Chapter 20 Tertiary ring-dykes of Centre 3, Ardnamurchan (Continued)

The intrusions to be described in this chapter are as follows (*see* Index Map, p. 201 (Plate 5)):

(D) Porphyritic Gabbro of Meall nan Con screen

(E) Great Eucrite

(E′) Outer Eucrite

(F) Quartz-gabbro of Meall an Tarmachain summit

(F') Quartz-gabbro, south side of Meall an Tarmachain

The Porphyritic Gabbro (D) forms the southern part of the Meall nan Con screen, which separates the Outer Eucrite (E′) from the Great Eucrite (E). It is evidently earlier than the two Eucrites, along the contact with which it is obviously baked except at its south end, where its separation from the Eucrites becomes a difficult matter. South of Meall nan Con, the Quartz-gabbro of Meall an Tarmachain (F) intervenes intrusively between the two Eucrites. Where the Eucrites come together, north and south of the Meall nan Con screen, it was not found possible to locate their actual contact, although there are indications north of Meall nan Con of the later age of the Great Eucrite. Since it is a feature of both intrusions that they are practically unchilled at their contacts with older rock-masses, it is not surprising to find that their mutual junction cannot be exactly determined.

(D) Porphyritic Gabbro of Meall Nan Con Screen

The southern portion of the Meall nan Con ridge, which is formed of granulitized agglomerate, is flanked to west and east by arm-like masses of fine-textured gabbro with felspar phenocrysts. These arms are apparently connected with a fairly large mass of coarser-grained porphyritic gabbro that occupies lower ground immediately south of the ridge. The arms are highly contact altered adjacent to the Outer Eucrite (E′) and the Great Eucrite (E), and are consequently easy to separate in the field from these intrusions. The contact alteration becomes less marked in the main mass of the Porphyritic Gabbro. At its southern extremity, the gabbro is coarser in texture and less apparently porphyritic. It is consequently very difficult there to distinguish it from the Eucrites, as already mentioned.

This marked decrease southwards in the contact metamorphism of the Porphyritic Gabbro is a remarkable feature. Possibly those parts of the intrusion next to the much older agglomerates of Meall nan Con had in consequence become colder, and so were more readily metamorphosed than parts farther away. The metamorphism will be dealt with in detail later together with that of other portions of the Meall nan Con screen (p. 315).

(E) Great Eucrite

This massive ring-dyke has been already frequently referred to. On the Memoir-map it will be seen that it forms a complete ring encircling a complex of other intrusions (the Interior Complex). As compared with the intrusions within and outside it, the Eucrite is highly resistant to weathering. Numerous crush-lines directed north to north-west cross the intrusion, and their positions are marked by hollows of erosion. Except for such discontinuities, the Eucrite forms a complete ring-ridge that surrounds a central area of low relief occupied by the Interior Complex. A striking sectional view of this great rock-wall is obtained from the Kilchoan–Achnaha road, which follows a deeply cut erosion-hollow between the towering purplish-tinted mass of Creag an Airgid to the east, and Beinn na h'Imeilte to the west. Little vegetation grows upon these rocky hills, which remain much as the ice-sheet left them, with conspicuous *roches moutonées* on which striae are frequently preserved. The road a little farther north emerges from this rocky defile into the broad, low-lying central area. At this point, the inner side of the eucrite wall extends to left and right as two curving lines of high crags that can be followed with the eye around to the north where they rejoin one another and so complete the circle (*see*

(Plate 6), p. 321, for view from north-east).

The typical rock may be described as a coarse felspathic gabbroid rock containing both augite and olivine; but the proportion in which these two ferromagnesian constituents occur varies greatly, and often abruptly. Where olivine becomes abundant and augite subsidiary, the rock may be termed an allivalite. The crystals of olivine are always conspicuous in size. Indeed, in some places this mineral forms crystal-aggregates a foot long, as for instance about 500 yds. south-west of the summit of Meall nan Con. The augite frequently occurs as large plates that ophitically enclose the felspar.

A local variation in type only noted at a high level along the south-eastern portion of the Beinn na h'Imeilte ridge may be mentioned. There, about 900 yds. east-south-east of the summit, the rock becomes finer grained and contains plentiful iron-ore, having some resemblance to the quartz-gabbroid marginal portion of the intrusion (p. 204 Xenolithic material is often abundant in this vicinity. Possibly we may be here approaching a local top to the mass. Towards the outside of the intrusion, east of Creag an Airgid, a pale or white variety closely allied to quartz-gabbro (S22686) [NM 4821 6671] is intermingled with the dark normal eucrite in small patches and in streaky fashion.

Pale, felspathic eucrite may be seen at almost any point along the ring-dyke, often in irregular areas, but frequently forming broad bands. There is no difference in texture between the pale areas and the normal darker rock, but their mutual margins are usually well defined. As a rule, the pale bands are aligned more or less parallel to the course of the ring-dyke. Their elongate form is presumably due to flow-movement, perhaps at a late stage in the intrusion of the magma, since the bands are broad in relation to their length.

True flow banding is fairly frequent along the inner side of the south-eastern portion of the intrusion, though of rare occurrence elsewhere. The bands are usually inclined at an angle of 45 degrees, in some places inwards towards Centre 3, in others outwards from it.

An internal feature of special interest are pegmatite veins. These are met with around the whole intrusion, and are best developed in its exterior portions. They are usually rich in augite, sometimes to such a degree that the vein-rock may be termed pyroxenite. They are sometimes composite. For example, a thick vein east-northeast of Meall an Fhir-eòin consists of augite-rich marginal portions and a felspathic centre, 2 inches and 8 inches wide respectively. The normal augite-rich veins are usually much narrower than this, but among them are numbers of straight-running individuals as much as 2 or 3 inches across. In direction these relatively wide veins are everywhere parallel to the course of the ring-dyke. Further, they are either vertical or else highly inclined. Augite-rich pegmatite similar to that forming the veins is often found in irregular masses of considerable size enclosed in the normal eucrite, and continuity between such masses and pegmatite veins has sometimes been observed. For example, on the ridge half a mile north of Meall Meadhoin, and just south of the south end of a quartz-dolerite intrusion lettered gD on the Memoir-map, a pegmatite vein inclined at 80 degrees towards Centre 3 widens out rapidly at its north-west end into a mass of pegmatite. The pegmatite masses must represent residu4.l liquid portions of the intrusion in which fluxes had become concentrated, which may have acted as reservoirs from which the cracks that developed in the cooling and contracting mass were filled.

Though the longitudinal pegmatite veins are the most striking, others can be recognized, thinner and less regular, which run mainly at right angles to the direction of the Ring-dyke. Good examples of such cross-veining may be seen along the top of the Eucrite ridge one third of a mile north of Meall Meadhoin, directed towards the Achnaha Centre (3). They are usually steeply inclined or vertical. The two sets of pegmatite veins, aligned as they are with reference to the Achnaha Centre and to the course of their parent ring-dyke, appear to provide convincing internal evidence of the steep nature of this intrusion. The longitudinal veins are so persistently vertical, or nearly so, that it seems impossible not to conclude that the walls of the intrusion are correspondingly steep.

Two easily accessible localities at which to examine the longitudinal veins may be mentioned. The first is along the walls of a west-north-west cleft, a short distance north of the new road from Achnaha to Sanna, on the Sanna side of the Eucrite ridge. The veins there seen deviate little from the vertical, excepting one that is inclined north-west at 60 degrees. The other locality lies east of a loch (Lochan an Dobhrain) a mile north of Glendrian farm, where there are fine examples of the longitudinal veins, spaced a few yards apart. The absence of pegmatite veins from the inner half of the Eucrite can be demonstrated in this vicinity, south of the loch above mentioned.

The longitudinal pegmatite veins may frequently be seen to traverse the broad bands and patches of pale eucrite already described. In some cases the direction of the bands and the veins practically coincides, as, for example, on the western slopes of the Eucrite ridge about two thirds of a mile north-north-east of Achosnich. More usually there is a small divergence of direction between them. For instance, east of the Kilchoan–Achnaha road, about 600 yds. south-west of Creag an Airgid summit, elongate masses of the pale eucrite are directed N. 30° E., while the pegmatite veins traversing them run E. 10° to 20° N.

Marginal relations

The marginal relations of the Great Eucrite are of special importance in Ardnamurchan geology, on account of this intrusion being in contact with so many different rock-masses. Evidence that the Eucrite is older than the Interior Complex of Ring-dykes which it encloses will be discussed in the next chapter. Along the greater part of its outer margin, it is considered to be intruding the various rocks that border it. While age relations are in some cases easily determined, in others much difficulty is experienced, for, notwithstanding the unchilled nature of the Eucrite at its outer margin, it has frequently effected little contact alteration of earlier gabbros. The relations of the outer margin in regard to each of these rock-bodies are described below, beginning with the Meall nan Con screen and proceeding in a clockwise direction round to the Cone-sheet Complex west of Faskadale Bay.

Meall nan Con Screen

Basalt lavas, agglomerates, tuffs, and intrusions all form part of this screen, and have been already briefly described under their respective headings. A character common to all is their intensely baked condition, amounting in many places to complete granulitization. This makes the diagnosis of the rocks in the field often a matter of great difficulty, more especially the distinction of basalt lavas from fine-grained tuffs. Large felspars that occur in the tuffs of the south part of the screen give these rocks a pseudo-porphyritic appearance. At first sight they might be mistaken for the adjoining, highly baked porphyritic gabbro (D), but a closer scrutiny discloses their heterogeneous, fragmental nature. Brown-weathering dolerite in broad outcrops is associated with the grey-weathering tuffs, and probably represents cone-sheets. Such rocks are to be seen 600 yds. south of the summit of Meall nan Con, but owing to the masking of their original character by granulitization their mapping could not be carried out. The highly altered condition of these Meall nan Con rocks emphasizes the pre-Eucrite nature of the mass as a whole. It is an easy matter to trace the line of junction of the baked rocks, that form a conspicuous ridge, with the Great Eucrite to the west, and with the Outer Eucrite to the east. To north and south the screen extends downhill sufficiently far to show that the junction is steep, and the granulitized rocks truly screen-like.

On (Figure 40), the ridge along the sky-line to the left is formed by the northern part of the screen; the dotted line indicates the junction of screen with Great Eucrite, which occupies the remainder of the view; the abrupt hill-face on the extreme right of the skyline is the upper part of the great scarp that surrounds the Interior Complex and marks the inner side of the Great Eucrite. In this view, from screen to scarp, we therefore see practically the whole width of the Great Eucrite Ring-dyke.

Immediately north of the screen, the Great Eucrite comes into contact with the Outer Eucrite. At this point there is some evidence of an intrusive relationship between the two Eucrites. Acid net-veins are found throughout the rocks composing the screen, and are especially abundant next to the two Eucrite intrusions on either side, though never plentiful in the Eucrites themselves. North of the screen, however, extending downhill from its termination, a line can be drawn between what is taken to be the margin of the Great Eucrite with a little acid veining and a gabbroid rock of somewhat different appearance in which net-veins are profuse, and which is mapped with the Outer Eucrite. The change in character is abrupt along this line, but no intrusive contact could be located between the two Eucrites. It is perhaps an impossible task to find a junction between two such coarse-textured and essentially similar rocks, but without such direct evidence it cannot be definitely said that they are different injections, likely though this may be.

At some junctions between Great Eucrite and screen the only change in the former at the actual contact is a slight decrease in coarseness of grain. Such a contact may be seen on the north side of Meall nan Con, 460 yds. north-north-west of the summit. A finer-grained margin is found farther south, east of a small loch on a watershed between two streams that flow respectively north and south parallel to the west side of the screen (Figure 41). At this place the junction is best exposed. The rock-scarp that elsewhere closely marks the contact of the granulitized rocks with the eucrite, here includes a portion of the Eucrite itself. On the rocky upper part of the scarp, above the level Qf the talus and towards the left of (Figure 41), a vertical junction between the Eucrite and screen is well seen. The Eucrite becomes distinctly finer in texture a few yards from the contact, at which it still is, however, fairly coarse in texture. The Eucrite of the crag overlooking the loch is crossed by a set of vertical joints that run at right angles to its junction with the screen. This junction extends from the left, where it crosses the scarp as described, somewhat oblique to the line of the scarp. It is consequently situated only a few yards back from the cross-jointed eucrite of the crag. The vertical joints are presumably due to contraction that accompanied cooling. They have not been filled either by gabbro-pegmatite or by acid magma such as forms net-veins, and would therefore appear to be of somewhat late formation. In the interior of the Great Eucrite similar late contraction-joints are also developed, but are not specially noticeable at close quarters, since they are rather widely spaced. They are, however, a remarkable feature of the ring of crags that mark the inner side of this great ring-dyke as viewed from the centre of the Interior Complex. What appear at this distance as closely-spaced vertical joints crossing the crags are everywhere directed towards this central view-point. On the steep face of Beinn na h'Imeilte the joints are especially well displayed. They may be compared with the cross-joints commonly met with in ordinary basic dykes, and afford a further indication of the steep-sided form of the Great Eucrite Ring-dyke.

