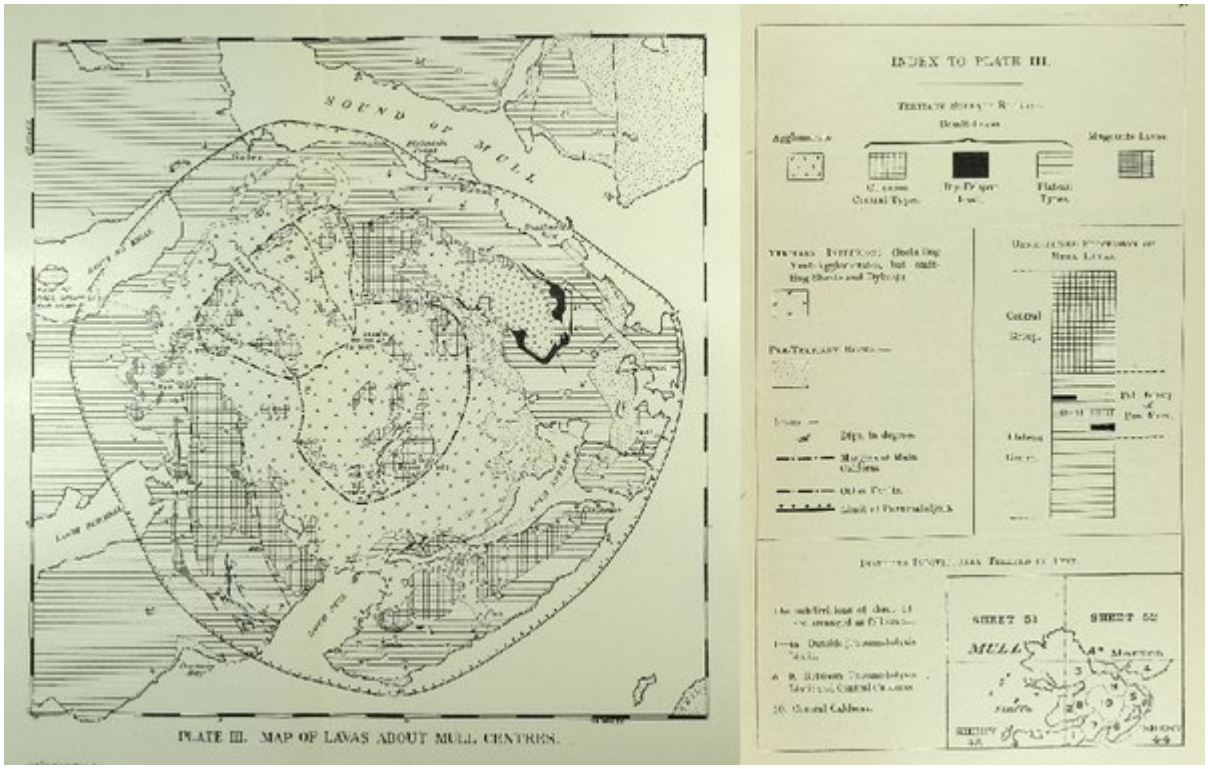



FIG. 30.—Sgùrr Dearg Vent.

*(Figure 30) Sgùrr Dearg Vent. Explanation of Figure 30. For the sake of clearness, only one post-agglomerate intrusion—the Beinn Mheadhon Felsite—is shown. A few dykes and a large number of sheets (mostly Early Basic Cone-Sheets, cf. one-inch Map Sheet 44) are omitted. Notes along margin of Sgùrr Dearg vent: A. Big-Felspar Gabbro breaks down to coarse powder at contact with Agglomerate. B. Scrap of Trias Sandstone at termination of Gabbro. C. Scrap of Trias exposed 30 yards down-stream from Vent. D. Small outcrop of Trias just outside Vent. E. Torness Felsite breaks down to Agglomerate in stream just south of map. F. Glas Bheinn Granophyre breaks down to Agglomerate; also small patch of Trias Conglomerate 30 yards within Vent. G. Glas Bheinn Granophyre breaks down to Agglomerate; the dips show inclination of Shale bedded in Agglomerate. H. Glas Bheinn Granophyre breaks down to Agglomerate or Breccia with associated Shales. I. Small outcrop, or large boulder, of Big-Felspar Gabbro breaking down to Agglomerate. J. Trias Conglomerate, perhaps a boulder in Agglomerate. K. Bedded quartzose Breccia of Agglomerate period; dip steep and irregular.*




