Chapter 33 Hybrids of Sròn nam Boc and Coille na Sròine Loch Bà

Introduction

The Sròn nam Boc and Collie na Sròine complexes of basic, intermediate, and acid rocks are grouped under the index-letter eD on the one-inch Map, Sheet 44. They both lie immediately outside the Loch Bà, Felsite of Chapter 32, between which and the Beinn a' Ghràig Granophyre they constitute an interrupted local screen. Possibly they may have originated as a ring-dyke, but this is quite uncertain. Their chief interest depends upon the fact that they exhibit phenomena of intricate intrusion and partial assimilation of a basic rock by the Beinn a' Ghràig Granophyre.

Within the areas coloured as dolerite or gabbro at the two localities under consideration, there is to be met with every grade of composition from basic to acid. Sometimes, one type of rock merges gradually into another; but, often, the transition is rapid, with concomitant veining and enclosure of more basic by more acid material, So that angular blocks of undigested gabbro lie here and there immersed in granophyre.

The remainder of the chapter is mostly devoted to the microscopic Petrology of material collected from the two localities named above. Two concluding sections, however, look further afield, and are entitled Other Mull Examples and Internal Migration compared with true Hybridization. W.B.W,

Petrology

The work of Dr. Harker on the gabbros and granophyres of Skye, and the subsequent elaboration of his views, have familiarized all students of petrology with the conception of hybridization as applied to igneous masses, and with the essential characters of hybrid rocks. It is interesting, therefore, to find in Mull further striking examples of the development of hybrids of intermediate composition characterized by special mineralogical and structural features.

Mr. Wright has provided us with a large number of excellently selected specimens, with carefully determined field-relations, to illustrate the phenomena of hybridization. His localities are Sròn nam Boc and Collie na Sròine on the slopes on either side of Loch Bà. The two suites of specimens show many resemblances, but it will be well to treat them separately at first, and then to summarize the essential features common to both.

Sròn nam Boc

The gabbro (S14724) [NM 5709 3911] of this locality is a moderately coarse, olivine-gabbro composed of olivine in well-formed crystals, zoned labradorite, coarsely ophitic pale augite, and iron-ore. The rock has suffered changes that may be attributed, partly to the thermal action, and partly to the chemical influence of the invading acid magma.

The olivine, which is full of dentritic magnitite, has been in some measure converted into rhombic pyroxene, actinolite, and serpentine, and shows good schiller-structure. In portions of the rock that appear to be albitized and acidified, olivine is surrounded by rhombic pyroxene, and independent rhombic pyroxene has developed, together with green hornblende.

In a specimen, collected to show the usual more pronounced type of acidification of the basic rock, we may detect three grades of alteration within the limits of a single slice (S14311) [NM 5705 3908]. Where least altered, the rock contains pseudomorphs after olivine, similar to those described above. This is succeeded by a zone in which the augite and felspar of the original rock have been largely recrystallized. The augite, locally, shows signs of granulitization, but more particularly of recrystallization in clots, where, along with slender radiating prisms of re-formed felspar, it gives rise to a sub-variolitic strueture. In the most acidified portion, there is a hypidiomorphic, to panidiomorphic, development of the ferro-magnesian minerals and more basic felspars: augite has recrystallized as small idiomorphic crystals; rhombic pyroxene, represented by pseudomorphs in green fibrous hornblende, has developed as finely ophitic patches and isolated crystals, and is frequently intergrown with augite; biotite occurs in general association with iron-ores; and basic re-formed felspars are deeply zoned with oligoclase. Patches of turbid alkaline material, with a fair amount of free quartz,

can be seen to have exerted a powerful corrosive effect on the felspars, producing a restricted, but intense, albitization.

