Qui Ness to Pund Stacks

[HP 622 032]–[HP 622 035]

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Introduction

The site presents a readily accessible view of the upper metagabbro, the highest exposed level of the pseudo-stratigraphy of the Shetland Ophiolite, within the Lower Nappe on the east side of Unst. It is bound to the east by a continuously exposed low-lying cliff section lying within the upper metagabbro. The site extends to the west for nearly a kilometre to include xeno lithic screens of wehrlite–clinopyroxenite marking the boundary between the lower metagabbro layer and the upper metagabbro layer; it also includes the western limit of a swarm of basic 'sheeted dyke'-like intrusions (Flinn, 1996). The coastal section provides very good exposures of the latter and shows their relationship to rhythmic banding, minor fine-grained gabbroic intrusions, hornblende pegmatites, quartz-albite ('plagiogranite') veins and lamprophyres, all characteristic of the upper metagabbro layer. The 'sheeted dyke'-like intrusions, although normal to the present erosion surface, are emplaced obliquely to both the petrological and geophysical Mohos and to the metadunite and lower metagabbro layers underlying them (Flinn, 1996). In the Gass (1980) model, hitherto used to represent the Shetland Ophiolite (Gass *et al.,* 1982; Prichard, 1985), the dykes are shown as normal to the underlying layers.

Description

The boundary between the lower metagabbro layer and the upper metagabbro layer is not as clearly or sharply defined as the boundary between the lower metagabbro layer and the underlying metadunite layer (see Skeo Taing to Clugan GCR site). Along the east side of Unst it is marked by a discontinuous string of wehrlite–clinopyroxenite screens, lithologically indistinguishable from those above and below the metadunite–lower metagabbro contact, the geophysical Moho. The geological relationships are summarized in (Figure 2.10).

The upper metagabbro layer is composed of a poorly contrasted assemblage of metagabbro, fine-grained metagabbro and 'sheeted-dyke'-like metabasic sheets, all subject to phyllitization and phacoidal shearing which tend to destroy lithological boundaries and to reduce the contrast between lithologies. The rocks of the upper metagabbro differ from the lower metagabbro in several respects: amphibole, where it occurs, is generally green rather than colourless and has feathery instead of granular grain boundaries; the plagioclase is commonly sodic and fresh or partly fresh instead of saussuritized; opaque grains with leucoxene/titanite rims are common.

Rhythmic banding occurs locally in the upper metagabbro, where it is texturally similar to the lower metagabbro, but it is of much more variable nature and band thickness than that seen in the lower metagabbro. Thin clinopyroxenitic bands occur locally but the greatest difference is seen at Qui Ness where there are several clearly defined bands of leucogabbro about 1 m thick.

The fine-grained metagabbros occur inextricably intermixed with coarser lower-metagabbro-like rock but, due to similar lithology and phyllitization, they are particularly difficult to distinguish from the metabasic sheets. The latter are best displayed at Pund Stacks (Figure 2.11), although they can be seen intermittently along the coast for 3 km to the north of that locality. Inland, the sheets are much more difficult to detect than on the coast due to lichen cover and generally poorer exposure. At most, the sheets occupy no more than 50% by volume of the outcrop. They are nearly vertical, have north to north-easterly strikes and are less than half a metre wide, discontinuous, and separated by narrow screens of host rock. They are oblique to any rhythmic banding developed in the host rock. None of the sheets cut the wehrlite–clinopyroxenite screens marking the western boundary of the upper metagabbro layer, even where these are well exposed, but west of the upper metagabbro boundary sheets do occur in the gaps between the screens, for example around [HP 610 030].

The 'sheeted' dykes are invariably very fine-grained, highly altered by hydration, and often phyllitized so that chilled margins and rarely preserved traces of doleritic or basaltic texture are all that remain of their original state. The dykes range in composition from boninite to dacite. Due to the presence of groups of parallel sheets of slightly different strike it is possible, in places, to determine an order of emplacement from intersection relationships. Those dykes with chilled margins, poorly preserved traces of doleritic or basaltic texture or extreme fine grain were the last to be emplaced. The first emplaced tend to be darker coloured and to have a more northerly strike than general. Many of these early dykes also have a vertical penetrative schistosity, about 20° clockwise relative to their strike, which results in lenticular dismemberment. This makes them particularly difficult to distinguish from the similarly schistose and lenticularized fine-grained metagabbro components of the upper metagabbro.

