St Kilda

OS Grid Reference: NA100000

Highlights

The exposures on St Kilda show hybrid rocks in which chilled, lobate, pillow-like masses of basalt in acid matrices provide convincing demonstrations of the coexistence of acid and basic magmas. At Glen Bay, a gabbro body has been most unusually chilled to a glass at its margin. Cliffs in east Hirta show some of the most spectacularly exposed cone-sheets in the BTVP.

Introduction

Relict fragments of a Tertiary central complex form the St Kilda group of rocky islets about 80 km west of Harris, Outer Hebrides. Profound erosion has left only a small proportion of the complex above sea-level and the exposed rocks are entirely intrusive. It is likely, however, that Lewisian gneisses are present offshore. A group of early, layered gabbros dominates the site; they are cut by a mixed (acid and basic) magma complex which is in turn intruded by a granophyre, forming the last major intrusion. A number of dolerite and felsite dykes and cone-sheets cut the plutonic rocks.

The islands were visited by MacCulloch (1819) who recognized the presence of basic and acid rocks. Ross (1884) showed that acid rocks veined the basic intrusions and therefore considered them to be younger. Geikie (1897) described the rock types and compared them with those of the Hebridean Tertiary central complexes. Cockburn (1935) published the first detailed map and account of the geology of St Kilda and recognized several subdivisions to the mafic rocks. Wager described relationships which he interpreted as indicating that basic magma had chilled against acid magma (Wager and Bailey, 1953; Fig. 7.4). The most detailed modern investigations of the geology have been those of Harding (1966, 1967), who made a particular study of the relationships between the acid and basic rocks which display a number of unusual features better represented on St Kilda than elsewhere. In 1979 and 1980 the islands were remapped by the British Geological Survey and the results of this research, and the accompanying 1:25 000 map, have been published (Harding *et al.*, 1984). The igneous sequence is summarized in Table 7.1.

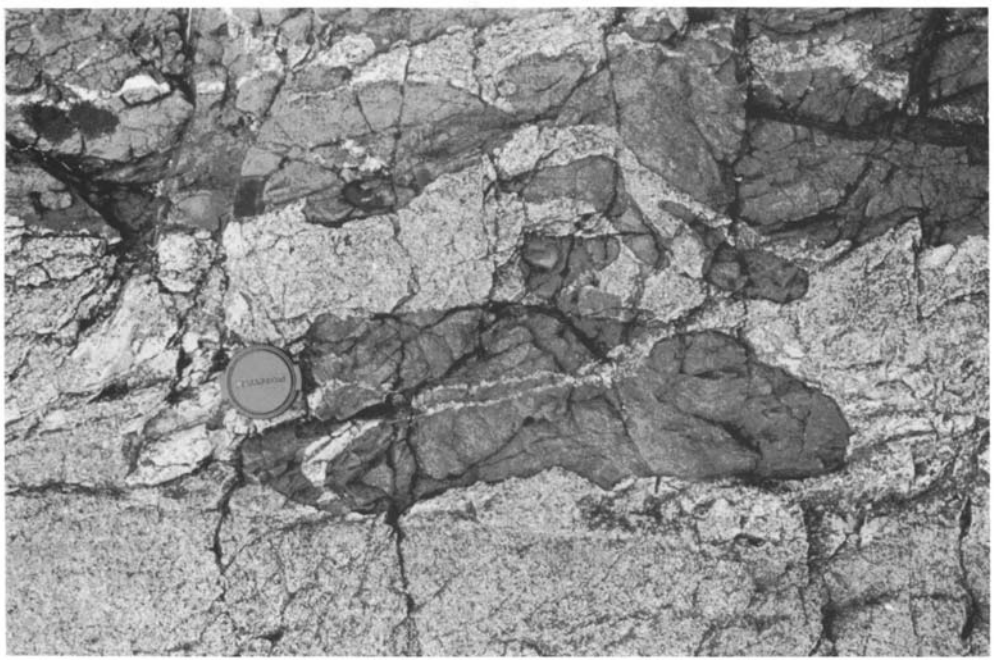

Figure 7.4: 'Pillows' of basic rock in a granitic matrix. Probably due to the simultaneous intrusion of granitic and basaltic liquids; an example of 'mixed magmas'. South end of Hirta, near Dun, St Kilda. (Photo: H. Armstrong.)

