Chapter 21 Basic dykes and sheets of the Cuillins

The minor basic intrusions to be described in the present chapter are those peculiar to the Cuillin district; in which district must be included the Blaven range as well as the Cuillins proper. In other words, we have to deal with certain groups of intrusions which have a distribution limited by the boundary of the great gabbro laccolite, or extending only a little beyond it. Some of these have the form of dykes and others of inclined sheets. Both are very numerous, and contribute in a very important degree to the physical features of the gabbro mountain-district. We shall consider the dykes and the sheets in turn, this being generally the chronological order of their intrusion.

In discussing the direction of the basic dykes of Skye in general, we expressly excluded from our remarks those of the Cuillin district, as in part following other laws special to themselves. We proceed to set forth these laws, in so far as we are able to discover them. What are here styled laws are of course empirical, and are merely a convenient summing up of observations in the field: nevertheless, as serving to connect the bearings of the dykes with local crust-movements centring in the heart of the gabbro tract, they probably do embody some real principles in the mechanics of dyke-intrusions, which further knowledge of this somewhat obscure subject may be expected to elucidate.

In the first place it is to be remarked that a vast number of dykes in the gabbro tract have approximately a radiate arrangement with reference to the centre of the tract. We shall style these the *radial set* of dykes. A tendency to radiation about the mountain tract was pointed out in the bearings of the Skye dykes in general. There, however, it was only a tendency, being a secondary influence modifying the operation of the primary law of parallelism, and producing deviations from the normal direction which did not exceed a moderate limit. In the gabbro area of the Cuillins radiation becomes (for this set of dykes) the primary law, and sweeps round the whole circle, excepting only the north-eastern quarter, where the granite interposes and these dykes are wanting. At the same time it is interesting to note that the law of parallelism comes in here as a secondary modifying influence; for in places where the radiate arrangement would impose a direction not very different from the normal direction for Skye (say N. 37° W.), there seems to be a tendency for the dykes to be attracted towards this latter direction.

Secondly there are many dykes which follow directions nearly at right angles to the radial dykes at their locality, as if forming a set in some sense conjugate with the other. These will be distinguished as the *tangential set.* They are subordinate to the radial set, and are not found everywhere; but in some places, *e.g.* the upper part of Coir' a' Ghreadaidh, they become extremely numerous. They seem to be constantly earlier than the radial dykes, and are often seen to be cut by them. As a rule, they are most developed towards the periphery of the gabbro laccolite, and some dykes outside this limit are probably to be referred to the same set.

Further, there is a very great number of dykes within the gabbro tract which have what may be regarded as the normal direction for the dykes of the island, and these may conveniently be called the *normal set.* This is not meant to imply that they constitute a single natural group referable to one epoch, for such is not the case. In those parts of the gabbro tract where the radial and tangential dykes make considerable angles with the direction common to the region (*e.g.* if one set runs E.–W. and the other N.–S.), the normal set comes out distinctly. In other circumstances it is apt to be confused with one of the other sets, unless some evidence as to relative ages can be obtained.

The sequence of the several sets of minor intrusions peculiar to the Cuillin district is apparently as follows:

(i.) the tangential set of dykes

(ii.) the radial set, or the majority of these

(iii) the inclined sheets, to be described below

(iv) a radial set of ultrabasic dykes, to be described in the following chapter

In this scheme no place is assigned to the normal set of dykes, for the reason that they belong to various epochs. Some are earlier than any of these local sets of intrusions; others cut not only the tangential and radial dykes but the inclined sheets also; none, however, cut the ultrabasic dykes, which are thus the latest of all the igneous rocks of the Cuillins.

The fact that the several local sets of minor intrusions peculiar to the Cuillin district fall into a fairly definite chronological order may be taken to indicate that each set constitutes a distinct natural group belonging to a certain defined epoch. If we regard them all as related to crust-movements which originated beneath the centre of the gabbro laccolite, we must connect the several groups with different stages of those movements, when the varying condition of strain set up in the rocks of the area favoured the formation of fissures in different directions. The number of intersections actually observed among the groups (i), (ii), and (iii) is, however, not large, and the sequence deduced perhaps needs further confirmation and possibly correction.

