Cruach Choireadail

OS Grid Reference: NM595305

Highlights

There is a superb, continuous section from gabbro at the base of the Glen More ring-dyke through intermediate rocks to granophyre at the top of the intrusion. The ring-dyke cuts basaltic pillow lavas which formed in a caldera lake, and is itself cut by numerous late basic cone-sheets.

Introduction

The site contains a virtually continuous section through the Glen More ring-dyke which clearly shows a gradual upwards transition from gabbro at the base to granophyre at the top (Fig. 5.15). The ring-dyke is the last major intrusion associated with the Beinn Chaisgidle Centre (Centre 2, Table 5.1). Two dyke-like arms which protrude upwards from the ring-dyke at Cruach Choireadail are connected by a horizontal sheet. Also exposed within the site are the arcuate Coire 'an t-Sailein quartz gabbro body, the Ben Buie olivine-gabbro intrusion, gabbroic plugs, some volcanic rocks and late basic cone-sheets.

Figure 5.15: Cruach Choireadail, viewed from the Coladoir River, exposing gabbro/granophyre of the Glen More ring-dyke. Cruach Choireadail site, Mull. (Photo: C.J. MacFadyen.)

The Mull Memoir (Bailey *et al.*, 1924) contains a detailed petrological description of the Glen More ring-dyke. The authors advanced a crystal fractionation model to account for the petrological variations. However, Holmes (1936) and Fenner (1937) challenged this view, while Koomans and Kuenen (1938) favoured the fractionation model. Skelhorn (1969) has produced a field guide to the Cruach Choireadail region and discusses the models for the petrogenesis of the Glen More ring-dyke.

Description

Between the Coladoir River and the summit of Cruach Choireadail (NM 595 305), a 450 m vertical section through one of the dyke-like apophyses of the Glen More ring-dyke is exposed (Fig. 5.16). The lowermost rocks are the most basic, containing about 44% silica (Koomans and Kuenen, 1938), and are moderately coarse-grained, speckled quartz gabbros/dolerites containing labradorite (40%), augite (40%), ilmenite + magnetite (12%) and minor amounts of quartz + alkali-feldspar intergrowths. Pseudomorphs of chlorite after olivine also occur but form less than 5% of the modal mineralogy (Koomans and Kuenen, 1938). The distribution of feldspar is sometimes uneven, resulting in leucocratic segregations and horizontal segregation veins of an acidic residuum up to a metre in thickness. These are common in the basic portion of the intrusion. There is a gradual and remarkably regular decrease in grain size upwards through the intrusion as the rocks generally become paler and more leucocratic. The proportion of acid mesostasis likewise increases upwards, olivine completely disappears, plagioclase becomes less calcic and the habit of augite changes from ophitic to acicular. The quartz gabbro passes upwards into a pinkish-grey, augite diorite with a hybridized appearance and finally into pinkish leucocratic "granophyre'. The summit ‘granophyre' is a fine-grained, quartz-microporphyritic, spherulitic, sodic felsite essentially composed of albite, orthoclase, quartz and alkali-feldspar intergrowths, and quartz and fibrous green hornblende replacement after acicular augite.

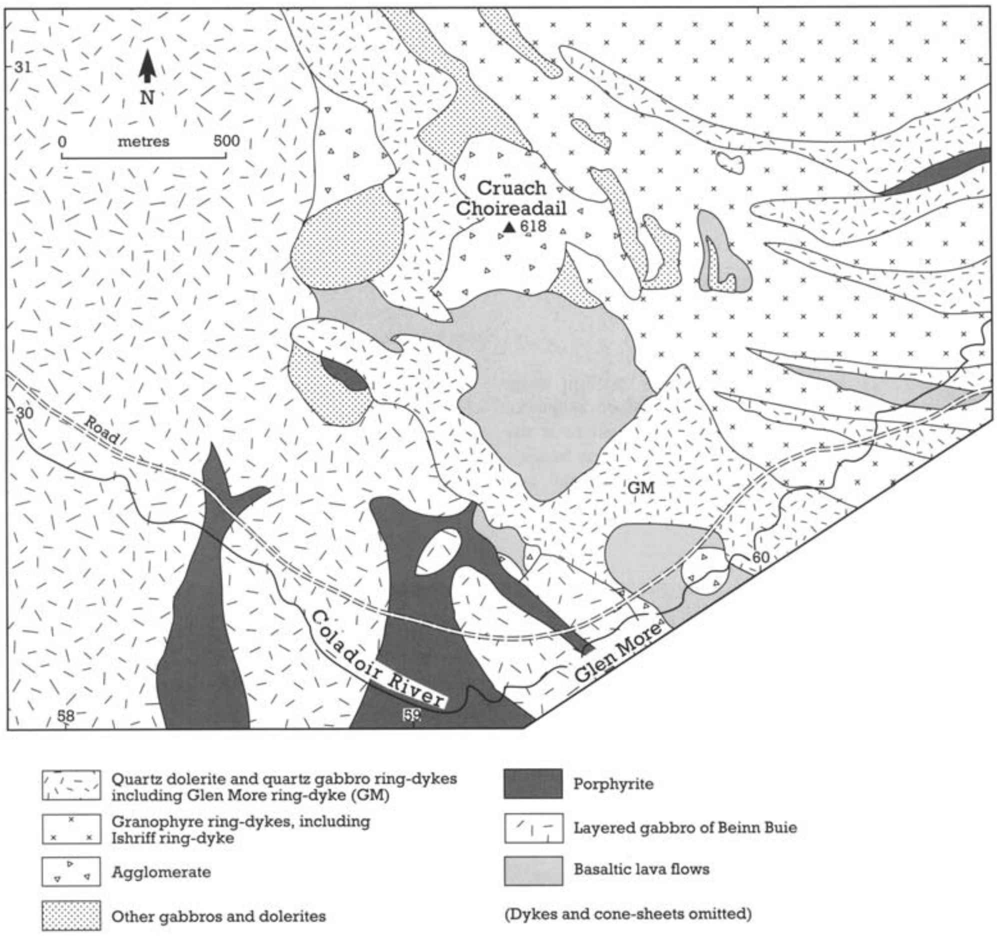

Figure 5.16: Geological map of the Cruach Choireadail site (adapted from the British Geological Survey 'One Inch' map, Sheet 44, Mull)

