Ben Hiant

OS Grid Reference: NM547623

Highlights

The steep slopes of Ben Hiant provide an excellent cross-section of volcanic vents filled with agglomerate, ash and pitchstone lavas. The vent rocks are cut by large basic intrusions of complex origins.

Introduction

The geological interest of Ben Hiant and the neighbouring hills of Beinn na h-Urchrach and Stallachan Dubha lies in the well developed assemblage of volcanic vents, associated lavas and major basic intrusions which are part of the early Centre 1 of the Ardnamurchan complex. The Ben Hiant quartz-dolerite mass and vent agglomerates dominate the geology of the site and thin remnants of the earlier lava plateau of this region are also well represented (Figures 4.2 and 4.3).

Early research in Ardnamurchan centred largely around the Ben Hiant area (Judd, 1874, 1886, 1890 and Geikie, 1888, 1897), but the significance and complexity of the area was not revealed until the work of Richey and Thomas (1930) and Richey (1938). Subsequently, little research specifically related to the area has been published, although samples from Ben Hiant have been used in a petrological study of doleritic intrusions within the Ardnamurchan complex by Gribble (1974) and in an investigation of the radiometric ages of the rocks in the complex by Mitchell and Reen (1973). In addition, the need for a reassessment of the status of Centre 1 has been suggested by Green and Wright (1969, 1974).

Description

The eastern slopes of Ben Hiant (Figure 4.2) to the north and south-west of Bourblaige (NM 547 623) expose the most representative remnants of the early lava plateau which has been mostly obliterated by the central complex. The lavas are either non-porphyritic or microphyric, alkali-olivine basalts containing alkali-rich pegmatoid patches in which analcite and alkali feldspar are present, together with augite zoned to aegirine augite. Several thin flows can be distinguished which commonly exhibit spheroidal weathering.

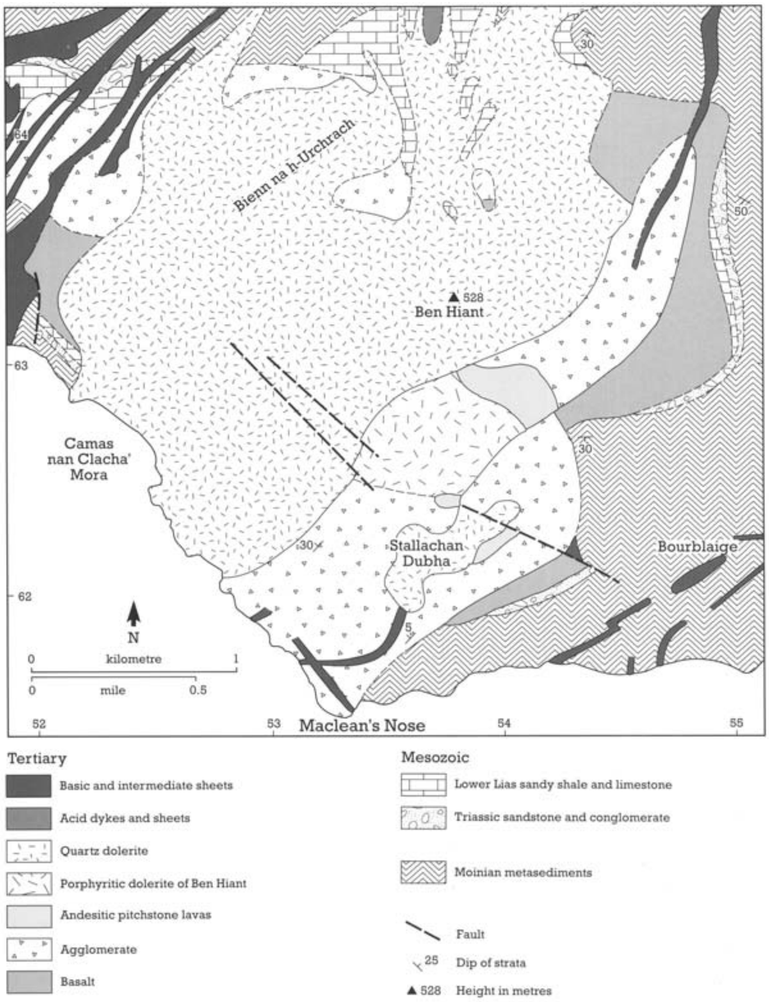

Figure 4.2: Geological map of the Ben Hiant site (after Gribble, 1976)

In two places, the base of the lava sequence rests upon a basal mudstone of a similar nature to sediments beneath the Mull lavas (Bailey *et al*., 1924). This deposit is underlain by Triassic sediments, themselves unconformably overlying Moine schists.

