Chapter 16 Rocks of Lower Old Red Sandstone age dykes and sheets

<ref>A fuller treatment in some respects has been given elsewhere (Clough, Maufe and Bailey 1909, p. 640).</ref>

Early lamprophyre sheets

A fuller treatment in some respects has been given elsewhere (Clough, Maufe and Bailey 1909, p. 640).

Many more or less horizontal sheets of hornblende-vogesite and spessartite traverse the schists in that part of the district which lies east of Caolasnacon on Loch Leven. They yield very readily to erosion, and thus often give rise, indirectly, to scarps and waterfalls. Very good examples run along the hill slopes west of Allt Coire an Eòin [NN 223 740], north-east of Ben Nevis, and others are well exposed in the River Leven. They weather in a rugged carious fashion on account of their richness in calcite. W. B. W., E. B. B.

The most southerly example known in Sheet 53 occurs at the base of the thin tremolitic hornfels, representing the Ballachulish Limestone, 1060 yards slightly east of south of Dalness [NN 168 512]. It is thrown by a small dislocation of the type connected with the Cauldron-Subsidence of Glen Coe. C T. C.

The lamprophyre sheets are certainly of comparatively early date, for very numerous examples have been seen to be cut by the north-east dykes. They are probably earlier than even the Moor of Rannoch "Granite", since, though well developed in its vicinity, they are nowhere known to cut it. It is likely that they are of the same general age as the little appinite bosses of the last chapter, for petrographically they differ from the appinites only in their finer texture. W. B. W., E. B. B.

In agreement with the view that these lamprophyre sheets are of earlier date than most of the igneous rocks of the district, it is interesting to note that a typical example exposed in a cutting in private ground, at the east end of the Aluminium Factory [NN 190 618] at Kinlochleven, shows a cross-cleavage. It cannot, however, be too clearly recognised that this is a local phenomenon and restricted, so far as is known, to this single example — unless the somewhat foliated lamprophyre described at the beginning of the next paragraph is a comparable case. E. B. B.

Lamprophyres, unclassed

On the river Leven, at the fall between the two main lochans a little down from the Blackwater Dam, a remarkable mass of lamprophyre occurs with distinctly foliated margin. At this point there is also a complex of porphyrite dykes which are chilled against the lamprophyre and against one another.

In the path to the north another lamprophyre is exposed with inclusions of quartz, quartzite, quartzose schist and granite. The granite is coarse and contains abundant very pink felspars. There is one large fragment of granite from which crystals have floated off at the margin into the lamprophyre magma. W. B. W.

Of other unclassed lamprophyre intrusions we may note the east-north-east dyke (S11612) [NN 1126 5486] of hornblende-spessartite or vogesite mapped by Peach in the River Coe [NN 155 569], south-west of Clachaig (p. 79). It is cut by an ordinary porphyrite dyke, and possibly belongs to the same suite of intrusions as the more or less horizontal sheets described in the previous section.

Another example is a thin north-east lamprophyre dyke (S11523) [NN 1592 5970] veined and baked by the Fault-Intrusion of Glen Coe. It is exposed in an important tributary, which enters Allt Gleann a' Chaolais [NN 145 605] from the east, but is not shown on the one-inch map. This dyke also may be closely related to the sheet series of intrusions. Nearby yet another lamprophyre dyke (S11524) [NN 1592 5970] shows even more clearly contact-alteration by the Fault-Intrusion. E. B. B.

On the north slopes of Sròn na Crèisee [NN 240 522] a hornblendic lamprophyre cuts the quartzose schists a little beyond the edge of the lavas. It has the form of a small dyke running north-west (S9738) [NN 2390 5258]. H. K.

Early felsite and andesite intrusions of Glen Coe

The horizontal lamprophyre sheets dealt with in the first section of this chapter are quite likely earlier than the Glen Coe lavas. The felsites and andesites now to be considered (Figure 33) are probably, as a group, contemporaneous with the lavas; they are early only in relation to the Fault-Intrusion of Glen Coe and the great swarm of north-east dykes. c. T. C., H. B. M., E. B. B.

Certain early felsites along the northern front of the Cauldron-Subsidence have already been referred to ((Figure 23), (Figure 24), pp. 156, 158). They are never found cutting the Fault-Intrusions, and they have sometimes suffered from shearing in the same manner as the Early Fault-Intrusion. In (Figure 23) two are seen in close association with branches of the Boundary-Fault. In (Figure 24) their distribution seems random.

Other felsites of similar type occur in Garbh Bheinn [NN 170 601] above Loch Leven, but may belong to a later period than the Fault-Intrusion since they sometimes adopt the N.E. direction characteristic of the Etive Swarm. They are not numerous, and are cut by the porphyrites with which they come in contact. E. B. B.