In a similar specimen of acidified gabbro (S14312) [NM 5705 3908], all trace of original olivine is lost. Augite has recrystallized as small crystals and grains with hypidiomorphic outline, but occasionally one may note a columnar development of this mineral in the form of large and definitely elongated prisms. The felspars are of two kinds, strongly corroded large individuals of acid labradorite, zoned by turbid alkali-felspar or micropegmatite, and smaller elongated oligoclase-crystals, of an evidently subsequent generation, edged with orthoclase and quartz. Rhombic pyroxene (pseudomorphed) in well-shaped crystals is a noticeable feature of the hybrid zone, as also is a general -separation of small regular crystals of magnetite. The rock contains much quartz, and, locally, a moderately coarse graphic intergrowth of this mineral with alkali-felspar.

A specimen (S14313) [NM 5705 3908], collected to show the nature of the obviously acid veins that traverse the basic rock, is of a beautiful granophyre. It consists of small extremely turbid crystals of plagioclase, possibly remnants from the basic rock, surrounded by granophyre-aggregates. The more obviously contaminated portions of the vein show hypidiomorphic augite, occasionally in columnar crystals, intergrown with magnetite,<ref>A. Harker, Tertiary Igneous Rocks of Skye, Mem, Geol. Surv, 1904, Pl. XXI., Fig. 2.</ref> and fibrous hornblendic pseudomorphs after rhombic pyroxene.

Other specimens (S14721) [NM 5705 3893], (S14725) [NM 5702 3907], (S14726) [NM 5698 3906] were collected to show the characters of the doleritic assemblage and the acid rock by which it is veined. The acid rock in these cases is a coarse granophyre. The doleritic rock is similar to the acidified rocks described above (S14312) [NM 5705 3908], but, adjacent to the granophyre, there is a zone characterized by coarseness of grain and a richness in augite and hornblendic and chloritic pseudornorphs after rhombic pyroxene. In this zone, there is a little brownish-green hornblende of pyrogenetic origin. We may also note the original augite of the dolerite being eaten into and developing a said° striation (S14725) [NM 5702 3907], or recrystallizing with columnar habit (S14726) [NM 5698 3906]. Rhombic pyroxene (pseudomorphed) has developed at the expense of olivine, and biotite is associated with the iron-ores (S14725) [NM 5702 3907].

An actual xenolith of basic rock (S14722) [NM 5716 3916] surrounded by granophyre shows well the nature of their reciprocal action. Internally, the xenolith has the usual characters of the acidified dolerite (cf. (S14311) [NM 5705 3908]. Olivine is replaced by serpentine, fibrous hornblende, and magnetite. Augite is in part recrystallized, and in part surrounded by a pseudomorph after rhombic pyroxene. In places, the original augite is curved and bent (p. 325), and shows an incipient development of salitic structure. Nearer the granophyre, augite has been resorbed with subsequent formation of greenish-brown hornblende; and all stages of dissolution may be studied. The granophyre itself, near the junction, contains columnar magnetite-bearing crystals of augite, now replaced by fibrous green hornblende.

A specimen (S14723) [NM 5713 3912], collected as illustrative of the typical medium-grained hybrid, may be best regarded as a basified granophyre. Little is left in the way of remnants of the basic material. The felspar is almost all fresh oligoclase and perthite; and there is an abundance of quartz with a little micropegmatite. The ferromagnesian minerals are augite with columnar habit, and hypidiomorphic crystals of smaller but stouter form. There are the usual pseudomorphs after rhombic pyroxene, and, in addition, a good deal of greenish-brown pyrogenetic hornblende.

Coille na Sròine

At the other locality, on the western slopes above Loch Bà, the more basic phases, acidified dolerites, are represented by four specimens (S14309) [NM 5533 3761], (S14310) [NM 5550 3771], (S14719) [NM 5545 3753], (S14720) [NM 5545 3753]. They contain patches of micropegmatite; their basic plagio- clase is much albitized; and their augite occurs in prominent twinned crystals showing herring-bone salitic striations. Olivine is represented by large chloritic pseudomorphs. Signs of contact-alteration, due to the proximity of the granophyre, are forthcoming in flecks of biotite developed in partially chloritized augite. In certain instances, the augite is strongly columnar with salitic striation (S14720) [NM 5545 3753], and is edged with greenish-brown pyrogenetic hornblende (S14719) [NM 5545 3753].