From the watershed at the small loch, the junction between Eucrite and screen continues southwards, keeping at first a straight course downhill along the base of the marginal scarp. It then must deviate from this course and passes around a highly granulitized little mass on lower ground below the scarp. This projecting tongue of the screen is the most highly altered portion of it. The interior of the tongue, which shows less alteration than the margins, consists of porphyritic fine-grained gabbro. This gabbro, as shown by frequent outcrops, is in continuity with the less altered porphyritic gabbro (D), already described (p. 294), which forms the southern part of the screen. Traced towards the margins of the tongue, the much altered porphyritic gabbro becomes finally a banded granulite at the actual contact with the Eucrite, which is unchilled. Transitional stages are found between the banded granulite and the porphyritic granulitized gabbro, a conclusion confirmed by microscopic examination of material collected (p. 316). At the junction with the Eucrite, layers of coarse rock resembling eucrite alternate with the finer-grained banded granulite, as though eucrite magma had been injected simultaneously with the flow-movement of a plastic mass. A similar interbanding is found at one other point along the outer margin of the Great Eucrite, at a contact with the Hypersthene-gabbro (a) (p. 303).

As already mentioned (p. 294), the separation of the porphyritic gabbro of the screen at its south end from the Great Eucrite and Outer Eucrite proved difficult, and the exact limits of the screen in this direction could not be accurately fixed. It is certain, however, that the screen ends in. the low ground separating Meall nan Con from Meall an Tarmachain, and that the Great Eucrite and Outer Eucrite there come together again. At this point the Outer Eucrite appears to be more prone to vary in composition than the Great Eucrite, but it has not been found possible to locate any intrusive contact between them.

Meall an Tarmachain screen

This screen forms a conspicuous ridge that bounds the central peak of Meall an Tarmachain to the north-west, and overlooks lower ground to the north occupied by the Great Eucrite. It forms a definite outer limit to the Great Eucrite at this locality, and separates it from an intrusion of quartz-gabbro (F) that constitutes the central peak of Meall an Tarmachain. Its rocks are greatly contact altered, but are perhaps chiefly agglomerate, as is shown by their frequently observed heterogeneous nature. The north-east end of the screen, as mapped, is partly at least composed of quartz-dolerite (p. 320). The relations between this baked quartz-dolerite and the Quartz-gabbro (F) could not be decided in the field. It is not impossible for this quartz-dolerite to be the margin of the Quartz-gabbro (F), baked by the Great Eucrite. At another point, however, quartz-gabbro included with (F) is intrusive against eucrite that appears to be continuous with (E) (*see* p. 318).

At the south-western end of the screen, above a little loch that lies in a hollow in the Great Eucrite, the margin of the latter turns abruptly eastwards across the direction of the screen. It then comes against quartz-gabbro included with (F), as above referred to.

Meall an Tarmachain capping

This capping overlies the Quartz-gabbro of Faskadale (A). Along the short distance that the Great Eucrite is in contact with it, their junction is steep or vertical. This junction is marked by a hollow eroded in the margin of the Eucrite, which extends straight down a steep hillside. The marginal rock, though coarse in grain, is more acid than the normal eucrite, since it contains a certain amount of acid mesostasis and also iron-ore, while olivine is somewhat scarce. It is in fact a basic type of quartz-gabbro. Acid net-veining is especially profuse in the granulitized rocks of the capping immediately next to the Eucrite, and probably emanated from this acid marginal portion of the intrusion.

Quartz-gabbro of Faskadale (A)

The fact that the Great Eucrite cuts across the Meall an Tarmachain capping that overlies the Quartz-gabbro (A), suggests that the Eucrite is the later of these two intrusions (Figure 39). There is also some direct evidence of their relative ages westwards of Meall an Tarmachain along the miles that they are in contact. A narrow zone of fine-grained gabbro, sometimes highly baked, is met with at intervals along this contact as far west as the Kilchoan–Achosnich road, and is intruded by the Eucrite. This zone satisfactorily fixes the outer limit of the Eucrite. On the other hand, its relation to the Quartz-gabbro outside it remains obscure. In some places it is abruptly succeeded by the Quartz-gabbro, as though distinct from it. In others, a gradation from one rock into the other appears to take place. Since a high degree of baking is only locally met with, it seems improbable that this zone is a screen older than both the intrusions which it separates. It seems more likely that it is a remnant of an early injection that preceded the main intrusion of the Great Eucrite.

This marginal rock is a brown-weathering fine-grained gabbro, often with porphyritic felspar, which on fractured surfaces has a peculiar dark-green colour that seems to mark some degree of contact alteration. Under the microscope, as investigated by Dr. Thomas, it is sometimes obviously granulitized (S22687) [NM 4722 6409]. In other cases, though extremely hard, as if baked, there are no signs of mineralogical change (S22366) [NM 4790 6569], (S22367) [NM 4797 6513]. The rock is an olivine-bearing fine-grained quartz-gabbro or quartz-dolerite.

In a knoll on the east side of the Kilchoan–Achnaha road, the marginal rock, a porphyritic fine-grained gabbro (S22366) [NM 4790 6569], is traversed by veins of quartz-gabbro which might have been derived from the marginal part of the Eucrite or from the Quartz-gabbro (A). Farther west, 400 yds. east-south-east of Lochan na Crannig, north-east of the Kilchoan–Achosnich road, a similar porphyritic rock is clearly intruded by the Great Eucrite. This exposure is situated just south of a north-north-west basic dyke shown on the map as cutting the Great Eucrite. At the contact, the Eucrite resembles a coarse-textured quartz-gabbro and sends veins into the porphyritic rock. In this neighbourhood the porphyritic gabbro ends somewhat abruptly on its outer side against fluxion gabbro, which is here, apparently, a marginal portion of the Quartz-gabbro (A), but no contacts were located.

At a higher level than the exposures described above, immediately below the Meall an Tarmachain capping, the only direct evidence of the prior age of the Quartz-gabbro (A) is forthcoming.

Here the Quartz-gabbro comes directly into contact with the Great Eucrite. It is found to be clearly altered, its weathered surfaces having that grey-black hue characteristic of baked rocks.

Under the microscope, it resembles closely in rock-type another specimen collected from the Quartz-gabbro in this vicinity (S21587) [NM 4791 6543], but is found to be crossed by lines of crushing; its felspars are turbid, and it is certainly baked (S21597) [NM 4834 6592]. This evidence appears finally to decide the relative ages of the Quartz-gabbro and Great Eucrite. It is, however, difficult to understand why similar contact alteration is not met with along the margin of the Quartz-gabbro across the valley to the west. Possibly the Quartz-gabbro retained too much of its original heat, except close to the capping, to be appreciably affected by the Eucrite. Such an explanation has been already offered in another case (*see* p. 294).

The Great Eucrite west of Meall an Tarmachain exhibits the same quartz-gabbroid marginal variation as it does next to the capping. Adjoining the Kilchoan–Achnaha road, this marginal type passes gradually into the normal eucrite in a distance of about 50 yds.

South-west of Loch na Crannaig, the Kilchoan–Achosnich road runs along the base of a high scarp that is composed of fine-grained quartz-gabbro, often porphyritic, baked in appearance and profusely net-veined. It was not found possible to separate this rock from the main portion of the Quartz-gabbro (A) to the south-east, to which it most probably belongs. The junction with the Great Eucrite must lie near or at the base of this scarp.

Quartz-gabbro of Aodann (d)

A narrow belt of quartz-gabbro separates the Great Eucrite from the Old Gabbro (b), and connects the area of the Quartz-gabbro (A), as mapped, with that of the Aodann Quartz-gabbro (d). Its significance is not known. It is separated from the Old Gabbro (b) by a strip of granulitized porphyritic rock that microscopically resembles cone-sheet types (S21562) [NM 4595 6619].

Farther north-west, a junction is exposed between coarse-textured eucrite and the fine-grained porphyritic variety of the Aodann Quartz-gabbro. This junction is situated about 80 yds.. southwest of the Achosnich road, 550 yds. east of Aodann. The margin of the Quartz-gabbro here forms a rocky feature that extends somewhat obliquely along the hill-slope, below which eucrite is frequently exposed. At the contact located, only a small outcrop of eucrite is seen, but it suffices to show that the junction is inclined at 70 degrees to the south-west, outwards from the Achnaha Centre (3). The Quartz-gabbro at the contact has that dark-green hue on fractured surfaces already noted in the case of the fine gabbro that separates the Quartz-gabbro (A) from the Great Eucrite (p. 301). Under the microscope, it is found to be granulitized (S22333) [NM 4574 6638], while specimens collected a few yards away show no signs of contact alteration (S22334) [NM 4572 6635], (S22323) [NM 4539 6653].

From this point north-westwards to Achosnich, no satisfactory evidence of age relations could be obtained. But alongside the northmost house in this village, the marginal type of the Eucrite, containing iron-ore, is found to invade and enclose as xenoliths a fine-grained quartz-gabbro with porphyritic felspar. There is no doubt whatever about the intrusive character of the Eucrite, but owing to discontinuity of exposure the relationship between the porphyritic rock and the normal coarse-textured type of the Quartz-gabbro (d), exposed a few yards away, cannot be determined. Possibly the porphyritic rock may be an early injection of the Great Eucrite, as already suggested for the similar marginal porphyritic gabbro found west of Meall an Tarmachain (p. 30,).

Younger Quartz-gabbro of Beinn Bhuidhe (h).

West of the track to Portuairk, 700 yds. north-west of Achosnich, a slight ridge of fine-grained non-porphyritic gabbro, extremely hard and baked in aspect (S22352) [NM 4399 6767], separates the Great Eucrite from the Quartz-gabbro (h). The question arises here again as to whether the fine-grained rock is a screen, or a much altered margin of the Quartz-gabbro, or an early injection of the Eucrite. Coarse-textured eucrite occurs in sharp contact with it, and whatever may be its origin, it appears to be earlier than the Great Eucrite.

Fluxion Gabbro of Portuairk (i)

An apparent contact between this intrusion and the Eucrite occurs along the shore, at which the Fluxion Gabbro (S22374) [NM 4406 6692] would seem to be the earlier intrusion, but there is no marked contact alteration. The issue is further complicated by the fact that the outer portion of the Great Eucrite, eastwards of this place, is itself a fluxion rock (S22355) [NM 4422 6816].

Hypersthene-gabbro (a)

Towards the neck of a promontory on the north-east side of Sanna Bay, formed of the Hypersthene-gabbro, this rock is highly contact altered and finally becomes a banded granulite. Exposures of eucrite are seen a few yards away, belonging to the Great Eucrite, which is evidently responsible for the alteration. The banded granulites are traversed by gabbroid veins.

East-north-east of Plocaig, where the outer margin of the Hypersthene-gabbro turns southwards and is cut across by the outer edge of the Great Eucrite, the Hypersthene-gabbro together with the Cone-sheet Complex in contact is highly baked.

Outer Cone-sheet Complex of Centre 2, west of Faskadale

The intense contact alteration affecting these rocks marks them as older than the Eucrite alongside. Alteration is evident even as far north as the coast. If it is all due to the Great Eucrite, it shows how greatly such pre-ring-dyke rocks are affected as compared with the Quartz-gabbro Ring-dykes that bound the Eucrite to the south. For the highly altered rocks west of Faskadale, though largely fine-grained and therefore easily affected, include also the Quartz-gabbro of Centre 1 (p. 145).

