Chapter 24 augite-andesite and pitchstone dykes

We proceed to give a brief account of some of the *andesite dykes* of Skye. Rocks with the characters of typical augite-andesites form dykes, usually of small size,<ref>The only large dyke observed which probably belongs here is one 30 feet wide running in contact with a coarse 70-ft diabase dyke in the Harrabol crofts. The rock is rather fine-textured and has the specific gravity 2/5, but has not been examined microscopically.</ref> in the neighbourhood of Broadford and in numerous parts of the Sleat district. These localities fall within the range of the Broadford and Sleat group of dykes described above, and these, as we have seen, are in great part intermediate between trachytes and andesites, while some are frankly andesitic. It is possible that the rocks now to be noticed are likewise related genetically to the trachytes and trachy-andesites; but, showing no trachytic affinities in their petrographical characters, they will be severed from the preceding group as probably distinct, and we shall show that they stand in close relation to another group of rocks to be described, viz. the acid pitchstones.

Our augite-andesite dykes show some variety of characters, and, though we have no chemical data, it is evident from the microscopical examination and from specific gravity determinations that they differ among themselves in chemical composition. These differences are in great measure connected with the existence in some varieties of a considerable amount of glassy base, the rocks in which glassy matter is abundant being more acid than those which contain little or none. The point has been emphasised by Professor Judd<ref>*Quart. Journ. Geol. Soc.,* vol. xlvi., pp. 371–382, pl. XV.; 1890.</ref> in his account of the "younger augite-andesites" of the Western Isles, among which doubtless our rocks are to be included.

As an example of the most crystalline type we take a specimen from a dyke ■ mile W.S.W. of Sgòrach Breac, or about 1½ mile E. of Ord, in Sleat, It is a dark grey close-grained rock, with only a few small phenocrysts and some small round spots which look like amygdules. Its specific gravity 2.80 shows that, for an andesite, it is of relatively basic composition. In a slice (S6858) [NG 643 129] it is seen to consist of little striated crystals of labradorite, abundant granules of augite, and small imperfect octahedra of magnetite. An interesting feature of the slice is the occurrence of circular areas up to about 1/10 inch in diameter, round which the little felspar prisms are arranged tangentially. They clearly represent vesicles. They are occupied sometimes by chalcedonic quartz and other secondary products, sometimes by a fine-textured rock-substance consisting of small interlacing prisms of oligoclase, altered microliter of augite, and interstitial matter which is probably devitrified glass. In some cases the centre of the vesicle is occupied by quartz and the rest by the fine-textured and devitrified material.

We have here an instance of a phenomenon which seems to be not uncommon in this group of rocks throughout Britain. Vesicles in the rock have been filled, or partly filled, at a late stage in the consolidation, by an oozing in of the residual fluid magma. This is doubtless of more acid composition than the bulk of the rock. It has usually consolidated mainly or wholly as a glass, which, however, may have been subsequently devitrified. Mr Teall<ref> *Geol. Mag.,* 1889, pp. 481–483, p1. XIV.</ref> has remarked the peculiarity in the andesitic dyke of Tynemouth. Professor Judd<ref>*Quart. Journ. Geol. Soc.,* vol. xlvi., p. 378; 1890.</ref> has recorded it in a rock of specific gravity 2.89, apparently a basic andesite, occurring on Ben Hiant, Ardnamurchan, and regarded by that author as a lava-flow but by Sir A. Geikie as an intrusive sill. Professor Sollas<ref>*Sci. Proc. Roy. Dubl. Soc.* (2), vol. viii., p. 93; 1893.</ref>. has noticed the same thing in an augite-andesite dyke at Barnesmore in Donegal.

Those andesites which contain a moderate amount of glassy base exhibit usually the "hyalopilitic" structure of Rosenbusch, and have often a fine texture. A good example is from a dyke at Glas Eilean, Bromlford (S9442) [NG 656 233]. It has a compact ground-mass with the light grey colour which the rocks of this type invariably show, due partly to weathering. There are numerous rectangular crystals of fresh striated felspar, often with markedly tabular habit; and in the slice these give extinction-angles up to 34° in symmetrically cut sections, indicating a moderately acid labradorite. The only distinct element of the ground-mass is felspar in minute "lath-shaped" sections, but there have apparently been little augite granules as well as interstitial glass, both now destroyed. A dyke 1050 yards E.N.E. of the summit of Ben Suardal is identical in characters with the preceding, except that it is of rather finer texture and more altered. Its specific gravity is 2.68 (S9573) [NG 640 208].

A different type, much richer in glass, is represented by a dyke on the shore of Loch Eishort, W. of Boreraig (S3201) [NG 615 165]. It is a fresh rock of nearly black colour with glassy-looking felspars up to nearly ¼ inch long. In the slice these are seen to contain large inclusions of the ground-mass: there are also smaller porphyritic felspars, which are clear. The light brown augite also belongs in part to an early date of consolidation, and is then idiomorphic. In addition there are imperfect crystals of magnetite. The dominant felspar is andesine or andesine-labradorite. The abundant ground-mass is essentially of a pale glass crowded with little rectangular gratings composed of two systems of black rods crossing, with minute felspar fibres, and what seems to represent destroyed augite (Plate 26)., Fig. 4.

Another type corresponds with the "tholeiite" of Rosenbusch, with characteristic "intersertal" structure. Here the proportion of glassy base may vary between wide limits, even in different parts of one dyke. A good example is a dyke between Rudha Guail and Loch na Dal, on the coast N.E. of Isle Ornsay. This becomes richer in glass towards the margin, and has a thin tachylytic selvage. One slice of this dyke (S5423) [NG 726 150] shows rectangular felspars about 1/30 inch long, augite in granules and little sub-ophitic patches, little crystals of magnetite, and abundant needles of apatite; but in addition interstitial patches of glass crowded with microlites of felspar and augite. A slice (S5424) [NG 729 152] of a more glassy portion is similar in all essentials, except that the patches of interstitial base are much more abundant. Some of these patches are of circular form, with the felspar "laths" arranged tangentially about them. These doubtless represent vesicles occupied by the residual base of the rock (Plate 27)., Fig. 2.

