Glen Bay Gabbro - St. Kilda: an illustrated account of the geology

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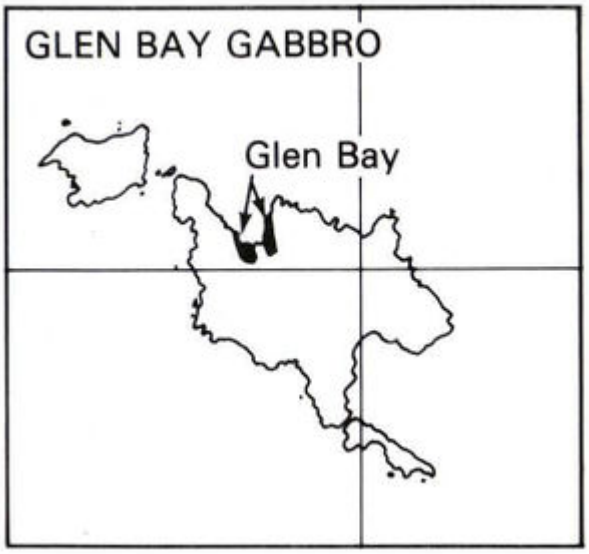

Map 4 Glen Bay Gabbro

Figure 12 Vertical banding in the eastern part of the Glen Bay Gabbro. Plagioclase bands up to 20 mm across alternate with darker bands in which pyroxenes and opaque minerals are concentrated.

Figure 13A Chilled margin of the Glen Bay Gabbro. Xenocrysts of plagioclase and olivine lie in a groundmass of plagioclase, pyroxene and opaque minerals. Both xenocrysts are rounded and corroded; the plagioclase has provided a nucleus for the growth of more sodic plagioclase (pale rim), and pyroxene has nucleated on the olivine. (S64879A), 150m south of tunnel at Gob na h-Airde; cross polarised light; area shown represents 4 mm across.

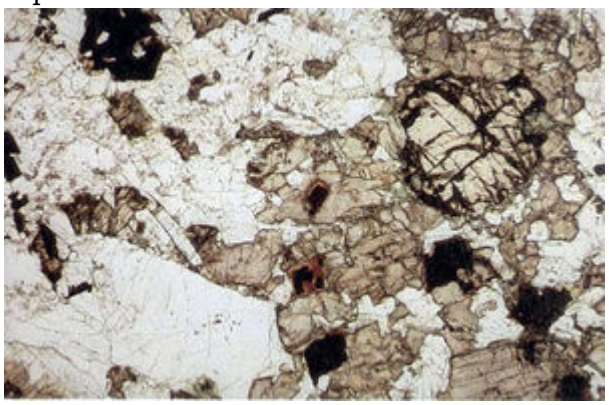

Figure 13B Gabbro consisting largely of plagioclase (2 mm long), rounded olivine enclosed in a mass of smaller pyroxenes (pale brown) and opaque minerals. Brown biotite mantles some of the opaque grains and prismatic apatite lies adjacent to the subhedral plagioclase. 565208, 300 m south of tunnel at Gob na h-Airde; plane-polarised light.

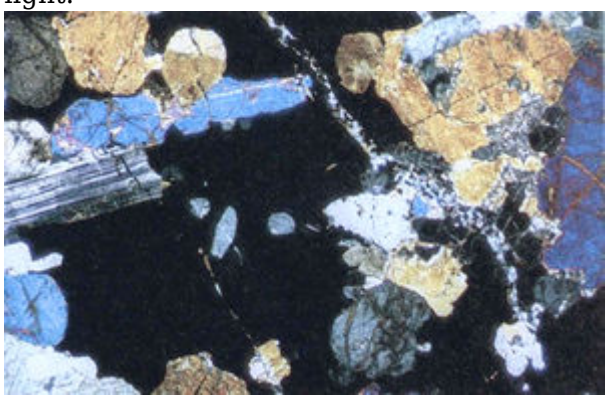

Figure 13C Gabbro rich in magnetite, ilmenite (opaque) and augite pyroxene (blue and yellow interference colours). Apatite is abundant as inclusions (grey) in the opaque minerals and its hexagonal (dark) outlines are visible next to pyroxene. Sinuous lines of crushed material penetrate the rock. Although this comes from an isolated block on Mullach Sgar, it is the same as some facies of the gabbro on the western side of Glen Bay. (S68268), cross-polarised light.

Chapter 7 Glen Bay Gabbro EG

Keywords: chilled margin, vertical banding, shearing, mineral analysis

On the rock shelves at the west side of Glen Bay there is abundant exposure of the Glen Bay Gabbro and of its contact with the Glen Bay Granite. Here the contact trends north-south and is steeply dipping although exposures of granite at the top of the rock shelves and others partly covered by glacial deposits indicate that the boundary is irregular and not predictable over any distance. The western contact of the Glen Bay Gabbro with the Western Gabbro is largely covered by hill slope deposits although at its northern end it is vertical, and in some prominent crags to the south, coarse and unchilled gabbro veins cut sheared Western Gabbro. The contact of the Gabbro with the Glen Bay Granite is extensively sheared by Granite veins in the gabbro and the finer grain size of the Granite at its margin clearly indicate that it is the younger intrusion. The Granite has split the gabbro into western and eastern outcrops. In the western part of the Gabbro concentrations of feldspar or of pyroxene and magnetite form impersistent bands or flattened lenses with a steep easterly dip. This type of banding was not seen on the eastern side but, in contrast, 100 m north of the outfall of Abhainn a Ghlinne Mhor there is a zone of vertical rhythmic banding about 3 m wide which consists of feldspathic bands alternating with ferromagnesian bands, each about 5 mm thick (Figure 12). these are sinuous and impersistent but in general strike north-south, and are parallel to the inferred contact of the gabbro with the breccia of Glacan Mor. At its eastern contact, south of the tunnel at Gob na h-Airde, the Gabbro is a splintery black glassy basalt with sparse phenocrysts of plagioclase and olivine and some small rounded inclusions of dolerite. Between this point and the coarse gabbro to the south, there is a gradation in grain size from basaltic dolerite through dolerite to gabbro. The attitude of the contact and the fine vertical banding indicate a vertical zone of chilling extending over a width of 100–120 m. The Gabbro is cut by small pegmatitic veins and pods of inconsistent attitude and by north-east-trending dykes of dolerite and microgranite (the Glen Bay Dykes) similar to Mullach Sgar Complex rocks. These indicate that the Gabbro predates the Complex. An isolated block of magnetite-gabbro similar to some lenses in the western part of the Gabbro (Figure 13C), occurs on Mullach Sgar and constitutes further evidence that the Complex developed after the Gabbro.

