Chapter 17 Basic dykes: field relations

Every geologist who has written of Skye, or of others of the Inner Hebrides, has remarked upon the prominent part played by dykes in the igneous geology of the region. By far the greatest number of them are composed of basic rocks — diabase, dolerite, basalt. They are by no means all of one age, or approximately so: on the contrary, numerous successive episodes in the history of Tertiary igneous activity in the region have been characterised by the intrusions of a vast number of dykes. Nor have they all fulfilled the same functions. We have already stated that some of them occupy the fissures through which the lavas were poured forth; while others, of later age, may perhaps stand in a like relationship to the intruded sills. We shall see that others again, and these doubtless a majority of the whole, did not, so far as we can ascertain, fulfil any such office, but are to be regarded as complete and self-contained intrusive bodies. These are younger than lavas or sills, and belong to more than one distinct epoch.

A complete investigation of the dykes would include the separation of them into distinct groups, the arranging of these in chronological sequence, and the petrographical description of each group. We have not been able to obtain the requisite data for such a complete account, and it may be doubted whether such data are attainable. The imperfect results which represent the very partial success of our attempts in this direction will be given below; but in the present chapter we shall make some general remarks upon the basic dykes of Skye as a whole, and more especially upon the characters which they exhibit in the field. These remarks are prompted by observations made during our detailed survey, which embraced only a part of the island; but from what has been written by other geologists, and in particular from the general account given by Sir A. Geikie,<ref>*Trans. Roy. Soc. Edin.* , vol. xxxv., pp. 29–74; 1888: *Ancient Volcanoes of Great Britain,* vol. ii., chapters xxxiv., xxxv.; 1897.</ref> it cannot be doubted that the results are applicable, not only to the whole of Skye, but to a much wider region.

The most striking features of the dykes as a whole are undoubtedly their astonishing number and their general community of direction. These and some other points appear clearly on the geological map, but we shall proceed to consider them more fully. And first it is very noticeable that the dykes are by no means equally numerous in different parts of the country. A small part of this inequality is no doubt only apparent, and results merely from the fact that over considerable areas the rocks are totally concealed by peat; but this affords no adequate explanation of the differences actually observed. For instance, the hills composed of granite and of Torridon Sandstone afford everywhere abundant exposures, but they often contain much fewer dykes than other areas adjacent.

A glance at the map is sufficient to show that *the frequency of the dykes* in different places depends very largely upon *the nature of the country rock.*

A striking illustration of this appears on comparing the basalt country and the gabbro of the Cuillins on the one hand with the granite tract on the other. While a square mile of the former often contains as many as a hundred dykes, an equal area of the latter shows on the average only five or six at most. This point calls for some remark as regards its bearing on the relative ages of the various intrusions. As Sir A. Geikie has long ago pointed out, there are dykes obviously older than the granite, being clearly cut off or enclosed and highly metamorphosed by it; while others again are later, and cut the granite. But the fact that the great majority of the dykes which approach the granite do not intersect it, must not be taken as implying that most of the dykes are pre-granitic. The reverse is certainly the case; and the dykes in general do not cut the granite, only because they experienced a difficulty in penetrating it. This is abundantly proved. We see, for example, that where the granite becomes a sheet of no great thickness the dykes do cut it, and where apophyses run out from the main body the dykes cut these freely. Further, in places where very numerous dykes approach close to the granite without entering it, as on the south side of the Beinn an Dubhaich mass, the great majority of them are not metamorphosed. These must be newer than the granite, although they stop short against it.

The fact that the gabbro in certain places in the Cuillin tract is, in contrast to the neighbouring parts, relatively free from dykes is explained by the presence of granite underlying it. This is well seen on Druim an Eidhne and in Coire Riabhach, where for about three-quarters of a mile from the granite boundary the gabbro contains almost no dykes, excepting those sent out by the granite itself. The Blaven range affords another good illustration, having far more dykes on its eastern than on its western side. This is doubtless due to the fact that the granite sheet, thick in Strath na Creitheach, thins out rapidly eastward. It also thins out southward, and so, as we approach Camasunary, we find the dykes appearing in force in the valley.

The resistance offered by the granite to the passage of the dykes cannot arise from its hardness and toughness, for in these respects it is inferior to the gabbro. Possibly chemical as well as physical considerations enter into the question. The freedom with which dykes, often of very small width, cut through the massive gabbro is a striking phenomenon. They are not noticeably fewer on the summits of the Cuillins than in the adjacent valleys, although they must have traversed between 2000 and 3000 feet of gabbro. To this, however, there seems to be a limit; for when we turn from the gabbro laccolite of the Cuillins to the gabbro boss to the northwest of Broadford, we find the latter almost entirely free from dykes, excepting only those of acid composition clearly belonging to the adjacent granite. Similarly the granite of the eastern Red Hills, apparently of the nature of a boss, is cut by very few dykes, and the undoubted boss of Beinn an Dubhaich by none.

The basalt lavas, as we have said, are freely traversed by dykes, and the same is true of the sills intercalated among the lavas, so long as they are of small or moderate thickness. We find, however, that those parts of the moorland hills which consist largely of thick sills have often very few dykes. Doubtless some of the dykes seen on the lower ground represent the feeders of the sill-like intrusions themselves, and naturally terminate in their own individual sills; but the general explanation must be that the thick sills offered an almost impenetrable barrier to the passage of dykes intruded later.

Another rock which is not often cut by basic dykes is the volcanic agglomerate. This is very remarkably illustrated in the lower part of Tairneilear, where dykes traversing the gabbro are seen to end abruptly against the boundary of one of the patches of agglomerate enclosed in the gabbro (Figure 62). It is noticeable that each dyke becomes slightly swollen towards its termination.

Turning to the sedimentary rocks, we find, as might be anticipated, that the Cambrian limestones are easily cut by the dykes, which occur in these rocks in the Strath district with great profusion. The Torridon Sandstone, which is here overthrust so as to rest on the limestones, affords a strong contrast in this respect; and near the junction of the two formations it is seen that while basalt dykes occur in the limestone often at average intervals of ten yards or less, a very small fraction of the number have penetrated the overlying sandstone. Leaving out the Sleat district, where over a large area the Torridonian is the sole country-rock, the only places where the sandstone contains abundant dykes are the isle of Soay, with a small area along the coast at the south-eastern base of Garsbheinn, and some parts of the isle of Scalpay. An apparent difficulty is suggested by the consideration that the Cambrian limestones of Strath, which are often crowded with dykes, presumably rest on Torridon Sandstone in its proper position beneath; through this the basalt dykes, or the basalt of the dykes in some form, must have found a way. The Torridon Sandstone again underlies probably the whole of the Ouillins. We must admit that the dykes were able to traverse the sandstone when no other course was open to them; and that the sandstone in the Strath district is comparatively free from dykes, only because the limestone in the immediate neighbourhood offered an easier passage.<ref>The implied assumption that the Torridonian was stripped from Ben Suardal, etc., in pre-Tertiary times is a justifiable one. In the Torran neighbourhood we see that it had been removed, not only from the summit, but from both flanks of the anticline before the deposition of the Lias. For some distance north of Strath Suardal too the sandstone must have been stripped away in pre-Tertiary times, for in several of the patches enclosed in the Beinn na Caillich granite the basaltic lavas are seen resting on Cambrian limestones.</ref> It is important to note, as we shall show hereafter, that the molten magma has often travelled along the dyke-fissures in directions very considerably inclined to the vertical and sometimes nearly horizontal. (See Chapter 23)

A rock remarkably impenetrable to dykes is the coarse Triassic conglomerate. At Eilean Leac na Gainimh, on the N.W. coast of Scalpay, a 12 ft dolerite dyke traversing the Torridonian stops abruptly at the base of this conglomerate.

Dykes are usually very numerous in the Jurassic strata. Macculloch<ref>*Trans. Geol. Soc.,* vol. iv., p. 171; 1817: *Description of the Western Islands of Scotland,* vol. i., pp. 395–398; pl. XVI., fig. 1; 1819.</ref> noted their remarkable abundance on the east side of the Strathaird peninsula, where, he says, without much exaggeration, "they in some places nearly equal, when collectively measured, the stratified rock through which they pass". Notwithstanding his statement to the contrary, they are equally abundant on the west side of the peninsula. It seems certain that in places a considerable proportion of them fail to penetrate the outliers of basaltic lavas (with sills) which rest on the Jurassic strata of Strathaird.