A few dykes of quartz-porphyry, felsite and hornblende-andesite cut the lavas within the cauldron. Some are traversed by the N.E. dykes, and they do not enter the Fault-Intrusion or Cruachan "Granite". Their local distribution shows that they belong to the Glen Coe centre. H. B. M.

Other examples, not shown in (Figure 33), come from the area between the two branches of the Glen Coe Fault south of Glen Etive. On the north-east end of Beinn Ceitlein a rhyolite dyke, traced through the quartzite in a north-west direction for 200 yards, is cut by various N.E. dykes of porphyrite and by one of quartz-porphyry. A little further south-east a somewhat similar dyke runs south for 150 yards, and shows beautiful spherulitic structures (S11460) [NN 1808 4989] near the side, which is approximately vertical. It is cut by at least two N.E. porphyrite dykes. Other small rhyolitic intrusions, without the N.E. direction of the Etive Swarm of dykes, and in one case cut by a porphyrite dyke belonging to that swarm, also occur on the same hill end.

Various patches of quartz-felsite and rhyolite, about 800 yd N.N.W. of the ordnance station, 2731 ft, on Beinn Ceitlein, are probably of intrusive nature, and, if so, belong to the early suite now considered. The Fault-Porphyrite chills against one of them. C. T. C.

See also south of Stob Beinn a' Chrùlaiste [NN 232 564] (Figure 28). E. B. B.

Etive Swarm of north-east dykes

Two great swarms of north-east dykes are represented in (Figure 18) (p. 129), though owing to lack of space only a small proportion of the dykes actually occurring have been inserted. The Etive Swarm alone concerns us at present. By far the greater number of its members are porphyrites. The rest are mainly microdiorites and quartz-porphyries, as set forth in detail in chapter 16. Various rock types are often associated in multiple dykes.

The Etive Swarm is interrupted in its centre by the Starav Granite, which, as explained in chapter 8, is of later date than the N.E. dykes. Even before reaching the margin of the Starav Granite there appears to be a somewhat sudden decrease in the number of the dykes. This relation is rather peculiar, as the diminution occurs within the Cruachan "Granite", the more marginal portions of which are cut quite freely by the dykes. A possible explanation will be offered presently.

For half a dozen miles south of the Starav Granite, in Sheet 45 (Geol.) and (Figure 18), the direction of the swarm is mainly north-north-east, rather than northeast as elsewhere. Anderson thinks that there is also a tendency for the dykes on this southern side to radiate from the curving margin of the granite when close to it (1937a, p. 508). He is further of the opinion that two dykes of the Etive Swarm penetrate the Starav Granite for a short distance; but one of these is from the

River Kinglas [NN 140 360]and is petrographically distinct from all other dykes attributed to the swarm (p. 173).

Allusion has been made to the existence of multiple dykes in the Etive Swarm. The most striking example is a multiple dyke (S14410) [NN 1538 5160]; (S14419) [NN 1538 5160] that has been traced for a mile and a half into Allt Fhaolain [NN 158 510] from the south-west. (Figure 34) illustrates its complexity. The order of injection of two dykes in contact has been determined here, as elsewhere, by noting which dyke presents a chilled edge to its neighbour. Chilling of the margins of the dykes is a conspicuous phenomenon throughout the whole district, and it has been found that when a dyke-fissure has been injected at two or more times, the marginal portion of an earlier dyke is very rarely separated from the country rock to allow of the entry of a later. Accordingly it is a very exceptional and local circumstance to find two chilled edges in contact. H. B. M.

The example given in the last paragraph shows the difficulty of arriving at any generalisation concerning the sequence of the various types of dykes *inter se.* As a further illustration, one may note the behaviour of the quartz-porphyry dykes south-east of Dalness. In various places they cut into, or are chilled against, porphyrite dykes; but in other places the reverse relations have been observed. A quartz-porphyry in the River Etive half a mile east-north-east of Alltchaorunn [NN 196 509] is chilled against a parallel dark grey more basic dyke on its north-west side, and about two-thirds of a mile south of Alltchaorunn [NN 196 509] the same quartz-porphyry dyke intrudes into a porphyrite; but further south again, in an exposure nearly a mile east of Stob Dubh, the middle of this quartz-porphyry is cut by a more basic dyke. Another quartz-porphyry dyke, three-quarters of a mile slightly south of west of Meall Garbh, and two similar dykes, on the east side of Beinn Ceitlein, are all distinctly cut by porphyrite dykes.

Two quartz-porphyry dykes cross the flinty crush-rock associated with the inner branch of the Glen Coe Boundary-Fault south-east of Dalness, without being crushed or thrown by it; and one of them can also be traced without any displacement across the outer branch on Beinn Ceitlein [NN 176 490]. C. T. C.