The margin of the Eucrite against these baked rocks may be seen, for example, 1000 yds. west of Faskadale Bay. At this point the Eucrite has its customary marginal facies of quartz-gabbro with conspicuous iron-ore, and becomes finer in texture, at its extreme outer margin (S24013) [NM 4894 7066], a few yards north of a track that runs to the north of a small loch (Lochan Dubh). The margin is traversed by thick veins of granophyre, poor in ferromagnesian minerals but containing abundant dark xenolithic patches. Similar broad acid veins, as well as numerous fine veins, cut the granulitized older rocks including cone-sheets. The fine veins are somewhat dark in colour and apparently baked. Possibly, therefore, the rocks outside the Great Eucrite have been affected by more than one intrusive episode subsequent to the injection of the Outer Set of Cone-sheets of Centre 2. J.E.R.

Petrology of the Great Eucrite

(Anal. III, (Table 4), p. 85)

The Great Eucrite of Centre 3, both petrographically and scenically, is one of the most important rock-bodies of Ardnamurchan. Like most of the other gabbros, it shows considerable variation both in structure and composition, and these variations have been already discussed in the foregoing account of the field relations. It has been pointed out that we may encounter felspathic masses approaching anorthosite in character, olivine-rich bodies of considerable dimensions, and other masses in which iron-ore appears to have segregated to a greater extent than elsewhere. Further, it has been suggested that this heterogeneity, in part at least, is due to movement within a partially differentiated mass.

In its most typical development the eucrite is a grey moderately coarse-grained gabbroid rock, in which dark ferromagnesian constituents and a greasy-lustred felspar occur in approximately equal proportions. The average grain-size is from a quarter to half an inch, but the felspars occasionally attain larger dimensions and show well-developed twin-lamellation in the hand-specimen. On a weathered surface olivine is frequently rendered conspicuous by the separation of limonitic decomposition products.

The rock consists of olivine, augite, a basic plagioclase felspar, and, usually quite subordinate, iron-ore, while hypersthene is an occasional constituent. The three main components occur in variable proportions, and this variation, coupled with changes in the basicity of the plagioclase, leads to the production of allivalitic and anorthositic types on the one hand, and normal olivine-gabbros on the other.

In the usual eucritic type the olivine occurs as irregularly bounded grains that may be an eighth of an inch in greatest dimensions (S22675) [NM 4680 6659] and are clearly of early separation. They seldom, if ever, show crystal-outline, but are usually rounded and embayed as if partially resorbed. The mineral is generally in a fresh condition and is almost colourless in thin section, but when decomposed there is a fairly copious separation of magnetite and the pseudomorphs are composed mainly of magnetite and talc (S21510) [NM 4721 6592]; ordinary serpentinous decomposition products are, however, frequently met with. It has a moderately wide axial angle and optically positive sign which take it out of the fayalite group, and which are features characteristic of those magnesian olivines which are somewhat rich in iron. Such a composition is confirmed by the general character of the pseudomorphs. The augite, black in the hand-specimen and pale-brown with a tinge of green in thin section (S21508) [NM 4548 6821], appears to be the normal aluminous variety that is common to all the gabbro masses. Usually it is definitely ophitic (S21251) [NM 4754 6665], and frequently encloses completely crystals and grains of both olivine and felspar. It is commonly free from minor inclusions, but occasionally presents brown margins towards plagioclase and frequently has well-developed schillerization. It is invariably of later solidification than either olivine or felspar.

The basic plagioclase in the normal eucrite varies from a basic labradorite to bytownite. It is usually zoned and much twinned, and occurs as mutually interfering somewhat elongated crystals. Where in contact with augite, however, or when completely enveloped by this mineral, it has had an opportunity of developing idiomorphic outlines. Frequently all the felspar has an optically negative sign, indicating the bytownite-anorthite end of the plagioclase series, but in other varieties of the rock the optical sign is variable, showing that, in such, labradorite-bytownite is the dominant species (S22675) [NM 4680 6659]. The latter felspar has a mean refractive index of about 1.57, corresponding to a composition of approximately Ab_3An_7. Felspar commenced to crystallize from the magma at a very early stage, for small globular crystals of a basic plagioclase are occasionally completely enclosed by olivine (S22364) [NM 4412 6834]. The bulk of the felspar, however, is moulded upon olivine and is, at any rate as far as its external zones are concerned, of later consolidation than this mineral.

Hypersthene occurs usually, in subordinate amount, in close association with olivine. It often forms what appears to be a reaction zone between olivine and felspar. At other times it occurs bordering olivine or occupying the place of this mineral in intimate association with magnetite (S22364) [NM 4412 6834], (S21507) [NM 4530 6819]. Occasionally the zone of rhombic pyroxene on the margin of olivine is followed outwards by a zone of augite which separates the rhombic pyroxene from felspar (S22355) [NM 4422 6816]. In the cases of kelyphitic borders to the olivine, magnetite is concentrated at the olivine margin and extends in dendroid or graphic manner throughout the hypersthene ((Figure 42) B), demonstrating that the rhombic pyroxene is a reaction product of a siliceous melt and the iron-magnesian olivine.

Accessory minerals are rare in the eucrite. Iron-ore is sparingly represented except along the outer margin and in certain segregations; apatite is almost universally absent except in the acid veins and gabbro-pegmatites described below (p. 308). The presence of apatite can usually be explained by the intervention of a partial magma in which this mineral was concentrated concurrently with magmatic volatile constituents.

Quite frequently a diminution in the proportion of augite in the eucrite gives rise to rocks of allivalitic nature. They are texturally similar to the eucrite and contain an identical olivine, but the plagioclase is generally more basic and less obviously zoned (S22629) [NM 4451 6788].

By the increase of felspar at the expense of both olivine and augite the eucrite becomes anorthositic (S21511) [NM 4875 6810] and of paler colour than the normal rock. Anorthositic bands and patches are quite common (p. 295) and consist mainly of bytownite with subordinate olivine and augite.

Amongst the more felspathic types occurring along the outer margin, or as segregations in the interior (S22319) [NM 4477 6691], (S22686) [NM 4821 6671], may be mentioned moderately coarse ophitic rocks that are more or less devoid of olivine and consist of somewhat elongated interlocking crystals of basic labradorite and ophitic brownish schillerized augite with a little iron-ore in large irregular crystals. The felspars commonly show slight albitization by an acid mesostasis, and the augite may exhibit local deschillerization with the generation of small scales of biotite in the affected portion.

Such slight acidification of the eucrite must be regarded as an effect produced by its own acid residuum. For instance, near its junction with the Quartz-gabbro of Aodann (p. 303), the eucrite is a normal, coarse-grained, olivine-rich variety with fresh olivine and a greenish diallagic augite (S22325) [NM 4561 6642]. The action of the migrating acid mesostasis has been to attack and albitize the earlier-formed felspars, deschillerize the original augite with regrowth following resorption, and to produce a residuum of alkali-felspar and quartz. In the hand-specimen this is noticeable as a veining of the solid rock by threads and streaks of lighter colour and finer texture.

Alongside the road between Aodann and Achosnich there has been a certain amount of shattering of the mass at or near its outer margin, and bands of the rock have been reduced to a comminuted condition (S22322) [NM 4539 6653]. The rock has suffered some acidification with attendant deschillerization and recrystallization of augite, decomposition of olivine, and albitization of original felspars.

It has already been mentioned that hypersthene is sometimes a constituent of the eucrite and appears as a reaction zone surrounding olivine. Hypersthene is also characteristic of the outer margin of the intrusion, south of Sanna Bay, where the rocks show fluxion structure and have a mixed aspect; and although some of these hypersthene-bearing rocks have a normal appearance (S22361) [NM 4423 6844], it is fairly certain that the rhombic pyroxene may be regarded as a product of reaction (S22323) [NM 4539 6653]. In cases where the eucrite has been highly acidified the changes are most marked (S22363) [NM 4417 6840]. Hypersthene has been developed in large plates, and the place of the normal monoclinic pyroxene is taken by recrystallized augite of paler tint and hypidiomorphic habit. Original felspars are albitized and zoned with acid plagioclase. Biotite has developed in large and small flakes in association with both augite and iron-ores, and perthitic alkali-felspar and quartz appear as a residuum. The rock under such conditions has lost most of its original characters and offers a distinct likeness to certain of the presumed hybrid rocks described below in connexion with the later intrusions of Centre 3 (p. 332).

Pegmatite veins

The Eucrite is frequently traversed by veins of pegmatitic nature (p. 296). Sometimes these are merely a coarsely crystalline variety of eucrite, containing the usual essential minerals, and at other times they are of special mineral constitution and show clearly the influence of an acid residual partial magma. The ordinary pegmatitic eucrite consists of a coarsely crystalline mass of olivine, augite, and basic plagioclase with a little iron-ore (S21583) [NM 464 668], (S22626) [NM 4462 6811]. The olivine may show reaction borders of hypersthene when against felspar, with the usual separation of magnetite in dendroid form. Augite may be deschillerized with the formation of scales of biotite in the affected areas, the basic felspar may be albitized, and interstices filled with dark-green hornblende. Occasionally a brown hornblende may be present, occurring in and replacing augite in the vicinity of olivine.

Sometimes hypersthene is an important constituent of the pegmatites (S21545) [NM 4708 6939] and occurs in large ophitic crystals that are often pseudomorphed by fibrous hornblende. The felspar in such cases is less basic than that of the normal eucrite, being an acid labradorite or andesine. Other coarse types (S21592) [NM 4827 6745] appear to have suffered considerable changes since their consolidation, for the normal augite is occasionally replaced by fibrous actinolitic hornblende and the felspar by a mosaic of prehnite.

The more purely pyroxenic veins (S21499) [NM 4427 6946] that are quite common throughout the Eucrite are found to consist almost entirely of augite with quite subordinate felspar. The augite is a pleochroic variety, the colour varying from pale bluish-green to pale yellowish-brown in thin section. The habit is hypidiomorphic, with good crystal-faces developed towards felspar. The felspar occurs interstitially, is well crystallized, not strongly zoned, and more calcic than normal labradorite. The augite in its colour and pleochroism is similar to that of certain hybrids and is quite distinct from that of the normal eucrite.

In most of these veins and patches there has been a segregation of apatite, which often occurs as large crystals.

Granulitic and xenolithic masses within the Great Eucrite

The granulitic and xenolithic masses enclosed by the Great Eucrite are sparsely distributed, mainly along the outer margin of the mass, and are represented in the collections by specimens from the neighbourhood of Aodann, Achosnich, and Sanna. These rocks form a most interesting and instructive suite, for they give some indication of the nature of early consolidations of the eucrite-magma, and also present structures that are due to reheating and attempted assimilation. As a general rule it may be stated that most of the granulitic inclusions are more basic, that is to say, richer in ferromagnesian constitutents than the normal eucrite that surrounds them. One of such. rocks, collected near Aodann (S22330) [NM 4585 6633], is a very fine-textured olivine-bearing granulite. It consists of abundant round granules of fresh colourless olivine 0.1 mm. in diameter, subordinate brownish augite, also in small granules but occasionally making larger patches by the grouping of hypidiomorphic crystals, a little iron-ore or opaque spinellid in octahedra, and a base of later-formed zoned crystals of basic labradorite felspar. There is little doubt that this rock is a granulitized representative of some early basic phase of a eucrite magma.

Other strips of granulitic material appear to be remnants of quartz-dolerite cone-sheets (S22344) [NM 4447 6724], which by metamorphism have developed biotite and rhombic pyroxene.

An unusual type of rock has been encountered towards the western margin of the mass and appears to be a gabbro-granophyre hybrid (S21526) [NM 4453 6920], (S22356) [NM 4416 6825]. The collected examples are fine-textured, compact rocks that are often banded, contain free quartz and alkali-felspar, and in their basic portions have the structure of a quartz-dolerite. The occasional presence, however, of large patches of diallagic augite (S22356) [NM 4416 6825] and labradorite felspar suggests that an already solid gabbro had played a part in their formation. The rock as now constituted is made up of pseudomorphs after prismatic rhombic pyroxene, iron-ore, biotite, recrystallized hypidiomorphic augite, and a plexus of fluxionally arranged narrow twinned crystals of labradorite. Locally there are veins or patches of alkali-felspar and quartz, in which green hornblende takes the place of the more usual ferromagnesian constituents. Biotite, also, may occur in sponge-like plates, and rhombic pyroxene as ophitic patches (S21526) [NM 4453 6920]. It is possible that these rocks may be recrystallized and otherwise modified members of the suite of porphyritic cone-sheets, but I rather favour the view that they are enclosed masses of gabbrogranophyre hybrid probably belonging to the Earlier Ring-dyke Complex.

