Rubha' an Eireannaich

Highlights

The site contains a fine, continuous section through a composite (felsite–basalt) sill intruded into Jurassic strata. Mixing of acid and basic magmas is demonstrated by the complete gradation from basalt at the margins of the intrusion to felsite in the core with thin, intervening hybrid zones.

Introduction

This site contains an exceptionally well-exposed example of a composite intrusion which demonstrates a virtually continuous variation from chilled upper and lower margins of basic rock, through hybrid rocks to a central felsite member. It is an excellent example of mixing between contrasting magma types. The sill lies at the northern end of a series of arcuate composite intrusions which focus on the Inner (Beinn na Caillich) Granite of the Eastern Red Hills centre. Buist (1959) has described the intrusion in some detail, and Bell (1983) worked on the geochemistry of the different components and produced a model for the formation of the intrusion. The main features of the intrusion have been summarized by Bell and Harris (1986).

Description

A sill of about 5 m in thickness intrudes sandstones and siltstones belonging to the Lower Jurassic Broadford Beds at Rubha' an Eireannaich, Broadford. In addition, two thin basic sills intrude the overlying sandstone and both sediments and the sill are intruded by basic dykes. The section through the sill can be summarized as follows (after Buist, 1959):

Upper basalt	up to 0.75 m
Hybrid zone	between 0.23 and 0.3 m
Felsite	up to 2.4 m
Hybrid zone	between 0.23 and 0.3 m
Lower basalt	up to 0.75 m

The lower and upper basic margins contain xenocrysts and phenocrysts of feldspar but the lower basic member also contains felsic stringers and small areas of fine-grained basic material, together with rare, partly resorbed gabbroic inclusions. The felsite core carries altered phenocrysts of sodic plagioclase and shows an increase in the proportion of groundmass quartz towards the centre of the sheet. The hybrid zones contain sodic plagioclase xenocrysts and phenocrysts of altered andesine and groundmass pyroxene is pigeonite, in contrast to the augite found in the basic margins. There is a complete gradation from one rock type into the other with no suggestion of chilling; this contrasts strongly with the external margins of the basic member which were chilled to (now devitrified) glass against the sedimentary rocks of the Broadford Beds.

Interpretation

The field evidence provided by the sill shows that basic and acid magmas were essentially available simultaneously. The initial injection of basic magma was followed by injection of the acid magma before the former had cooled and consolidated. The absence of a well-defined boundary between these contrasting magma types, a feature also observed in other composite intrusions (for example, in the Marscoite Suite in Harker's Gully; the composite sills of Arran, see below), led Bell (1983) to conclude that high-temperature diffusion occurred between the basic and acid members at their present level in the crust. In addition, the presence of feldspar xenocrysts in the basic margins indicates that some mechanical mixing occurred prior to intrusion.

Geochemical work by Bell (1983) has shown that for all of a range of elements determined, there is complete compositional continuity between basic and acid members of the sill, and that the chondrite-normalized, rare-earth

element patterns for the basic and acid members are parallel.

From these data, Bell concluded that the basic and acid components were cogenetic. He envisaged two periods of hybridization of the acid and basic magmas. An early event involved limited addition of porphyritic acid magma to basic magma forming a basic hybrid with xeno-crysts, the basic member was then intruded to form the present marginal rocks in the sill. This was rapidly followed by further porphyritic acid magma which formed the centre of the sill. At this stage, *in situ* hybridization occurred by diffusion of elements between the two contrasting magmas while they were still both close to their liquidus temperatures (Bell and Harris, 1986). This process formed the *c.* 0.30-m-thick hybrid zones which now separate the basic margins from the acid core.

Conclusions

The site provides a very clear example of a common phenomenon in the British Tertiary Volcanic Province, namely, the coexistence of basic and acid magmas. In this instance, there was limited mechanical mixing between the different magmas prior to intrusion; further limited high-temperature diffusion within the intrusion occurred during the emplacment of the basic magma, which was followed very rapidly by the central injection of acid magma. The exposures at Rubha' an Eireannaich provide a continuous section through all of the rock types which can be readily distinguished in the field.

References