The general account of the field-relations of the basic dykes of Skye contained in a former chapter is in many respects applicable to the special groups of dykes under notice; so that a few remarks on this subject will be sufficient. Both tangential and radial dykes are of quite moderate width, never rivalling the imposing dimensions attained by several of the basic dykes in other parts of the island. They may often be traced for long distances with practically straight courses and uniform width, though in some places towards the centre of the tract the smaller ones tend to become rather sinuous and otherwise irregular. A noticeable hade is not uncommon, more particularly towards the peripheral part of the gabbro tract and a little beyond it; and the hade, when it occurs, is evidently not determined by the same law which operated in the dykes away from the mountain-tract. It is found especially in the tangential set of dykes, and there the direction of inclination is outward from the centre of the tract. Multiple dykes are very rare in the radial set, and have not been observed in the tangential, although the individual dykes sometimes occur at very short intervals. This is perhaps due in part to the fact that each set of dykes belongs to a single epoch. It is partly attributable to the nature of the country-rock, but not wholly so; for in what we have called the normal set in the gabbro mountains multiple dykes are in some parts not infrequent,

It is not necessary to enter upon any full petrographical account of the dykes of the Cuillins, since this would be in great part a repetition of what has already been written. It is to be remarked, however, that these dykes are, so far as our observations go, all of thoroughly basic composition, the less basic types found in some other parts of Skye being unrepresented. The specific gravity of the rocks varies from 2.88 to 3.00, being often near the higher limit. The common types are non-porphyritic dolerites and basalts, of medium to fine texture, the smallest dykes having a very compact aspect.

The *inclined basic sheets* demand fuller notice. This very remarkable set of intrusions consists, in brief, of a vast number of roughly parallel sheets of basic rock intersecting the gabbro mountains in almost all parts, and having a general inward dip at moderate angles. We shall style them intrusive sheets, not sills, since it is convenient to reserve the latter term for that particular type of sheet-formed intrusion which follows the surfaces of bedding of stratified rocks. This latter type has been sufficiently illustrated by the sills of the basalt-plateaux, the thin lava-flows acting for this purpose as bedded rocks. The intrusive sheets cutting the massive gabbros obviously have their direction and inclination determined by quite other factors.

That the two great sets of sheet-formed intrusions are quite distinct in origin is sufficiently apparent from their distribution. The sills proper, attaining their maximum development in a distant part of the island, die out in the belt of metamorphosed lavas which fringes the gabbro of the Cuillins, and nowhere enter the latter rock. The inclined sheets, on the other hand, are strictly confined to the gabbro mountains, and their peculiar disposition, in whatever way it may be explained, points to a connection with some focus of eruption situated beneath the gabbro laccolite. Further, the considerations detailed above enable us to assign them to a late epoch in the history of igneous action in Skye, certainly much later than the epoch of the great sills.

The inclined sheets, though, as stated, found only in the gabbro mountains, are not limited to the gabbro itself. They intersect also the numerous patches of volcanic rocks enclosed in the gabbro mass and, in places, the basalt, shales, and granite which underlie it. They also intersect, as we have said, numerous dykes which themselves cut the gabbro. It is evident therefore that, whatever the relation of the inclined sheets to the plutonic rock may be, they are quite distinct

from it, and belong to a time long posterior to its intrusion.