A somewhat remarkable rock occurs as a lenticle near the junction of the Eucrite with the Quartz-gabbro, just north of Aodann (S22321) [NM 4509 6663]. It consists of felspars of about an eighth of an inch in size, set in a granulitic matrix. The felspars are a basic labradorite that often shows evidence of resorption and subsequent regrowth. In the marginal portions of the felspar crystals, and extending into the matrix between them, occur abundant small globules and rounded crystals of olivine, about 0.2 mm. in diameter. The matrix is composed of small mutually interfering crystals of felspar, or of an ophitic intergrowth of felspar and augite. Similar olivine-granulites were noted near the margin of the Ben Buie Eucrite in Mull,<ref>H. H. Thomas *in* Tertiary Mull Memoir, 1924, p. 252.</ref> and are clearly due to the reheating and partial recrystallization of an early-formed basic portion of the eucrite. Such an origin appears to be probable in this case. The actual contact between the eucrite and granulite, though sharp, is welded, and as there has been no development of a fresh suite of minerals at the contact it is probable that the two rocks had approximately the same composition.

A very beautiful olivine-augite-magnetite-granulite has been collected from a point 750 yds. south-west of the summit of Meall nan Con (S22658) [NM 4986 6764], while coarser rocks with similar structure and porphyritic regrown felspars are occasionally encountered along the outer margin of the Eucrite west of Meall an Tarmachain ((S22366) [NM 4790 6569], p. 302).

Metamorphism by the Great Eucrite

The metamorphic effects of the Great Eucrite, as might be expected, were general and widespread. It has wrought definite changes in most of the other igneous rocks with which it is in contact, but perhaps the most marked effects have been produced in the Lias shales and cone-sheets, which form its northern boundary to the east of Rudha Groulin, and in the complex that forms the screen of Meall nan Con (p. 312).

As in the case of the Liassic sediments (Pabba Shales) metamorphosed by the Hypersthene-gabbro (a) of Centre 2 (p. 235), these same shales, where in contact with the Great Eucrite, have suffered an identical type of metamorphism and have been converted into an interesting series of biotite-hypersthene-hornfelses (S22621) [NM 4699 7064], (S22622) [NM 4698 7073], (S22637) [NM 4757 7077], (S22439) [NM 4704 7063]. They are well banded and sometimes contorted rocks characterized by a crystallization of labradorite-andesine felspar in minute stumpy crystals, patches of spongy pleochroic hypersthene, red-brown biotite, magnetite, and minute rectangular crystals of cordierite, in an alkali-felspar base that is moderately rich in apatite. The biotite usually occurs in ragged plates of spongy character, enclosing felspar. The hypersthene is an intensely pleochroic variety, and commonly forms moderately large ophitic or poecilitic patches, but occasionally occurs as minute prisms. The cordierite is frequently pinitized, but the undecomposed mineral with characteristic sectorial twinning can sometimes be detected.

The nature of the original sediments and the mineralogical characters assumed by them on metamorphism have been discussed in connexion with the metamorphism effected by the Hypersthene-gabbro (p. 235).

Certain fine-grained granulitic rocks (S22637) [NM 4757 7077] occur between the cone-sheets west of Meall Eigin-aig and south-east of Rudha Groulin, just north of the Great Eucrite boundary. Their granulitic structure is imparted to them by granulitic augite, plagioclase, and iron-ore, which occur in a hornfelsed base of alkali-felspar and quartz. The augite is a greenish-brown pleochroic variety and occurs in greater abundance in some bands than in others that are more felspathic. The base often has free quartz around which spread lakes of quartz and orthoclase in very fine micrographic intergrowth. The exact nature of the rocks from which this metamorphic type originated is in doubt, but an original kataclastic structure is suggested, and it is possible that they belong to the agglomeratic series that occurs within the same area to the west of Faskadale.

Acid veins in and around the Great Eucrite

Acid veins (S22305) [NM 5010 6898] that appear to emanate from the Eucrite, and occasionally penetrate older rocks beyond its margin, are generally of granophyric composition. They are, however, usually basified and contain remnants of undigested augite and nuclei of albitized basic plagioclase of gabbro-derivation. More or less complete assimilation of xenolithic ferromagnesian material has brought about the crystallization of biotite, and the rocks in their most homogeneous condition may be described as biotite-bearing basic granophyres. Biotite and zoned plagioclase felspar occur in a matrix of alkali-felspar and quartz, which commonly shows micrographic structure. Such veins may be observed to cut the old gabbro that forms the northern end of the Meall nan Con screen.

Certain thin acid minor intrusions that traverse the Eucrite may be referred to here, because it is more than possible that they belong to the eucrite-magma. They are likewise usually of granophyric nature and are composed essentially of acid plagioclase, alkali-felspar, and quartz. Their graphic structure is frequently quite coarse, as in the case of a dyke at the southern extremity of Sanna Bay (S22360) [NM 4427 6842], and an excess of quartz appears as fair-sized individual crystals with a tendency towards idiomorphism in another dyke, north of Achosnich (S21519) [NM 4449 6746]. In all cases they are basified by the partial resorption of either gabbro-material or their own composite basic margins. In the latter case, basic patches in the granophyre show a fine subvariolitic structure similar to that of many of the quickly cooled quartz-dolerite or tholeiite dykes. Reaction with included basic material has usually given rise either to biotite (S22359) [NM 4429 6841] or to hornblende that may occur as long acicular crystals replacing augite (S22360) [NM 4427 6842].

A remarkable rock (S22274) [NM 4416 6942], occurring just south of the mouth of Allt Sanna, is a basic granulitic hybrid formed by the hybridizing influence of acid veins emanating from the Great Eucrite on a basic granulitic gabbro belonging to the Hypersthene-gabbro intrusion (a) of Centre 2. It varies in texture from a moderately coarse highly felspathic rock with little augite, first into a band composed almost entirely of augite, and then into a typical augite-felspar-granulite containing about equal proportions of these two minerals.

The augite is a deeply coloured olive-green variety, strongly pleochroic in shades of green and brownish-yellow, subophitic to hypidiomorphic in habit. In the basic band, crystals are equidimensional and reach a millimetre or so in size. They are associated with small crystals of labradorite, large patches of pink pleochroic sphene, and some epidote. In the coarse felspathic portion, the felspars show signs of disruption and acidification, and there has been a concentration of apatite in moderately large prisms close to the basic band and also within the adjacent augite. In character and mode of origin the rock recalls the Camphouse Augite-diorite (p. 153) and certain modified rocks occurring near the outer margin of the Hypersthene-gabbro (p. 228). H.H.T.

(E′) Outer Eucrite

Typical olivine-rich eucrite forms a large part of this mass, At its northern end, alongside a stream that runs north-north-west along its outcrop, biotite is a common constituent. Acid veining is frequent here as well as farther to the south-east. Near the head of this stream, quartz-dolerite containing porphyritic felspar and biotite (S22651) [NM 5026 6917], is veined with granophyre, and is perhaps a continuation of similarly veined dolerite that cuts across the Great

Eucrite north of the Meall nan Con screen. These veined rocks resemble in composition a ring-dyke (I) of the Interior Complex, from which they may be an irregular offshoot.

A variety frequently met with east of Meall an Tarmachain, at the southern end of the mass, consists of a coarse network of felspathic eucrite, with meshes of normal eucrite. The felspathic eucrite contains augite, but not olivine (S21599) [NM 4954 6626]. South of Meall an Tarmachain a considerable outcrop of this felspathic type is met with (S21851) [NM 4919 6627].

The relations of the Outer Eucrite to the Great Eucrite have been already discussed (p. 298). It has been shown that the Outer Eucrite is distinct from the Fluxion Gabbro of Faskadale, and perhaps of later age (p. 290). That it must be later than the granulitized agglomerates and basalt lavas of the Meall nan Con screen is evident, but some details concerning the intrusions belonging to the screen may be given here. The grey-black gabbro cutting obliquely across the screen at its north end is certainly baked throughout, and its porphyritic margin against basalt to the north is granulitized (p. 315). The Porphyritic Gabbro (D) alongside the Outer Eucrite is very highly baked, though, as already mentioned (p. 300), at the extreme southern end of the screen the alteration of the Porphyritic Gabbro appears much less intense. J.E.R.

Petrology

The Outer Eucrite is petrologically similar to the Great Eucrite. Normally it is an olivine-rich rock, sometimes allivalitic with olivine and bytownite in about equal proportions. The olivine and basic plagioclase are not far separated from each other as regards the time of their crystallization, for they frequently exhibit mutual interference, and although felspar for the most part appears to follow olivine a basic plagioclase was sometimes the first mineral to crystallize. This early felspar phase is clearly enveloped by olivine, which in turn had a later plagioclase moulded upon it (S22655) [NM 5065 6737]. As in the case of the Great Eucrite, hypersthene in variable amount occurs in close association with olivine which it obviously replaces, and, when a zone of hypersthene separates olivine from felspar, it is to be noted that the felspar in the immediate neighbourhood exhibits signs of acidification. Other parts of the mass are more definitely augitic and consist of much twinned labradorite, a little olivine, and a variable amount of ophitic augite. When ophitic augite is predominant it frequently shows deep-brown borders towards the felspar, as was noted in the case of the Great Eucrite. Sometimes the rock is highly felspathic, with comparatively little augite and olivine (S21599) [NM 4954 6626], (S22459) [NM 4892 6615].

This Eucrite has suffered the same type of local acidification by its own residual partial magma as has the outer margin of the Great Eucrite. Where acid material has permeated it the felspars are albitized and zoned with less basic varieties, augite is deschillerized and fringed with hornblende (S22652) [NM 5004 6970], and biotite has apparently been formed as a product of crystallization following resorption of augite.

The Meall Nan Con screen

Petrology

The chief interest attaching to the rocks that form the Meall nan Con screen lies in their relative antiquity and the metamorphism that has been impressed upon them by the later intrusions on either side, namely, by the Great and Outer Eucrites. The screen is of a composite nature and comprises basalt lavas, agglomerates, and cone-sheets, most of which are reduced to the state of granulites; and old gabbro intrusions that plainly show modification and the effects of thermal metamorphism. From north to south, the screen is composed of basalt lavas at the extreme northerly end, then the old gabbro of Meall nan Con (Centre 1), followed by basalt lavas, agglomerates, and cone-sheets, and at the extreme south a moderately large mass of porphyritic gabbro (D).

The basalt lavas

The basalt lavas have suffered changes of an identical kind to those exhibited by the basalts which came within the metamorphic influence of the Hypersthene-gabbro (a) of Centre 2, to the north of Kilchoan, and south of Beinn na Seilg (p. 237). Their porphyritic and arnygdaloidal structures are still discernible in the hand-specimens, but the rocks have a cleaner and more finely crystalline appearance and tougher texture than their unaltered representatives. The outcrop within the screen includes both porphyritic and non-porphyritic types, both of which have invariably passed over into granulites. In the porphyritic lavas that are perhaps most prevalent, the porphyritic felspars have suffered little change except slight albitization and a ragged marginal regrowth. The fine-grained matrix, however, has been more or less completely recrystallized into a finely granular aggregate of augite, hypersthene, plagioclase felspar, and magnetite, with frequent plates of biotite which embrace all the other constituents. The rhombic pyroxene often tends to segregate on or near the larger felspars (S22298) [NM 5042 6781], and in the more felspathic areas (S22302) [NM 5019 6832]. It builds minute rounded granules of similar dimensions to those of the augite, but is easily distinguishable by its pronounced pleochroism and manner of decomposition.

The non-porphyritic types (S22307) [NM 4996 6903] are extremely compact rocks, now converted into the finest granulitic aggregates of augite, hypersthene, medium labradorite and magnetite, with a few scattered, small, ragged phenocrysts of labradorite. Hypersthene occurs throughout the rock, but more particularly in the felspathic areas and as granular bands of considerable linear extent. It is difficult to account for such hypersthene-rich bands without assuming actual fusion as part of the metamorphic process. Similar compact types are encountered in the agglomerates (*q.v.*) of Meall nan Con summit. In one of these (S22304) [NM 5015 6848] occur narrow bands, composed entirely of granulitic augite, which are similar in all but composition to those of hypersthene mentioned above. The main body of the granulite may contain some olivine, probably recrystallized from the original olivine of the basalt.