Several examples of quartz-porphyry dykes cut by porphyrites might be cited from the north-eastward continuation of the Dalness district. Another relation commonly observed is the cutting of other dykes by "pock-marked" microdiorites. The pock-marks which characterise these late dykes are little pits due to the weathering out of chloritic pseudomorphs after rhombic pyroxenes. Albitised pyroxene-microdiorites are well developed in the neighbourhood of Stob Mhic Mhartuin [NN 207 575], and are constantly seen to cut the more normal porphyrites. E. B. B., G. W. G.

That there should be an irregularity in the sequence of dyke-types, and that quartz-porphyry dykes, for instance, should be later than some of the porphyrites and earlier than others, is in keeping with the evidence already given in chapter 13 regarding the relations of the dykes to the Meall Odhar Granite. It will be remembered that this granite seems to coalesce with a quartz-porphyry dyke, is cut by many porphyrite dykes, and cuts a few. C. T. C.

The injection of the dykes bears witness to a redistribution of earth-stresses, which, taking place after all subsidence of the Glen Coe block had ceased, brought about an important modification of the original outline of the cauldron amounting to an elongation normal to the direction of the dykes. The dykes have added their own width to the cross-section of the country which they traverse. This feature is brought home by a consideration of (Figure 35) and (Figure 36). H. B. M.

In the River Etive, a little above Alltchaorunn [NN 196 509], thirty-one dykes were encountered in a distance of 1133 yd (measured at right angles to their strike), and the aggregate width of these dykes amounts to 335 yd. Assuming this an average for the district, although such an assumption probably gives too high a figure, the major diameter of the Glen Coe Cauldron owes 2½ of its 9 miles of length to the insertion of the Etive Swarm of dykes. (For other measurements, see Anderson 1937a, p. 509.) C. T. C.

Two main features call for interpretation. The parallelism of the dykes, and the concentration with reference to the Etive centre.

The N.E. direction, so characteristic of the dyke phase, is perhaps foreshadowed in the elongation of the Etive boss and its alignment with the Glen Coe Cauldron (*cf.* Richey, *in* Sum. Prog. 1915, pp. 36, 37). Be this as it may, the parallel N.E. dykes bespeak a period when the Etive igneous centre was involved in some terrestrial readjustment affecting a much larger region. The stress as transmitted to the Etive district must have been of the nature of relative tension or, in other

words, marked relief of pressure. This, in the presence of magma under suitable conditions of hydrostatic pressure, led to the formation of dykes orientated at right angles to the direction of least compression.

The fact that the dykes are not all of one epoch, but constantly cut one another with chilled edges, shows that the growth of the regional stress was maintained over a long period. The introduction of the dykes gave intermittent relief to the growing "tension."

The concentration of the Etive Swarm is easy to understand. The intrusion of the Meall Odhar Granite, intervening at an early stage of the dyke phase, and that of the Starav Granite, coming at the close of the same, afford almost a demonstration of the existence, during the whole of the dyke phase, of a large body of unconsolidated magma in the pipe extending from the Cruachan "Granite" down to the general magma basin below. This unconsolidated magma would be incapable of resisting tensional stresses, and its weakness would be a quite sufficient cause to locate the Etive Dyke-Swarm. Probably the dykes were injected from the pipe rather than from the molten reservoir beneath. C. T. C., H. B. M., E. B. B.

One further point demands explanation: we find the outlying portions of the Cruachan "Granite" cut by dykes as freely as the surrounding schists, but the inner portion, near the edge of the Starav Granite, appears for the most part to have escaped. This suggests that the unconsolidated subterranean magma, which located the Etive Swarm of dykes, existed in the form of peripheral ring-dykes, or ring-bosses, and not of great central bosses filling subterranean cauldrons. The Meall Odhar ring-dyke of granite is a case in point, for it is almost certainly connected with a north-east quartz-porphyry dyke (p. 172), which is found outside, but not inside, the partial ring. Sgòr an Fhuarain [NN 177 637]

To realise the significance of this conception, one has merely to consider what would have taken place had the regional "tensions", which led to the production of the Etive Swarm, come into being before the consolidation of that irregular ring-dyke, the Fault-Intrusion of Glen Coe. It is obvious that a swarm of dykes would have originated, extending outwards on either side from the ring of Fault-Intrusion, and that few if any of the dykes would have penetrated within the circumference of the boundary-fault. In like manner had the "tensions" been communicated to the district, when the Inner "Granite" of Ben Nevis was in its present situation and still liquid, the Ben Nevis Swarm of dykes would have been excluded from the lavas and schists surrounded by the granite. Now although the Inner "Granite" of Ben Nevis did not rise to its present position till after the intrusion of the great majority of the Ben Nevis dykes, we do find the central lavas and schists free from dykes. It is reasonable therefore to suggest that the dyke-swarms of Etive and Ben Nevis, each with its central region of discontinuity, have proceeded from ring-dykes, of which the Meall Odhar Granite may be taken as a type.