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

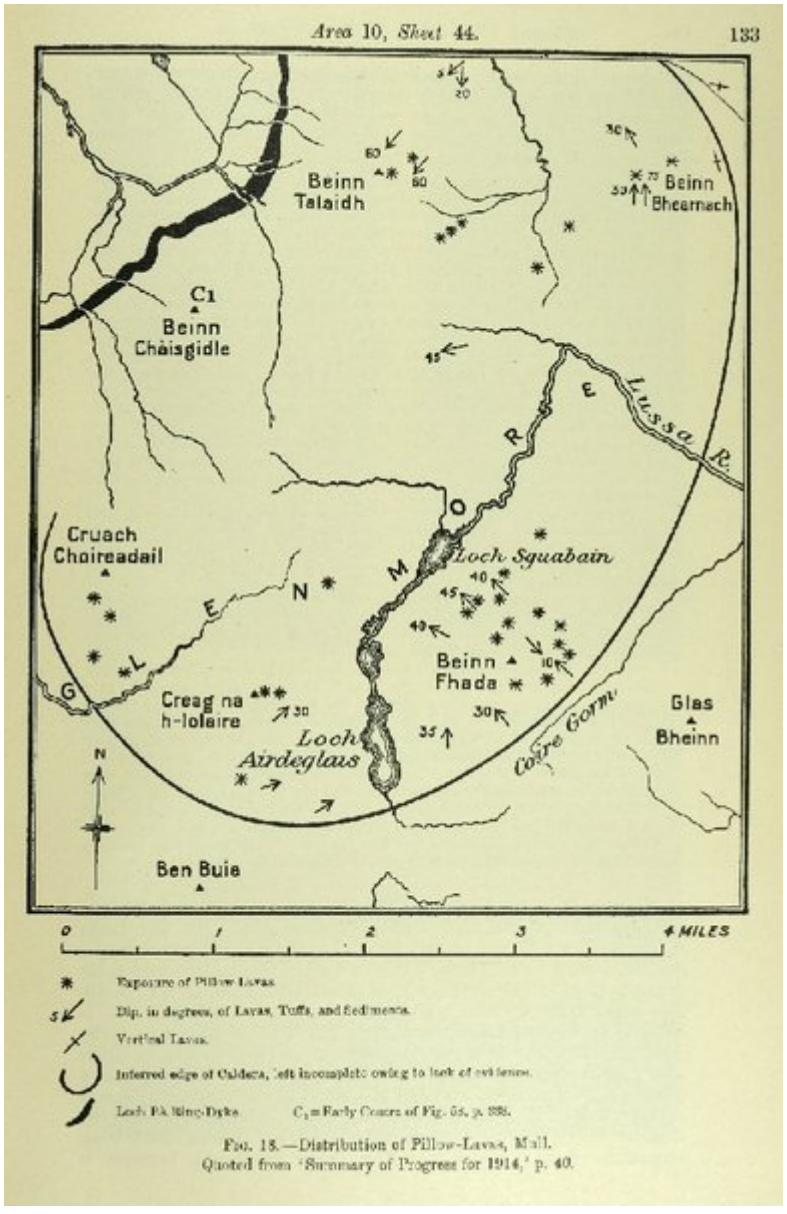
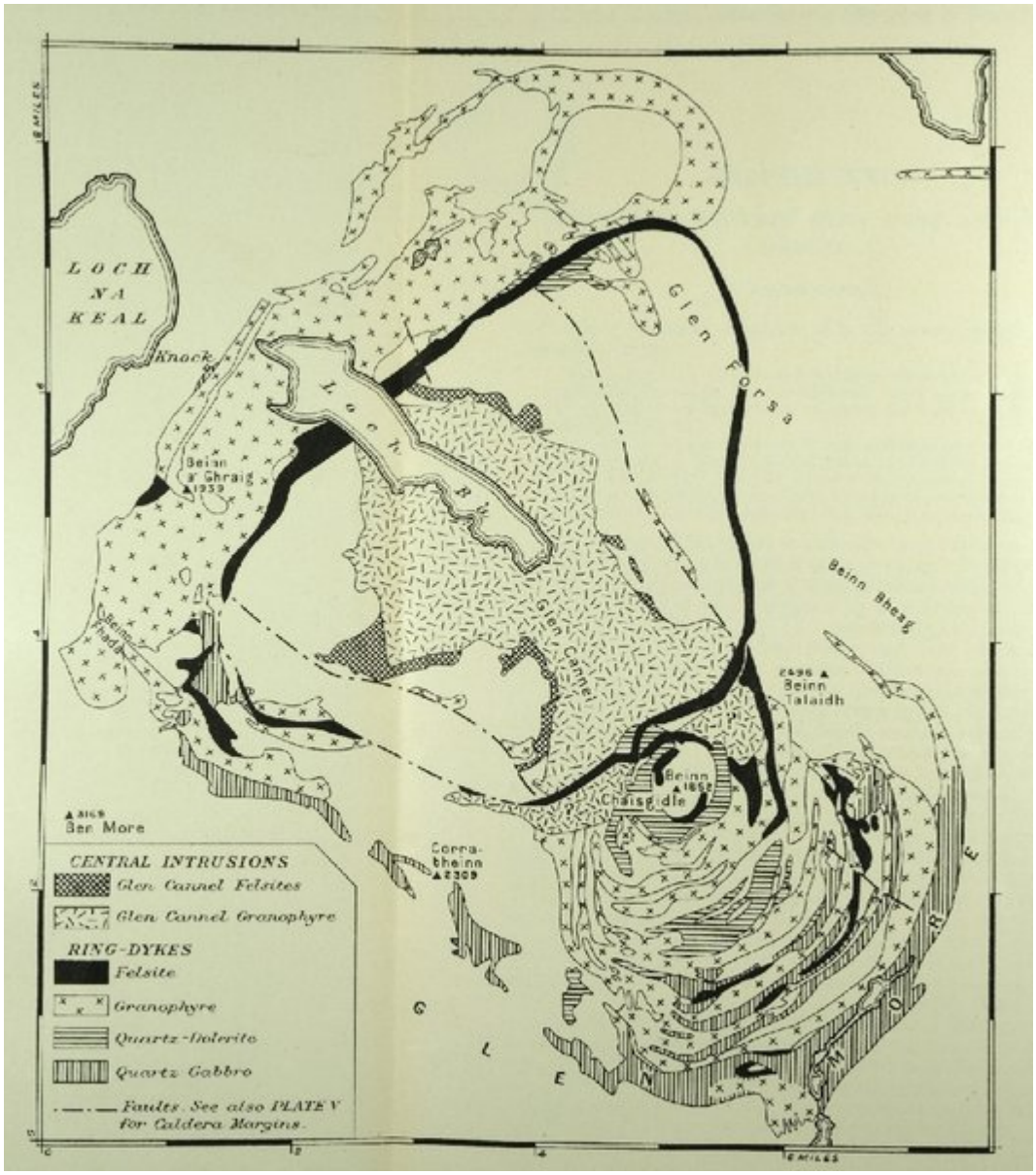



Fig. 18.—Distribution of Pillow-Lavas, Mull.
Quoted from 'Summary of Progress for 1914,' p. 40.