The agglomerates

On account of the highly metamorphosed condition of the screen it is not at all easy to be certain of the rock-types originally present amongst the agglomeratic material, but it would appear that the usual trachytic or bostonitic and basaltic types formed the greater number of fragments. The acid fragments (S22308) [NM 5011 6751] show small regrown crystals of perthite in a granular matrix of acid plagioclase, orthoclase, and quartz, while scattered through the rock as a whole are minute well-formed prisms of greenish augite and equally small grains of magnetite. These rocks compare quite closely with the metamorphosed trachytic fragments encountered in the agglomerates of the Ben Hiant vent (p..134). The basalt lava fragments are mainly of the microporphyritic type and, like the lavas of the main outcrop described above, show small porphyritic felspars that have been reheated, albitized, and regrown, in a fine granulitic matrix of augite, hypersthene, labradorite, and magnetite, with occasional plates of biotite (S22300) [NM 5028 6796]. Quite often these fine-textured pyroxene-granulites exhibit a definite fluxion structure, but whether such is determined by the original flow-banding of the lava or superimposed as the result of reheating under stress cannot be determined, although the general coarseness of the texture would lend probability to the latter view. One such rock (S21513) [NM 4994 6896] is composed of a coarse granular mass of hypersthene, augite, plagioclase, and magnetite, in which a well-marked banding is developed, and which envelops the usual albitized and regrown porphyritic crystals of labradorite. The grain-size, however, is greater than that usually met with in the granulitized base of the basalt lavas that form the main mass.

Within the screen, especially in that portion occupied by agglomerate, occur a number of other granulitic types which point to an acidification of the basic rocks, probably basalt lava, either before or during metamorphism.

There is plenty of evidence that the material of the screen was invaded from time to time by granophyric matter that emanated from later intrusions. The result of this invasion has been the formation of granulites, richer in the acid plagioclases and alkali-felspar, which carry biotite and hornblende as characteristic minerals. Microporphyritic basalts have usually been completely granulitized, but where traversed by acid strings, and in quartzo-felspathic areas, the rocks have developed large plates of deep-brown biotite and aggregates of recrystallized alkali-felspar and quartz (S21593) [NM 5041 6816]. Larger granophyric veins have developed biotite by the process of basification (S22299) [NM 5051 6762]. In other cases, in which completely granulitized basalt can be seen in contact with acid material, the acid magma has been basified. On crystallization it has yielded large crystals of rhombic pyroxene, now pseudomorphed, andesine to labradorite felspar in stumpy prisms, recrystallized augite, and green uralitic hornblende, in a base of quartz (S21595) [NM 5009 6913]. Biotite may occur in addition.

Cone-sheets cutting the screen, especially within the agglomerate-region, have likewise come within the metamorphosing influence of the Eucrites. They have suffered a good deal of recrystallization with the formation of hornblende and biotite, but their original structure in a great measure is preserved (S22651) [NM 5026 6917].

Old Gabbro of Meall nan Con (see p. 145)

This mass is a moderately coarse-textured olivine-gabbro (S21514) [NM 5014 6899] that consisted originally of large crystals of olivine, interlocking crystals of basic labradorite, ophitic augite, and small patches of indefinitely shaped magnetite. It has suffered to a great extent from the general thermal metamorphism that has affected all the rocks of the Meall nan Con screen. The olivine is now pseudomorphed by a highly birefringent and pleochroic green micaceous mineral charged with magnetite. The felspars, in addition to showing the effects of early shattering, are blotchy owing to local acidification and subsequent reheating. The original felspar exhibits a peculiar type of turbidity and a grey tint by transmitted light, which is characteristic of rocks that have suffered a general reheating. The turbidity is due presumably to the formation of innumerable ultra-microscopic inclusions.<ref>The peculiar cloudiness of felspars, induced by metamorphism, has been discussed at some length by Mr. A. G. MacGregor in The Geology of North Ayrshire, Mem. Geol. Surv., 1930, pp. 50, 51.</ref> A further result of reheating has been the formation of a narrow reaction rim of hypersthene to the olivine, which separates it from the adjoining felspars. The augite has a well-marked schiller structure that appears to have been induced as a secondary feature, and occasionally it has a narrow fringe of amphibole separating it from the more siliceous parts of the rock.

Acidification is noticeable in the felspars, which have their exteriors resorbed and replaced by oligoclase; also, this mineral makes irregular clear patches within the older turbid labradorite. Small patches of micrographic orthoclase and quartz, rich in apatite, occur interstitially, and augite where in contact with this material has reacted with the formation of biotite. The acidified areas often have a microgranulitic structure determined by the recrystallization of pyroxene and felspar. This structure suggests that the rock continued to be under metamorphic influence, or was subjected to fresh metamorphosing conditions, after the acidification had been accomplished. This is also borne out by the appearance of the felspars which show much more pronounced modification by solid solution than is usual in simple cases of acidification.

Farther to the north the gabbro passes more or less insensibly into what must have been a quartz-dolerite facies (S21594) [NM 5009 6913], (S22306) [NM 5007 6917]. Here, however, the effects of metamorphism are even more obvious, and except for remnants of crystals of basic plagioclase, no original constituent remains. The original and partially resorbed felspars give to the rock a microporphyritic aspect, while the matrix is fine-grained, dark-coloured, and finely crystalline in texture. Microscopically it is seen that the larger original felspars have been shattered, resorbed, and acidified by the growth of albite-oligoclase and orthoclase on their peripheries, as also internally wherever any flaw laid them open to attack. The matrix is a moderately coarse pyroxene-granulite composed of granular augite and rhombic pyroxene, scattered magnetite, small crystals of acid plagioclase, and moderately abundant biotite, in a base of alkali-felspar and quartz. The acid matter has locally collected into well-defined interstitial areas where it exhibits a beautiful micrographic structure. In some cases (S22306) [NM 5007 6917], the rhombic pyroxene (hypersthene) builds relatively large crystals that behave ophitically with respect to the small recrystallized felspars of the matrix.

In this portion of the gabbro-mass the results of thermal metamorphism are most apparent. The whole rock, with the exception of the larger felspars, has suffered recrystqllization, and even these felspars have been modified to a considerable extent.

The Porphyritic Gabbro (D, see p. 294)

Although the greater portion of this gabbro, which forms the southern end of the screen, has suffered great metamorphic changes, there are areas, situated some distance from the junctions with later intrusions, in which the original nature of the mass can be demonstrated. Such areas yield rocks of eucritic nature in which fresh olivine is a plentiful constituent (S22661) [NM 5007 6771], occurring as large irregularly bounded crystals. It is associated with augite, hypersthene, and basic plagioclase, and the rock has a typical gabbroid structure. The augite occurs as subophitic to hypidiomorphic crystals and aggregates that exhibit a poorly developed diallagic structure, and frequently show signs of granulitization. It is often in association with a strongly pleochroic hypersthene that occurs as moderately large crystals. The ferromagnesian constituents are set in a wholly felspathic matrix that is composed of fairly large crystals of basic labradorite and a mass of smaller recrystallized individuals of similar composition. Such rocks certainly represent the original gabbro, which, though granulitized, to some extent, retains to a considerable degree its original structure. Close against the Great Eucrite, however, the gabbro passes into a completely recrystallized rock of finer texture ((Figure 31)A, p. 230), which might be termed an olivine-gabbro-granulite The gabbro in this form consists of a granulitic mass of augite, olivine, labradorite, and magnetite, in which olivine is more abundant near to the junction with the less altered gabbro. The felspar is clear and free from inclusions. Hypersthene is a common constituent of most of these gabbro-granulites and is evidently a product of metamorphism. It occurs intergrown with augite, and also as isolated crystals and subophitic patches, in a matrix of completely recrystallized felspar that contains abundant granules of pyroxene.

In the fine-grained granulites a banding, probably due to partial fusion, is a conspicuous feature near and at a junction with the Great Eucrite (p. 300). The constituent minerals are mainly the same as before, namely, augite, hypersthene, magnetite, and labradorite, but the chief differences lie in the absence of olivine, the parallel orientation of the felspars, and in the alternation of finely and coarsely crystallized material from band to band (S22657) [NM 4985 6768], (S22659) [NM 4986 6764].

Close to the Outer Eucrite, on the eastern side of the screen, some very beautiful olivine-spinel-granulites have been detected (S26671) [NM 5024 6681] (Figure 43). These evidently result from the reheating of an allivalitic gabbro. They are rocks in which there is considerable and rapid variation both in texture and in composition. This variation is determined, not by the occurrence of different minerals, but by the relative sizes and concentration of the same constituents. The coarser and more felspathic portions of the rock consist of a mosaic of bytownite that encloses moderately abundant colourless olivine with subordinate augite and green spinel. The finer-textured portions are composed of a similar mosaic of felspar densely packed with granules of olivine, and octahedra and rounded grains of dark-green spinel (pleonaste-hercynite). The felspar of the matrix occasionally gives place to large all-embracing plates of red-brown biotite ((Figure 43) B). The source of the potash required for the formation of biotite is probably to be attributed to alkali-felspar that had been introduced into the original rock in the form of an alkali-felspar and quartz magma, prior to the metamorphism of the gabbro.

It is interesting to note the petrological similarity of this granulitized gabbro of the Meall nan Con screen to the lenticles and schlieren of granulitic character which occur in the marginal portion of the Hypersthene-gabbro of Centre 2 (p. 229), as well as in the peripheral. portions of the Great Eucrite (p. 308).

The basalt-agglomerate screen west of Faskadale

Petrology

The rocks forming this screen are highly granulitized, and as basaltic material enters largely into its composition, both as lavas and agglomerate, pyroxene-granulites preponderate. The basaltic material has passed over to fine-textured pyroxene-granulites (S26740) [NM 5002 7018], in which a rhombic pyroxene as well as a monoclinic variety is abundantly developed. In such rocks a few of the larger felspars retain their original form, but have suffered albitization and some recrystallization. Biotite, in association with rhombic pyroxene, occurs in restricted areas, and probably occupies approximately the position of original olivine.

The screen is traversed by acid veins, many probably emanating from the Great Eucrite, and the thicker of these are of granophyre with very beautiful micrographic structures (S26738) [NM 5013 7020], ranging from an extremely fine intergrowth that is exhibited by perthite-quartz phenocrysts to a coarse graphic growth in the surrounding matrix. Normally they are quartzo-felspathic rocks without any original ferromagnesian minerals, and carry little in the way of accessories. Others, which appear to have been modified by the absorption of basic material (S26739) [NM 5021 7006], consist of a coarse mosaic of albiteperthite with interstitial quartz, which includes large plates of biotite (partly chloritized), irregularly bounded crystals of greenish-brown pyrogenetic hornblende, and a few small almost colourless crystals of augite edged with uralitic hornblende. Finely divided magnetite is fairly abundant in association with the hornblende, and is presumably a result of basification. Some of the narrow acid veins that traverse the completely granulitized portions of the screen, and which in all probability were primarily of granophyric composition, have developed abundant stumpy crystals of rhombic pyroxene and oligoclase in an alkali-felspar base. H.H.T.

(F) Quartz-gabbro of Meall An Tarmachain summit

This mass forms the central peak of Meall an Tarmachain, and is for the most part a quartz-gabbro with well-developed acid mesostasis. Olivine is present as a rule, and where the acid mesostasis becomes sparse the rock approximates to eucrite. Exposures are generally good, but fail along the greater portion of the margin. Two contacts, however, have been established, one with the Outer Eucrite (E′), the other less well seen with the Great Eucrite (E). The contact with the Outer Eucrite is situated 200 yds. E. 30° S. of the summit. The Quartz-gabbro becomes rapidly finer grained towards its irregular junction with the coarser textured Eucrite, and encloses xenoliths of eucrite (Figure 44). There can be no doubt as to the relative ages of the two rocks in contact. A junction with the Great Eucrite was located in a corrie west of the central peak, 400 yds. W. 0° S. of the summit, on the north side of a stream that flows south-west. The Eucrite is a rather felspathic type, but is coarse-textured and shows no signs of chilling at the junction. The Quartz-gabbro possesses a well-fluxioned edge against the Eucrite. The fluxioned felspars are steeply inclined parallel to the slightly irregular plane of junction of which 3 ft. in depth is seen. The Eucrite is not appreciably baked (S22683) [NM 4889 6620]. A fine-grained vein apparently derived from the Quartz-gabbro crosses the Eucrite (*see also* p. 301).

