'S Airde Beinn

Highlights

A large, elongate dolerite plug intrudes the lava plateau along a regional structural lineament. The plug has produced a marked thermal aureole in the surrounding lavas; the aureole has been divided into three distinct zones on the basis of their mineralogy. High-temperature alteration of amygdales gave rise to larnite, rankinite and other uncommon calc-silicate minerals.

Introduction

'S Airde Beinn is a small but conspicuous rock-girt hill with a central depression occupied by a lochan (Figure 5.11). The hill is carved from a doleritic plug which rises through the flat-lying, trap-featured lavas of the Mull Plateau. Such plugs are of restricted occurrence in the Tertiary Igneous Province and on Mull are best developed in the north of the island. It is not only the largest but also the best-known plug on Mull, having been described by Judd (1874), Geikie (1897), Bailey *et al.* (1924) and Richey and Thomas (1930). The thermal effects of the intrusion on the adjacent lavas and their amygdales have been detailed by Cann (1965); the mineralogy of the aureole is a key feature of the site.

Description

The 'S Airde Beinn plug [NM 470 540] rises as much as 60 m above the surrounding countryside and it measures 850 by 440 m. It is elongated in a NNW direction parallel to the Tertiary regional structural trend and dyke swarm. The rock is a coarse-grained dolerite composed of olivine, titaniferous augite, labradorite and magnetite and it is mineralogically identical to the lavas which it intrudes. Bailey *et al.* (1924) suggested affinities to some of the pillow lavas of the Mull complex, but Beckinsale *et al.* (1978) showed the gabbro to be quartz- and hypersthene-normative assigning it to Group 2 (Table 5.2). In thin section, the olivine is either fresh or partly altered to iddingsite and forms large irregular crystals. Large zoned feldspars are enclosed ophitically by clinopyroxene and a second generation of acicular augite associated closely with magnetite occurs interstitially in a chloritized residuum. The walls of the intrusion are close to vertical but there is no obvious abrupt contact between the plug and the adjacent lavas; the lavas appear to grade locally into the dolerite. The thermal effect of the intrusion upon the basalt country rock explains this apparent gradational contact. There is an increase in the granularity of the basalts as the intrusion is approached, accompanied by a change in amygdale compositions which normally contain minerals such as thompsonite, natrolite, analcite, heulandite, stilbite and gyrolite. The changes in basalt and amygdale composition in the thermal aureole around the plug are discussed in detail below.

Interpretation

The 'S Airde Beinn plug is one of several plugs which intrude the lavas of Mull and Morvern, most of which have NNW–SSE elongations, approximately parallel to the regional dyke swarm. It also lies on a major fault zone traceable in a similar direction from Druim Fada [NM 465 555] to the shores of Loch Frisa [NM 475 510]. The numerous plugs of north Antrim are also elongate parallel to the regional dyke swarm, where the dykes and plugs are seen to merge. Like 'S Airde Beinn, many of the Antrim plugs are surrounded by pronounced thermal aureoles (cf. Tilley and Harwood, 1931; Preston, 1963); they are considered to have been long-lived feeders for lavas high in the Antrim Palaeocene lava field. A similar explanation is most likely for the Mull and Morvern plugs, which must have been coeval with the dykes and intruded as part of the same phase of magmatism, connected with Palaeocene crustal extension.

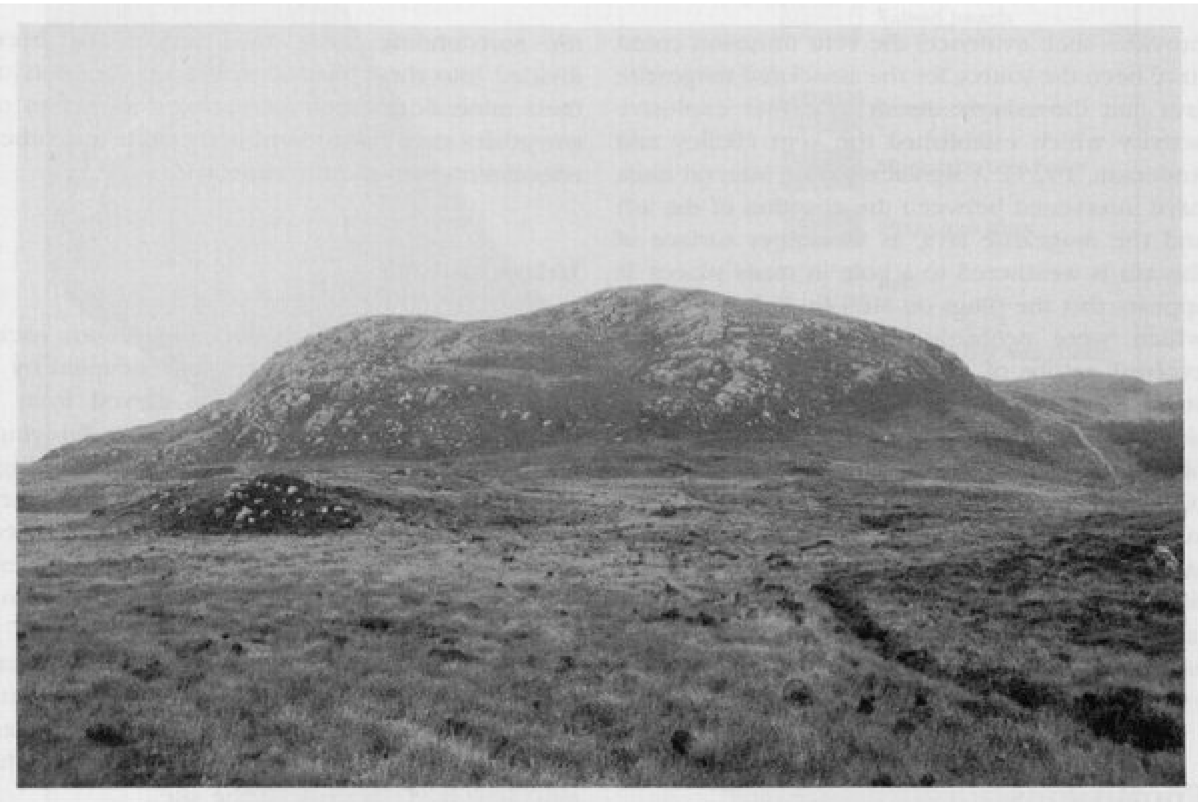
The principal value of the site is in the presence of the conspicuous metamorphic aureole associated with the plug. The apparent gradation from the coarse dolerite into the basalt at the contact was considered by Bailey *et al*. (1924) to indicate that the ascending magma which formed the plug melted and mingled with the lava wall-rock. Cann (1965), however, argued that only the most highly metamorphosed lavas have reacted with the magma. He distinguished three zones of progressive thermal metamorphism. The first is characterized initially by an increase in the amount of interstitial chlorophaeite, by the degree of alteration of pyroxene and olivine and by olivine being replaced by hypersthene and iron ore to produce a fine-grained hypersthene–augite–plagioclase–iron ore granulite. The second stage is characterized by the reappearance of olivine and an increase in granularity. Where a reaction with the magma has occurred, the third stage is reached, and olivine becomes the dominant ferromagnesian mineral.