In chapter 14 Maufe refers the immunity of the central schists and lavas of Ben Nevis to another cause (p. 184), but his account was written before the explanation outlined above had been thought of, and there was no subsequent opportunity for reconsideration. The ring-dyke theory of the location of centrally discontinuous dyke-swarms has a further application in Ben Nevis: it satisfactorily accounts for the observation that the few dykes of the swarm which are later than the Inner "Granite" do not enter beyond its marginal portions. E. B. B.

Ben Nevis Swarm of north-east dykes

The Ben Nevis Swarm of dykes is so closely comparable with the Etive Swarm that we need not enter into detail in regard to it ((Figure 18), p. 129); as minor points of difference we may note that the course of the dykes seems to be somewhat more east of north-east than that of the Etive dykes, and that microdiorites are about as abundant as porphyrites.

The relations of the dykes to the Outer and Inner "Granites" of Ben Nevis, and to the lavas and underlying schists which form the central portion of the mountain, have already been discussed in chapter 14. Anderson's discovery in Sheet 62 (Geol.) of early members of the swarm forming a small group running east-north-east and cut off by the Outer "Granite" is a welcome addition to our knowledge (p. 179) since the first edition of this memoir appeared. The explanations offered above in regard to the origin of the Etive dykes are equally applicable in the present instance. H. B. M.

Dykes north-west of Loch Linnhe

North-west of Loch Linnhe there are various dykes which probably belong to the Lower Old Red Sandstone period. Notable among them are certain broad felsite dykes well developed in the vicinity of Glen Tarbert [NM 910 600]. In most of their course within Sheet 53 they run in a general east-north-east direction (p. 190), and are crossed by west-north-west basaltic dykes of presumably Tertiary age. West of Allt a' Choire Dhuibh [NN 095 630]three of the felsite dykes turn so as to run west-north-west, and one of them is followed by a later basaltic dyke which chills against its more acid companion.

These felsite dykes range up to about 20 ft in thickness, and as they weather with a terra-cotta hue they often make conspicuous objects. Both in the field and under the microscope they recall the acid intrusions of the Old Red Sandstone rather than of the Tertiary period. They freely cut the Strontian "Granite" in Sheet 52 (Geol.), and also other minor masses of plutonic rock with which they happen to come in contact. E. B. B.