About a quarter of a mile north of Meall an Tarmachain summit, small masses of porphyritic quartz-dolerite are surrounded by the Great Eucrite. The rock composing them is unbaked (S22685) [NM 4937 6669], and they are concluded to be later than the Eucrite. Possibly they are offshoots from the neighbouring Quartz-gabbro (F). J.E.R.

Petrology

The gabbro is a moderately coarse doleritic rock composed essentially of labradorite and a subophitic augite, both minerals having an equally coarse type of crystallization (S22689) [NM 4956 6636], with subordinate magnetite. A few pseudomorphs in serpentine and magnetite represent original olivine. There is usually some acid mesostasis and also well developed acid veins, which have produced marked albitization of the adjacent felspar ((Figure 45) B), and which have crystallized as a mosaic of perthitic alkali-felspar and quartz. Towards the Great Eucrite (E), the rock assumes the character of a moderately coarse fluxioned quartz-dolerite or gabbro (S22683) [NM 4889 6620], but at its contact with the Outer Eucrite (E′) it becomes finer in texture and distinctly porphyritic (S22688) [NM 4947 6634], the felspars measuring up to half a centimetre in length. The porphyritic individuals are of a strongly zoned optically positive labradorite that shows strong marginal reaction effects and a final marginal growth of oligoclase. The matrix consists of subophitic to subcolumnar augite and hypidiomorphic crystals of labradorite, which, like the porphyritic felspars, are edged with oligoclase. Magnetite is moderately abundant as irregularly scattered grains, and there is a little mesostasis that has effected the usual changes in the earlier-formed constituents.

A similar fine-grained porphyritic type (S22685) [NM 4937 6669], which occurs to the north of Meall an Tarmachain, shows an augite with a much more pronounced ophitic tendency, and in addition to pseudomorphs after olivine contains abundant partly decomposed crystals of hypersthene. Biotite occurs in association with the augite and also with the iron-ores, and it is probable that the rock has suffered some metamorphic change.

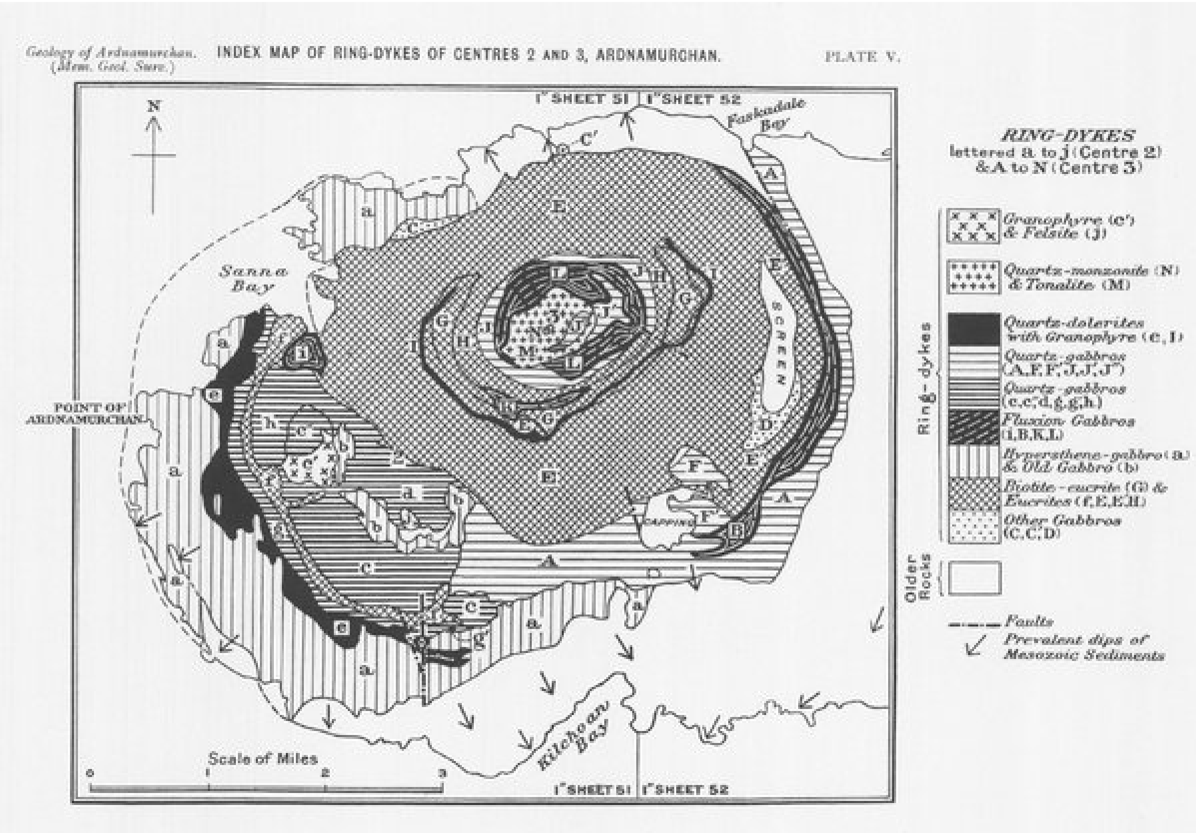
The mass, to the north of Meall an Tarmachain, is separated from the Great Eucrite by a narrow screen that is mainly composed of agglomerate, but which, at its north-east end, includes granulitized olivine-bearing quartz-dolerite (S22684) [NM 4901 6668] (p. 301). The latter rock contains a moderate amount of acid mesostasis in the form of alkali-felspar, and lakes of alkali-felspar and quartz in graphic intergrowth. It is also traversed by veins of acid composition. H.H.T.

(F') Quartz-gabbro, south side of Meall An Tarmachain

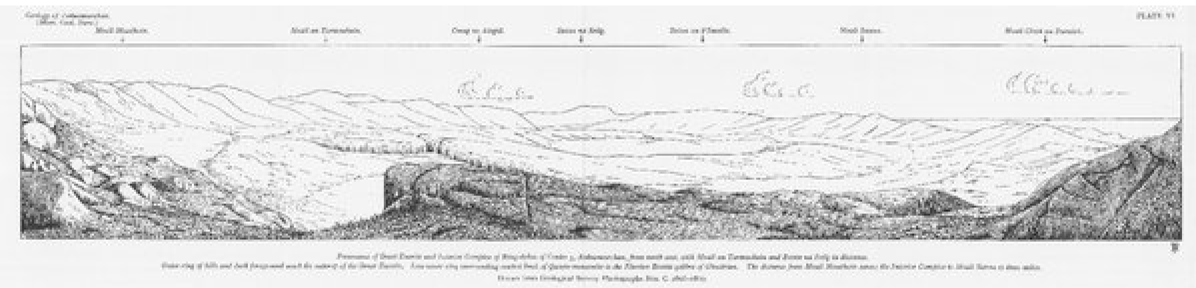
South of the central peak of Meall an Tarmachain, a ridge of quartz-gabbro extends southwards. It is bounded to the east by the Outer Eucrite and to the west by the large capping of basalt lavas and agglomerates. On the north, it is separated from the Quartz-gabbro (F) by a continuation of the rocks of the capping, which extend up the hillside in screen-like fashion.

This mass passes into a fuzzy-weathering quartz-dolerite at its margins to west and north. It appears to be breaking through the capping to the west, for the base of the capping abuts against the base of the ridge formed of the Quartz-gabbro. Its age relative to the Outer Eucrite (E′) is unknown.

To the south, the Fluxion Gabbro of Faskadale is mapped as a separate intrusion from the Quartz-gabbro (F'), on account of the difference in composition of the two rocks, though no contact between them was located, J.E.R.



(Plate 5) Geology of Ardnamurchan. Index Map of ring-dykes of Centres 2 and 3, Ardnamurchan. (Mem. Geol. Surv.)



(Plate 6) Panorama of Great Eucrite and Interior Complex of Ring-dykes of Centre 3, Ardnamurchan, from north-east, with Meall an Tarmachain and Beinn na Seilg in distance. Outer ring of hills and dark foreground mark the outcrop of the Great Eucrite. Low inner ring surrounding central knob of Quartz-monzonite is the Fluxion Biotite-gabbro of Glendrian. The distance from Meall Meadhoin across the Interior Complex to Meall Sanna is three miles. Drawn from Geological Survey Photographs Nos. C2806, C2807, C2808, C2809.

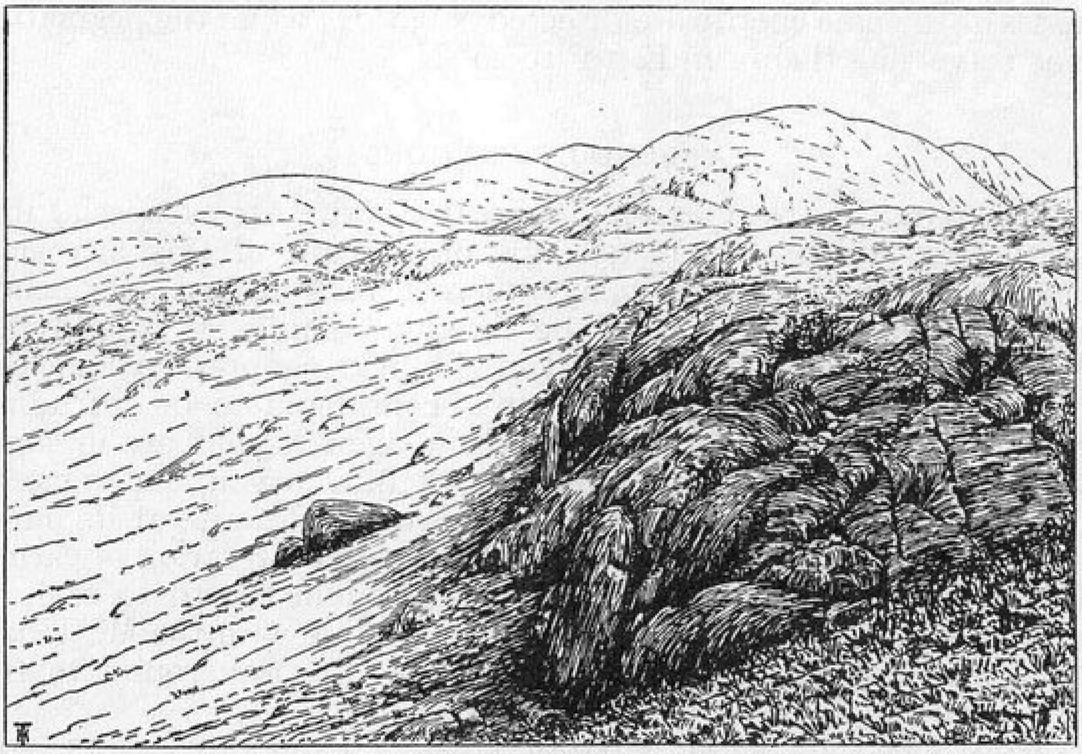


FIG. 40.—*View of Meall nan Con and Meall Meadhoin from north. Dotted line indicates junction of Meall nan Con Screen, forming ridge to left, with Great Eucrite Ring-dyke, forming Meall Meadhoin and foreground.*
Drawn from Geological Survey Photograph No. C. 2818.

(Figure 40) View of Meall nan Con and Meall Meadhoin from north.Dotted line indicates junction of Meall nan Con Screen, forming ridge to left, with Great Eucrite Ring-dyke, forming Meall Meadhoin and foreground. Drawn from Geological Survey Photograph No. C. 2818.