The distribution of the inclined sheets is roughly indicated on the accompanying sketch-map (Figure 72), and it is at once evident that it is closely related to, though not coincident with, the limits of the gabbro itself. The limit of the sheets lies within that of the gabbro to the west, but beyond it to the east. Closer examination, with reference to a contoured map, makes it clear that there is a vertical as well as an areal distribution. Within a certain area, roughly that of the gabbro outcrop and perhaps corresponding pretty closely with the original extension of the gabbro laccolite, the sheets are present *everywhere above a certain imaginary surface.* It is in many places not very different from a horizontal plane at an altitude of about 1000 feet. From this, however, it makes some noteworthy departures corresponding in a general way with the deformed base of the gabbro laccolite itself, as illustrated in the accompanying longitudinal section across the mountains (Figure 73). Over the greater part of the area the lower part of the gabbro is almost or quite free from sheets. This is well seen on the western border, where this gabbro practically without inclined sheets amounts to about 1000 feet vertically, and makes a strip about a mile wide on the map. Traced southward and eastward, the lower limit of the sheets approximates more and more to the lower surface of the gabbro, and in the southward direction reaches it a little beyond Coire Labain. In the interior valleys of Sligachan and Camasunary, with their main branches, and on the shores of Loch Coruisk, there is only a small thickness of gabbro free from inclined sheets; although it makes a considerable spread, owing to the fact that the form of the ground corresponds nearly with the base of the gabbro not far below. It is particularly to be remarked that similar strips of gabbro without sheets, nearly half a mile in width, run along Glen Sligachan and Druim an Eidhne respectively, although the one rises only a few hundred feet above sea-level and the other is above the thousand-foot contour-line. This illustrates the way in which the lower limit of the sheets follows the shape of the base of the gabbro. Along the southern border the inclined sheets come down to the base of the gabbro; and along the southeastern border, *i.e.* on the outward slopes of the Blaven range, they come down considerably below the gabbro, intersecting the strips of basaltic lavas and Jurassic strata and the irregular sheets of granite which together form the slopes.

The inclination of the intrusive sheets is with a very marked regularity inwards: in other words, as shown by the arrows in the figure, they *dip towards a certain point in the interior* of the district, approximately beneath the granite hill Meall Dearg, marked by an asterisk. The angle of dip varies. On the ridges both of the Cuillins and of the Blaven range it is usually about 35° to 40° from the horizontal, and similar or somewhat higher angles are observed on the slopes of the Cuillins towards Coruisk, the dip sometimes rising to as much as 50°. On the outward slopes of the Cuillins, on the other hand, the inclination is gentler, the dips falling to 20° or even as low as 10° in places. There seems indeed to be a general rule that the inclined sheets become steeper towards the interior of the district.

At any given locality the sheets preserve their parallelism with a remarkable degree of regularity, rarely touching or cutting one another, although, in the higher parts of the mountains especially, they occur at very short intervals. Nor do they often, like the sills in the lava group, run in contact with one another, though such instances of double and triple sheets are not unknown. The individual sheets attain no great magnitude, the great majority being not more than two or three feet thick, and many less than a foot. They are visibly continuous for very long distances, and. run as a rule with great regularity. Only occasionally is a sheet found to be interrupted and displaced in a fashion already noticed in the case of the dykes; either with or without visible connection of the parts by strings and veins, but at least with a tendency to such connection (Figure 74). The general regularity of behaviour of the sheets in such a country-rock as gabbro is very striking.

Since there is almost conclusive evidence that the sheets die out downwards, we must suppose that they have been fed by dyke-fissures, and the only dykes which can be pointed out as probably marking the positions of these fissures are some of those with radiate disposition. In a few instances dykes of this set have been observed turning abruptly into sheets. It is true that in the great majority of cases which we have noticed during the mapping the radial dykes are cut by the sheets, but exceptions are found in which the reverse relation occurs. Even if the inclined sheets invariably cut the radial dykes, it might still be that the latter were, as a group, contemporaneous with, and the feeders of, the sheets; for it may be with these sheets, as with the sills of the plateaux, that the higher were intruded before the lower. It is more probable that some of the radial dykes hold this relation, while others are of somewhat earlier age, and are independent intrusions.

To illustrate the *chemical composition* of the inclined sheets a complete analysis has been made by Dr Pollard. Side by side with it we reproduce for comparison the analyses of two other basic rocks of the district. It is to be noticed that, despite the intimate association of the inclined sheets with the gabbro laccolite, there is no close resemblance between them as regards chemical composition. The characteristic high alumina-percentage of the gabbro, and its low titanic acid, iron-oxides, alkalies, and phosphoric acid, find no parallel in the inclined sheets. These late intrusions show more general resemblance to the basic sills of the plateau country; but this has probably no special significance, the sheets being undoubtedly a local group connected with the Cuillin centre. In the arc-spectrum taken by Sir J. Norman Lockyer the lines of chromium and vanadium are conspicuously shown.