*(Figure 18) Distribution of Pillow-Lavas, Mull. Quoted from Summary of Progress for 1914, p. 40.*

FIG. 29.—Distribution of Gneiss-Fragments in Mull Agglomerates.

*(Figure 29) Distribution of gneiss-fragments in Mull Agglomerates.*




*(Plate 6) Map showing ring-dykes*

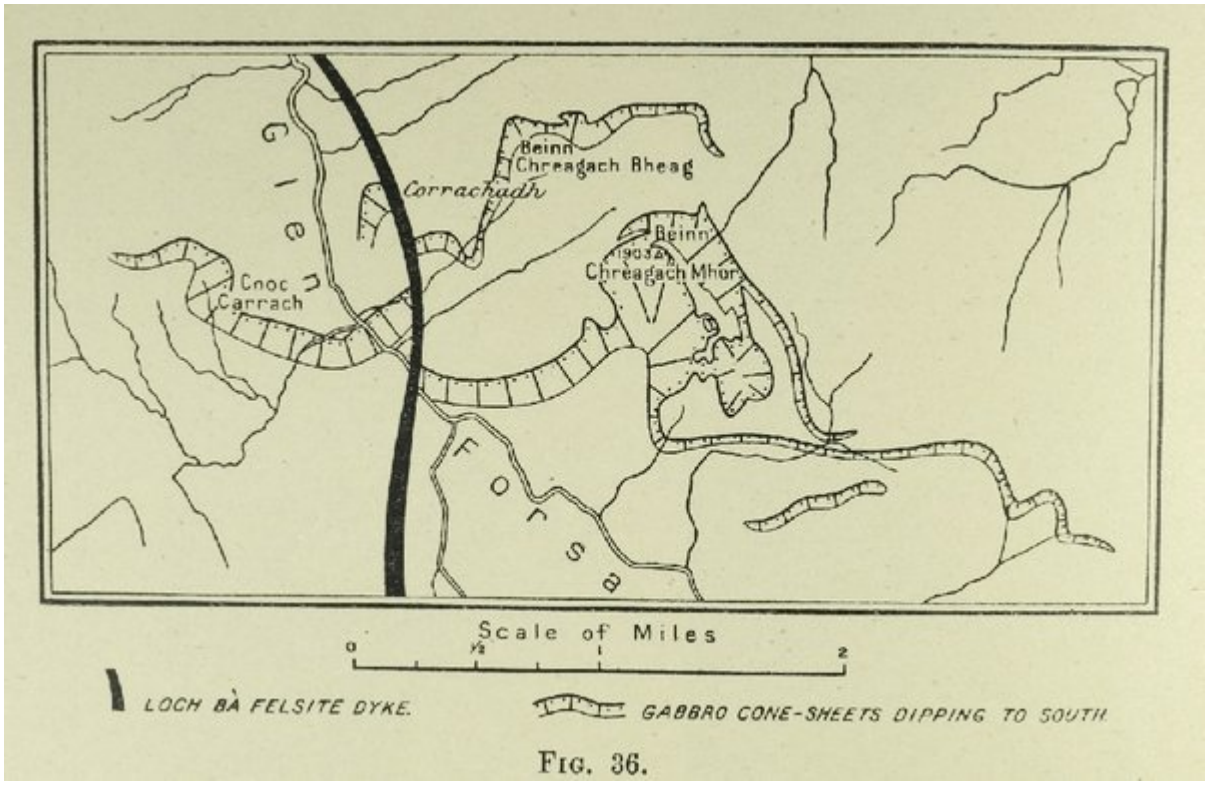



FIG. 36.

*(Figure 36) Early Basic Cone-Sheets of Beinn Chreagach Bheag and Beinn Chreagach Mhòr probably displaced at Loch Bà Felsite.*