If we confine our attention to a single country-rock, we find that the dykes are not always uniformly distributed throughout its area, but sometimes show a certain tendency to congregate in particular belts of country. Mr Clough notes this in the Torridonian tract which forms the greater part of Sleat. "As we pass from Kyleakin to the Point of Sleat, along a line oblique to the general direction of the dykes, they gradually become more abundant; but there are certain spaces in which they are fewer than on either side. For about three miles S.W. from Kyleakin we do not usually find more than three or four in the breadth of a mile; near Kinloch there are more than twice as many in the same breadth; in a tract which comes to the Sound of Skye between Knock Bay and Camas Baravaig they are again less numerous; but S.W. of this they appear again in great force. On the S.W. side of a line connecting Ob Gauscavaig and Tormore they are too numerous to be all shown on the one-inch map". In the basaltic tract, the only more extensive area of uniform geological constitution, the irregularities in the frequency of the dykes seem to have something of the same peculiarity; but here the principle, if it be one, is obscured by a more important factor, viz. the obstruction offered to dykes by the massive sills. There are thus more dykes in the valleys than on the plateaux. Moreover there are considerable stretches of country almost wholly concealed by peat. The principal area of granite presents a distribution of dykes more nearly comparable with that found in the Torridonian tract of Sleat. If a line be drawn in a direction N.W. by N.–S.E. by S., from Glamaig to Torran, it is seen that in the granite to the north-east of this dykes are very rare, their scarcity being emphasized by the occurrence of numerous dykes in the patch of basaltic lavas and gabbro forming the northern part of Beinn na Cro. To the south-west of the same line, between it and a parallel line near Allt na Measarroch (N.E. of Marsco), lies a belt which includes most of the dykes of the granite tract: about Beinn Dearg (of Sligachan) it contains as many as thirty dykes in a breadth of two miles. Still further to the south-west, on Marsco, Ruadh Stac, and the slopes beyond Strath na Creitheach, dykes again become comparatively rare. We must remember, however, that, in consequence of the different geological relations of the granite in different parts of the area, its vertical thickness must present great variations, and this may, as already remarked, have an important influence on the frequency of the dykes.

In this connection we may notice the distinction drawn by Sir A. Geikie<ref>*Trans. Roy. Soc. Edin.,* vol. xxxv., p. 33; 1888: *Ancient Volcanoes of Great Britain,* vol. ii., p. 122; 1897.</ref> between the "Solitary" and the "Gregarious" types of dykes. His instances of the former are drawn from outlying parts of the Tertiary igneous province, *e.g.* the Cleveland dyke, and the Skye dykes undoubtedly tend to occur in sets; but we find also single dykes, usually of rather large size, occurring alone. A good example is the diabase dyke, more than 50 feet wide, which makes a prominent feature on the eastern face of Beinn na Caillich as seen from Broadford (*see* (Figure 5), p. 17). It bears W.N.W. and can be traced for only a short distance. There are also some which, though occurring among other dykes, may be far from any other of their own kind. Such are the coarse diabase or gabbro-like dykes, not belonging to the gabbros proper, which are found in a few places.

More striking than their gregarious habit is the tendency of the dykes to occur in actual juxtaposition, without any intervening strip of country-rock. Two or more dykes, sometimes ten or twelve, can often be traced running in actual contact with one another for considerable distances. In this way arise what may be styled double, triple, and *multiple dykes,* a peculiarity already noticed in the basic sills. The several members of such an assemblage constitute in some respects a geological unit: for example they are necessarily mapped in most cases as one dyke, to which the epithet "multiple" may be attached to mark its true nature. They may die out successively, producing the effect of the multiple dyke thinning away, or they may part company, giving a fallacious appearance of bifurcation or branching. A good example of a multiple dyke is seen near Gilchrist, to the south-east of the loch. Here, abutting upon the road from Broadford to Torran, is a prominent ridge formed by what appears to be a large dyke more than 100 feet wide traversing the Cambrian limestones. Following it for a short distance from the road, we find it dividing, so as to enclose a strip of limestone some 400 feet long and 30 or 40 feet wide. This strip is not enveloped by a single large dyke, but caught between two distinct dykes; and a closer scrutiny of the road-side section reveals that we have to do not with one large dyke but with at least six contiguous dykes. They are recognisable as distinct intrusions by petrographical differences and in some cases chilled margins.

Multiple dykes are not confined to any one part of Skye, but there are certain parts of the island, very rich in dykes, where this mode of occurrence is exceedingly prevalent. This is the case in the basaltic country to the north-west of the mountains, between Loch Sligachan and Glen Eynort or between Glen Varragill and Loch Harport; and again throughout the Straithaird peninsula, to the southeast of the mountains (*see* (Figure 52), p. 238). There are even places where the dykes which run singly are a minority. In the granitic tract multiple dykes are very rarely met with. One is seen on Druim Eadar da Choire, having a total width of 23½ feet and consisting of nine members, as follows, from S. to N.: (i.) with strong prismatic jointing, ½ ft; (ii.) massive, with a few amygdules, 2 ft; (iii.) highly amygdaloidal and much decomposed, ½ ft; (iv.) like ii., 6 ft; (v.) with spheroidal structure, 3 ft; (vi.) like iii., ½ ft; (vii.) with large irregular crystals of augite, up to 1 inch, and grains of olivine, 6 ft; (viii.) like iii., ½ ft; (ix) with spheroidal structure and containing large felspar phenocrysts, 4½ ft.

The several components of a multiple dyke are certainly not always referable to the same group of intrusions. This appears both from petrographical considerations and from direct evidence — such as the chilling of one member against another — which proves a certain time-interval between the separate intrusions. Chilled edges are, however, less frequently seen in the area of principal distribution of multiple dykes than in outlying districts, where occurrences are rarer and the multiple character perhaps a more fortuitous circumstance. Rarely, if ever, can we verify that one member cuts a transverse dyke, while others are cut by it. Mr Clough notes that at one place in the Sleat district, "half a mile N.N.E. of Rudha Chàrn nan Cearc, a N.N.W. coarse dolerite dyke is crossed by some E.–W. calcite strings, while a later fine-grained dyke runs with the coarse dyke and cuts through some of the strings".

In most of the multiple dykes the several members, while differing in histological and structural characters and perhaps to some extent in composition, are all of basic rocks; but in other cases acid rocks are associated with the basic. An example easily accessible is seen on the shore N.E. of Corry Lodge, Broadford. It is a multiple dyke 26 ft in width, half of which is occupied by a single member consisting of granophyre. This has on one side a single basalt dyke 1 ft wide, and on the other a group of basalt dykes with a total width of 12 ft. The granophyre cuts obliquely across one of the latter, proving that it is of later intrusion. Dykes consisting of several members which differ considerably in composition may conveniently be termed *composite multiple dykes.* As an example showing more complexity, we may take one near the coast 1100 yards S.S.E. of Camasunary, well seen just below the escarpment formed by the basaltic lavas of Strathaird. This shows, in order: compact felsite with sinuous flow-structure, 8 ft; basalt, 2 ft; felsite as before, 11 ft; basalt, 7 ft; felsite, 4 ft; basalt, 1 ft; felsite, with a tongue of basalt cutting into it, 4 ft; porphyritic felsite, 1 ft; basalt, 2 ft; compact felsite, 17 ft; basalt, ½ ft; compact felsite, 18 ft; in all twelve members in a width of 75 ft. This is perhaps not the full width, for after 20 ft of concealed rocks we come next to a porphyritic dolerite, and other dykes follow without any interval. We have had occasion in a former chapter to allude to composite multiple dykes consisting, like these, of basic and acid members. They were there introduced in connection with certain triple composite dykes of symmetrical habit presenting remarkable petrographical phenomena at the junctions of the component members. The commoner kinds of composite dykes have no systematic symmetry of habit (though this may come in locally and by accident), and do not show any sensible effects of reaction between basic and acid rocks. They have a somewhat wider distribution than the special type, and aro of later date, being constantly found to intersect the ordinary basic sills. After what has been said before, there is no need to mention more examples in this place.