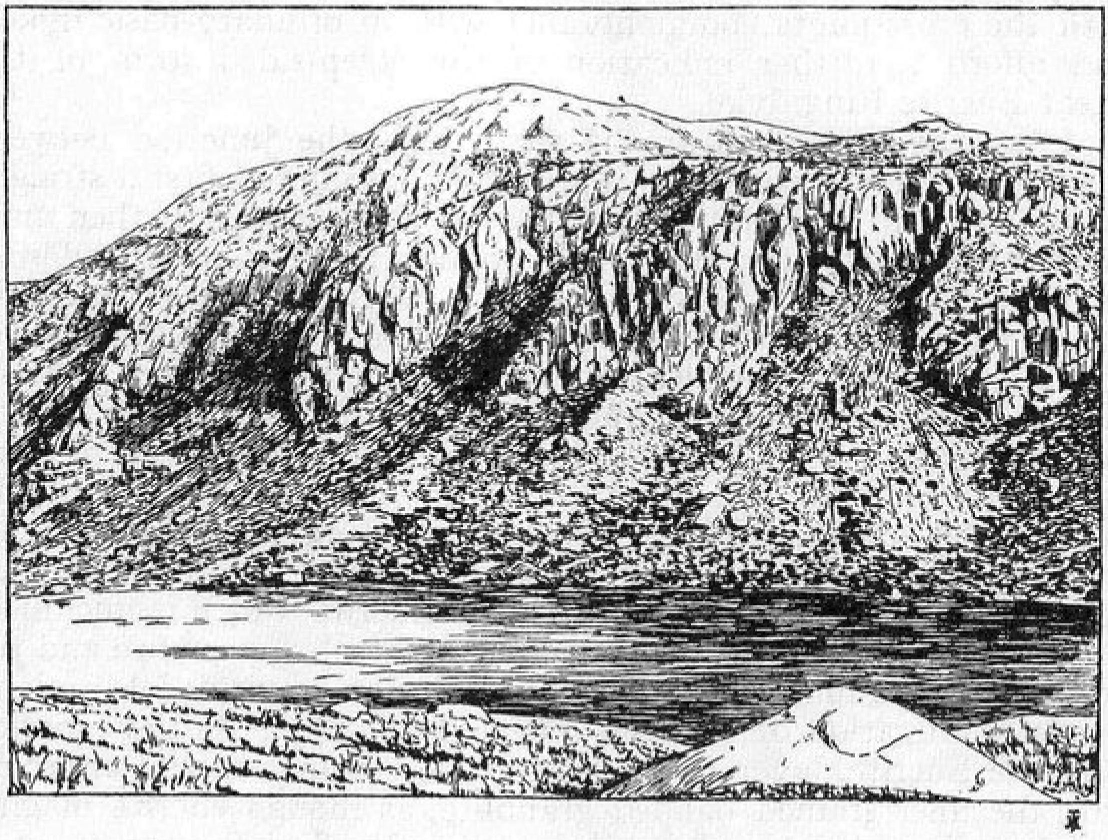


FIG. 41.—*View of crags on west side of Meall nan Con.*
Broken line indicates junction of granulitized rocks of Meall nan Con Screen with Great Eucrite Ring-dyke, that forms vertically-jointed crag overlooking loch.
Drawn from Geological Survey Photograph No. C. 2817.

(Figure 41) View of crags on west side of Meall nan Con.Broken line indicates junction of granulitized rocks of Meall nan Con Screen with Great Eucrite Ring-dyke, that forms vertically-jointed crag overlooking loch.Drawn from Geological Survey Photograph No. C. 2817.

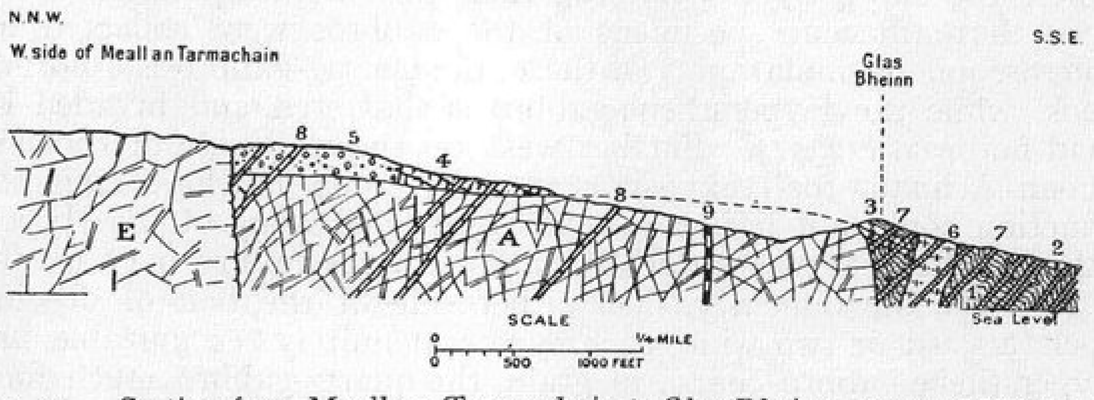


FIG. 39.—*Section from Meall an Tarmachain to Glas Bheinn, north of Kilchoan.*
1, *Moine Schists.* 2, *Trias.* 3, *Lower Lias (limestone and shale).* 4, *Tertiary basalt lavas.* 5, *Vent-agglomerate (Centre 1).* 6, *Porphyritic Dolerite of Glas Bheinn (Centre 1).* 7, *Outer Cone-sheets of Centre 2.* 8, *Cone-sheets (Centre 3).* 9, *Quartz-felsite dyke.* A, *Quartz-gabbro Ring-dyke (Centre 3).* E, *Great Eucrite Ring-dyke (Centre 3).*

(Figure 39) Section from Meall an Tarmachain to Glas Bheinn, north of Kilchoan. 1, Moine Schists. 2, Trias. 3, Lower Lias (limestone and shale). 4, Tertiary basalt lavas. 5, Vent-agglomerate (Centre 1). 6, Porphyritic Dolerite of Glas Bheinn (Centre 1). 7, Outer Cone-sheets of Centre 2. 8, Cone-sheets (Centre 3). 9, Quartz-felsite dyke. A, Quartz-gabbro Ring-dyke (Centre 3). E, Great Eucrite Ring-dyke (Centre 3).

TABLE IV

PORPHYRITIC CENTRAL MAGMA-TYPE (*see* Fig. 7)

	EUCRITE, GABBRO, AND BASALT.								
	I.	A.	II.	III.	B.	IV.	V.	VI.	
SiO_2 ..	47·26	47·28	47·75	48·28	48·34	49·60	49·78	50·12	SiO_2
Al_2O_3 ..	22·80	21·11	19·46	20·38	20·10	15·06	18·82	15·98	Al_2O_3
Fe_2O_3 ..	2·21	3·52	2·31	1·78	1·97	5·29	5·58	4·91	Fe_2O_3
FeO ..	5·41	3·91	6·28	6·70	6·62	5·00	4·85	6·31	FeO
MgO ..	7·76	8·06	7·50	7·93	5·49	4·44	4·15	4·43	MgO
CaO ..	10·93	13·42	11·32	11·80	13·16	9·69	10·40	10·86	CaO
Na_2O ..	1·72	1·52	2·46	1·75	1·66	2·62	3·04	3·60	Na_2O
K_2O ..	0·29	0·29	0·24	0·14	0·98	0·70	0·56	0·70	K_2O
$H_2O > 105°$	0·90	0·53	0·50	0·76	0·44	1·29	} 1·35	0·53	$H_2O > 105°$
$H_2O < 105°$	0·11	0·13	0·18	0·09	0·02	2·65		0·46	$H_2O < 105°$
TiO_2 ..	0·38	0·28	·0·43	0·23	0·95	2·38	1·34	1·76	TiO_2
P_2O_5 ..	0·06	trace	0·62	0·02	0·04	0·29	trace	0·08	P_2O_5
MnO ..	0·31	0·15	0·17	0·28	0·32	0·19	0·28	0·18	MnO
CO_2 ..	0·10	—	trace	0·03	0·11	0·44	—	0·21	CO_2
FeS_2 ..	0·00	—	0·16	0·04	0·00	0·00	0·00	0·05	FeS_2
Fe_7S_8 ..	0·00	—	trace	0·00	—	—	—	—	Fe_7S_8
SO_3 ..	—	—	trace	—	—	0·40	0·00	trace	SO_3
Cr_2O_3 ..	—	—	0·05	—	—	0·02	0·00	0·04	Cr_2O_3
(Co, Ni)O ..	0·00	—	—	0·00	0·00	0·00	—	—	(Co, Ni)O
BaO ..	0·00	—	—	0·00	0·10	trace	0·03	0·04	BaO
Li_2O ..	0·00	—	trace	0·00	0·00	trace	—	trace	Li_2O
C	—	—	—	—	—	—	traces	—	C
Organic matter ..	—	—	—	—	—	trace	—	—	Organic matter
	100·24	100·20	99·83	100·21	100·30	100·06	100·18	100·26	

I. (21250; Lab. No. 735.) Biotite-eucrite. Ring-dyke, Centre 3, Ardnamurchan. Bank of stream, 1 mile E. 33° S. of Achnaha. *Anal.* E. G. Radley.

A. (8194; Lab. No. 19.) Olivine-gabbro. Major Intrusion. Coir' a' Mhadaidh, Cuillins, Skye. Quoted from A. Harker, 'Tertiary Igneous Rocks of Skye,' *Mem. Geol. Surv.*, 1904, p. 103. *Anal.* W. Pollard.

II. (22821; Lab. No. 790.) Hypersthene-gabbro. Ring-dyke, Centre 2, Ardnamurchan. In side of hollow ¼ mile W. 33° S. of Trigonometrical Station at 1123 ft., Beinn na Seilg, and 1000 yds. E. 27° N. of

(Table 4) Porphyritic Central Magma-Type (see (Figure 7)).

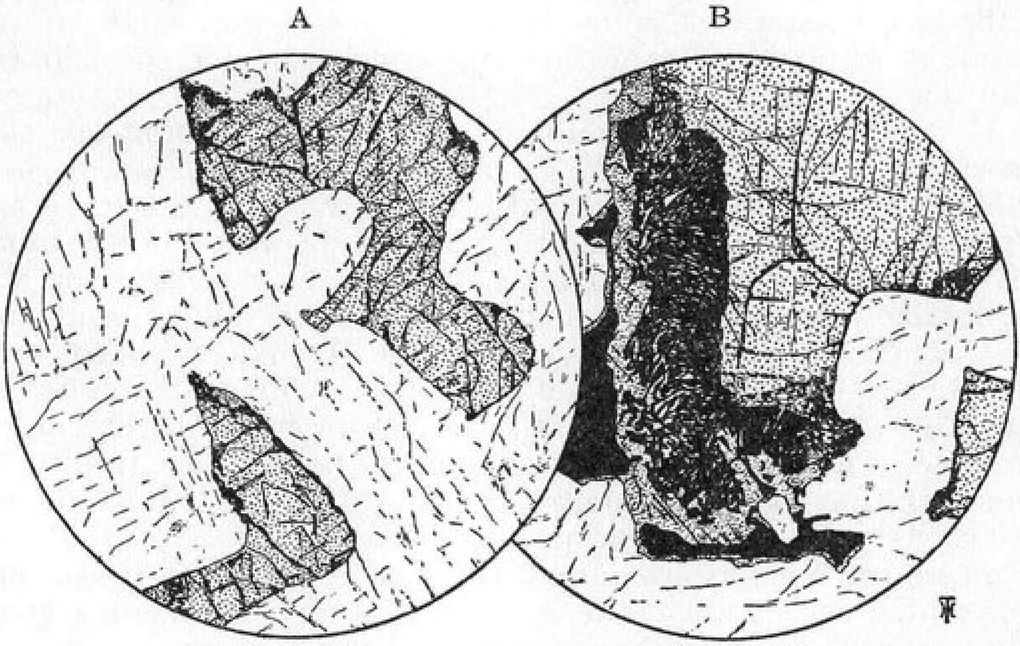


FIG. 42.—*Great Eucrite.*

A. (22675) × 20. *Eucrite, typical of the Great Eucrite of Centre 3. The section shows olivine with slight marginal development of secondary magnetite, and plagioclase that varies in composition from basic labradorite to bytownite.*

B. (22355) × 20. *Same type with well-developed reaction border between olivine and felspar. The reaction border consists of dendroid magnetite and hypersthene.*

(Figure 42) Great Eucrite. A. (S22675) [NM 4680 6659] × 20. Eucrite, typical of the Great Eucrite of Centre 3. The section shows olivine with slight marginal development of secondary magnetite, and plagioclase that varies in composition from basic labradorite to bytownite. B. (S22355) [NM 4422 6816] × 20. Same type with well-developed reaction border between olivine and felspar. The reaction border consists of dendroid magnetite and hypersthene.