The extreme glassy type of andesite is illustrated by a dull grey rock of specific gravity 2.15 from a dyke in Broadford Bay (S9441) [NG 65 23]. This is evidently considerably altered from its original state, but seems to have been of the nature of an andesite pitchstone. There are no phenocrysts, but only a much altered base full of slender felspar fibres and little dark rods, with partial parallel and rectangular grouping, which probably represent destroyed microlites of augite.

Rocks in any way comparable with the above seem to be at least very rare in Skye outside the area which has been indicated; but certain rocks from Druim an Eidhne may be mentioned here as probably devitrified andesitic pitchstones. The best example was found as a dyke, a foot in width, intersecting the gabbro on the highest point of the ridge named. It is a grey, compact, and rather splintery rock of specific gravity 2.79, with a strongly-marked fine banding, caused by lines and little spots of dark greenish-grey upon a lighter ground. The little spots, as seen on the hand-specimen, suggest spherulites. In a thin slice (S8702) [NG 493 226] the appearance in natural light is precisely that of a pitchstone. The only porphyritic elements are rare crystals of brown hornblende and felspar of small size. The general mass of the rock shows a multitude of minute crystallites, varying in size and arrangement. In some bands these are preserved intact, and appear as a crowd of minute rods of pale green colour, probably augite. More usually the crystallites are replaced by chloritic or ferruginous matter. The larger ones occur in groups with a stellate arrangement, surrounded by a clear space. These clear spaces, with the general base in which the crystallitic growths are set, appear colourless and struc-tureless in natural light. Polarised light, however, shows a finely crystalline and evidently felspathic mass with confused interlacing structure. It is probably a devitrified glassy base, but concerning devitrification in rocks of this kind of composition there is very little information available.

A point to which we have already alluded is the relation subsisting between the augite-andesites and pitchstones in the same area. Not only do the andesitic dykes contain in many cases a variable amount of glassy base, and come to be represented in some instances by practically vitreous rocks, still of intermediate acidity; but there seems to be a somewhat intimate relationship between the andesites and true pitchstones of acid composition. This is better illustrated in some other parts of the British province — e.g. in Arran — than in Skye, but a few words on the subject will not be out of place.

Professor Judd,<ref>*Quart. Journ. Geol. Soc.,* vol. xlvi., p. 379; 1890.</ref> in a paper already cited, has remarked on the tendency in these "younger augite-andesites" for the glassy to become separated from the crystalline portion. The point is an interesting one as perhaps throwing light upon one kind of differentiation — viz., that effected by the separation, or partial separation, of the crystals already formed at a given stage from the residual fluid magma.<ref>Compare also Judd in *Geol, Mag.,* 1888, pp. 1–11.</ref> The composition of the residual magma thus separated would depend upon the stage of consolidation at which the process was effected: it might be sub-acid or thoroughly acid. Again we may recognise different degrees of separation, depending upon circumstances, as follows: (i.) a patchy arrangement on a small scale of the glassy base in the augite-andesites, such as is often seen in slices, and the oozing of the magml, into

vesicles as noted above; (ii.) kernels and patches of larger size, composed of relatively acid glass, embedded in an andesitic dyke; (iii.) composite dykes of augite-andesite and pitchstone, such as those of Cir Mhòr and Tormore in Arran<ref>Judd, *Quart. Journ. Geol. Soc.,* vol. xlix., 536–564; 1893.</ref>; and (iv.) separate dykes of augite-andesite and pitchstone associated in the same area.

The second of these four cases is illustrated by one example from Skye cited by Professor Judd. It is from Bealach a' Mhaìm and presumably from a dyke; though the mode of occurrence is not recorded. The dyke-rock itself is stated to have a specific gravity 2.89, and must therefore be of considerably basic composition. The glass which occurs locally as patches in the midst of it yielded the analysis here quoted in column I.: its relatively acid nature, and especially its high content of alkalies, are very remarkable. For comparison we have the Eskdale dyke, in Dumfriesshire, described by Sir A. Geikie, with enclosed glassy portions of which analyses are quoted under B and C. It is interesting to refer also to the Armathwaite dyke, described by Mr Teall, an augite-andesite closely like some of those of the Western Isles and doubtless belonging to the same group. It illustrates how the interstitial base of such a rock, which yields 58 per cent. of silica in bulk-analysis, may be comparable in composition with some acid pitch-stones (*see* column C)

	I	A	B	C
SiO_2	61.80	58.67	65.49	70.76
Al_2O_3	14.91	14.37	14.66	10.93
Fe_2O_3	8.27	1.64		3.59
FeO	not det.	6.94	5.44	not det.
MnO	not det.	trace		
MgO	0.27	4.65	P57	4.21
CaO	3.33	7.39	3.73	3.29
Na_2O	6.50	3.01	not det.}	7.22
K_2O	5.19	1.42	not det.}	by diff.
Ignition	0.87	2.02	not det.	
	101.14	100.11		100.00
Specific gravity	2.63	2.7		

I. Glass in "labradorite-andesite" (? dyke), Bealach a Mhaìm, between Sligachan and Glen Brittle: mean of duplicate analyses by S. Parrish and H. J. Taylor, *Quart. Journ. Geol. Soc.,* vol. xlvi., p. 364; 1890.

A. Glassy portion of the Eskdale dyke, near Eskdalemuir Manse, Dumfriesshire: anal. J. G. Grant-Wilson, *Proc. Roy. Phys. Soc. Ellin.,* vol. v., p. 253; 1880.

B. Isolated kernels of black glass dispersed through the same rock: anal. J. G. Grant-Wilson, *ibid.,* p. 254.

C. Insoluble residue of Armathwaite dyke, Cumberland, amounting to 35.57 per cent. of the rock, and representing approximately the insterstitial base: anal. W. F. K. Stock, *Quart.* Journ. *Geol. Soc.,* vol. xl., p. 225; 1884.