The splitting of one dyke by a parallel dyke distinctly later and independent is very exceptional.<ref>See, *e.g.,* Macculloch, *Description of the Western Islands of Scotland,* vol. iii., p1. XVIII., fig. 1; 1819.</ref> There are, however, in certain dykes, of more or less basic composition throughout, appearances suggestive of the splitting and *evisceration* of a partially consolidated dyke by a slightly later injection of a magma sufficiently different to be distinguishable. The result is a triple arrangement with bilateral symmetry, comparable in this respect with that described in the peculiar composite dykes and sills of the former chapter, where it has originated in the same way. The dykes now under notice, however, are basic throughout, though they exhibit variations between their central and marginal parts so great as to bespeak considerable differences in chemical and mineralogical composition. This is illustrated by the following specific gravity determinations:

Dyke (18 ft), in Cambrian limestone, on shore at mouth of stream immediately north of Sgeir Mhòr, Torran —

Central porphyritic band	2.86
Non-porphyritic part, 1 ft from edge	3.02

Porphyritic dyke (3 ft), in Cambrian limestone, about 1000 yards N.N.E. of summit of Beinn Suardal —

Central porphyritic band	2.85
Marginal non-porphyritic band	2.80

Dyke (1 ft), in Lias, on shore 150 yards N.W. of Rudh' an Eirreannaich, Broadford —

Centre	2.80
Margin (including fine selvage)	2.74

Dyke like the preceding, at same locality —

Centre	2.82
Marginal part (not actual selvage)	2.78

Dyke cutting gabbro in valley of Allt Aigeinn, 600 yards E. of summit of Garbh-bheinn —

Central part	3.00
Marginal part	2.66

In these cases, and others which might be cited, there is a symmetrical disposition of the variations, the two marginal portions of the dyke resembling one another and differing from the interior portion. There is no such sharp line of demarcation as would exist had the marginal and central portions been intruded at quite different epochs. It is not possible, however, to account for the variation by "differentiation in situ" after the intrusion. This appears from the magnitude of the differences observed, especially in the last example. It would be difficult also on such a hypothesis to explain the fact that in the first two cases instanced the distribution of the porphyritic elements is involved; or again that, except in the first case, the marginal portion of a dyke is apparently less basic than the interior. We must therefore suppose, either that the magma as intruded consisted of distinct and different portions, which did not mix freely; or that there was a first intrusion, represented by the margins of the dyke, and, before that had consolidated in the interior part, a second intrusion, now represented by the central band of the dyke. The phenomena of some other dykes<ref> One instance is a dyke of porphyritic basalt near Port na Long in the southern part of Sleat, noticed below. This contains a number of bands alternately rich and poor in phenocrysts. The following note by Mr Clough illustrates what seems to be a phenomenon of the same kind: "The weathered horizontal section across a dyke (S7373) [NG 608 036] rather less than a mile W.S.W. of the top of Cnoc an Sgùmain, near Armadale, shows a close alternation of paler and darker parts, often about an inch thick, parallel to the sides. The darker parts are also finer grained, and project somewhat. It is not clear that the sides of the bands are chilled, and perhaps the finer bands have been injected before the earlier rock was thoroughly cooled. In the thin slice of the same rock are many little patches of fine grained dolerite, and these perhaps represent a phase of consolidation of the magma rather than something quite foreign to the dyke".</ref> seem to indicate that the former alternative is a possibility; but the circumstances of the cases here noticed, and especially the symmetrical arrangement, accord better with the latter explanation.

Considering now the *directions of the dykes,* we may glance first over the wider area, including a large part of Scotland and the northern parts of Ireland and England, in which dykes which are either known or reasonably supposed to be of Tertiary age are met with. Sir A. Geikie has given a map indicating the distribution and bearings of these dykes.<ref>Trans. *Roy. Soc. Edin.,* vol. xxxv., p1. I.; 1888.</ref> From this it appears that in the west and south of Scotland, including the islands, and the north of Ireland the general direction varies between N.W.–S.E. and N.N.W.–S.S.E., changing in the north of England to W.N.W.–E.S.E. In the Midland Valley of Scotland and the Southern Highlands the general bearing seems to be W. by S.–E. by N., becoming more W.S.W.–E.N.E. as we approach the Grampians.<ref>The camptonite dykes of the Orkneys, conjectured by Dr Flett to be of Tertiary age, also have this latter direction: see Flett, *Trans. Roy. Soc. Edin.,* vol. xxxix., p. 870; 1900. So far as any direct evidence goes, however, these may be Palaeozoic intrusions.</ref> These latter departures from the more usual direction of trend might with some straining be interpreted as a tendency towards a roughly radial arrangement; but the change takes place rather abruptly, and is more suggestive of a second distinct system of dykes. At the same time it is noteworthy that those dykes which differ markedly in bearing from the majority occur in an extensive tract of Palaeozoic and older rocks, so that their

Tertiary age cannot, in the nature of the case, be established by direct proof. If we exclude them, we may say that the British Tertiary dykes have a very general bearing between north-west and north-north-west.

In Skye this general direction is maintained with remarkable persistence, and is common to dykes belonging to different petrographical groups and different epochs of intrusion. In and about the Cuillins only do we find, in addition to the dykes having the normal trend, other sets which depart widely and systematically from it; viz, one set with a roughly radiate disposition and another conjugate set at right angles to the former. Excluding these from present consideration, we may say that the vast majority of the Skye dykes have directions between N.W. and N.N.W. Locally there are variations extending to N. by W. or nearly N. on the one hand and to N.W. by W. on the other, the change coming on gradually. Taking seventy localities pretty evenly distributed over the whole area, we find the average bearing to be about N. 37° W. In some places we find, in addition to dykes having the normal direction, others which run N.–S., N.E.–S.W., or E.–W. These are few in number and obviously exceptions. In some cases their direction has been determined by pre-existing faults. In the Lias about Broadford, for instance, there are a number of N.–S. dykes occupying small fault-lines. In the Sleat district Mr Clough has found dykes occasionally following lines of crushing as well as of faulting. Thus several N.N.E. dykes following crush-lines were noticed on the shore W.S.W. of Ramasgaig.

If we examine the variations from the average direction seen in dykes which still fall within the normal limits, we see very evident indications of some law governing those variations. These limited departures from the average seem to be disposed in relation to the great plutonic intrusions, or no doubt more accurately to crust-movements closely connected with those intrusions. We may express this roughly by saying that there is a certain tendency for the dykes to radiate from the central mountain district (Figure 63). A large proportion of the dykes do point more or less accurately towards the mountains, but this is partly owing to the fact that the general trend of the whole island is approximately in the normal direction of the dykes. Where the radial arrangement would involve a departure of more than 20°, or at most 25°, from the average bearing for the whole region, it is not found, but the tendency in question becomes merely a modifying factor, within those limits, of the general law. Thus, over a considerable area to the northwest of the Cuillins and round Loch Harport the bearing of the dykes is quite normal; south-west of there it is somewhat more westerly; north-eastward it becomes steadily more northerly. But, although near and to the north of Loch Sligachan it is only a few degrees W. of N., it never deviates so far as due N. On the southeast side of the Cuillins we find in and near the Strathaird peninsula a similar tendency in the dykes to point towards the mountains. At the extremity of the peninsula the bearing is N.N.W., but passing northward we find it change gradually until to the east of Belig it has become N. 60° W.

In the tract to the south-west and south of Broadford the dykes tend to point towards the granite boss of the eastern Red Hills and to be at right angles to the curved anticlinal axis which runs from Broadford to Torran and includes the other granite boss of Beinn an Dubhaich. Thus, about Kilchrist and Beinn Suardal the bearing is N.W. by W., but south and south-west from there it changes gradually to N.N.W. on the north and south sides of Beinn an Dubhaich. Farther west, however, about Kilbride and Torran the dykes have a much more westerly trend, as if belonging to the former system connected with the Cuillin centre. In the tract extending from Kyleakin to the Point of Sleat the tendency to a radiate arrangement is equally marked, though spread over a greater extent, in accordance with the greater distance from the central mountain district. In the middle of this tract the bearing is quite normal; towards the north-east it is much more westerly; and towards the south-west it changes gradually to something like N.N.W.

The direction of the dykes seems then to depend upon two factors. Causes of primary importance have impressed an approximate parallelism upon the dykes throughout a large region of which Skye is only a small part: the normal direction in Skye does not differ much from N. 37° W. Variations from this direction stand in relation to causes of secondary or local importance, which find their expression in a partial radiate arrangement with reference to certain centres of disturbance (*see* below, Chapter 25).

A characteristic feature of the dykes is their general *rectilinearity.* Writing more especially of the Sleat district, Mr Clough says: "The directions of most of the dykes are tolerably straight and parallel. Dykes which bend sharply and run out of their usual direction for considerable distances are not common. In a few places, however, we do see dykes which twist when they come to lines of pre-existing crush or fault. Instances of this are seen on the N. side of Camas a' Mhuilt (Isle Ornsay), where a dyke, coming from the S.E., suddenly twists and runs slightly S. of W. along a crush line; and again about a quarter of a mile N.N.E. of Geur Rudha, where a dyke, coming from the N.W., runs slightly S. of E. along a fault.

In the latter locality the width of the dyke when running with the fault is only half the usual breadth: the fault-breccia is hardened by, and certainly older than, the dyke.

"In a few places dykes make conspicuous changes of direction, though we do not know that the changed path is a line of fault. Perhaps it is merely a thin joint line. Several instances of this kind occur a little E. of Ob Lusa: in the most marked instance a N.W. dyke several yards wide suddenly bends and runs N.E. for perhaps 20 yards: in the N.E. part the width is in places hardly a foot."

"It is occasionally found that a dyke comes suddenly to a blunt end, but that at a little distance from this end, either in a N.E. or S.W. direction, a dyke of a similar character suddenly appears and runs in a direction parallel to that of the old dyke. A marked instance of this kind was noticed on or near the coast rather more than a third of a mile E.N.E of Rudha Dubh Ard, near Ord, where a peculiar dyke with xenocrysts of quartz (S6134) [NG 628 145] appears to be shifted laterally, the S.E. portion towards the N E., in four different places, though the dyke is never seen in a crushed state: the amount of the apparent displacement in these four places together is nearly 100 yards".