In the Coladoir River, the Glen More ring-dyke is separated from the earlier Ishriff Granophyre ring-dyke by a narrow screen of basalt and dolerite. These thermally metamorphosed rocks are probably early members of the late, basic, cone-sheet complex (Table 5.1). This screen is traceable for some distance up the slopes of Cruach Choireadail. The numerous NW-trending sheets traversing the lavas are truncated by the Glen More ring-dyke and form the main wall rocks; however, the ring-dyke is itself cut by late basic cone-sheets (Bailey *et al*., 1924) in the north-west, showing that it has been bracketed by the late basic cone-sheet emplacement episode. Examples of the lavas associated with the South-East Caldera (Centre 1) are located to the south of Cruach Choireadail and the small lochans and are notably packed with large feldspar phenocrysts in many instances. Occasional pillow structures are observed in these altered basalts indicating that the lava sometimes flowed into standing water within shallow lakes. The pillows vary in size from a few centimetres to over one metre in length and have chilled margins but seem to be devoid of concentrically arranged vesicles. Well-developed pillow lavas along the Beinn Fhada plateau above Loch Sguabain in upper Glen More, are described in the Loch Sguabain report (see above).

Between the two dyke-like parts of the Glen More intrusion, a small gabbroic plug is exposed, cut by late basic cone-sheets. Identical plugs are found around Cruach Choireadail having chemical affinities with the caldera lavas and they may be regarded as potential feeders for them. Other features of interest within the Cruach Choireadail site include the agglomerates or breccias towards the summit and an exceptionally large xenolith of the Ben Buie layered gabbro (exposed at the western end of the site) at a height of about 250 m. This gabbro is the youngest intrusion of the earlier Glen More Centre (Centre 1; Table 5.1).

Interpretation

The continuous vertical section through the Glen More ring-dyke, showing an unbroken transition from basic rocks at low levels in the intrusion to acid rocks at high levels, is one of the most clearly demonstrated examples of such compositional variation in the BTVP. The close association of basic and acid rocks, and by implication magmas, in the same intrusion is a common feature of intrusions in the Province. The fine exposures in this site provide an excellent opportunity to study the problem.

The gradual change in rock type at different levels in the intrusion was attributed by Bailey *et al*. (1924) to *in situ* differentiation involving crystal settling towards the base and migration of residual, progressively more evolved magma into the upper parts of the ring-dyke. Objections have been raised to this mechanism. Skelhorn (1969) pointed out that the gabbros at the base lack rhythmic layering, igneous lamination and other features characteristic of cumulate rocks. Further evidence against a model involving fractionation of basaltic magma by crystal settling is the lack of marginal border rocks representing the parental basaltic magma (cf. Wager and Deer, 1939) and the observation that granophyre is in direct contact with the country rocks, against which it is chilled. Another possible mechanism involves the simultaneous intrusion of acid and basic magmas, with mixing of the two contrasted magmas to give intermediate rock types which certainly have the textural attributes of hybrid igneous rocks. The magma mixing and hybridization model was advanced by Holmes (1936) and Fenner (1937), but Koomans and Kuenen (1938) argued against it on the grounds that:

1. there was an absence of biotite, hornblende and orthopyroxene which they claimed were characteristic of a "hybrid series';

2. the predominantly curved trends on the chemical variation diagrams (as opposed to straight-line relationships produced by magma mixing); and

3. the lack of intrusive breccias or sharp contacts between the various rock types.

They suggested that gravitative separation and settling of augite and iron oxides (+ plagioclase) resulted in the formation of the granophyre, and that subsequent ‘pneumatolytic emanations from the lower reaches of the column' were responsible for the textural features of the intermediate rocks.

Clearly, the close association of basic and acid rocks, and the apparent height control on their occurrence in the intrusion, have important petrogenetic implications. However, it is obvious from a cursory glance at the literature that a thorough petrological investigation of the Glen More ring-dyke is long overdue. This would have to take into account modern work on magma mixing and zoned magma chambers; until this is done the site will not attain the international status which it almost certainly merits.

Conclusions

The Glen More ring-dyke shows continuous variation from gabbroic rocks in its lower levels through intermediate rocks to granophyre in the highest parts of the intrusion. This variation may have been caused by:

1. settling of early-formed crystals (augite, magnetite, calcic plagioclase, plus some olivine) towards the base of the intrusion, allowing the remaining magma, enriched in silica, potassium and sodium, to crystallize as granophyre at the top of the ring-dyke or, alternatively,

2. basaltic magma may have been injected into the base of the ring-dyke at the same time as granitic magma entered the top; the two magmas then mingled to give the rocks of intermediate composition now found between the gabbro and granophyre.

Pillow lavas in the site formed when basaltic magma flowed into a caldera occupied by a lake (see also Loch Sguabain).

Reference list

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