We have next to describe the *acid pitchstones* of our area. Pitchstone is a rock of comparatively rare occurrence in Skye; but in virtue of its very distinctive appearance it attracts the eye wherever it is found", and it was recorded by some of the earliest explorers of the island. As the observed occurrences are few, and exemplify more than one variety of the rock, we shall notice them severally. They are all situated nearly on one line running N.W.–S.E.; and with one exception they are within or closely on the border of the granite area (*see* (Figure 76), p. 387). They form, in every case examined, dykes of quite small width, and in some cases not the whole width of the dyke has the character of a typical pitch-stone. In more than one instance the dyke itself is concealed beneath the great screes of the Red Hills, and only loose fragments have been found.

Two or three pitchstone dykes occur on Glamaig. Jameson<ref>*Mineralogy of the Scottish Isles,* vol. ii., p. 90; 1800. </ref> found here fragments of yellowish and green pitchstone, but was -not able to discover their source. Macculloch<ref>*Descr. West. Isl, Scot.,* vol. i., p. 401; 1819.</ref> noted fragments of two varieties, one black with a few glassy felspars enclosed, the other olive-green with a structure (spherulitic) which he remarked as a novel peculiarity.

Von Oeynhausen and von Dechen<ref>*Karsten's Archiv für Mineralogie,* vol. i., p. 85, pl. III., fig. 2; 1829.</ref> found a dyke 2 or 3 feet wide of dark green spherulitic pitchstone, apparently on the north face of the eastern peak of Glamaig, at ¾ of the height of the hill, besides loose fragments of the black variety. Zirkel<ref>*Zeits. deuts. geol. Ges.,* vol xxiii., p. 89; 1871.</ref> uses nearly the same language as the authors just quoted, but it is not clear whether he refers to the same dyke.

At least two pitchstone dykes intersect the granite of Glamaig, and these are the most northerly and the most westerly of which we have found any evidence in Skye. One at about 1300 feet altitude, or about half-way up, on the western slope is not that of von Oeynhausen and von Dechen, but may possibly be the same that was recorded by Zirkel. It bears N.W. by N., and has a width of about 2 feet, but seems to be a double dyke, consisting of two members each about a foot wide. The purely glassy portion is of a dark greenish grey colour, and has a specific gravity 2.31. It encloses only rare crystals of felspar up to ■ inch in length, but more frequently little spherulites. These are usually only 1/10 inch to 1/20 in diameter, but some, especially in the dull devitrified portion of the dyke, reach a diameter of an inch. The glass is pale yellow in a thin slice (S8733) [NG 50 30] and mostly free from any crystallitic growths; but in certain narrow bands (1/10 inch wide), parallel to the dyke, there are little rod-like bodies with a tendency to star-like groupings reminiscent of the well known Arran pitchstones. They seem to be of augite or hornblende, but are too minute to exhibit their optical properties clearly. The little felspar crystals, which are scattered very sparingly through the rock, are simple or once twinned: occasionally they form the nuclei of spherulites. The small spherulites are paler in slices than the glassy matrix, but have a well defined border of deeper tint, a light yellowish brown: sometimes there are two or even three concentric rings of this nature. The spherulites have an elliptic section, being elongated in the direction of flow, *i.e.* parallel to the walls of the dyke. The black cross which they show between crossed nicols is not a very regular one, and it is clear that it arises not from a radiate structure but from a concentric-shell arrangement, like that seen in many oolitic limestones (Plate 20), Fig. 5. The birefringence is comparable with that of an alkali-felspar. By using a mica-plate we find that the spherulites are of the "positive" kind (*i.e.* the least axis of optical elasticity is in the radial direction), and we may conceive this effect as resulting from "negative" felspar-fibres arranged tangentially.

There is more than one dyke of this type on Glamaig, for fragments of a rock closely resembling that just described occur in the screes some 600 feet higher up. Macculloch's black porphyritic pitchstone belongs probably to still another dyke concealed by the screes. We have not found it on Glamaig itself, but boulders of it occur in the drift of the district on the line of the other Glamaig boulders. It is a black rock with pitchy lustre, enclosing fresh felspars up to 4 inch in length, and having, like most of these pitchstones, a certain fissile character. A specimen from the drift near Drynoch Lodge gave the specific gravity 2.37. A specimen of the well known rock of the Sgùrr of Eigg, selected for its resemblance to these boulders, gave 2.42. The resemblance, however, seems to be a superficial one only. The felspars in our rock are wholly of a monoclinic species, with carlsbad twins. The other porphyritic elements are green augite crystals and some small octahedra of magnetite. The ground-mass has a yellowish colour, with evident flow-structure. It encloses little rods, from 0.005 inch downward, of faint green colour and presumably of hornblende or augite; the smaller ones are gathered into stellate groupings, each surrounded by a clear space. Much more minute crystallitic growths disseminated through the colourless glassy base impart the yellowish tint and slight turbidity which are noticeable with a low magnification,

The next locality for pitchstone is on the eastern slope of Glas Bheinn Mhòr. Loose fragments are found beside the Strath Mòr foot-path, in some of the scree-deltas thrown out by the small streams which intersect the slope. Our attention was called to these fragments by Sir A. Geikie; but, though their source is probably in the immediate neighbourhood, we have not succeeded in detecting it, and it is probably concealed under the screes. The rock has a dark olive-brown glassy ground-mass enclosing closely-set crystals of felspar up to ¼ inch long. Its specific gravity is 2.44, Thin slices show that, besides felspars, both oligoclase and sanidine, green augite and magnetite figure among the phenocrysts, and these several minerals are grouped in aggregates. Some felspar crystals are so honeycombed with inclusions of the groundmass that they consist to the extent of fully one-half of glass. A more unusual feature is the occurrence of quartz micrographically intergrown in felspar phenocrysts and of radiating fringes of micro-pegmatite bordering groups of crystals. The glassy ground-mass has a yellowish cloudy appearance, due to an immense number of very minute crystallitic elements visible only with a high magnifying power. They are partly globulites, partly short rods. Perlitic fissures are sometimes seen surrounding the phenocrysts (Plate 24)., Fig. 3.