Displacements of the same kind but amounting only to a few feet may be seen in numerous places in the Lias on the shores of Broadford Bay, as shown in the accompanying ground-plans. Sometimes the dyke is cut off abruptly (Figure 64); sometimes it runs out into a number of tapering veins, which may or may not be directed towards the detached continuation of the dyke (Figure 65) and (Figure 66); sometimes an actual continuity is preserved between the several portions by means of a narrow connecting string of dyke-rock. The same neighbourhood affords examples of a whole set of dykes bent aside for a short distance into a new direction, without any ostensible reason in the form of faults or joints (Figure 67). In the Cowal district of Argyllshire Mr Clough<ref>*Geology of Cowal (Mem. Geol. Sur. Scot.),* p. 144; 1897.</ref> has noticed similar sharp diversions occasioned by lines of crush in the country-rock, earlier than the dykes affected. In the case here considered such crushing, if it occurs, affects only the concealed strata below the Lias.

Apart from such abrupt changes, the dykes usually hold their course very steadily; but there seems to be some difference in this respect when they occur in different country-rocks. In the Lias shales departures from rectilinearity, though not usually to any great degree, are frequent. In the Cambrian limestones the dykes are straighter, though in a few places near Torran some curiously curved examples occur. The straightness of the dykes which intersect the basaltic country is generally very striking. The same is usually true in the gabbro, except in the case of some small dykes and veins, which are also apt to have abnormal directions; but in the granite irregularities on a small scale are more frequent. A curved or zig-zag course is not seldom found in connection with variations in width and interruptions or continuity in outcrop, pecuu-arities which may be taken to indicate the dying out of a dyke in the upward direction.

In *width* the basic dykes vary from a few inches to over 100 feet, not reckoning the greater widths attained by the grouping of several to form a "multiple dyke". The widest single dykes are those which occur remote from any others of their own kind. Dykes of one kind in the same neighbourhood and in the same country-rock do not vary very greatly in width; but dykes of presumably the same group in different places and in different rocks may show considerable variations. The numerous dykes which intersect the Liassic shales on the shores of Broadford Bay are as a rule not very large ones. Excluding-on the one hand very narrow and rather irregular intrusions, which may be called veins rather than dykes, and on the other hand a very few large multiple dykes, we find from about forty examples a mean width of 4 ft. In the crofts of Harrabol a large double dyke may be followed for about 300 yards, the two members of which are 70 and 30 feet wide, respectively; and at Rudha na Sgianadin, a headland about two miles north-west of Broadford, there is a 100 feet triple composite dyke, consisting of a central member of granophyre and two of dolerite.

The dykes in the Cambrian limestones are as a rule rather larger than those in the Lias shales. The largest, ranging up to as much as 50 ft in width, belong to the pre-granitic set, and are of thoroughly basic rocks. For the rest, a large number of those about Kilchrist, Torran, etc., range from 4 to 10 ft in width, but there are many smaller. On Beinn Suardal, where they are very numerous and close, Mr Clough notes that they are also comparatively narrow. In the Sleat district, mainly of Torridonian strata, he found them generally wider. They there average 5 to 10 ft: dykes 30 or 40 ft wide are not common. A coarse diabase dyke about ¼ mile west of Tormore is in places 120 ft wide, but does not maintain this size.

The dykes which cut the granite vary from 1 ft to 20 ft in width: measurements of thirty-five examples gave an average of 6 ft. The only very large one is the solitary coarse diabase dyke already noticed on the flanks of Beinn na Caillich, with a width of over 50 ft. The much more numerous dykes intersecting the basaltic plateaux probably average 4 or 5 ft in width or less. This does not include the multiple dykes, which often exceed 50 feet. As before, the single dykes which reach the greatest size are those of "solitary" type, of coarse texture and thoroughly basic composition. One on the south-west slope of Broc-bheinn, and about 1¼ mile north-east of Drynoch Lodge, is locally 150 feet wide. The dykes cutting the gabbro of the Cuillins are on the whole fairly comparable in magnitude with those of the basalt country; but there are in places very numerous narrow dykes, sometimes running in unusual directions or changing their course abruptly.

Although the majority of the dykes do not depart very noticeably from the vertical attitude, there are very many which do show a marked *hade.* If this is seen in one, it is usually seen in numerous others in the same neighbourhood. In many parts of the basaltic country in particular both simple and multiple dykes show a more or less marked inclination, the moorland hills north of the Cuillins and between Sligachan and Portree affording abundant instances. The hade is especially noticeable where the weathering away of a dyke, or of the less durable members of a multiple dyke, has given rise to a little ravine. Allt Daraich, near Sligachan, is a good illustration.

The hade is not a mere accident, but must have some real significance. This is manifest from the fact that it has always the same direction. With scarcely an exception among the large number of cases observed, the inclination is downward towards the N.E., or at least towards some point in that quadrant (according to the varying direction of strike of the dykes). Now we have already seen that the prevalent dip of the basalt plateaux is towards the west or some point south of west. The observed hade of the dykes is, then, in a general sense, such as would result if they had been originally vertical, and had been tilted in common with the rocks which they intersect. If such a suggestion could be established, it would be of very great help in classifying the dykes; for the regional disturbance to which the inclination of the plateaux is due belongs to a fairly determinate epoch, and we might thus discriminate between those dykes of earlier epochs and those of later. Unfortunately we have not found it possible to use this apparently simple criterion in the manner suggested. A large proportion of our observations relate to multiple dykes, and it cannot be doubted that a later intrusion would tend to follow the guidance of an earlier one, even when that involved some departure from the vertical direction. Even the simple dykes we cannot assume to have been always vertical when intruded, for what is presumably the primary law might conceivably be modified by the condition of crustal strain at the epoch of the intrusion. Such a modifying factor is certainly suggested in the case of the special sets of dykes peculiar to the Cuillins and not included in the present discussion, as well as in the imperfectly symmetrical composite dykes of Scalpay described on pp. 212–214. Further, we are not at liberty to suppose that when a country is broken into blocks and these tilted at an angle to the horizon, vertical dykes are necessarily tilted through a like angle: we must allow for possible deformation of the individual blocks themselves. These reasons sufficiently explain why we have failed to discover any evident connection between the hade of the dykes and their age.

The *longitudinal extent* of the individual dykes is a point on which it is not easy to obtain very precise information. On the moors the rocks are often obscured or wholly concealed by peat, and even on the bare mountains dykes are lost by passing under the screen. In some other tracts, such as that occupied by the Cambrian limestones, where the rocks are fairly well exposed, the number and closeness of dykes of similar lithological characters often makes it impossible to identify an individual dyke along its extent, unless it can be followed uninterruptedly, foot by foot. Perhaps the granite offers the best ground for such an examination, the ground being often quite bare over considerable areas, and the dykes usually not too numerous. A given dyke, six to ten feet wide, cutting the granite can in several instances be traced for a mile or a mile and a half. The dying out of the dykes in general is often connected with a change in the country-rock. On the slopes of the basalt plateaux the ending of a dyke against one of the thick intrusive sills is of course a dying out in the upward direction, and does not imply the termination of the dyke laterally. It is by no means a rule that the broadest dykes are also the longest: the solitary dykes of coarse diabase, for instance, are usually less than a quarter of a mile in length.

In a very few cases we have observed what may be an interruption of continuity, *i.e.* two closely similar portions occurring on the same line but divided by an interval, the appearances suggesting that the two may be parts of one dyke, continuous at a greater depth. Such a thing may often occur without detection, or at least without the possibility of proof. It may be considered in connection with the interruptions by lateral displacement already described, and is probably always associated with the dying out of the dyke upward, as already remarked in the imperfect triple composite dykes of

Scalpay.<ref> *Cf.* Sir A. Geikie, *Trans. Roy. Soc. Edin.,* vol. xxxv., pp. 52–55; 1888: and *Ancient Volcanoes of Great Britain,* vol. ii., pp. 147–150; 1897.</ref>

The visible termination of a dyke is not uncommon where exposures are plentiful, *e.g.* in the bare glaciated curries of the Cuillins or on a rocky shore. It does not always take place in the same way. Sometimes the dyke ends rather abruptly; more frequently it tapers to a point, though it may be rather suddenly; very often it branches, and ends in a number of irregular veins. A 50-feet dolerite dyke crosses the south-easterly ridge of Marsco, in a saddle near the figures 2112 on the six-inch map, and is quickly lost; but on the same line a little to the S.W. occurs a number of narrow parallel veins of basalt, about thirty in all, divided by narrow strips of the country-rock, the total width being about six feet. In this case the continuity, if it exists, cannot be traced. Almost all cases of bifurcation and branching of dykes which we have seen have been in connection with dying out. Other irregularities, such as changes of direction, width, and shade, often occur near the terminations of dykes.