A rock (S14318) [NM 5725 3899], collected to illustrate a variety into which the above-described basic phases rapidly pass, is of generally more acid character. It completely lacks pseudomorphs after olivine, but has a little pyrogenetic hornblende in its quartz-rich portions. The original augite appears to have been recrystallized with a tendency to assume the columnar habit. There are pseudomorphs after rhombic pyroxene. Basic felspars have been broken up, albitized, and fringed with perthite.

A rock of still more acid character (S14712) [NM 5539 3757], which encloses one of the basic phases (S14719) [NM 5545 3753] as a xenolith, is a basified granophyre with an acicular type of crystallization of its constituents. The slice itself contains no recognizable fragments of basic material, but consists of elongated crystals of augite pseudomorphed in fibrous hornblende, and elongated crystals of oligoclase-albite fringed with orthoclase and perthite, in a matrix of micrographic material and free quartz.

Three specimens (S14713) [NM 5539 3755], (S14714) [NM 5540 3753], (S14715) [NM 5540 3751] were collected to show varieties of rock that, in the field, apparently pass gradually into each other. They are all characterized by a prevalence of pyrogenetic hornblende. The augite of the original rock has departed from the ophitic form, and has assumed a hypidiomorphic columnar habit, and is occasionally intergrown with the brown-green hornblende. They show a variable amount of true granophyric material, between which and the more basic portions, the usual rhombic pyroxenes have been developed. Felspars have suffered all changes from partial acidification to complete resorption.

Further specimens may be noted, of which one (S14716) [NM 5541 3749], taken to illustrate an indefinite junction between more and less acid types, shows an abundance of pyrogenetic hornblende; while another (S14717) [NM 5541 3747], of a type that sometimes presents definite boundaries against the more general and coarser material of its neighbourhood, is a felspathic rock rich in pseudomorphs after rhombic pyroxene.

Three specimens (S14711) [NM 5538 3759], (S14710) [NM 5538 3761], (S14709) [NM 5537 3763] show the gradual transition. of the hybrid rock to the granophyre (S14708) [NM 5537 3765]. They are well-mixed rocks, in which pseudomorphs after rhombic pyroxene are characteristic of the more basic material (S14710) [NM 5538 3761], while pyrogenetic hornblende is a feature in the more acid regions (S14709) [NM 5537 3763]. The granophyre itself is a beautiful rock, and, at the point from which the specimen was taken, appears to be unmodified by the assimilation of basic material.

Summary

To appreciate the significance of the mineralogical and structural peculiarities of the rocks described above, we must first endeavour to disentangle the effects of thermal alteration from those attributable to chemical activity. In the former category, we may safely place the development of actinolitic hornblende within the pseudomorphous representatives of olivine, the granulitization and recrystallization of augite, and the production of biotite from chlorite and in the neighbourhood of iron-ores.

Turning now to those changes which can be referred directly to mutual action between an acid magma and an already consolidated more basic rock, we note effects due to both local and general absorption. Acidification of the basic rock is responsible for the partial, or complete, replacement of olivine by rhombic pyroxene. Similarly, it accounts for the edging of original augite with brownish-green hornblende of pyrogenetic character, and also for the attack of original basic plagioclase crystals, their corrosion, and subsequent irregular replacement by felspar of more alkaline character.. In like manner, basification of the acid magma has led to crystallization of newly-formed hypidiomorphic rhombic pyroxene, of independent grains and prisms of pyrogenetic hornblende, and of comparatively basic plagioclase felspar. Hydrothermal exchange has probably been involved in the alteration of augite to fibrous green hornblende, frequently noticeable in cases, where the acid magma has come in contact with pyroxene and yet has failed to produce a hornblendic fringe of typical pyrogenetic character.