It is probable that more than one dyke of pitchstone occurs on this slope of Glas Bheinn Mhòr, for, at a spot not far north of the last, two pitchstone boulders were found in the drift of Strath Mòr, which differ from the variety just noted. One contains only scattered rectangular felspars about ■ inch long in a grey ground-mass. This has a patchy appearance from the intermingling of truly vitreous portions with others of somewhat duller, enamel-like aspect. The specific gravity of this rock is 2.34. A thin slice shows that besides the felspar phenocrysts there are, as usual, smaller ones of augite and a few grains of magnetite. The felspar is sanidine, and it encloses large patches of glass, besides crystals of augite and magnetite. The yellow and rather cloudy glass which forms the matrix owes its appearance to a crowd of minute globulites, barely resolved under a high-power objective. The other boulder from this place has a specific gravity 2.346. Under the microscope it shows a similar yellow glass, in which sanidine phenocrysts are embedded, and the yellowish turbidity is resolved with high magnification into a vast number of very minute rods and globulites. There are little clear spaces surrounding green microlites of larger dimensions, though still less than 1/500 inch long, which tend to aggregate into roughly stellate groups, recalling some of the well known pitchstones of Arran.

Jameson<ref>Mineralogy of the Scottish Isles, p. 93; 1800.</ref> in 1800 recorded fragments of dark leek-green pitchstone on the slopes of Beinn na Caillich, and in 1818 discovered their source in the form of a "vein in a stream descending from that mountain", probably Allt a’ Choire, above the farm of Coire-chatachan (see Macculloch,<ref>Descr. West. Isl. Scot., vol. i., p. 401.</ref> passim). Several pitchstone dykes, or dykes composed partly of pitchstone, intersect the granite of Beinn na Caillich. One high up on the northern face does not seem to be exposed, but fragments were found at an altitude of over 2000 feet. It is a deep olive-green glassy-looking rock, enclosing numerous little felspars and other crystals, and the specific gravity was found to be 2.35. A slice (S6796) [NG 599 231] shows the little felspars to be mostly. sanidine, but with some plagioclase. There are also some yellowish grains of augite and an occasional slender prism of a greener augite (extinction-angle 38°); and a few pyramidal crystals of quartz occur. The mass of the rock is a clear colourless glass full of little rod-like crystallites, which in the neighbourhood of the porphyritic crystals have a marked fluxional arrangement. The largest of these minute rods just show a faint greenish tint, and they are presumably either augite or hornblende, the former being perhaps the more probable in view of the augite phenocrysts, though comparison with the Arran rocks forbids us to insist on this point.

Low down on the eastern slopes of the hill two or three dykes occur in the burn Allt a’ Choire, which flows down to Coire-chatachan. A small water-fall at about 350 feet altitude is caused by a triple dyke running nearly E.–W. The two flanking members consist of compact quartz-bearing felsitic rocks which gave specific gravities 2.53 and 2.58 (S8842) [NG 620 230]. The central member is a pitchstone of more subdued lustre than the preceding, but also of olive-green colour: its specific gravity was found to be 2.30. Porphyritic elements are rare and of small dimensions: a thin slice (S6794) [NG 617 233] shows that they are of sanidine with rather rounded outlines. The transparent colourless matrix of the rock is only partly glassy, and in large part crystalline, consisting of felspar. It is crowded, as before, with minute rod-like crystallites. Some larger ones show a greenish tint and a fibrous structure, and give extinction-angles up to 16°, indicating hornblende. Each is surrounded by a clear space free from the smaller crystallites; a feature familiar in the Arran and other pitchstones (Plate 24)., Fig. 2. Slices cut from the marginal portion of the rock showed some differences from the above. There are little bands wholly made up of closely-packed very minute spherulites, each giving the black cross. More complex, but less perfect, spherulitic growths of a brownish tint surround the few small porphyritic felspars, and form detached wisps. There is here less glass in the base of the rock, most of which shows depolarisation, especially evident in the clear spaces surrounding the hornblende crystallites (S6795) [NG 616 234].

That rocks similar to the pitchstones of the Red Hills occur also in the Sleat district appears from a specimen collected by Mr Clough from a dyke at Allt Duisdale, near Isle Ornsay. It is a dark rock with a pitchy lustre, enclosing scattered felspars up to ■ inch long, and having the specific gravity 2.36. It has a marked flow-structure, and also a rough platy or columnar fracture oblique to this. A thin slice (S6130) [NG 681 128] shows that the porphyritic elements, only sparingly present, are, in the order of their crystallisation, imperfect octahedra of magnetite, light green prisms of augite, and clear untwinned crystals of sanidine, rounded and corroded. The rest is a clear colourless glass crowded with minute slender prisms with imperfect terminations. Some of these are of sanidine, but the majority have a greenish colour, and are found by their extinction-angles to be augite, perhaps with some hornblende.

The above pitchstones seem by their low specific gravities to be, at least in the main, of acid composition. This criterion is however not entirely satisfactory, and we have already remarked on the resemblance of one of the rocks to that of the

Sgùrr of Eigg, which is of sub-acid composition. Published analyses of British Tertiary pitchstones show that those of truly acid nature have specific gravities ranging from 2.29 to 2.37, while the pitchstone of Barnesmore Gap in Donegal (with 64.04 per cent. of silica) gives 2.41, and that of the Sgùrr of Eigg (with 65.81 per cent.) 2.42. These sub-acid glasses are therefore very little denser than others containing 8 or 10 per cent. more silica.