Minor components of the upper metagabbro are hornblende pegmatite, lamprophyre and small quartz-albite ('plagiogranite') veins of hydrothermal or pegmatitic appearance. Elsewhere 'plagiogranite' occurs in the form of albite-granite (locally with granophyric texture) or quartz-albite porphyry. Pegmatites containing brown hornblende and altered plagioclase occur as very minor, irregular bodies in the area of (Figure 2.10), although larger examples are found elsewhere. The lamprophyres can be seen in places along the coast forming more prominent, continuous sheets than those forming the metabasic, quasi-sheeted-dyke complex.

Interpretation

The upper metagabbro layer has been previously interpreted as the roof region of a high-level magma chamber at a constructive plate margin (Gass *et al.,* 1982; Prichard, 1985). Underplated gabbro was held to have been intruded by fine-grained gabbro and late felsic differentiates, such as hornblende pegmatites and 'plagiogranite'. The presence of swarms of basic sheets was considered to indicate a passage into an overlying sheeted-dyke layer. This formed the roof to the magma chamber, underlying the sea floor, and was either removed tectonically during obduction or was subsequently eroded. However, in terms of this model, it is difficult to explain the presence of xenolithic masses of wehrlite–clinopyroxenite in both the upper metagabbro and across the boundary between the base of the lower metagabbro and the top of the metadunite layer. These occurrences suggest that the metadunite and the metagabbro layers are separate intrusive bodies and not successive cumulate products of crystallization in a magma chamber as proposed previously.