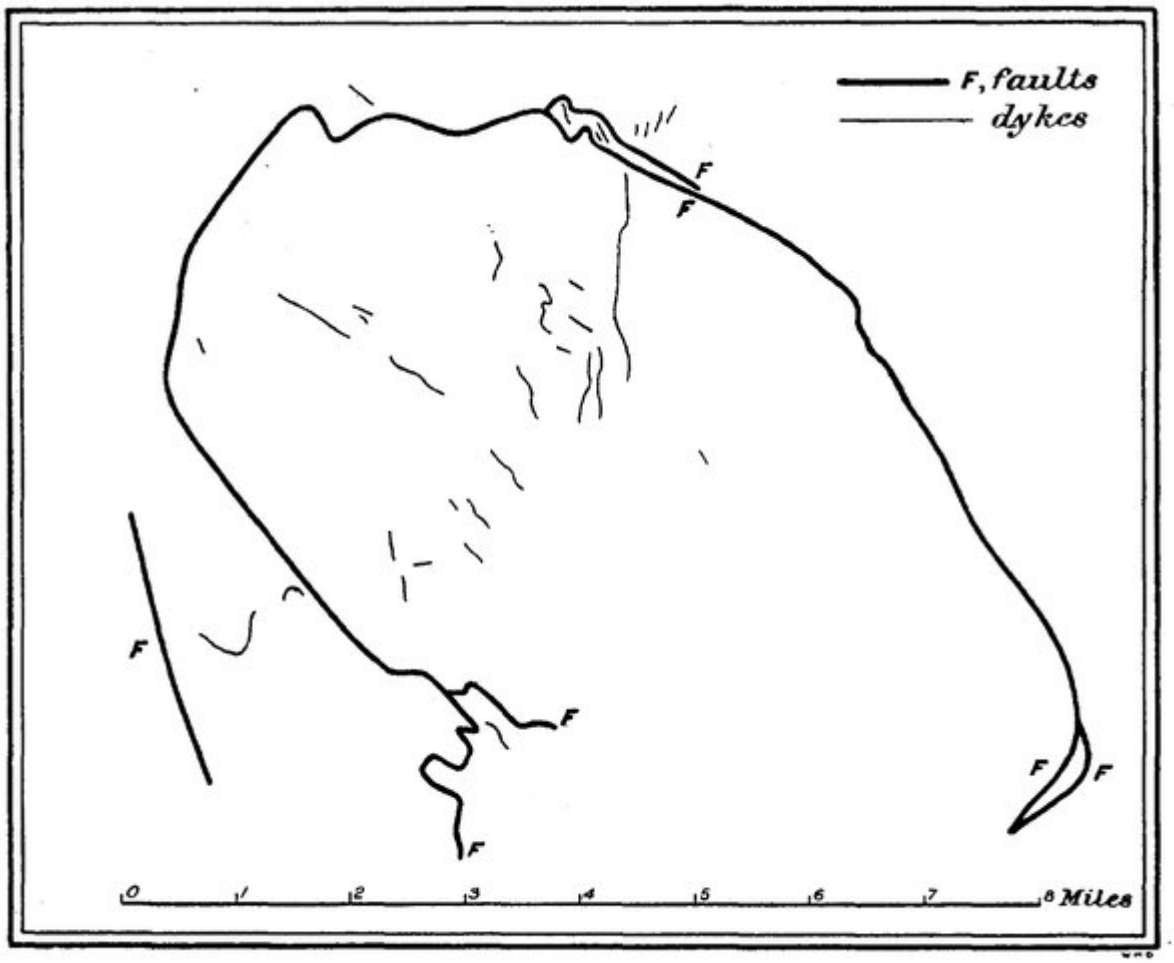


FIG. 33. Map of early felsite and andesite dykes of Glen Coe

(Figure 33) Map of early felsite and andesite dykes of Glen Coe.

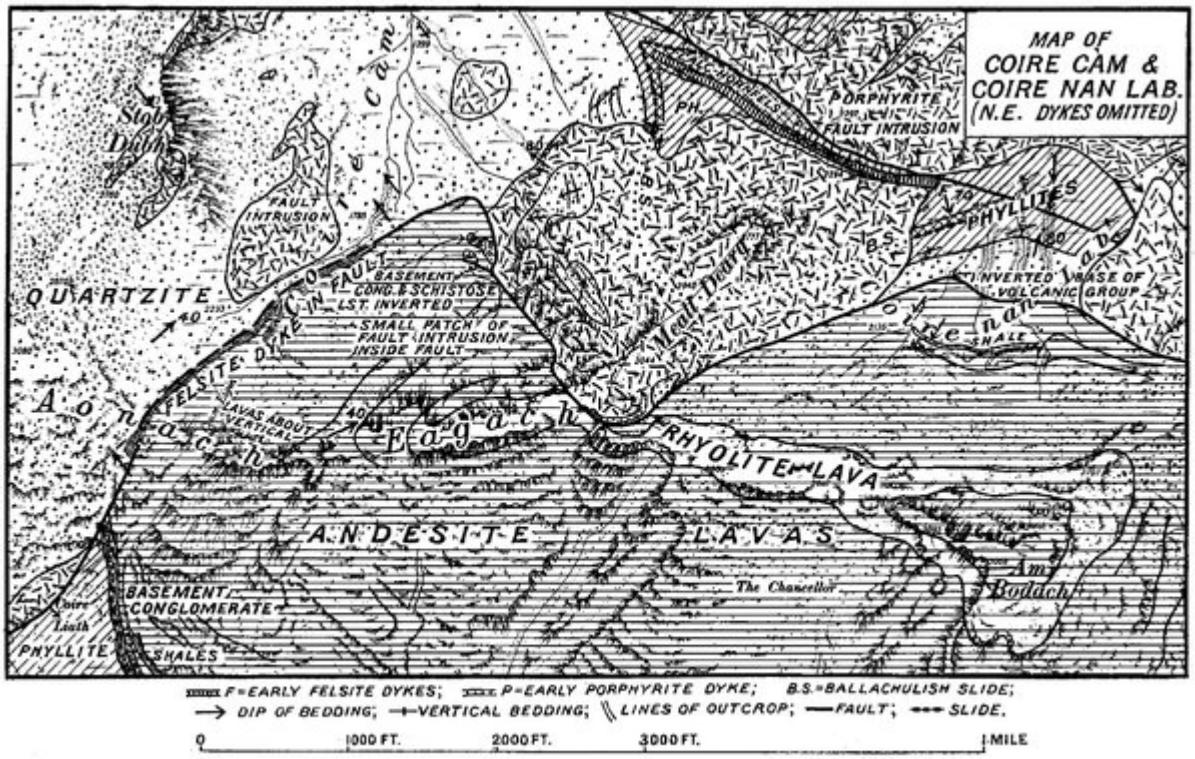


FIG. 23. Map of Coire Càm and Coire nan Lab. North-east dykes omitted. (The Fault-Intrusion is chilled at its contact with the early dykes north of Meall Dearg)

(Figure 23) Map of Coire Càm [NN 154 585] and Coire nan Lab [NN 167 584]. North-east dykes omitted. (The Fault-Intrusion is chilled at its contact with the early dykes north of Meall Dearg [NN 163 585]).