Some of the more obvious petrographical characters of the basic dykes as seen in the field will be more conveniently noticed here than under the heads of the several groups.

One such point is the occurrence of *amygdules,* which are not uncommon in certain types of dykes, chiefly those consisting of the finer-textured rocks. It is to be noted, as compared with the amygdules in the lavas, that those in the dykes are usually considerably smaller and also more regularly spherical, only occasionally showing any very noticeable elongation in the direction of flow. As a rule, too, they occupy collectively a much smaller proportion of the total volume.

Mr Clough has remarked an exceptional case. In a basaltic dyke, about three feet thick, a little above the road in Allt Bealach na Coise (S.W. of Isle Ornsay), the central half is extremely full of amygdules. Perhaps they constitute half the mass of the rock. Many of these amygdules are notably different from those in most of the basaltic dykes, being of very irregular shape and repeatedly branched, and sometimes as much as three or four inches long". The same observer remarks that dykes with amygdules elongated parallel to the walls are decidedly more common in the Isle of Soay than in other parts of our area.

Sir Archibald Geikie<ref>*Trans. Roy. Soc. Edin.,* vol. xxxv., p. 38; 1888: *Ancient Volcanoes of Great Britain,* vol. *ii.,* pp. 129, 130; 1897.</ref> has drawn attention to some of these points, and has further remarked what is a very characteristic feature of the amygdules, viz. that they are not uniformly distributed through the width of the dyke. Very often they are absent from the marginal parts and clustered chiefly along a central band; or there may be narrow bands containing amygdules on both sides of the central one. The largest amygdules occur towards the centre of the dyke.

The amygdules are seldom empty. Their contents are usually such as may be regarded as alteration-products of the minerals conposing the dyke, and there is more variety here than in the amygdules of the basaltic lavas.

Many of the dykes have features indicative of *flowing movement.* The most obvious are the orientation of the felspar phenocrysts in porphyritic dykes, the elongation of amygdules in a common direction (which, as just remarked, is not very often seen), and various kinds of banding depending on the distribution of phenocrysts, amygdules, xenoliths, etc. Mr Clough writes: "In all portions of the basic dykes the phenocrysts usually have their long axes in planes parallel to the adjacent side. A clear instance of this parallelism is seen at the N.E. side of a broad dyke on the coast S.S.E. of Tarskavaig Free Church: in one place the side bends at an angle of about 45° and the long axes of the felspar phenocrysts change direction also, so as to keep parallel to the side. At the side of another dyke about a quarter of a mile N.E. of Ardnameacan, there are a great number of thin tabular crystals, hardly 1/100 inch thick, of felspar, and nearly all these have their broad sides parallel to the sides of the dyke. Within the basic dykes it is also commonly found that there are certain bands approximately parallel to the dyke side which contain amygdules and phenocrysts in special abundance. The amygdules in the bands nearest the side are of much smaller dimensions than those farther off. The phenocrysts, on the other hand, are often quite as large close to the side as in the middle. A well-marked alternation of bands, some crowded with and others almost destitute of felspar phenocrysts, is found in a few cases". In some of the finer-textured rocks a microscopic examination sometimes shows a partial parallelism of the little elongated felspars of the rock which is an indication of flowing movement prolonged to a somewhat later stage.

Very many of the basic dykes, and more especially those of small or moderate breadth, show some degree of *marginal modification* in texture, structure, etc., in consequence of the more rapid cooling of the edge as compared with the interior parts of the dyke. Even in dykes of moderate dimensions, however, this is by no means universal, and it is easy to understand that the chilling depends upon a number of variable factors; the distance from the source of the intruded magma, prolonged flow of molten matter through the dyke-fissure, the specific thermal conductivity of the rock bounding the dyke, its temperature prior to the intrusion, etc.

The extreme result of rapid chilling, viz. a vitreous selvage, is not a common phenomenon; the petrographical characters of these selvages of basalt-glass will be discussed in a separate chapter. Much more often we find merely a progressive change of texture, in the sense of its becoming finer, towards the edge of the dyke, and perhaps a change also in micro-structure; sometimes the appearance of a small amount of interstitial glassy matter in the margin of the dyke. Again the marginal parts of a dyke may differ from the interior in the absence of amygdules or of porphyritic crystals, or in other ways as already intimated.

The smallest dykes, less than a foot in width, often show a uniform fine texture throughout, indicative, as we must suppose, of a relatively rapid cooling of the whole. This is especially well seen in many of the small dykes cutting the gabbro; and in this case the dyke seems to be firmly welded on to the gabbro in contact with it, so that it does not break away from it under the hammer.

Apart from modifications of a marginal kind, the rock of a dyke is commonly uniform throughout. Anything in the nature of *segregation-veins* is found only very exceptionally. A few cases have been observed, the segregations being in the form of irregular streaks, elongated but discontinuous, of coarser texture and lighter colour than the general body of the dyke. This difference is due to a higher proportion of the felpathic relatively to the ferro-magnesian constituents. In an example from the northern ridge of Beinn Suardal the dyke-rock gave the specific gravity 2.92, the veins only 2.67.

To be distinguished from these inconstant and irregular "segregation-veins" are the true veins or narrow strings occasionally seen in a dyke, which clearly cut the general mass of the dyke, so that they must be regarded as distinct and later injections. The phenomenon is not a common one. Mr Clough has noted one or two cases. "In a broad dolerite dyke with felspar phenocrysts, about a third of a mile slightly N. of E. of the head of Loch Ghlinne (in one-inch map 61), there are many thin strings, from a quarter to one inch thick, which keep parallel to the sides. These strings also contain felspar phenocrysts, but their margins are distinctly chilled. In a basaltic dyke rather more than half a mile N.W. of the head of Loch Eishort a number of finer strings, about an inch thick, were observed, which had no special joints confined to themselves".

Very many of the basic dykes are traversed by *joints,* which are evidently of the nature of shrinkage-joints, due to the contraction of the rock in cooling. By far the most common type of regular jointing is the columnar or prismatic, the rock being broken into rude, or sometimes into rather regular, columns perpendicular to the walls of the dyke. The joints are best developed at the margins, but in small dykes they extend through the whole width. Columnar jointing with any approach to regular arrangement is usually confined to dykes consisting of fine-textured rocks, and the joints may then occur rather closely, so that the individual columns are sometimes not more than an inch in diameter. They may be less, especially in very compact selvages; and the thin glassy crust found at the extreme margin of some dykes may, as Professors Judd and Cole have shown, exhibit columnar jointing on a microscopic scale.

More rarely the dykes have a platy structure due to plane joints parallel to the bounding walls. This feature, exceptional in the basic dykes, is found more frequently in some other groups in the district. In some instances it is connected with a flow-structure in the dyke-rock.

In Skye, as in most other regions, it is found that the dykes do not, as a rule, produce any very noteworthy *metamorphism in the rocks which they traverse.* Conspicuous exceptions to this rule are few: they are found where the dykes occur in great profusion, and the country-rock is one specially susceptible to thermal metamorphism. The most interesting case observed is on the east shore of Camas Fhionnairidh, an inlet of Loch Scavaig, at about 700 or 800 yards from Camasunary farm-house. Here a large number of dykes occur in close succession, and the earthy limestones of the Lias, exposed on the shore, are highly altered. They contain large aggregates of lime-bearing silicate-minerals, including good.

crystals of diopside of considerable dimensions, forming nodular masses.<ref>Heddle records the occurrence of idocrase at the junction of a dyke with a calcareous rock, 1½ mile from Broadford, on the road to Kilbride. *Mineralogy of Scotland,* vol. ii., p. 53; 1901.</ref>

Although any important metamorphism in the sense of the production of new minerals is only exceptionally found in the rocks bordering our basic dykes, minor alterations, such as the production of platy jointing in shales, the marmorisation of limestones, and especially the decoloration (by partial deoxidation) of red sandstones, are observed much more widely. On these points Mr Clough has furnished the following notes. The case of the Ord limestones is interesting in connection with what has been said above of the Strath marbles, near the plutonic intrusions, but no close examination of the rocks has been made.

"The contact-metamorphism in the neighbourhood of the dykes is not usually great. About a quarter of a mile W.S.W. of the N. end of Loch an Iasgaich a band of shale in the Kinloch Torridonian series is crossed by close joints, not more than [redacted] inch apart, for rather more than a foot off the side of a thin dyke. The joints hade steeply N.E. parallel to the side of the dyke: they do not extend into some pebbly grits which are equally near the side".

"The reddish colour of the Torridonian arkoses and grits is generally converted into a dirty grey. This red colour is largely due to elastic grains of felspar, and in the altered beds these grains are of a grey colour. The change of colour extends eight or nine yards off the sides of some of the dykes, and is seen well on the coast N. of Tarskavaig Point and between Ob Gauscavaig and Inver Aulavaig".