Although pitchstones are of comparatively rare occurrence in Skye, there are in places very numerous dykes which, although not glassy, reproduce in other respects the characteristics of that group of rocks, and are perhaps to be regarded as devitrified and otherwise altered pitchstones. — They are dykes of no great width, usually only a foot or two, exceptionally as much as six or even ten feet. Their direction is commonly about W.N.W.–E.S.E., but varies in extreme cases from W.–E. to N.S. They are dull compact-looking rocks, often crowded at the margin with little spherules which show conspicuously on a weathered face; and these are sometimes alligned so as to give what Mr Clough has styled a "rodded" structure. A number of specimens were examined from the neighbourhood of Coire-chatachan and the slopes of Beinn na Caillich. Five of these gave specific gravities ranging from 2.45 to 2.54, with a mean of 2.50. For the sake of clearness we will refer to these presumably altered rocks as the Coire-chatachan type. Their local distribution is indicated in (Figure 76), above.

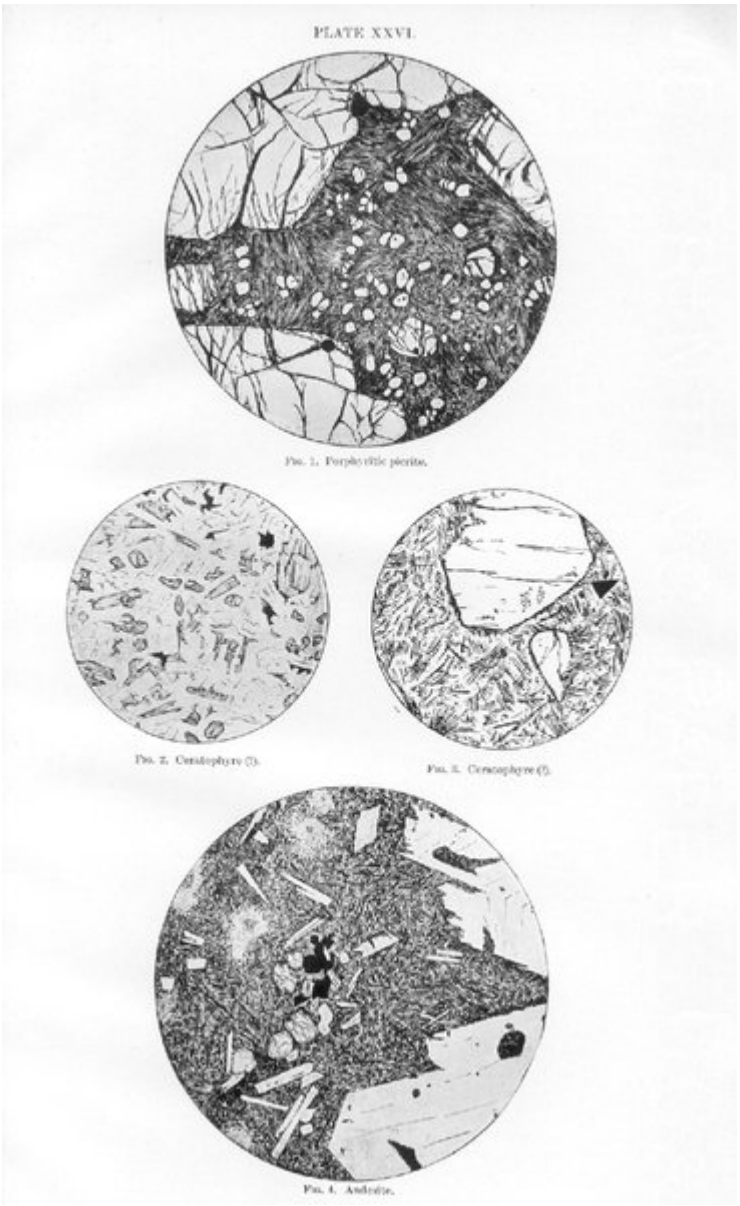
Before describing these dykes it should be observed that rocks of precisely similar characters are found in immediate association with typical pitchstones, and there have every appearance of an identical origin. Thus the dark green pitchstone of Glamaig, already described, passes into a dull grey compact rock, with fluxion-lines weathering out as slender ribs on an exposed face. A thin slice (S8841) [NG 510 302] is very instructive. In natural light it appears practically identical with the pitchstone (S8733) [NG 50 30], consisting of what looks like a pale yellow glass with scattered crystallites and enclosing little phenocrysts of sanidine and more rarely of green augite. With crossed nicols the appearance is totally different. What looked like a glass is found to be birefringent and to consist of a mosaic, the individual elements of which average about 1/50 inch across. These elements, however, are not crystal-grains, for they give shadowy or "undulose" extinction, of a kind indicating a divergent fibrous structure. The birefringence is nearly equal to that of quartz. That this is due to devitrification of a once glassy rock is placed beyond doubt by another portion of the same slice. Here we have in natural light the same appearance of a glass, but with a patchy arrange: ment, little patches of pale yellow or yellowish brown tint, of irregular but rounded shape, being separated by nearly colourless and quite clear parts with a disposition like a network of veins. With crossed nicols we see that the yellow patches are still isotropic: the clear parts, however, structureless in natural light, break up into a mosaic comparable with that just described. The radiate structure of each element of the mosaic is here more developed, so as to give a perfect black cross. These clear doubly refracting parts evidently follow a system of cracks, partly with a general parallelism which corresponds with the platy jointing and flow-structure of the dyke. The evidence of devitrification seems in this instance to be complete.