The outstanding features, therefore, of these hybrid rocks of Mull are: the acidification of basic felspars in irregular fashion; the replacement of olivine by rhombic pyroxene; the fringing of augite, frequently recrystallized, by pyrogenetic hornblende; the complete local assimilation of basic material followed by the independent crystallization of rhombic

pyroxene; the basification of the acid magma with the production of pyrogenetic hornblende; and a general increase in the basicity of the early separating felspars. Referring to the independent crystallization of rhombic pyroxene in these rocks of hybrid character (acidified basic rocks), it must be remarked that, while this mineral is highly characteristic of the Mull occurrences, it must not necessarily be regarded elsewhere as an index of hybridization. It must be remembered that, even in Mull, it is a common constituent of the leidleites (Chapter 25).

The microscopic structures of these hybrid rocks are equally characteristic. In almost every case, rapid transitions from acid to basic types are met with, and a xenolithic structure is noticeable, even when the enclosed rock has been greatly modified by the surrounding magma. It is a noteworthy fact, pointing to selective assimilation and diffusion, that the shape of included xenolithic masses remains practically unaltered although their constitution is radically changed.

Other Mull examples

There are many other examples of hybridization in Mull, where relatively basic and acid rocks are in contact; and perhaps the most noteworthy is that discussed under the heading of Craig Porphyrite in Chapter 22. (see also pp. 210, 317).

Marked interaction between magma and its containing sedimentary walls is dealt with in connexion with the xenoliths of the Loch Scridain sills (Chapter 24), and the sandstone-granophyre assimilation-zone of the Glas Bheinn Granophyre (Chapter 12).

Internal migration compared with true hybridization

There is no positive evidence in Mull that any of the recurrent types of intrusions owe their distinctive characters to assimilation of foreign material, or commingling of magmas, prior to their arrival in their present position. In fact, there appears good ground for assuming that such divergent characters as they possess are more generally the outcome of normal processes of differentiation.

A word must be said here concerning many rocks, that, in some measure, present microscopic characters suggestive of hybridization in a restricted sense of the term. Such rocks are the Late Basic Cone-Sheets (Chapter 28), some of the Ring-Dykes (Chapter 30), and the so-called augite-diorites (Chapter 18). We have, in Mull, numerous rocks of quartz-dolerite composition, derived from a magma, which, as crystallization progressed, clearly gave rise to an acid differentiate. This acid partial magma was of strikingly different composition to the early crystalline phases, and its temperature of complete consolidation was evidently far below that at which the larger and earlier-formed individuals had practically ceased to grow. It represents the original magma, almost depleted as regards lime and magnesia, but retaining abundant alkalies and dissolved water, and, with them, extreme fluidity. That it was capable of migration under gravitational, or other, forces from one portion of the mass to another is quite clear; for, owing to such movement, it often achieved a local concentration, or traversed the earlier products of consolidation as strings and veins. Under these circumstances, it was brought into contact with early crystalline phases, with which it was no longer in equilibrium, and an appearance of injection of a relatively basic rock by a relatively acid magma has been produced. The disturbances of equilibria, moreover, have simultaneously engendered absorptive processes, similar to, but generally less active than those known to have operated in the formation of true hybrid rocks that resulted from invasion of magma from an external source.

The process of true hybridization involves the action of an independent magma upon ,an already consolidated rock, or the commingling of two independent magmas of different chemical composition; but the process outlined above involves merely the reaction, without any considerable rise of temperature, of a differentiate, or partial magma, on already separated crystalline phases. It will be seen that the two processes have much in common, and in extreme cases the results may be indistinguishable. The main difference noted is that the disturbances of chemical equilibria are relatively reduced in the case of internal migration. In this connexion it is interesting to note the general absence of rhombic pyroxene and pyrogenetic hornblende from most of those rocks of Mull which have a mixed acid and basic character, except where definite xenolithic structure, observable in the field, furnishes, in itself, direct evidence of hybridization. H.H.T., E.B.B.