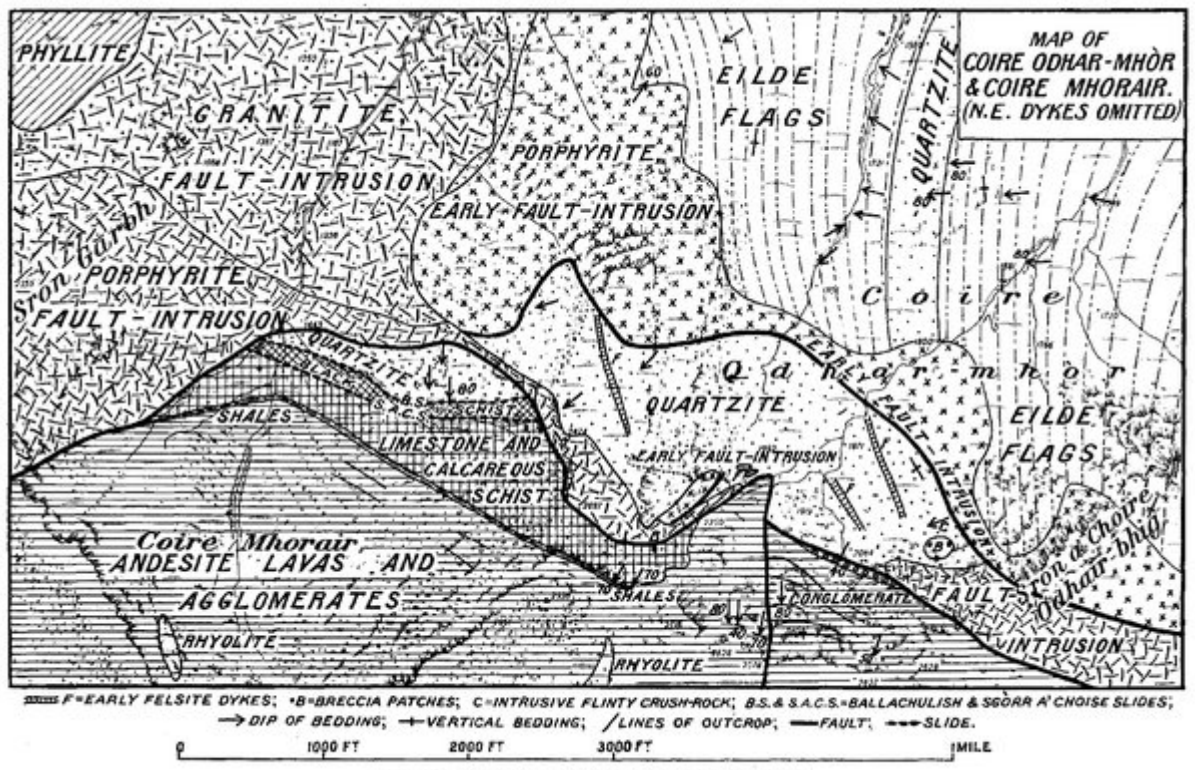


FIG. 24. Map of Coire Mhorair and Coire Odhar-mhòr

(Figure 24) Map of Coire Mhorair and Coire Odhar-mhòr [NN 196 583].