Some of the Coire-chatachan dykes, though now devoid of vitreous matter, show so close a general resemblance to the rock just described that we may confidently assign to them a like origin. Good examples are afforded by a dyke (sp. gr. 2.54) about 1100 yards N.N.E. of the old house of Coire-chatachan and another (sp. gr. 2.53) in the lower part of Allt a' Choire. Slices (S6785) [NG 623 239], (S6793) [NG 619 231] closely resemble pitchstones when examined in natural light. There is a general cloudiness, due to a crowd of excessively minute crystallites (as in some well known pitchstones, such as that of Corriegills, Arran); and there are also larger crystallites, each surrounded by a narrow clear space and in the more altered parts by a ring of darker brown. Between crossed nicols the rocks show a microcrystalline structure, often with a confused "felsitic" appearance, but elsewhere consisting of evident grains of untwinned felspar. There is no black cross, and very little approach to a radiate arrangement such as is clearly, but it would seem exceptionally, developed in the Glamaig rock. Even in that case it is to be observed that no true spherulites, with defined boundaries, were formed in the process of devitrification. The spherulites there found (S8733) [NG 50 30] are undoubtedly primary growths. In no rocks in Skye have we found any evidence of typical spherulites formed in connection with devitrification. Some of the Coire-chatachan dykes contain spherulites, or have contained them, but these structures seem to be in every case original, and, as we shall see, have often been destroyed by the secondary changes which the rocks have undergone. As an example of this we may take a one-foot dyke seen about 850 yards N.N.E. of the old house, a dull compact-looking rock with flow-lines marked by alternations of lighter and darker grey. A thin slice (S6790) [NG 622 231] shows very numerous yellow spots, 1/100 to 1/20 inch in diameter, set in a paler, evidently crystalline, matrix. The spots are round and sharply defined: they have a darker border, and the larger ones have sometimes dark concentric rings.

They seem certainly to represent spherulites; but, if so, they have doubtless had their structure wholly destroyed by recrystallisation, for they are now merely fine-textured granular patches. The paler matrix consists of elongated grains or imperfect crystals, up to 1/50 inch long, extinguishing pretty accurately parallel to their length, and with the properties of orthoclase. Round the spherules they sometimes assume a radiating arrangement. Although the rock has now nothing of the characters of a pitchstone, comparison with other specimens suggests that such may have been its original state. Its composition is apparently that of a trachytic rock.

Other examples show what must be regarded as a more radical kind of alteration, probably affecting the bulk composition of the rock; and in such cases the term '"devitrification" does not adequately express the changes undergone. A 10 ft dyke about 900 yards N. of the old house is of a dull compact rock with strong flow-structure, marked by closely alternating whitish and greenish grey bands: the specific gravity is 2.52. A slice (S6784) [NG 621 236] shows the greenish tint to be due to little patches and streaks of chloritic and ferruginous matter. Some portion of this evidently replaces little crystallites like the larger of those seen in the pitchstones, and the cloudy, finely disseminated matter may perhaps be derived from the destruction of more minute crystallitic growths. The general mass of the rock has the confused "felsitic" structure noted in the other specimens, and where the elements of the aggregate are large enough to be identified, they are apparently orthoclase. There are, however, in addition, numerous irregular patches of clear quartz-mosaic, which from their manner of occurrence must certainly be set down as secondary, and seem to point to an introduction of silica from without. This appears more clearly in a dyke a little north of the preceding, and differing from it in general aspect only in being spherulitic. Distinct spherules and axiolitic bands formed by their coalescence make up a considerable part of the rock (S6786) [NG 621 237], and some of them, preserving perfectly their radiating and tufted structures, must be nearly in their original state. Elsewhere there is considerable alteration evinced by the occurrence of abundant clear quartz in the form of sectors cutting into the yellowish brown spherulites and axiolites. They are often continuous with similar clear quartz occupying the interstices of the spherulites and forming streaks between the bands. In this case it appears that changes of a kind involving partial silicification have almost wholly destroyed the original nature of the matrix, and attacked to some extent the more durable spherulitic growths. The siliceous replacement must have been of a gradual kind, for both in this and in the preceding rock it is within the clear quartz areas that the forms of the little crystallites of the original rock are most perfectly preserved. The same remark applies to a rock in many respects resembling the last, occurring at the north-eastern base of Beinn na Caillich, about 550 yards N.W. by N. of the Lochain. It was found only in the form of abundant loose fragments, but evidently belongs to a dyke of this group. It has a lamellar jointing coinciding with a strong fluxion-banding and is crowded with little spherulites, which have the "rodded" arrangement.

A dyke seen on the coast to the N.N.E. of Corry Lodge, Broadford, has characters which in many respects resemble those of the more altered of the Coire-chatachan dykes, and is possibly like them a transformed glassy rock; but it is essentially different from them in its original nature. It contains abundant crystals of quartz, and must have been a rock of thoroughly acid composition.



(Plate 26) Fig. 1. (S9980) [NG 427 141] × 32. Porphyritic Picrite, sill S. of Leac nan Faoileann, I. of Soay. The porphyritic elements are olivine and picotite. These recur also in a second generation, but the bulk of the ground-mass is of slender rods of felspar with sub-parallel arrangement and interstitial augite, the structure recalling that of some variolitic basalts. See p. 380. Fig. 2. (S7370) [NG 585 105] × 20. Ceratophyre (?), large dyke W. of Loch Gauscavaig, near Tarskavaig, Sleat: showing an aggregate of crystals of alkali-felspar with small crystals of augite and grains of magnetite. See p. 397. Fig. 3, (S6851) [NG 610 045] × 20. Ceratophyre (?), dyke nearly ■ mile N. by W. of Cnoc an Sgùmain, Armadale: showing phenocrysts of crypto-perthite in a ground-mass composed of an aggregate of crystals of alkali-felspar penetrated by very numerous needles of augite. See p. 397. Fig. 4. (S3201) [NG 615 165] × 30. Glassy Augite-Andesite, dyke on shore of Loch Eishort, W. of Boreraig: showing phenocrysts of felspar, augite, and magnetite in a ground-mass composed of clear glass crowded with crystallitic growths, largely in the form of minute rectangular gratings. See p. 401.