"The reddish colour in the Tarskavaig Moine schists, which have been stained with an Indian red colour near the conglomerate at the base of the Secondary rocks, is also changed into grey near a large intrusive sill near the base of the conglomerate. The felspar pebbles in the schistose grits are generally of a red colour, but near the sill they all become dirty grey. The quartz veins in the same schists become crossed by many thin short cracks or joints running in different directions. Some of the veins have also a peculiar pale amethystine colour. The foliation planes of the schists also lose their lustre to a large extent in the neighbourhood of intrusions, so that it is difficult to distinguish the phyllites from Torridonian shales. This is particularly noticeable in Gillean Burn, and on the N. side of this burn near the E. boundary of the schists".

"The greenish epidotic grits at the base of the Torridonian system are often changed into black or dark grey rocks for several feet off dykes. The change is seen near basaltic dykes in the following places: in a burn 250 yards N.N.E. of the foot of Allt Doire Daraich; near the foot of Allt Thuill; two-thirds of a mile W.S.W. of the foot of this burn; and about 700 yards W.S.W. of Rudha Guail."

"The green chloritic schists in the Lewisian gneiss series are also often rendered dark grey or black and hardened near dykes. This is seen rather more than half a mile S.W. of Cnoc a' Chaìse Mòr, on the shore S. of Kilmore Church, and in the bay N.W. of Bogha Charslice".

"The limestone veins which penetrate the Torridonian rocks near the Secondary conglomerate about two-thirds of a mile N.N.E. of Tarskavaig Point are rendered saccharoid near some dykes. One specimen of the altered limestone gave a specific gravity of 2.68".

"In the burn about 1500 yards slightly S. of W. of Ord a dyke goes through Cambrian limestones belonging to the Ghrudaidh and Eilean Dubh divisions, and alters them considerably for a breadth of about four feet. The Ghrudaidh limestone loses its leaden colour and granular aspect and becomes a white compact rock with black streaks. A specimen of the unaltered rock gave a specific gravity of 2.825, while an altered specimen taken on the same strike and about two feet and a half off the dyke has a specific gravity of only 2.709. The change in the Eilean Dubh limestone is less marked, as this limestone is of a creamy colour when unaltered. The colour of the altered rock becomes, however, a purer white and is varied with greenish strings composed of some soft substance. A specimen of the unaltered limestone has a specific gravity of 2.83, while one of the altered limestone on the same strike gave the figure 2.64".

"Much of the limestone near Ben Suardal is too much altered by granitic intrusions to allow a special alteration near the dykes to be discerned. We often see, however, a prominent set of nearly vertical joints parallel to the dykes. Such joints are conspicuous in the limestone scars a little N. of the top of Ben Suardal, and as seen from the road in Strath Suardal they might be mistaken for bedding. Similar joints, sometimes three or four in the breadth of a yard, are well seen a little N.W. of Loch Lonachan". (C. T. C.) In some localities near Torran, again, where dykes are especially numerous, they have perhaps given rise to some further change in Cambrian limestones already metamorphosed by the granite; but this, in the nature of the case, is very difficult to verify.

Some of the dykes have produced certain metamorphic effects, small in degree and in extent, in the amygdaloidal basalts; but this is usually a mere induration without any evident production of definite new minerals. For example, some hundred yards beyond Carbost Pier a dyke stands up in prominent relief on the rocky shore of Loch Harport. Adhering to each face of it is a band a few inches wide of amygdaloidal basalt which is hard enough to behave under erosion as if it were part of the dyke. A thin slice, however, does not reveal any characteristic mineral of thermal metamorphism (S9805) [NG 375 327].

In the gabbro, the granite, and the basic sills again we have found little indication of any change due to the dykes which traverse them. The sills, and also earlier basic dykes cut by later ones, not infrequently exhibit a certain development of epidote, which is perhaps to be ascribed to this cause. Thus Mr Clough has noted, about 250 yards N.E. of the summit of Ben Suardal, near Broadford, an irregular sheet of coarse dolerite with enclosed xenoliths of granophyre, both the sheet and its xenoliths showing epidotisation.

Most of the basic dykes are in a very fairly fresh condition, even so susceptible a mineral as olivine showing in the majority of cases but little indication of chemical change. This is probably due less to the comparatively late geological date of the intrusions than to the scouring effect of ice, which has removed very generally those superficial portions of the rocks which had been decomposed by pre-Glacial weathering. Nevertheless, there are abundant instances of dykes exhibiting the effects of *atmospheric decomposition,* and Mr Clough's observations prove that some part of this is post-Glacial. Writing of the south-eastern part of the island, surveyed by him, he says:

"There is evidence that some dykes which are now in a very soft and readily disintegrated condition have during the Glacial period formed ridges. If the boulder-clay at their sides could be cleared away, these dykes would appear as ridges projecting more or less conspicuously over the surrounding rocks, but it is evident that in their present soft condition they could not long continue as ridges. It is still less likely that in the boulder-clay period rocks in such a condition could resist the strong denuding influences at work. Consequently the decomposition of these rocks must be held to be comparatively recent — at all events post-boulder-clay. The evidence referred to was observed in sections at the sides of new roads in the following places: about 150 yards N.E. of Loch Gauscavaig, nearly half a mile slightly S. of E. of Tarskavaig Free Church, and rather more than a third of a mile E.S.E. of Tormore (near Armadale). In the first locality the junction between the boulder-clay and the N.E. side of the dyke is vertical for at least three feet. In all the sections there are indications of a thin deposit lying over the boulder-clay and composed in the main of portions of disintegrated dyke rock. In the second locality a similar deposit, four or five feet thick, appears to occur *in situ* below a portion of the boulder-clay. The boulder-clays in all the localities are of the common stiff stony character".

The progress of chemical decomposition in a dyke has in most cases been directed by the joint-fissures which traverse the rock. In certain types of dykes there has resulted from this a division of the rock into rude spheroids, a few inches in diameter, with sound interior and decomposed exfoliating crust. On the other hand, there are cases in which decomposition seems to have affected most readily the rock in the interspaces between an irregular system of joints. Some of Mr Clough's observations in the Sleat district fall apparently under this head. He says: "Some of the decomposed dolerite dykes contain thin cross jointed strings of sounder hard rock, varying in width from two to six inches. The strings have no general direction nor chilled margins, and in sections at right angles to the dyke direction they sometimes form a polygonal network, the meshes in which are filled with more decomposed rock. On the roadside two-thirds of a mile S. of Dun Scaich (near Tokavaig) some of the meshes are three or four feet long: many of the strings have median sutures and remind us of the 'sheaths' in tachylyte, to be described in another place (p. 336). They sometimes pass gradually into the decomposed rock, and we could not discern by microscopic examination that the constituents of the two rocks differed in character. About 700 yards S.W. of Ob Gauscavaig an olivine-dolerite dyke which weathers into huge irregular blocks, and is for the most part in a very soft decomposed condition, contains a few scattered strings of harder rock which seem also composed of olivine-dolerite. The strings have no general direction nor chilled margins, and they are perhaps allied in character to those in the dyke near Dun Scaich".

The behaviour of the dykes as contributing to the details of superficial relief of the country is, of course, determined by the joint effects of chemical and mechanical destruction, or more accurately by their differential effects as between the dykes and the country-rock. According as a dyke is more or less durable than the encasing rocks, it tends to form a prominent *feature* or ridge on the one hand or a *trench* or depression on the other.

On the floor of any of the glaciated corries of the Cuillins the gabbro and the dykes which intersect it, both in a perfectly fresh state, make up together a single smooth surface. There has been no differential weathering, because there has been no appreciable weathering at all since the glaciation. On the slopes above, the dykes often occasion gulleys, and on the mountain-ridges they sometimes give rise to deep notches. The weathering of the dyke in the latter case is not in general connected with any considerable chemical decomposition, but results from splintering by frost. The dykes, and notably the multiple dykes which cut the basaltic lavas and intercalated sills, are very often marked by trenches and gulleys, sometimes deep ravines, and the courses of the streams have very frequently been determined by the dykes. On the other hand, the dykes so numerous in the limestone district stand out in relief, often forming very regular walls two or three feet high. The same thing is seen in a less marked degree in the granite area, and sometimes in the Liassic strata, *e.g.* in some parts of the coast sections. Concerning the older rocks of the Sleat district, Mr Clough writes as follows:

"Most of the dykes are easy to trace by their features. In the Torridonian and Moine rocks only a few dykes make scars or ridges: most of them make either little trench-like hollows which often cross contour lines for considerable distances, or else smooth narrow terraces which keep nearly parallel to the contour lines and are bounded on the high side by a cliff of the country-rock. A great many of the burns in the district run along dykes, and have worn deep narrow channels — some almost impassible — along them. The dykes which form hollows and terraces have no doubt been more readily decomposed and denuded than the country-rocks at their sides. In some of the soft granulitic and chloritic rocks belonging to the Lewisian gneiss series on the S.E. side of the Moine thrust the dykes make scars or ridges much more frequently than in the harder rocks, whether these be Torridonian or Moine rocks or hard mylonitised gneisses. This is very well shown by comparing the dyke features in the area between the head branches of Allt a' Charn-aird with those made by the same set of dykes a little further N.W., where they pass through mylonitised gneiss and Torridonian rocks".