Two vents, infilled with agglomerates, tuffs, crater lavas and two major dolerite intrusions, cut through the remnants of the lava plateau and the underlying country rocks; they form the high terrain of Ben Hiant and Beinn na h-Urchrach. The volcaniclastic material within the vents consists of fragments up to 0.3 m in diameter and larger volcanic bombs several metres across. These deposits are both bedded and unbedded. The fragments are predominantly of trachytes and porphyritic basalt lavas, but acid and rare fine-grained basaltic rock types also occur. Clasts of Moine country rock contribute to the agglomerate near to the vent margins.

The well known exposures at Maclean's Nose (NM 533 616) show a sharply defined and near-vertical vent margin. Here the agglomerate contains several beds of tuffaceous material composed of comminuted basic rock, plus crystals of quartz and mica likely to have been derived from Moine schists. Large basaltic blocks have close petrological affinities to the adjacent lavas and appear to have fallen into the vent from the walls of the crater.

In the south-eastern vent, lavas are intercalated with the volcaniclastic rocks. The most noteworthy is a suite of andesitic pitchstone lavas seen at three localities, which are considered to have been erupted within a caldera. At least three flows interbedded with thin tuffs are recognized, each showing a triple-tiered structure comprising a slaggy amygdaloidal lava top overlying a layer of lava with small, subhorizontal columns and passing downwards into a layer characterized by larger vertical columns; such a flow structure is typical of lavas which have cooled slowly. There is some evidence in the pitchstone lavas to suggest at least limited auto-intrusion not dissimilar to that found in the pitchstone of the Sgurr of Eigg (see above). The rocks are relatively fresh, dark-brown to black in colour with a fine-grained or glassy texture. Microphenocrysts of augite–ferroaugite, pigeonite–ferrous pigeonite (Emeleus *et al.*, 1971) and labradorite occur in a groundmass which shows different degrees of devitrification and consists of acid glass, oligoclase microlites, rare orthopyroxene and accessory iron–titanium oxides and apatite. The chemistry of the pitchstones is andesitic (being more basic than the Sgurr of Eigg flow); they were termed augite andesites or inninmoreites by Richey and Thomas (1930) and are similar to rocks now termed icelandites (Carmichael, 1964).

Within the Ben Hiant vents there are two major dolerite intrusions. The smaller is a roughly circular mass of porphyritic dolerite intruded into the agglomerates and pitchstone lavas of the south-east vent, to the south of Ben Hiant. This dolerite is cut by the later Ben Hiant Intrusion which contains a large xenolith of the porphyritic dolerite to the north of the Ben Hiant summit. A similar rock type, characterized by large, conspicuous labradorite/bytownite phenocrysts (up to 15 mm in length), forms the escarpment of Glas Bheinn (NM 495 648) near Kilchoan and is perhaps related in origin. The contacts of the porphyritic dolerite with the andesitic pitchstone lavas are of particular interest since the earlier, but not the later, lavas show contact alteration suggesting that intrusion of the dolerite was contemporaneous with the infilling of the vent.

The larger intrusion of Ben Hiant forms the hills of Ben Hiant, Beinn na h-Urchrach and Stallachan Dubha and reaches the coast at Camas nan Clacha' Mora (NM 524 626). The mass consists of a number of varieties of quartz dolerite and of less common olivine dolerite, all having strong tholeiitic characteristics. The intrusion is best described as a non-porphyritic, ophitic dolerite; however, larger crystals of altered olivine, augite, ilmenite and labradorite do occasionally occur. A mass of columnar-jointed variolitic rock, probably formed by chilling at the upper contact, overlies and grades into normal dolerite to the south-west of the Ben Hiant summit. Labradorite microphenocrysts lie in a typically feathery-textured, variolitic groundmass of acicular augite, magnetite and oligoclase/andesine feldspar. Rare glomeroporphyritic aggregates of augite and labradorite also occur. The margins of the Ben Hiant intrusion contain xenoliths of basic volcanic rocks and of schist; where the latter have suffered partial melting, hybrid rocks are in evidence.