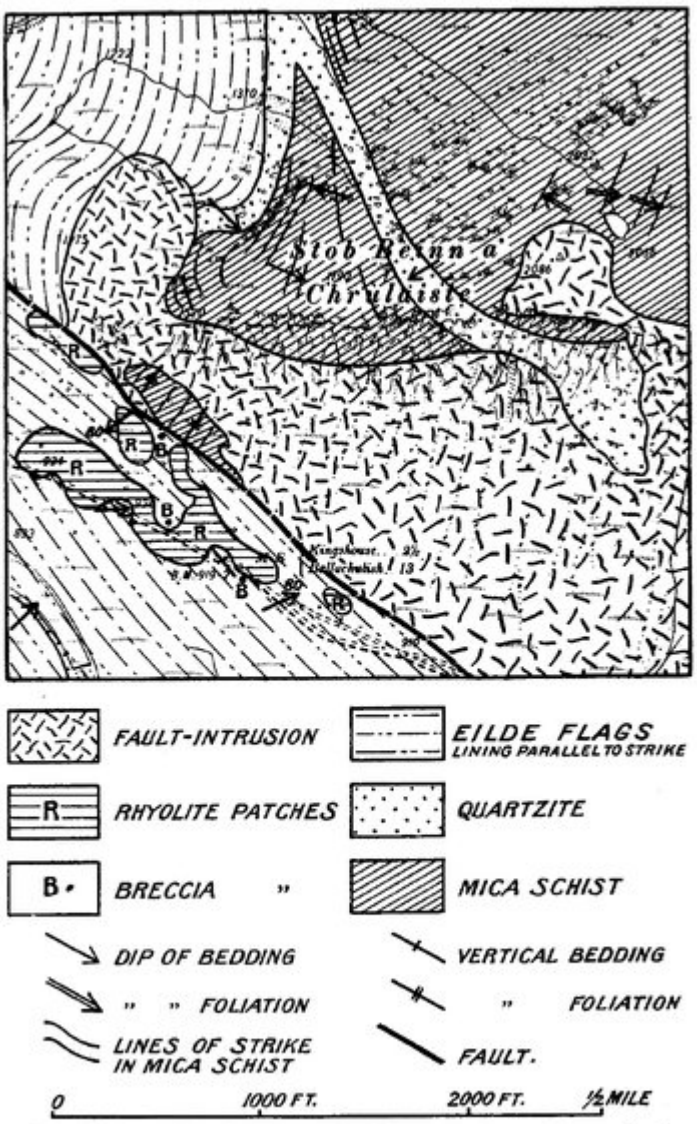


FIG. 28. Map of Stob Beinn a' Chrùlaiste. North-east dykes omitted

(Figure 28) Map of Stob Beinn a' Chrtilaiste. North-east dykes omitted.

VOLCANIC ROCKS: *Ben Nevis, Glen Coe, Lorne*
BASALT, ANDESITE, RHYOLITE.

DYKES: *Mostly of Nevis and Etive Swarms.*
PORPHYRITE, MICRODIORITE, LAMPROPHYRE, PORPHYRY.

INCLINED SHEETS: *Loch Fyne.*
QUARTZ-PORPHYRY.

ULTRA-ACID, ACID and INTERMEDIATE PLUTONS.
GRANITE, QUARTZ-DIORITE: 1 *Ben Nevis*; 2 *Mullach nan Coirean*; 3 *Loch Linnhe*; 4 *Strontian*; 5 *Ballachulish*; 6 *Glen Coe*; 7 *Rannoch*; 8 *Etive*; 9 *Garabal*; 10 *Loch Melfort.*

BASIC and ULTRA-BASIC PLUTONS, *including a few giant xenoliths*
APPINITE, MONZONITIC AUGITE-DIORITE, ETC., including
K = *KENTALLENITE.*

FIG. 18. Map of igneous rocks of South-West Highlands referred to Lower Old Red Sandstone Period

(Figure 18) Map of igneous rocks of South-West Highlands referred to Lower Old Red Sandstone Period.

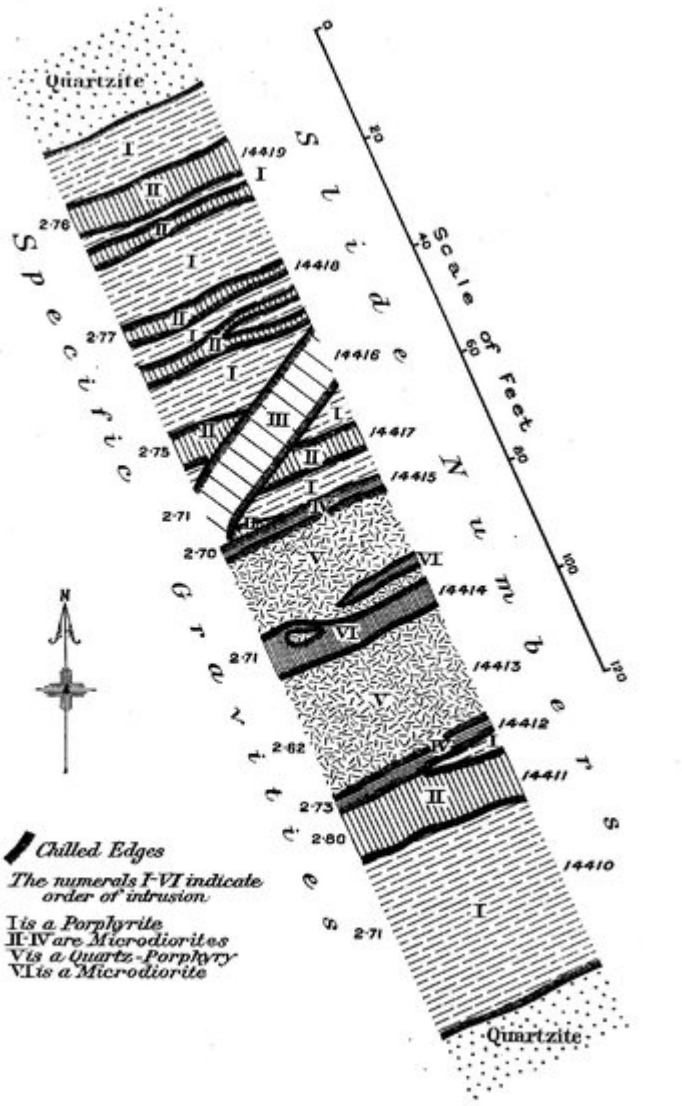


FIG. 34. Map of multiple dyke in the bed of Allt Fhaolain, ½ mile above the bridge, Glen Etive

(Figure 34) Map of multiple dyke in the bed of Allt Fhaolain [NN 158 510], ½ mile above bridge, Glen Etive.