	I.	A.	B.
SiO_2	47.64	47.28	45.24
TiO_2	1.27	0.28	2.26
Al_2O_3	14.15	21.09	15.63
Cr_2O_3	0.01		trace
V_2O3	0.06	0.02	
Fe_2O_3	5.18	3.52	5.56
FeO	7.96	3.91	7.19
NiO, CoO	trace		trace
MnO	0.33	015	0.23
MgO	7.38	8.06	7.82
CaO	11.71	13.42	9.38
Na_2O	2.38	1.52	2.01
K_2O	0.71	0.29	0.72
H_2O above 105°	1.44	0.53	2.21
H_2O at 105°C	0.19	0.13	1.12
P_2O_5	0.09	trace	0.20
S	0.03		CO2, 0.49
	100.53	100.22	100.06
Specific gravity	3.01	2.90	2.85

I. (S8062) [NG 468 256]. Dolerite, inclined sheet intersecting the gabbro, 100 yards S. of Loch a' Bhàsteir, near Sgùrr nan Gillean: anal. W. Pollard. Barium sought but not found.

A. (S8194) [NG 449 242]. Olivine-Gabbro, Coir' a' Mhadaidh: anal. W. Pollard; repeated for comparison.

B. (S7854) [NG 502 336]. Olivine-Dolerite, sill in basaltic lavas, summit of Ben Lee, near Loch Sligachan: anal. W. Pollard; repeated for comparison.

Petrographically the inclined sheets, while constantly of basic composition, present some range of variety. The most usual type is a *moderately fine-textured dolerite, without olivine.* Such rocks are widely distributed throughout the gabbro mountains, and may be studied in the Sgùrr nan Gillean group and many other places. In hand-specimens they are dark grey, evidently crystalline rocks, without porphyritic elements. In thin slices they are seen to have a typical ophitic to sub-ophitic structure. The felspars present narrow rectangular sections, about 1/50 inch long, with albite twinning: when a little broader, they show carlsbad twinning in addition. Their extinction-angles indicate labradorite. The augite, very pale brown in the slices, enwraps and sometimes encloses the felspars. It is usually fresh, but in places has given rise to patches of a green chloritic material with confused scaly structure. Opaque iron-ore is abundant in grains and sometimes in skeleton-shapes: it is in the main magnetite, though ilmenite can also be identified. In addition there may be a little pyrites, visible as brass-yellow specks on a hand-specimen. Olivine is not found in this common type, and apatite is only sparingly present. An amygdaloidal structure is rare here and in the inclined sheets generally.

Slight variations from this type occur in some examples. In one or two slices there are, in addition to the dominant felspar with its "lath-shaped" sections, scattered crystals, larger and broader, with no good outlines. These are untwinned, and sometimes show a slight zonary banding between crossed nicols. They are clearly of somewhat late crystallisation, being

moulded on the augite, which in these places is partially idiomorphic (S8061) [NG 473 256]. More exceptionally these shapeless zoned felspars become an important constituent (S7472) [NG 540 221], as in some varieties of the basic dykes.

Another variety arises from the presence of relatively large felspars, inch or more in diameter, which give the rock something of a porphyritic appearance. The sporadic occurrence of these felspars often suggests that they may be derived elements (xenocrysts of Sollas) from the gabbro, and this suspicion is confirmed by microscopic examination. The crystals are sometimes curiously fissured, and contain little round inclusions with a peculiar disposition (often following pericline lamellae) which may be of secondary origin (S7471) [NG 530 211]. These scattered felspars are found in several cases in sheets which enclose abundant debris (xenoliths) of gabbro, *e.g.* on Sgùrr a Bhàsteir (S7855) [NG 462 260], in Lota Corrie, and at several places on Druim nan Ramh; a circumstance which strengthens the supposition that they are of foreign origin.