Description

The islands of the St Kilda group comprise St Kilda or Hirta, Dun, Soay, Borery and surrounding stacks, and Levenish (Fig. 7.5). Of these, all but Hirta and Dun are virtually inaccessible and appear to be made up of breccias of gabbro and dolerite cut by a few composite felsite–dolerite sheets. The geology of Hirta and Dun is, however, more varied (Table 7.1). The earliest intrusion was the Western Gabbro, which is a layered intrusion forming the western edges of the two islands. The layering, which is a reflection of varying modal proportions of mafic minerals (principally olivine Fo65–75 and diopsidic augite;Harding *et al*., 1984) and plagioclase, dips towards a focus c. 2 km ENE of Hirta. The gabbro also contains minor orthopyroxene, amphibole, spinel and iron–titanium oxides. This gabbro appears to have been sheared and crushed and then veined by numerous sheets of basalt and dolerite on the west cliffs of the Cambir *(c.* NF 075 101). Similar breccias of gabbro in finer-grained basic sheets form the outlying islands and north Hirta and all have been grouped as a separate unit (Harding *et al*., 1984). The Glen Bay Gabbro intrudes and is chilled against the basic breccias. The chilled contact on the east of Glen Bay is most unusual since there is complete textural gradation from a 10 mm border zone of splintery, glassy basalt to gabbro exposed on the east side of the bay. Fine, vertical banding occurs in the marginal zone parallel to the contact and the effects of chilling are estimated to extend for 100–120 m into the gabbro (Harding *et al*., 1984, p. 12). Gabbro on the west of the bay is much sheared and granulated and is separated from the eastern outcrops by the oldest granite on Hirta, the Glen Bay granite. This granite is chilled against the earlier gabbro and, like the gabbro, shows signs of fragmentation. The next intrusive phase involved four pulses of mixed basic and acid magmas which formed the Mullach Sgar Complex between Glen Bay and Village Bay (Fig.7.5). This group of rocks includes dolerite, microdiorite, microgranite and rocks of hybrid (mixed dolerite and granite) aspect. Angular and lobate masses of marginally chilled basic rocks occur in more acid matrices and are veined by felsic material (cf. Fig.7.4); a large amount of shattering of the dolerite and basalt has occurred, giving areas of complex net-veining (cf. Ardnamurchan Point to Sanna). Although extremely complex in detail, Harding *et al*. (1984) suggest that initial intrusions of basaltic magma were followed successively by granitic magma and further basalt. The final major intrusion is the Conachair Granite which forms the high ground north-east of Village Bay. This granite intrudes the Mullach Sgar Complex without notable chilling along the contact. The granite typically contains quartz, turbid, perthitic alkali feldspar and albitic plagioclase, with minor amounts of biotite and amphibole. Other accessory minerals include zircon, sphene, rutile, anatase, Ti-magnetite, fluorite and needle-like, deep-brown crystals of the rare-earth-bearing silicate chevkinite. The Conachair Granite characteristically has a microgranitic texture often with a considerable content of granophyrically intergrown quartz and feldspar. Some of the larger quartz crystals are interpreted as corroded, inverted high-temperature quartz. Radiometric age determinations on this granite give a date of c. 55 Ma, indicating a Palaeocene age.