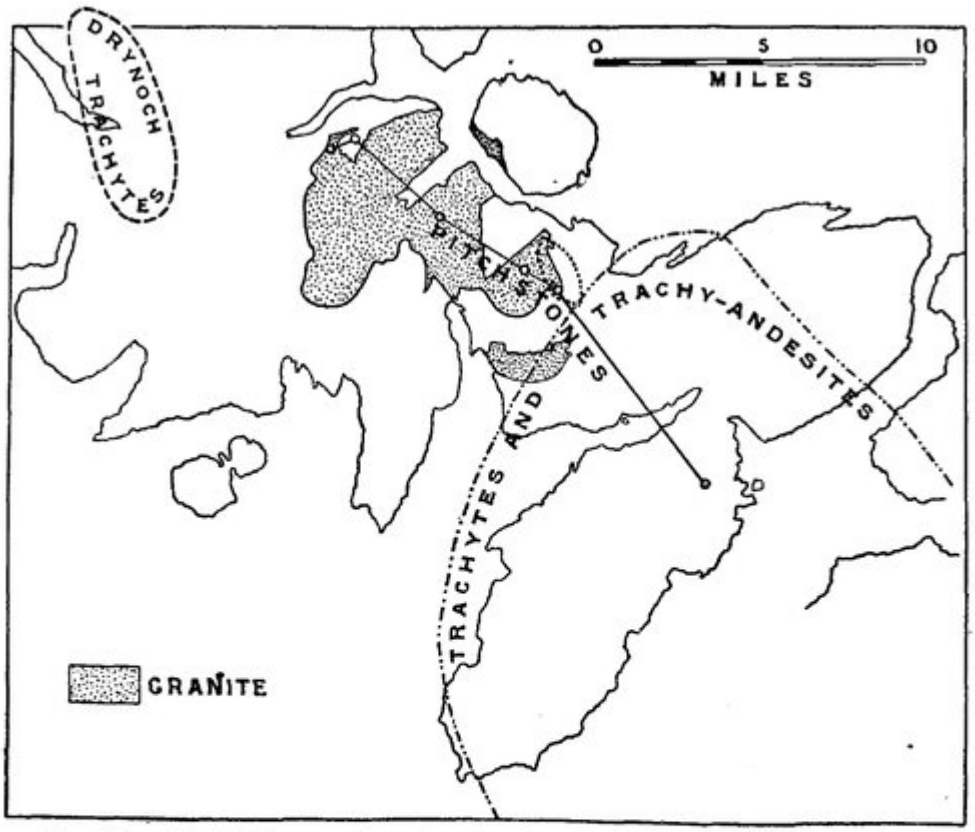


FIG. 76.—Sketch-Map to show the distribution of some trachytic and other dykes.

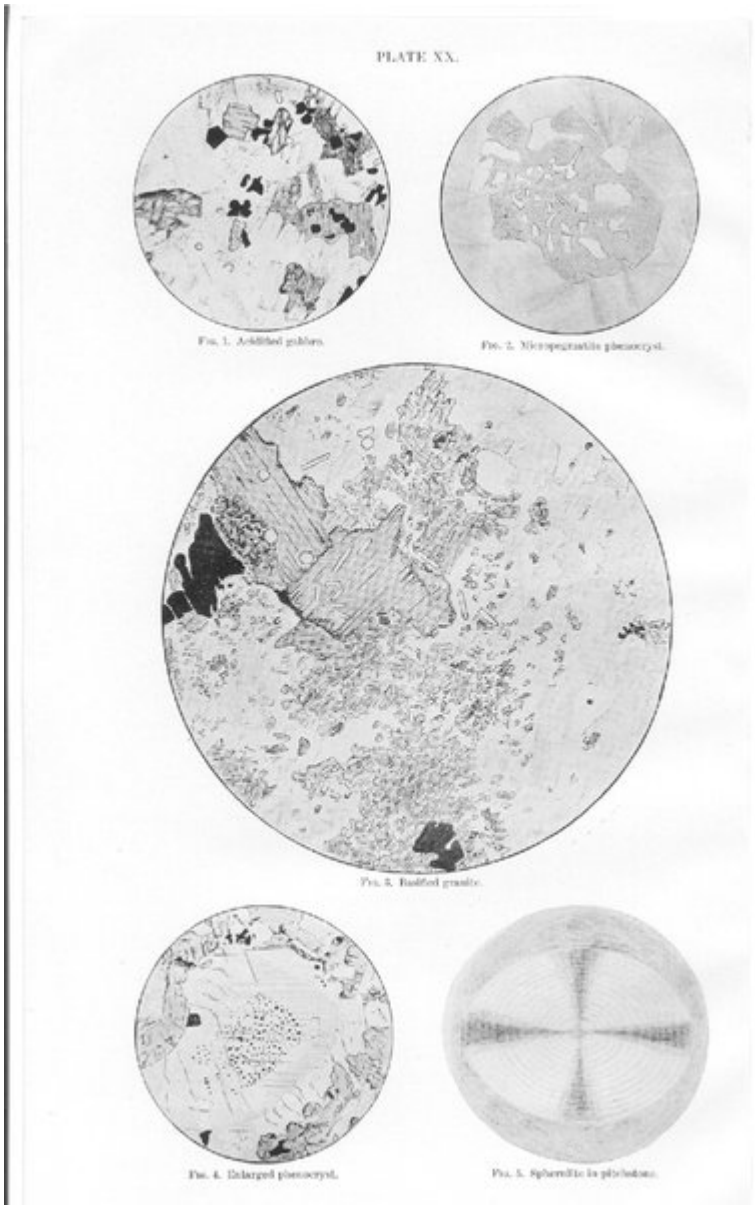
(*a.*) The broken line encloses the oval area of distribution of the Drynoch group of trachytes.

(*b.*) The line made up of dots and dashes marks the limits of distribution in Skye of the trachytic and allied dykes of Sleat and the Broadford district.