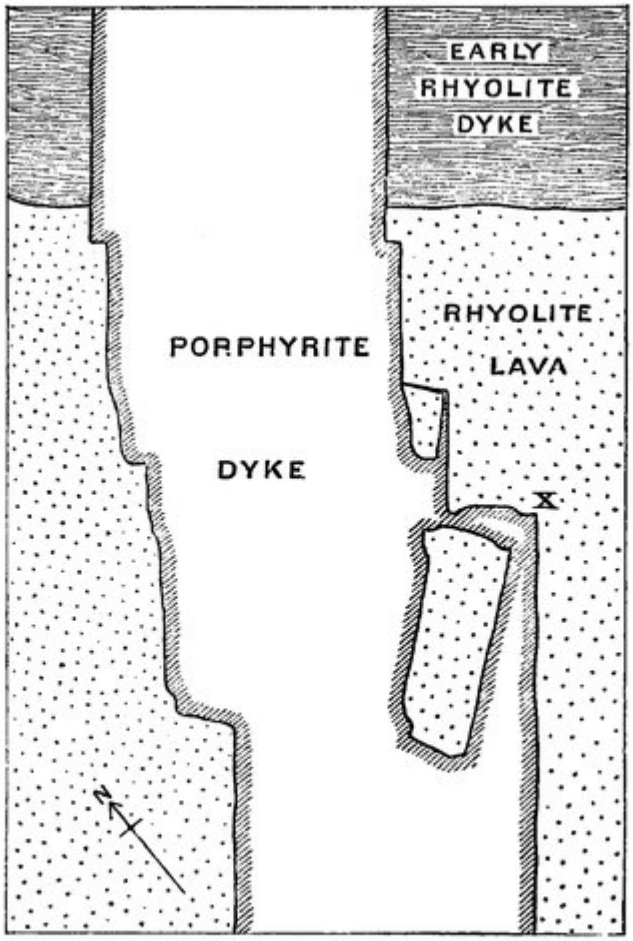
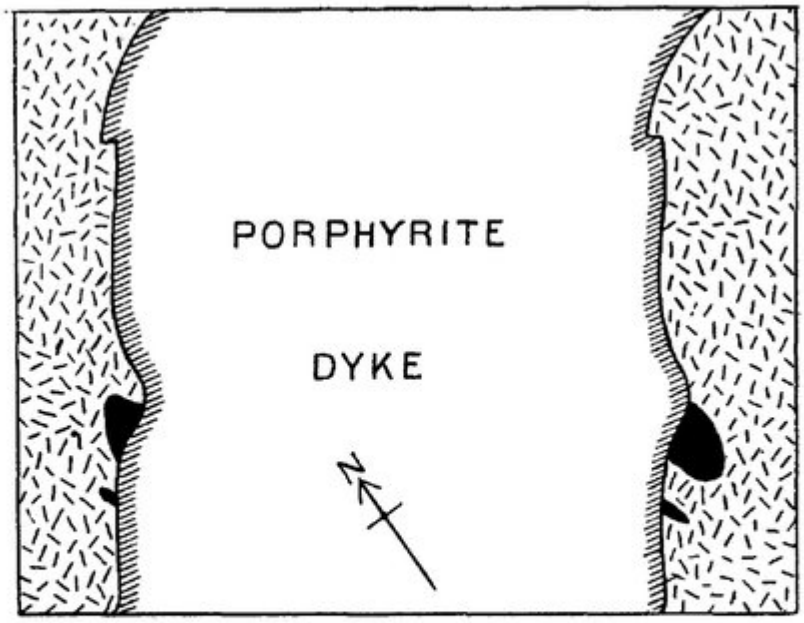


FIG. 35. Map of porphyrite dyke traversing rhyolites at the foot of the northern front of Buachaille Etive Beag

The walls of country-rock are counterparts the one of the other

(Figure 35) Map of porphyrite dyke traversing rhyolites at the foot of the northernn fromt of Buachaille Etive Beag [NN 192 548]. The walls of country-rock are counterparts the one of the other.



(about $\frac{1}{2\frac{1}{4}}$ natural size)

FIG. 36. Map of porphyrite dyke traversing Moor of Rannoch "Granite" in bed of River Etive, 500 yd above Kingshouse (Sheet 54, Geol.)

Two basic lumps have been bisected

(Figure 36) Map of dyke, River Etive, bisecting two basic lumps in Moor of Rannoch "Granite" in bed of River Etive 500 yd above Kinghouse (Sheet 54, Geol.) Two basic lumps have been bisected.