Cann (1965) has also identified three classes of amygdale minerals on the basis of their behaviour on metamorphism. The first class consists of amygdale assemblages originally dominated by zeolite minerals such as thompsonite, natrolite and analcite with rare heulandite and stilbite. These show a consistent sequence of metamorphic change directly related to the stage of metamorphism attained by the surrounding basalts; many have been converted to plagioclase late in the first stage of metamorphism. Gyrolite is the dominant original amygdale mineral in the second class and this passes first into reyerite and then to wollastonite during metamorphism. A rim of aegirine-augite surrounds the wollastonite on its first appearance, caused by a reaction between the wollastonite and the basaltic magma. Amygdales originally filled with calcite constitute the third class. These have been altered to anhydrous calc-silicate assemblages of larnite, rankinite and wollastonite which form concentric monominer-alic zones decreasing in Ca/Si outwards. The hornfelsed basalt around the amygdales has had its composition altered by the loss of Si and, at a late stage, of Mg and Al and has gained principally Ca. In places, melilite has replaced the amygdale walls and, near the amygdales, the basalt is unusually rich in augite. Metamorphosed 'amygdales' consisting largely of ferromagnesian minerals (hypersthene, olivine, hornblende) are also present and are attributed by Cann (1965) to the infilling of vesicles or voids in partly formed amygdales during the metamorphism.

Conclusions

The 'S Airde Beinn plug caused distinctive, high-temperature alteration of the surrounding basalt lavas. Three zones of thermal alteration have been recognized in the basalts and their amygdales, on the basis of mineralogy and petrography. The formation of the calc-silicate minerals larnite and rankinite provides particularly compelling evidence for high temperatures in the aureole and there has also been reaction between the basalt lavas and the marginal dolerite at the edge of the plug. This plug, in common with others in Mull and Morvern, probably acted as a long-lived feeder for lava flows since removed by erosion. It was intruded at the same time as dykes cutting the lavas.

References



(Figure 5.11) A view of 'S Airde Beinn from the south. 'S Airde Beinn site, Mull. (Photo: CJ. MacFadyen.)

Mull Memoir (Bailey *et al.*, 1924)	Beckinsale *et al.* (1978)	Morrison (1978) Thompson *et al.* (1982) Morrison *et al.* (1985) Thompson *et al.* (1986)
Central Group (= NPCMT) (Includes pillow lavas in central complex)	Not dealt with in detail	Some samples analysed, all zeolitized or hydrothermally altered.
Plateau Group (majority = PMT) Pale Group of Ben More (= PMT) (with interlayered mugearite and Big-Feldspar Basalt)	Group 1 olivine basalts (mainly sampled in north-west Mull) and Group 3 olivine basalts (mainly sampled around Lochaline, Morven)	Mull Plateau Group (MPG) Note that many are transitional between alkali basalt and tholeiite, and compare closely with Skye Main Lava Series. Some lower crust contamination.
(Staffa Type at base = NPCMT)	Group 2 of south-west Mull	Staffa Magma Type (SMT) Variably enriched in lower and upper crustal contaminants.

(NPCMT = Non-Porphyritic Central Magma Type) later = tholeiitic basalt
(PMT = Plateau Magma Type) later = alkali olivine basalt but many flows are in fact transitional between alkali basalt and tholeiite
Total thickness of Mull lavas estimated about 2000 m (Bailey *et al.*, 1924)

(Table 5.2) Classification and correlation of the Mull lavas