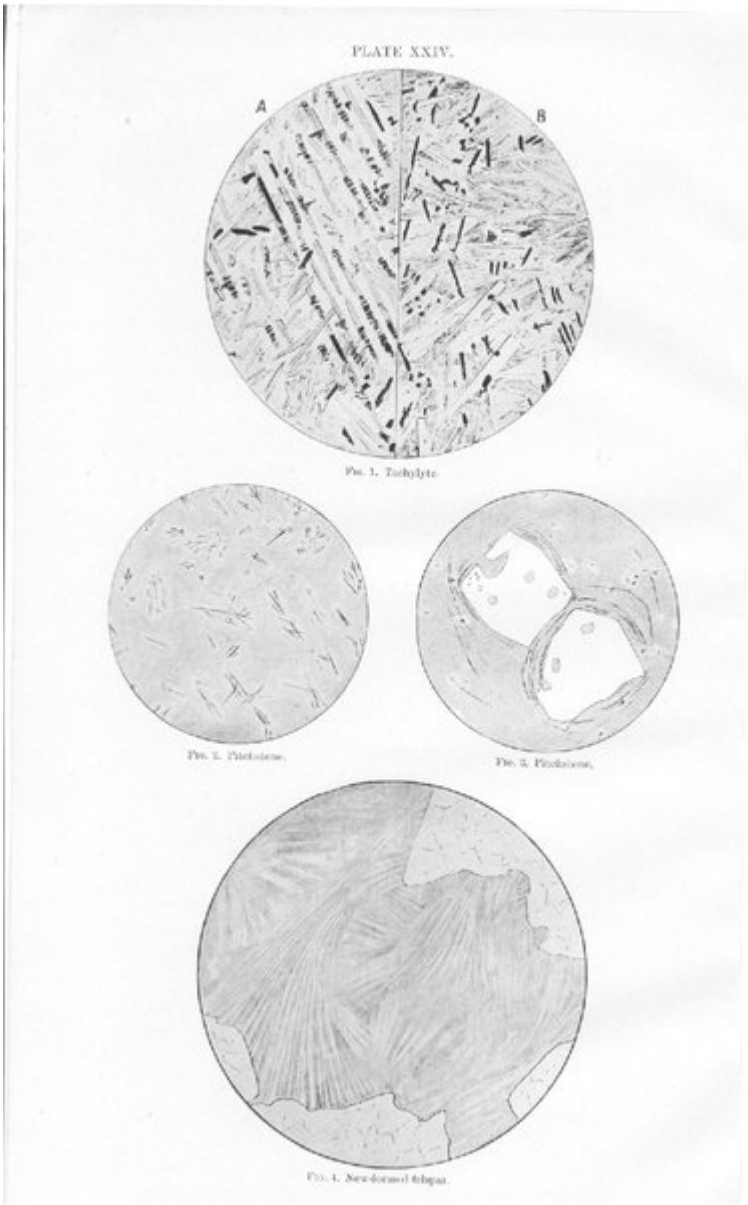
(*c.*) The small circles connected by straight lines indicate the known localities of acid pitchstone dykes.

(*d*) The small oval enclosed by the dotted line shows the area affected by the Coirechatachan type of dykes, probably altered pitchstones. It falls in the middle of the narrow strip of country including the occurrences under (*c*).

(Figure 76) Sketch-Map to show the distribution of some trachytic and other dykes. (CL) The broken line encloses the oval area of distribution of the Drynoch group of trachytes. (b.) The line made up of dots and dashes marks the limits of distribution in Skye of the trachytic and allied dykes of Sleat and the Broadford district. (c.) The small circles connected by straight lines indicate the known localities of acid pitchstone dykes. (d) The small oval enclosed by the dotted line shows the area affected by the Coirechatachan type of dykes, probably altered pitchstones. It falls in the middle of the narrow strip of country including the occurrences under (c).



(Plate 20) Fig. 1. (S8962) [NG 500 258] × 20. Gabbro partially fused and injected by the granite magma, gully on the N.W. face of Marsco. The minerals shown are felspar, partially destroyed augite, greenish brown hornblende, magnetite, apatite, and some interstitial quartz. Of the original constituents of the gabbro there remain relics of augite and some of the large crystals of labradorite. See p. 182. Fig. 2. (S5344) [NG 490 230] × 30. Phenocryst of micropegmatite in spherulitic dyke, Druim an Eidhne. It has served as the starting-place for subsequent spherulitic growths. See p. 284. Fig. 3. (S8694) [NG 513 249] × 40. Granite modified by absorption of gabbro material, S.E. ridge of Marsco. The figure shows aggregates composed of greenish brown hornblende with little scales of biotite, larger flakes of biotite enclosing apatite, and irregular grains of magnetite. The rest is of quartz, oligoclase, and orthoclase. See p. 184. Fig. 4. (S8188) [NG 418 351] × 20. Porphyritic Olivine-Dolerite, dyke on Roineval, two miles N of Drynoch: showing a felspar phenocryst enlarged by a later growth with crystalline continuity. See p. 329. Fig. 5. (S8733) [NG 50 30] × 50, crossed nicols. Spherulite in pitchstone, W. face of Glamaig: showing a concentric shell structure. See p. 404.



(Plate 24) Fig. 1. (S8850) [NG 708 183] × 150. Tachylyte, dyke ¾ m. N.E. of Kinloch, Sleat district: a quasi-spherulitic rock. See pp. 349, 350. A. Outer portion of one of the large spherulitic bodies, showing parallel rods of augite, with some magnetite, embedded in a colourless glass. B. Central part of a spherulite, showing abundant felspar, as well as augite and magnetite, with a smaller proportion of glassy base. Fig. 2. (S6794) [NG 617 233] × 20. Pitchstone, dyke in Allt a' Choire, above Coirechatachan, near Broadford: showing groups of crystallites, each surrounded by a clear ring. The turbid appearance of the rest of the glassy mass is due to a crowd of more minute crystallitic growths. See p. 407. Fig. 3. × 20. Pitchstone, E. slope of Glas Bheinn Mhòr; showing perlitic cracks surrounding phenocrysts of quartz: also groups of crystallites, each surrounded by a clear ring. See p. 405. Fig. 4. (S7479) [NG 523 201] × 30. Xenolith of quartzite from a basic dyke, S. end of Blath-bheinn. The figure shows the quartzite corroded by the basic magma and an inlet occupied by radiating fibres of new-formed felspar, probably oligoclase. See p. 352.