Distinct from the preceding are the truly porphyritic rocks which are found, sometimes numerously, in certain parts of the mountains. The prevalent type in Coir' a' Chruidh, to the east of Gars-bheinn, is a *porphyritic dolerite,* without olivine (S8710) [NG 476 187]. It has a compact dark grey ground, through which are scattered abundant small felspars and rarer black specks of augite. Thin slices show these felspars to be labradorite with carlsbad and albite twinning and some degree of zonary banding. They are clear, and contain large inclusions of the ground-mass. Sometimes they are aggregated, together with some augite, to form "glomero-porphyritic groups. The ground-mass is of little felspar laths with subordinate augite, but abundant magnetite in minute crystals and granules. The specific gravity of a specimen from Coir' a' Chruidh is 29.07.

A common type on Gars-bheinn and its neighbour to the north, Sgùrr a' Choire Bheag (not named on the Ordnance map), has porphyritic felspars up to nearly ¼ inch in diameter with more or less rounded outlines. These are sometimes so numerous as to make up quite half of the rock (S8711) [NG 466 191]. They are labradorite, with carlsbad, albite, and rarely pericline twinning, and contain round glass-inclusions. The ground-mass is rather fine-textured, and has the granulitic structure as a rule, consisting of little felspars, abundant augite, and some small crystal-grains of magnetite.

On Sgùrr Thuilm occur numerous sheets of a *porphyritic olivine-dolerite* (S7856) [NG 440 247], not observed elsewhere. It is a dark grey, finely crystalline rock, showing abundant small felspars, usually less than ■ inch in length, with partially rounded shape. These in a thin slice are seen to contain irregular inclusions like altered glass-cavities. They have the usual carlsbad and albite twinning, and also very evident zonary banding between crossed nicols. The ground-mass is of the granulitic kind, and consists mainly of small lath-shaped felspars and light brown granules of augite. In addition to the slender felspars with albite twinning, ranging up to about 1/50 inch in length, there are a few more shapeless crystals, zoned but not twinned, forming a later generation. Magnetite granules are fairly plentiful, and olivine is represented .by green or yellow-green strongly pleochroic pseudomorphs, with straight extinction referred to a marked set of cleavage-traces, comparable with the mineral already noticed in the basaltic lavas and gabbros.

The prevalent type is, as we have stated, that of a dolerite without olivine. There are, however, in several parts of the mountains sheets of *olivine-dolerite* of a decidedly more basic type, in which that mineral is present in some abundance. Such sheets do not occur in great number, but they are often very prominent, owing to their superior durability and to the rusty weathered surface which they present. A strong sheet of this kind, with conspicuous felspars (not porphyritic) from ■ to ¼ inch in diameter, forms the two summits of Blath-bheinn. This is of coarse texture, resembling a gabbro in general appearance (S8712) [NG 530 217]. Another red-weathering sheet is seen at the summit of Sgùrr Dearg, forming the perilous slope towards the east. This is, like the other, a dark rock with a tendency to spheroidal weathering, but it is not of such coarse texture (S8836) [NG 444 216]. It has a specific gravity 2.96. Several small sheets, comparable in some respects with that of Blath-bheinn summit, crop out on the western face of Sgùrr na Stri (S8713) [NG 496 190], and others might be enumerated from other localities.

The felspar of these rocks is of varieties more basic than labradorite. In the Sgùrr na Stri sheets it is bytownite, in the other examples mentioned anorthite. It always shows a strong zonary banding between crossed nicols, but this is only near the border of the crystal; our specification applies to the interior and principal portion. There is carlsbad and albite twinning, and in the coarser-textured rocks pericline also. Glass-inclusions are sometimes conspicuous by their relatively

large size. Olivine is represented by abundant pseudomorphs of green serpentine, sometimes with pilitic hornblende. Magnetite occurs in various forms, and occasionally a few needles of apatite. The augite is of a pale brown colour in thin slices, with evident zonary growth, the central part being paler than the margin. In the Sgùrr Dearg sheet it has the ophitic habit, but the coarser rocks have a structure approximating more to the hypidiomorphic.