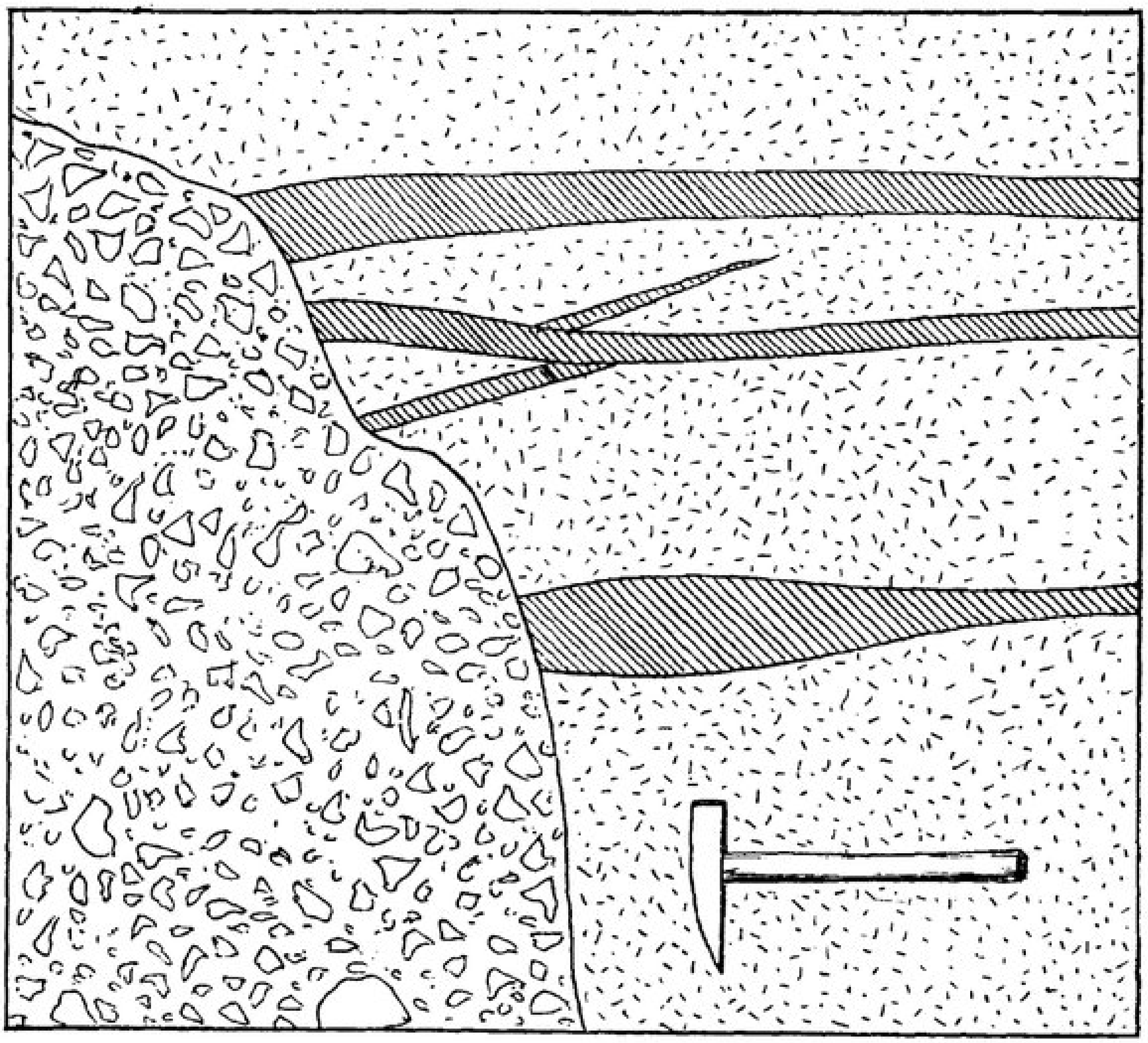

FIG. 62.—Ground-plan of a small area in the lower part of Tairneilear, showing dykes terminating abruptly against volcanic agglomerate.

(Figure 62) Ground-plan of a small area in the lower part of Tairneilear, showing dykes terminating abruptly against volcanic agglomerate.

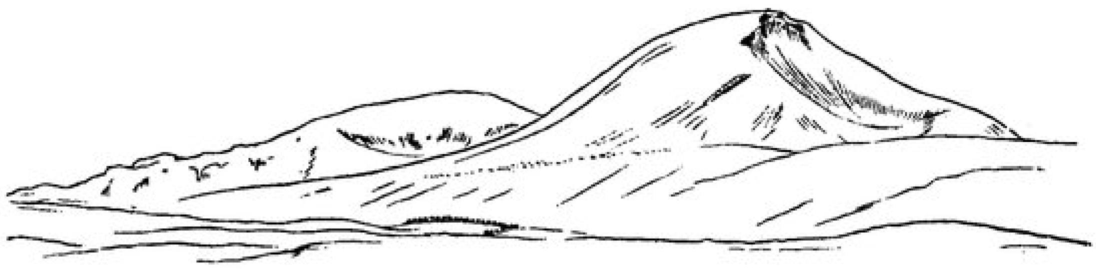

FIG. 5.—Contrasted outlines of volcanic agglomerate and granite, as seen from Broadford.

(Figure 5) Contrasted outlines of volcanic agglomerate and granite, as seen from broadford. The low broken hills to the left mark the situation of the Kilchrist vent, and are composed of volcanic agglomerate. The smooth outline of the granite is seen in Beinn Dearg Bheag and Beinn na Caillich, which form part of the Red Hills. In one place on Beinn na Caillich this smooth outline is broken by the outcrop of a large dyke intersecting the granite.

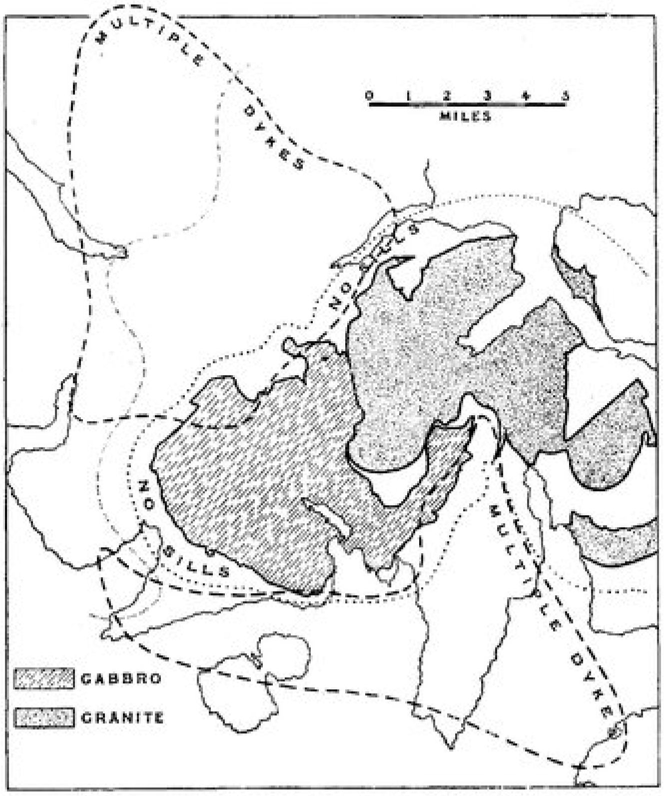

FIG. 52.—Sketch-map illustrating the distribution of the basic sills, and also of the multiple basic dykes, in relation to the large plutonic intrusions. Scale, ¼ inch to a mile.

(*a*) The heavy dotted line indicates the area (embracing the plutonic intrusions with a narrow surrounding belt) which is free from sills belonging to the great group. The lighter dotted line marks the limit (in this part the eastern limit) of multiple sills. This depends partly upon the general attenuation of the group in this direction, but partly also upon the progress of erosion, since the multiple sills are developed chiefly in the upper portion of the lava group.

(*b*) The heavy broken line indicates the distribution of the principal multiple basic dykes. They are found within an elongated oval tract, about eleven miles long, centring in the great gabbro laccolite and having its long axis in the general direction of the dykes themselves. This oval tract, however, is divided into two detached areas by the plutonic masses. It is not improbable that better exposures might enable us to join these two areas on the west side of the Cuillins, but on the east side the granite has offered an impenetrable resistance (see Chap. XVII.).