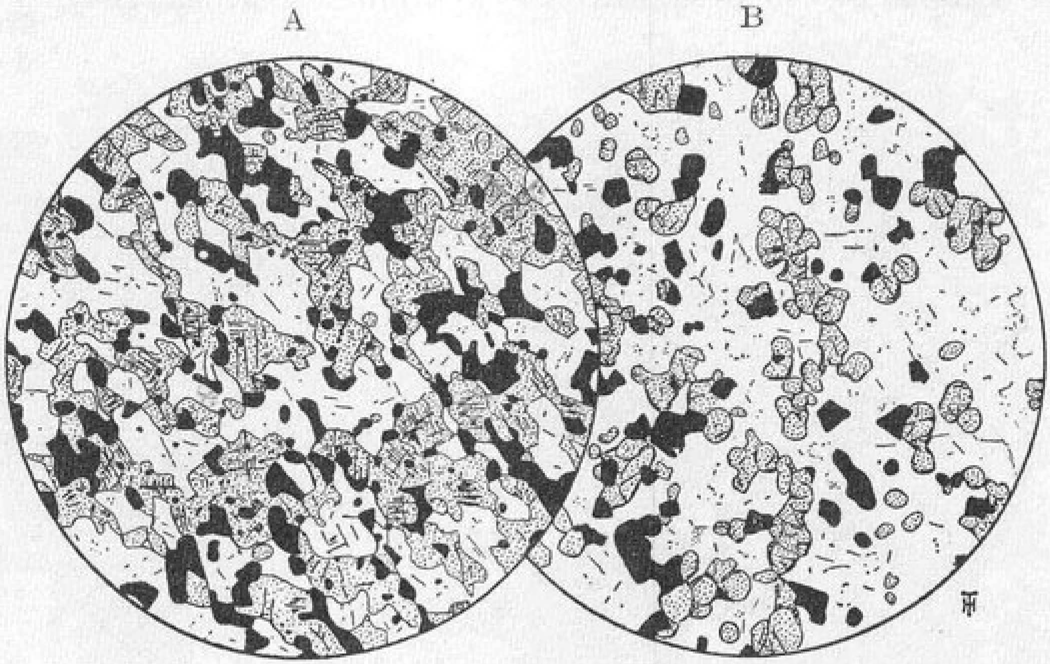


FIG. 31.—*Granulitic Masses associated with Basic Ring-dykes.*

A. (22658) × 20. *Granulitic gabbro, at margin of Great Eucrite south-west of Meall nan Con. A completely recrystallized rock composed of augite, clear plagioclase, and abundant iron-ore. All the constituents tend to have a granulitic development.*

B. (23620) × 20. *Granulitic gabbro of allivalitic composition, enclosed by Hypersthene-gabbro. It is composed of granulitic olivine, basic plagioclase felspar, and iron-ore. The rock has been completely recrystallized and has developed a faint banding.*

(Figure 31) Granulitic masses associated with basic ring-dykes.. A. (S22658) [NM 4986 6764] × 20. Granulitic gabbro, at margin of Great Eucrite south-west of Meall nan Con. A completely recrystallized rock composed of augite, clear plagioclase, and abundant iron-ore. All the constituents tend to have a granulitic development. B (S23620) [NM 4223 6631] × 20. Granulitic gabbro of allivalitic composition, enclosed by Hypersthene-gabbro. It is composed of granulitic olivine, basic plagioclase felspar, and iron-ore. The rock has been completely recrystallized and has developed a faint banding.

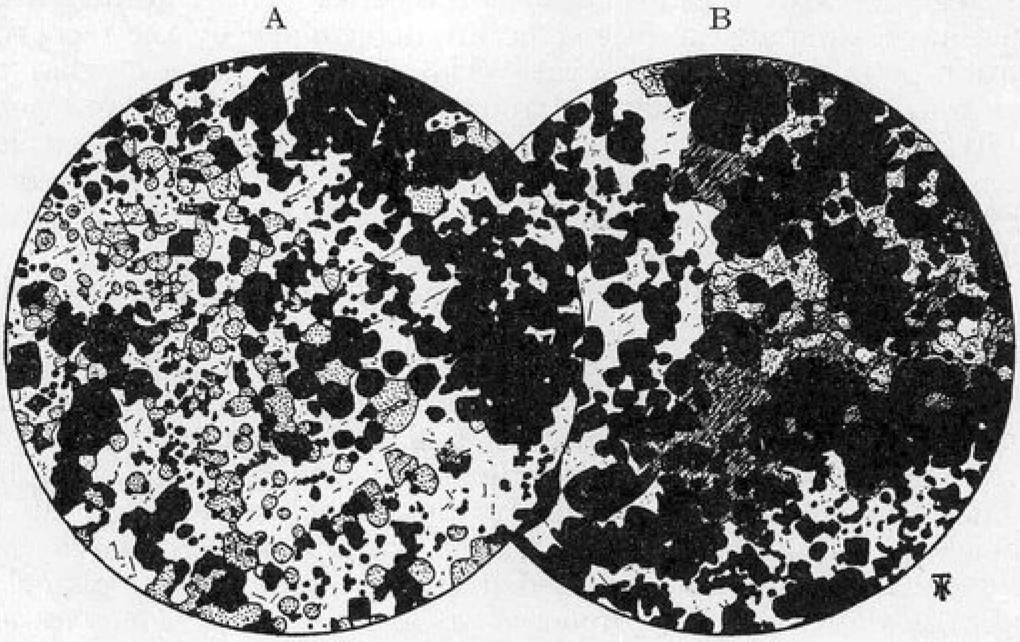


FIG. 43.—*Olivine-spinel-granulite.*

A. (26671)×20. *The rock consists of rounded grains of olivine and an almost opaque dark-green spinellid in a matrix of basic plagioclase felspar.*
B. (26671)×20. *Another portion of the same section, with the same magnification, showing the large plates of biotite that occasionally replace felspar as the matrix of the other constituents.*

(Figure 43) Olivine-spinel-granulite. A. (S26671) [NM 5024 6681] × 20. The rock consists of rounded grains of olivine and an almost opaque dark-green spinellid in a matrix of basic plagioclase felspar. B. (S26671) [NM 5024 6681] × 20. Another portion of the same section, with the same magnification, showing the large plates of biotite that occasionally replace felspar as the matrix of the other constituents.

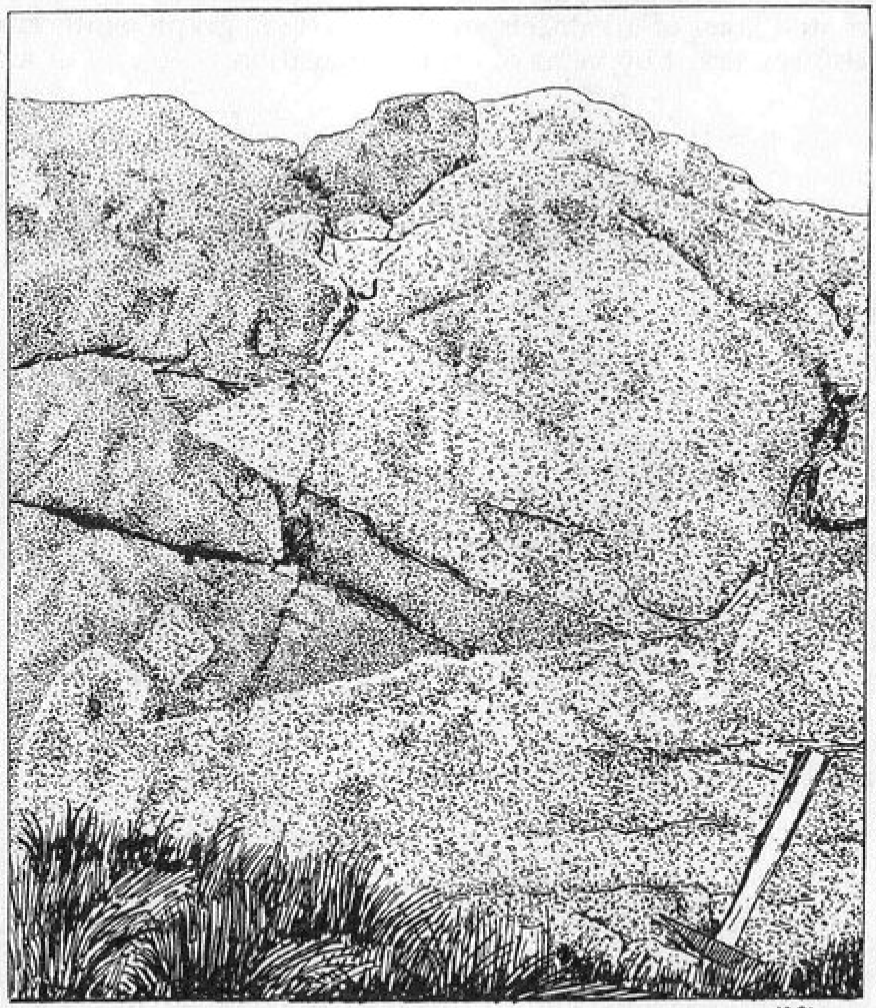


FIG. 44.—*Intrusive Junction of Quartz-gabbro of Meall an Tarmachain (left) with Outer Eucrite, south-east side of Meall an Tarmachain.*
Drawn from Geological Survey Photograph No. C. 2812.

(Figure 44) Intrusive Junction of Quartz-gabbro of Meall an Tarmachain (left) with Outer Eucrite, south-east side of Meall an Tarmachain. Drawn from Geological Survey Photograph No. C. 2812.

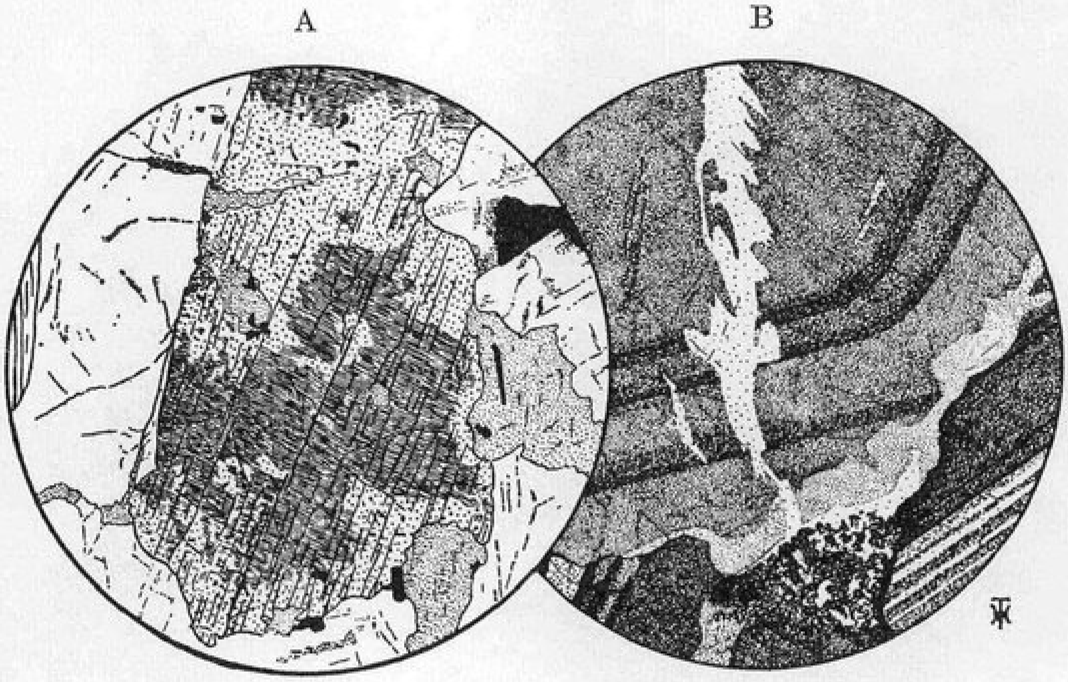


FIG. 45.

A. (22345) × 20. *Large crystal of augite showing the local obliteration of schiller-structure as one of the results of acidification* (p. 276).
B. (22351) × 23. *Zoned crystal of basic plagioclase fringed with a late crystallization of albite-oligoclase and veined by albite. Crossed nicols.*

(Figure 45) A. (S22345) [NM 4373 6780] × 20. Large crystal of augite showing the local obliteration of schillerstructure as one of the results of acidification (p. 276). B. (S22351) [NM 4390 6770] × 23. Zoned crystal of basic plagioclase fringed with a late crystallization of albite-oligoclase and veined by albite. Crossed nicols.