In the strong ledges which these sheets rich in olivine build, and usually too in the rusty colour which they assume on exposed faces, we find a resemblance to the peridotites to be described in the following chapter. Although the apparent similarity is dispelled by closer examination, we have seen that these sheets are still decidedly more basic than the majority. Regarding them as a distinct sub-group, we also find indications that they are of somewhat later intrusion than the general assemblage of inclined sheets. So far as has been observed, they intersect all other intrusions which they encounter, and are intersected by none, which cannot be predicated of the inclined sheets as a whole. It is therefore possible that these few sheets may be intermediate in age, as well as in composition, between the ordinary dolerite sheets and the succeeding ultrabasic intrusions.

The inclined sheets of basic rocks not infrequently carry *xenoliths,* though rarely in such quantity as is observed in certain groups of the basic dykes of the island. Instances occur on Sgùrr a' Bhàsteir, on Bidein Druim nan Ramh and the neighbouring part of the ridge, in Lota Corrie, Coir' a' Mhadaidh, and other parts of the Cuillins. The "Inaccessible Pinnacle" of Sgùrr Dearg rests on a sheet exceptionally full of xenoliths. In certain sheets also there are, as remarked above, quasi-porphyritic crystals of felspar which seem to be of foreign derivation. The phenomena are very similar to those already described in the dykes. In the present case, however, the enclosed debris is apparently always of gabbro, and may therefore have been picked up from the rocks which the sheets traverse. The xenoliths are often clustered together about particular places along the outcrop of the sheet in which they occur, and they are sometimes very unequally distributed in the width or thickness of the sheet, a circumstance also observed in some of the dykes. This is well seen in an inclined sheet, 6 feet thick, which crosses the southerly ridge of Sgùrr an Eidhne at about 1240 feet altitude. The sheet consists of two bands, the underlying one full of gabbro xenoliths, the overlying one quite free from them. There is, however, no sharp division between the two portions, and it cannot be doubted that the whole represents a single intrusion. The magma as intruded must have consisted of two portions, one with and the other without xenoliths, and the two portions have been drawn out into the sheet form without mingling except at their actual junction with one another.