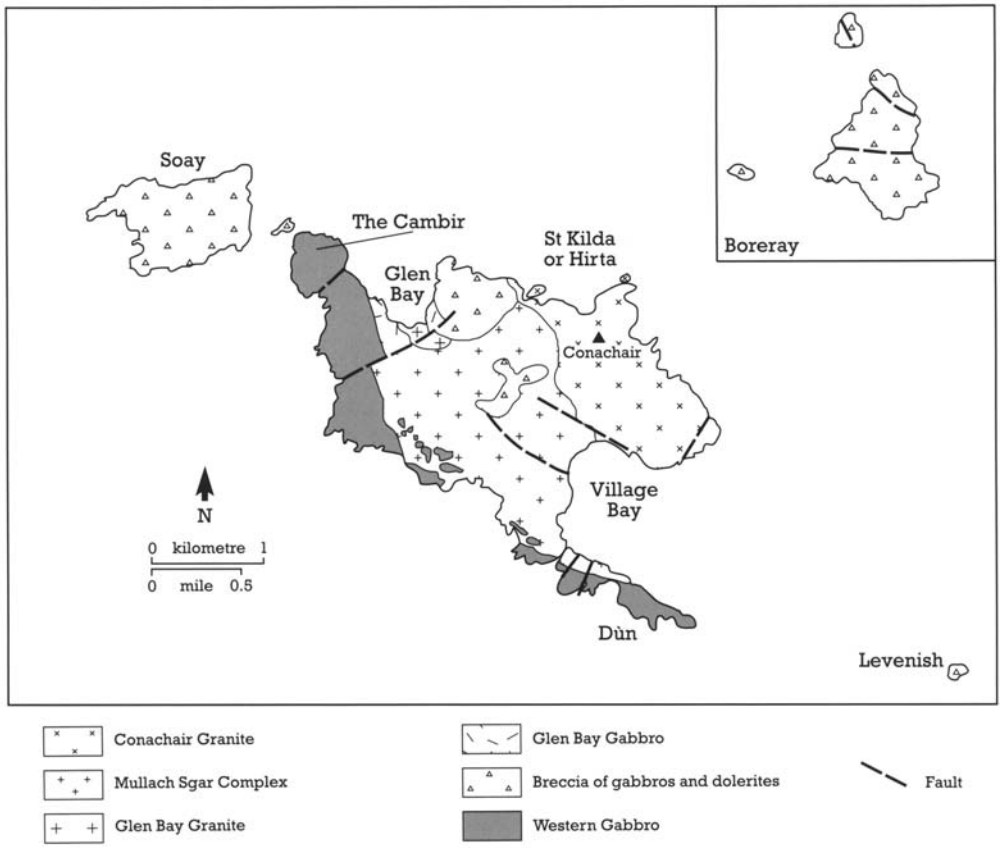

Figure 7.5: Geological map of the St Kilda archipelago (adapted from the British Geological Survey 1:25 000 Special Sheet, St Kilda)

Several generations of minor intrusions with compositions ranging from basalt to rhyolite have been recognized (Cockburn, 1935; Harding *et al.*, 1984). Frequently these are inclined sheets (Harding *et al.*, 1984, figs 24c and 25c) whose disposition suggests that they once formed a classic cone-sheet complex. Many of the inclined sheets cut the Conachair granite and are therefore the latest intrusions in St Kilda.

Interpretation

St Kilda is formed from the remains of a central complex of Palaeocene age which is situated towards the margin of the European continental shelf where it is probably emplaced into Lewisian gneisses. The earliest intrusions were coarse, layered gabbros which subsequently became crushed and shattered and were then intruded by a multiplicity of dolerite and basalt sheets and veins. Some of these must have been emplaced prior to complete solidification of the earlier, very variable-textured gabbros. The distinctly later Glen Bay gabbro is most unusual among the gabbroic intrusions of the BTVP in possessing a glassy, chilled-margin which gradually grades into normal gabbro. Presumably the intrusion was emplaced into cold, solidified, earlier gabbro which itself had a high-melting point and was possibly effectively anhydrous. Normally, BTVP gabbros have complex contacts with earlier, relatively low-melting point acid rocks (cf. Rum, Harris Bay; Skye, Coire Uaigneich), or are not conspicuously chilled against other mafic bodies. This occurrence would appear to be unique in the Province.

The Mullach Sgar Complex provides a superb example of the coexistence of acid and basic magmas and their near simultaneous intrusion. Evidence for mixed basic and acid magmas occurs elsewhere in the Province (cf. Ardnamurchan Point to Sanna; Arran, Ard Bheinn and Drumadoon–Tormore; Skye, Marsco and Mheall a' Mhaoil, Kilchrist and Rubha' an Eirannaich; Mull, Cruach Choireadail, Allt Molach–Beinn Chàisgidle and Loch Bà–Ben More), but the pillowed exposures of chilled basaltic rocks in unchilled felsic matrices are exceptionally fine. The early recognition of their significance by Wager and Bailey (1953) has been crucial in elucidating some of the more puzzling field relationships within the Province, particularly where limited outcrops suggest that acid rocks veining and brecciating dolerite or gabbro are

significantly younger than the mafic rocks, yet the broader relationships clearly show that this is not the case (cf. Rum, Harris Bay). The pervasive shattering of many of the St Kilda gabbros and dolerites is a striking feature of the complex and suggests that explosive release of water may have occurred towards the end of their solidification, followed by rapid injection of quickly cooled basaltic magma. It is also possible that the highly unusual glassy, quenched contact of the Glen Bay Gabbro may owe its origin to high-temperature, hydrothermal quenching.

Conclusions

An early layered gabbro intrusion forms much of the islands of theSt Kilda archipelago. On Hirta and Dun, and to a lesser extent elsewhere, it underwent penetrative shattering and brecciation which may have been caused by explosive release of water as it completed crystallization. A further gabbro intrusion was quenched to a glassy rock against the breccias and itself intruded by granite. Basaltic and granitic magmas coexisted at this stage and the next intrusion consisted of several pulses of mixed basic and acid magmas. The last major intrusion, following soon after the mixed magma bodies, was a major body of granite in the east of Hirta. A final phase of basalt intrusion gave rise to a suite of cone-sheets which focuses to the north-east of Hirta.

Reference list

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