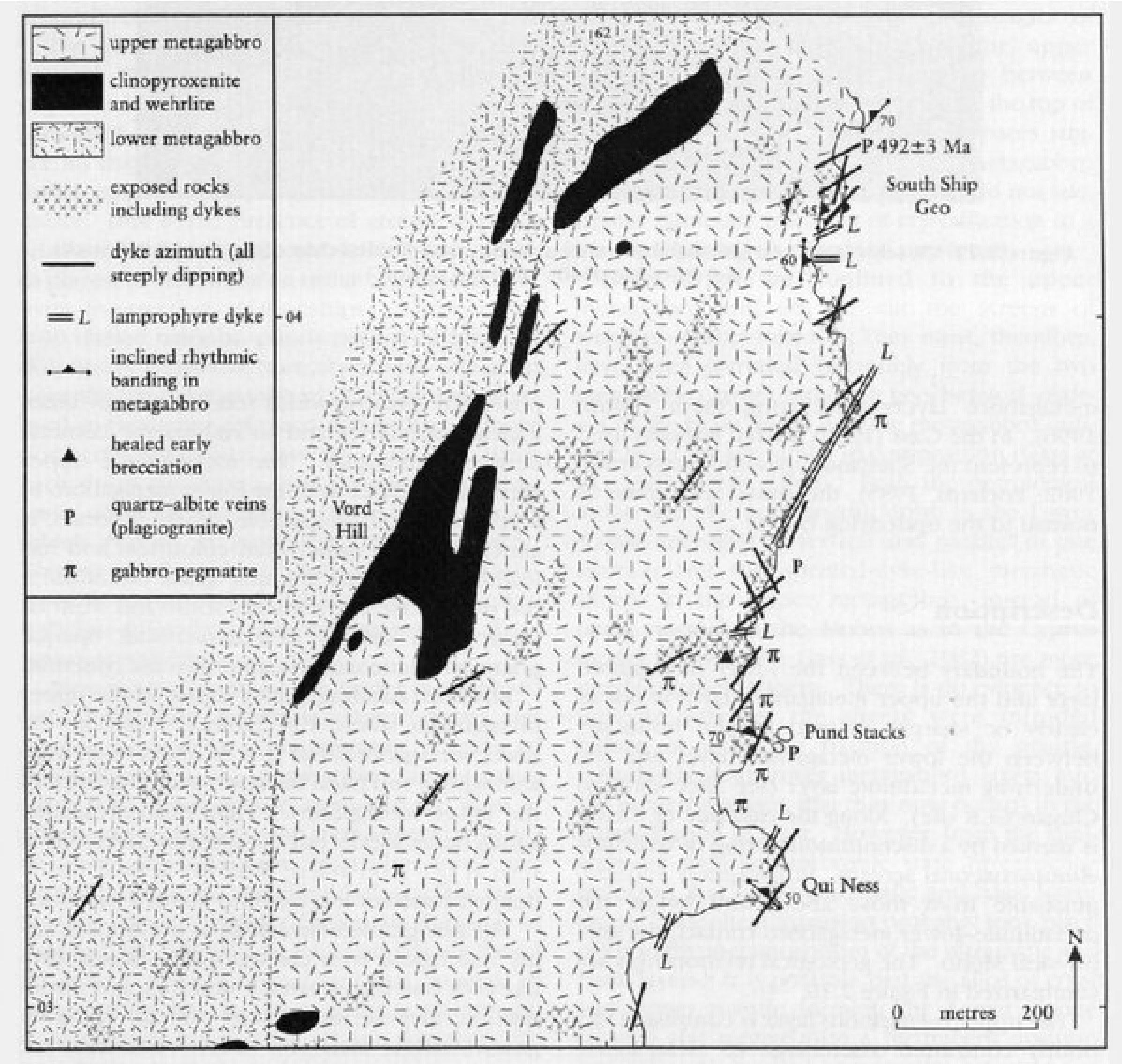
Basic dykes are confined to the upper metagabbro and do not cut the screens of wehrlite–clinopyroxenite. They must, therefore, have been intruded separately from the two metagabbro layers, although geochemical analyses of the basic sheets and the metagabbro indicate that they are similar in composition (Gass *et al.,* 1982; Spray, 1988). Both the petrological Moho and the geophysical Moho in the Lower Nappe are steep to vertical and parallel to one another but the sheeted-dyke-like metabasic sheets in the upper metagabbro, instead of being normal to the Mohos as in the Cyprus model (Gass, 1980; Gass *et al.,* 1982) are more nearly parallel to them. There is no evidence to indicate whether the sheets were intruded before or after the rotation of the mantle, metadunite and lower metagabbro layers into the vertical position that they now occupy in the Lower Nappe in Unst. However, from the similarity of their metamorphic state (greenschist facies) to that of the ultramafic and basic lower layers, basic-sheet intrusion probably took place prior to the metamorphism of the ultramafic and basic layers. It is possible that the slice of crust and upper mantle forming the Lower Nappe slipped and rotated into a recumbent position on a listric fault at the constructive margin prior to the intrusion of the dykes.

Spray and Dunning (1991) obtained a U-Pb age of 492 ± 3 Ma from zircons extracted from a quartz-albite 'plagiogranite' vein at South Ship Geo (Figure 2.10). They considered that the vein was formed at high temperature, before the greenschist facies hydration of the metagabbro, whereas Flinn considers that it is a dacitic sheeted dyke. Either way, the zircon age obtained must be close to the age of formation of the ophiolite. This age is very close to that obtained from the Virva GCR site for the obduction of the Upper Nappe.

Conclusions

This site provides an easily accessible continuous section through the upper metagabbro and quasi-sheeted-dyke complex forming the uppermost exposed level in the Shetland Ophiolite. It reveals the lithologically and structurally complex nature of this layer and its separation from the underlying lower metagabbro by xenolithic screens of wehrlite–clinopyroxenite. This example of ophiolitic-sheeted dykes is the clearest and most extensive available in Britain.

[References](#)



(Figure 2.10) Map of the Qui Ness area, Unst.

(Figure 2.11) Closely spaced, parallel metabasic sheets of the quasi-sheeted-dyke complex at Pund Stacks, Unst [HP 6218 0340]. (Photo: D. Flinn.)