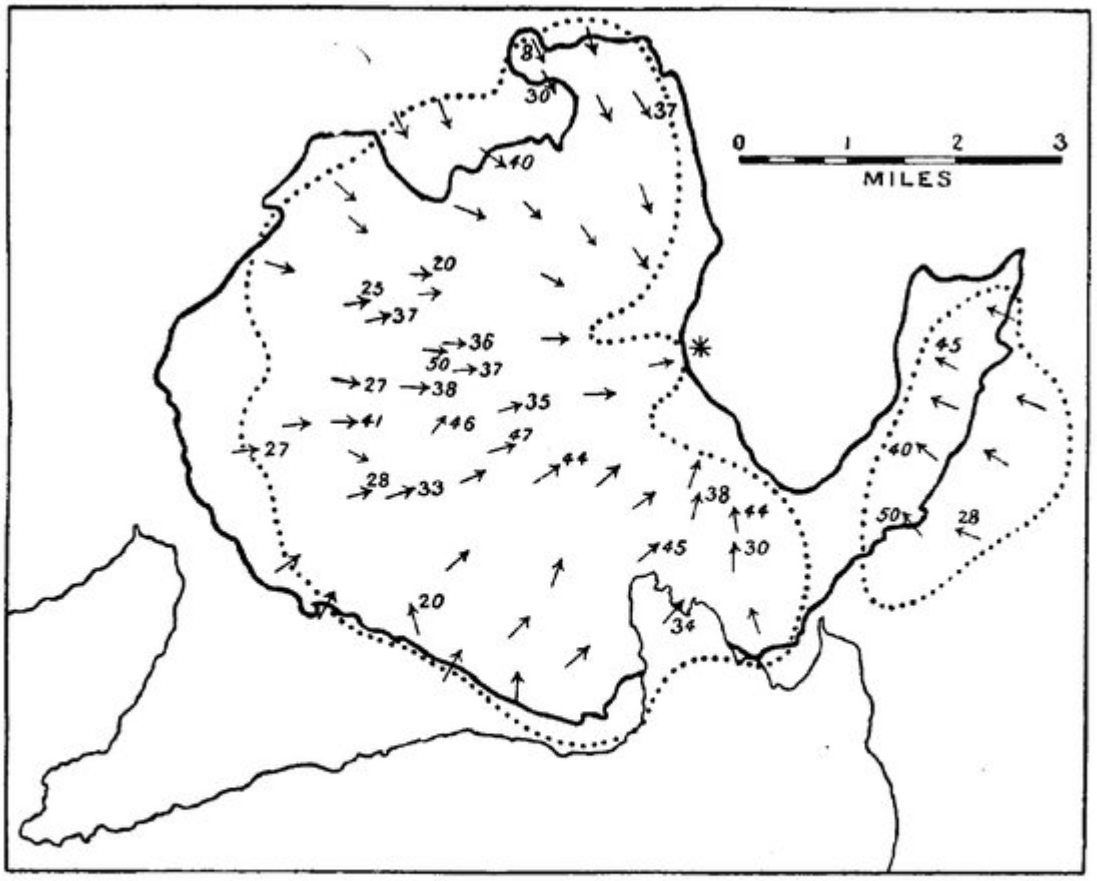

FIG. 72.—Sketch-map to illustrate the distribution and inclination of the inclined basic sheets of the Cuillins. The strong line marks the outline of the gabbro area: the dotted lines enclose the areas within which the inclined sheets are found, and the arrows (with figures) indicate the dips of the sheets.

(Figure 72) Sketch-map to illustrate the distribution and inclination of the inclined basic sheets of the Cuillins. The strong line marks the outline of the gabbro area: the dotted lines enclose the areas within which the inclined sheets are found, and the arrows (with figures) indicate the dips of the sheets.

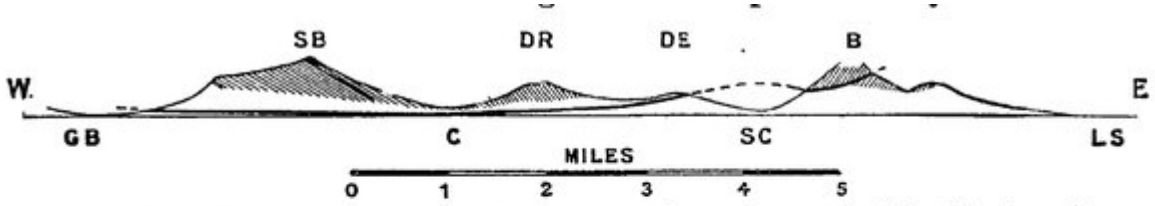

FIG. 73.—Section across the gabbro area to show the vertical distribution of the inclined sheets. The strong line shows the base of the gabbro laccolite: the short lines represent the inclined sheets, and are drawn at approximately the true inclinations. The letters refer to localities, as follows: GB, Glen Brittle; SB, Sgùrr na Banachdich; C, Coruisk; DR, Druim nan Ramh; DE, Druim an Eidhne; SC, Strath na Creitheach; B, Blath-bheinn; LS, Loch Slapin.

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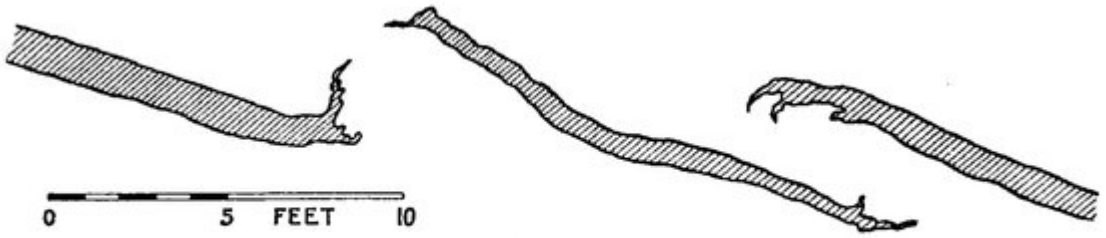

Fig. 74.—Section to illustrate the shifting of an inclined basic sheet, cutting the gabbro, near the outfall of Allt a' Chaoich, Loch Scavaig.

(Figure 74) Section to illustrate the shifting of an inclined asic sheet, cutting the gabbro, near the outfall of Allt a' Chaoich, Loch Scavaig.