The chilled margin of the Gabbro is glassy for a width of 10 mm, and contains xenocrysts of plagioclase and olivine up to 3 mm long and inclusions of foreign gabbro and dolerite. At distances of 5 to 45 m from the margin, xenocrysts up to 4 mm long lie in a groundmass of plagioclase, olivine, calcium-rich and calcium-poor pyroxenes, opaques, quartz and apatite in a size range of 0.05–0.35 mm (Figure 13A). In the banded gabbro feldspars in the light bands commonly reach 7 mm in length but the pyroxenes and opaques in the dark bands average only 1 mm. The pyroxenes in the Gabbro between the chilled margin and the banding are generally subhedral with variable clustering or clotting (Figure 13B), but west of the banded rock inclusion of plagioclase crystals is a feature of the calcium-rich pyroxenes and a subophitic to ophitic texture in the rock is more pronounced. Plagioclase crystals in the groundmass have cores of $An_{55}Ab_{45}$ and exhibit a simple normal zoning pattern to $An_{30}Ab_{70}$. Some larger crystals have corroded cores and complex zoning patterns, and they resemble grains from some Western Gabbros so closely that these seem a likely source. A few augite grains with compositions similar to those in the Western Gabbro are also present but unlike the feldspars they appear to have been more susceptible to alteration in the gabbroic magma so that only skeletal 'blebby' relics remain. The augite of the Glen Bay Gabbro differs from the xenocrysts in showing slight pleochroism and variably developed exsolution of Ca-poor pyroxene lamellae along both 100 and 001 directions in the crystal. Chemical analyses indicate that the Gabbro contains 2.6% TiO_2 and most of this is present as ilmenite. It is invariably associated with magnetite either in irregularly shaped masses or in acicular grains. Some titanium also occurs in biotite which commonly mantles grains of magnetite and ilmenite (Figure 13B), and in titanite (sphene), another

alteration product associated with shear planes. Sparse, large olivine grains are zoned from $Fo_{60}Fa_{40}$ at their cores to $Fo_{30}Fa_{70}$ at the rims, and the rim compositions correspond with those of the smaller groundmass olivines which vary between $Fo_{30}Fa_{70}$ and $Fo_{25}Fa_{75}$. Olivine constitutes between 1 and 2% of the rock, a low but consistent presence also shown by quartz and alkali feldspar which occur in sporadic patches throughout the rock and represent crystallisation of the last residues of liquid. Apatite varies in abundance and has recrystallised over a range of temperatures in a number of different crystal habits. Near the gabbro margin it occurs as long needles; these are joined more than 30 m from the margin by crystals of stumpy prismatic habit, and west of the banded gabbro irregularly-shaped interstitial grains also appear.

In contrast to the relatively undisturbed nature of the gabbro of east Glen Bay, the gabbro on the western rock shelves is very sheared and granulated. A few lenses however retain the original igneous texture and some exhibit mineral lamination broadly coplanar with the bands which dip at 60° to the east. Apart from the absence of fresh olivine the constituent minerals are the same as those of the eastern part of the Gabbro, although the proportion of calcic amphibole (ferroedenite), biotite, chlorite and albite developed at the expense of the original minerals is much greater. In addition to mineralogical changes, the main textural difference in the shear zones is that large crystals have been broken into smaller domains and this has resulted in a fine-grained mortar texture.

Chemically, the Glen Bay Gabbro is richer in TiO_2, K_2O, P_2O_5 and rare earth elements than are earlier gabbros and dolerites on St Kilda (E^W, D and EK), and it almost certainly has a different source. It marks a separate stage in the evolution of the St Kilda volcanic centre and may represent part of a magma chamber developed at a relatively high level in the earth's crust. One way of explaining the unusually thick chilled margin of the Gabbro is by postulating that a large block or segment of cold gabbro-dolerite breccia (EK) collapsed into such a magma chamber, following perhaps a particularly violent surface eruption.

Chemical analysis: Glen Bay Gabbro. Mean of 5 analyses

Major elements Oxide wt %		Minor elements (ppm)	
SiO_2	50.4	Li	7
TiO_2	2.6	F	550
$A1_2O_3$	13.4	S	650
Fe_2O_3	3.4	V	340
FeO	12.2	Cr	25
MnO	0.3	Co	52
MgO	4.2	Ni	16
CaO	7.9	Cu	24
Na_2O	3.7	Zn	160
K_2O	0.9	Rb	20
H_2O+110	0.5	Sr	250
H_2O-110	0.1	Y	54
P_2O_5	0.4	Zr	265
	100.0	Nb	30
		Ba	590
		Pb	15

* Analyses by members of BGS Analytical Chemistry Unit,
• Laboratory of the Government Chemist, and R. R. Harding

References

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