Minor intrusions are scattered throughout the site and include basic and composite dykes and intermediate cone-sheets.

Interpretation

Vent deposits in eastern Ardnamurchan around Ben Hiant, and those outside the site forming an arcuate belt from Camphouse to Kilmory, represent the first manifestations of centralized volcanic activity in the region after the extrusion of the plateau lavas. The vents appear to be of a much later date than the lavas since they contain material of a very different composition and acidic vent lavas, interstratified with agglomerate and ash, are significantly different from the crater lavas on Mull. The two vents of Ben Hiant were probably active for a prolonged period, during which explosive activity predominated and plateau basalts were not erupted; the products of this activity infilling enormous craters (Richey and Thomas, 1930). As the greatest height of the vent deposits is now over 300 m above sea-level, Richey and Thomas have argued that the crater walls were at least this high; this assumes that there has been no tectonic uplift of the deposits. Where the vent margins are exposed in the Ben Hiant area, there is usually remarkably little brecciation of the country rock which is difficult to reconcile with vents characterized by violent explosive activity; the breccias may be partly the products of debris avalanches off the walls.

The form of the Ben Hiant Intrusion is of particular interest and uniqueness. Judd (1890) erroneously interpreted the terrace- or scarp-like topographic features of the south-eastern parts of the outcrop as a succession of lava flows but Geikie (1888) correctly concluded that the dolerite was intrusive (Figure 4.3). He speculated that the intrusion has the form of a suite of coalescing sills, an interpretation also favoured by Gribble (1974). Richey and Thomas (1930) interpreted the north-western part of the intrusion, which overlies agglomerate, as a lateral off shoot extending from a lower mass with vertical contacts, while the south-eastern margin was considered to be formed by a suite of sheets which coalesced to form a single intrusion. The sheets dip at angles slightly less than those shown by the Centre 1 cone-sheets with which they share a similar composition. The intrusion is therefore suggested to be a mushroom-shaped body in part and also an assemblage of coalesced sheets. The rocks which form the successive terraces vary slightly in chemistry (Gribble, 1974; Gribble *et al*., 1976) and modal mineralogy (Gribble *et al*., 1976, confirming Judd, 1890). Gribble (1974) has argued that the intrusion is not a single homogeneous body and it is possible that several pulses of magma were responsible for the intrusion, the problems that it poses not yet having been resolved.

Figure 4.3: Ben Hiant from the east, showing terracing developed along the location of minor intrusions. The headland to the left is Maclean's Nose, formed by volcanic breccias. Ben Hiant site. (Photo: C.H. Emeleus.)

In comparison with the other major late dolerites of Ardnamurchan (Richey and Thomas, 1930; Skelhorn and Elwell, 1966; Holland and Brown, 1972; Gribble, 1974), those of Ben Hiant are distinctly tholeiitic, showing only slight iron-enrichment trends. Gribble (1974) suggested that the magma which formed the Ben Hiant Intrusion was the parental magma for all the rocks of Centre 1 and the source from which the rocks of Centre 2 and 3 were ultimately derived having a composition similar to the non-porphyritic Central Magma Type of Bailey *et al*. (1924).

Conclusions

Early explosive volcanic activity and limited lava effusion produced the vents of Ben Hiant and eastern Ardnamurchan which represent the first manifestations of the central complex. A significant repose period had intervened between this activity and the earlier eruption of plateau basalts. The vents were active for a prolonged period and were later intruded by doleritic and quartz gabbro masses and the largest of these, the Ben Hiant Intrusion, is probably largely a mass of coalesced cone-sheets. The magma which formed this intrusion may have been parental to all the rocks in Centre 1 and compositionally similar to the parent magmas for the intrusions in Centres 2 and 3.

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