(Figure 52) Sketch-map illustrating the distribution of the basic sills, and also of the multiple basic dykes, in relation to the large plutonic intrusions. Scale, ¼ inch to a mile. (a) The heavy dotted line indicates the area (embracing the plutonic intrusions with a narrow surrounding belt) which is free from sills belonging to the great group. The lighter dotted line marks the limit (in this part the eastern limit) of multiple sills. This depends partly upon the general attenuation of the group in this direction, but partly also upon the progress of erosion, since the multiple sills are developed chiefly in the upper portion of the lava group. (b) The heavy broken line indicates the distribution of the principal multiple basic dykes. They are found within an elongated oval tract, about eleven miles long, centring in the great gabbro laccolite and having its long axis in the general direction of the dykes themselves. This oval tract, however, is divided into two detached areas by the plutonic masses. It is not improbable that better exposures might enable us to join these two areas on the west side of the Cuillins, but on the east side the granite has offered an impenetrable resistance (see Chapter 17).

Fig. 63.—Sketch-map illustrating the bearings of the basic dykes in different parts of Skye. The letters C and R mark the situations of the Cuillins and the Red Hills respectively.

(Figure 63) Sketch-map illustrating the bearings of the basic dykes in different parts of Skye. The letters C and R mark the situations of the Cuillins and the Red Hills respectively.

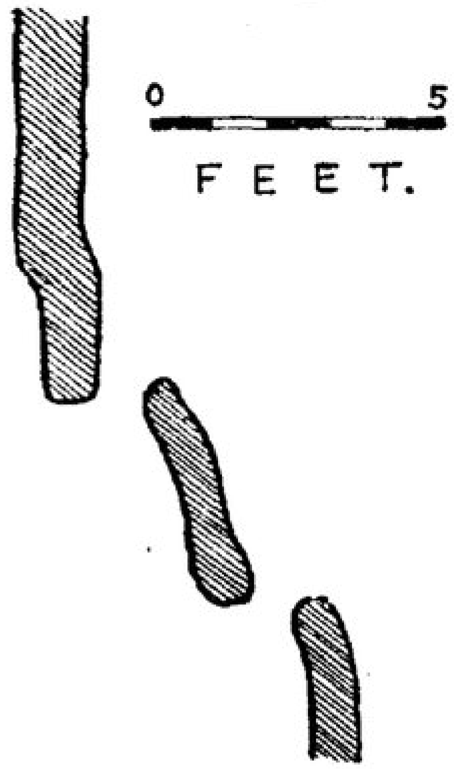

FIG. 64.—Ground-plan on shore west of Broadford Bay; to show the abrupt breaking off and lateral shifting of a dyke.

(Figure 64) Ground-plan on shore west of Broadford Bay; to show the abrupt breaking off and lateral shifting of a dyke.

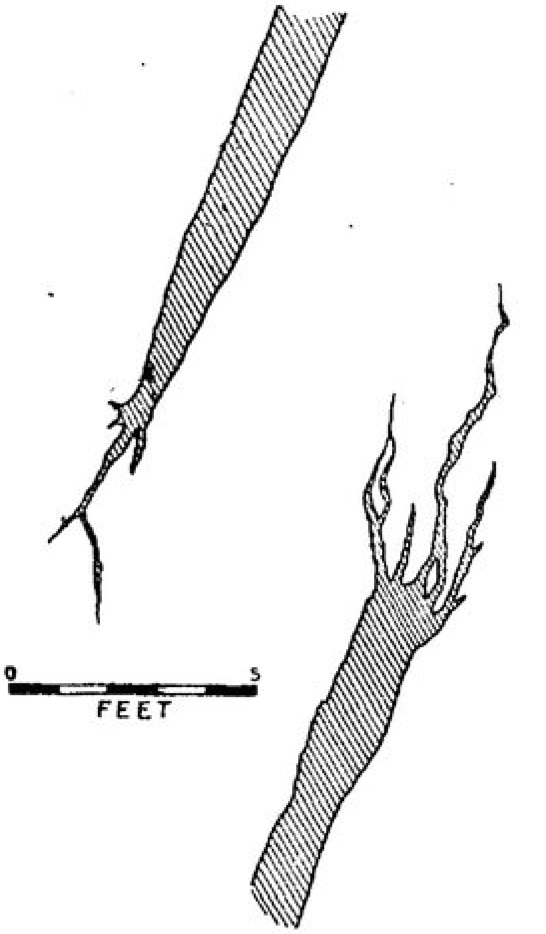

FIG. 65.—Ground-plan on shore west of Broadford Bay; to show lateral shifting of a dyke, the two portions of which run out into veins.

(Figure 65) Ground-plan on shore west of Broadford Bay; to show lateral shifting of a dyke, the two portions of which run out into veins.

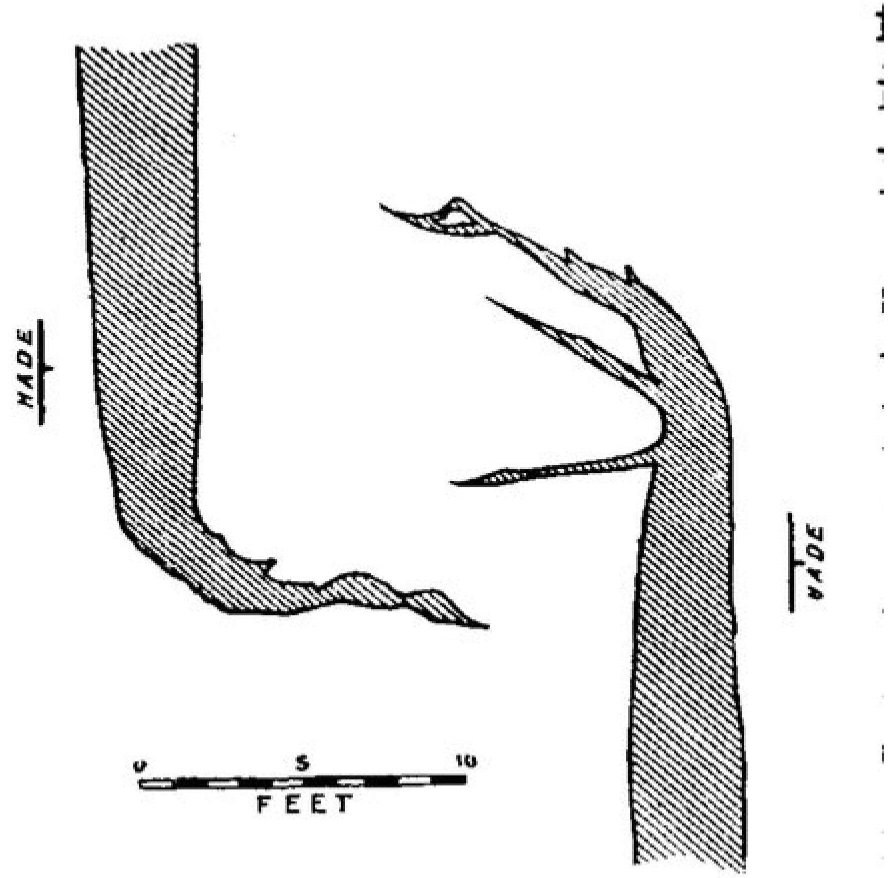

FIG. 66. — Ground-plan on shore west of Broadford Bay; to show lateral shifting of a dyke with veins tending to connect the two detached portions.

(Figure 66) Ground-plan on shore west of Broadford Bay; to show lateral shifting of a dyke with veins tending to connect the two detached portions.

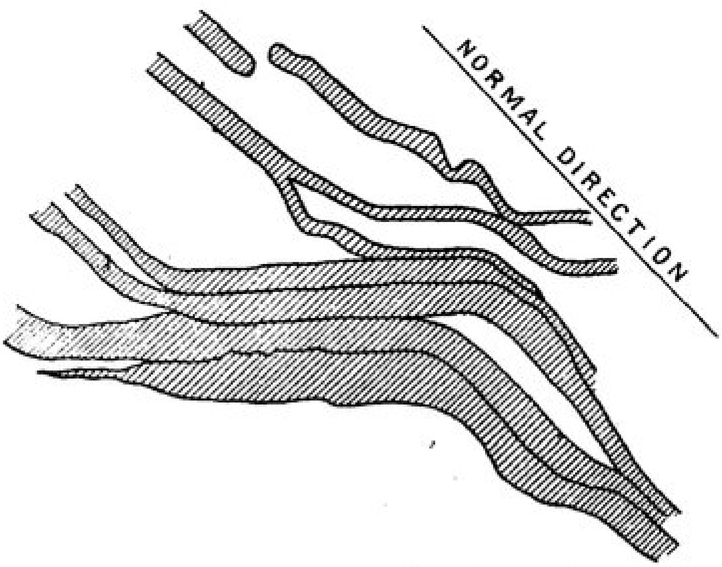

FIG. 67.—Ground-plan on shore west of Broadford Bay; to show a number of associated dykes sharply deviated for a short distance.

(Figure 67) Ground-plan on shore west of Broadford Bay; to show a number of associated dykes sharply deviated for a short distance.