HILL OF BARRA

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OS Grid Reference: NJ803257

Introduction

Olivine-rich ultramafic rocks believed to represent the Lower Zone of the 'Younger Basic' layered sequence can be recognized in both the Belhelvie and Insch intrusions, but natural exposures are generally very poor because the rocks are heavily serpentinized. However, Hill of Barra, at the eastern end of the Insch intrusion, is exceptional in forming a positive topographic feature and in providing relatively good exposures, despite the degree of serpentinization (Gould, 1997) (Figure 3.5).

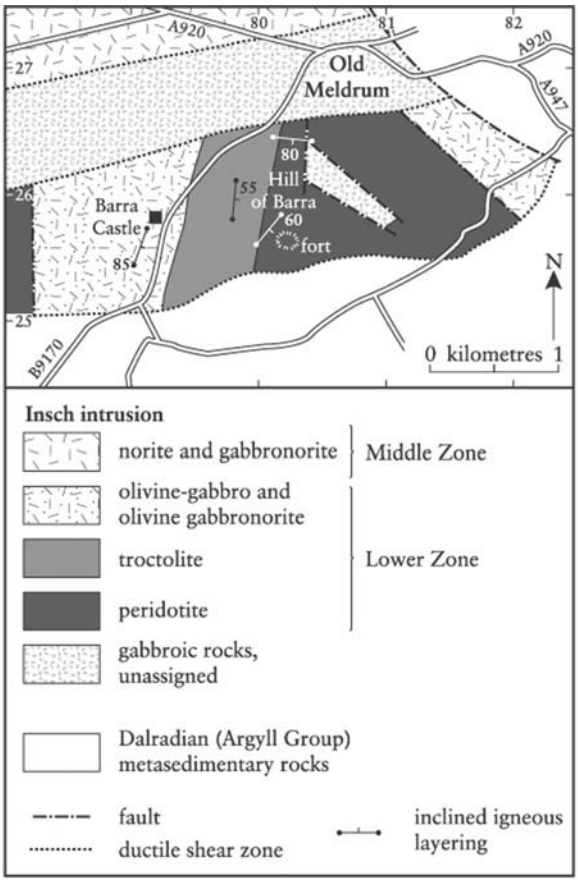

Figure 3.5: Geological map of the area around the Hill of Barra GCR site, Insch intrusion, from Ashcroft and Munro (1978) and BGS 1:10 000 sheets NJ72NE (1989) and NJ82NW (1989).

In terms of the original layered sequence, the Hill of Barra peridotites are referred to the basal subdivision of the Lower Zone (LZa) as defined byWadsworth (1982) and are classified as olivine cumulates. Although the eastern end of the Insch intrusion is structurally complicated, geophysical evidence (mainly magnetic anomalies) and borehole sampling have shown that there is a relatively continuous sequence from LZa peridotites (olivine cumulates), to LZb troctolites (plagioclase-olivine cumulates) and LZc norites (plagioclase-orthopyroxene-olivine cumulates) along the southern edge of the intrusion, between Old Meldrum and Cuttlecraigs (, 1978). In this segment, the succession appears to 'young' from east to west, with the observed layered structures mostly striking approximately N–S and generally dipping steeply eastwards, indicating that the rocks have been overturned (Figure 3.5). An apparently identical sequence of Lower Zone cumulates has been described from the Belhelvie intrusion (Wadsworth, 1991).

Description

The principal outcrops on Hill of Barra form the west-facing ramparts of an ancient fort. They comprise dark-weathering serpentinized peridotite, which displays fairly well-developed jointing; one set of joints dips steeply eastwards, and another set steeply westwards. There is also evidence of very faint compositional layering, which appears to be the result of slight variations in the amount of interstitial feldspar in the original cumulate. This rudimentary layering is dipping at angles between 50° and 60° towards the ESE, approximately parallel to the eastward-dipping joints. The upper slopes of Hill of Barra are also littered with blocks of layered peridotite and troctolite. The freshly exposed rock surfaces are dominated by dull-black serpentinized olivine, but scattered poikilitic crystals of intercumulus pyroxene can be discerned, and at least a trace of interstitial plagioclase (now substantially altered to secondary minerals), can be seen on weathered surfaces, since it is slightly more resistant to weathering than the serpentine. The plagioclase content may approach 10% by volume in the relatively feldspathic layers. Westwards from Hill of Barra, towards Barra Castle, plagioclase gradually increases in abundance, and eventually occurs as cumulus grains, giving rise to the troctolitic (plagioclase-olivine) cumulates of LZb.

Although the ultramafic rocks of LZa are heavily serpentinized, remnants of fresh olivine occur locally and have compositions in the range of $Fo_{87–86}$ (Wadsworth, 1991). The serpentine forms a distinctive mesh-structure, and is associated with granular aggregates and stringers of magnetite. The intercumulus pyroxene generally occurs as large poikilitic crystals, and although augite is the most obvious variety of pyroxene, because it is relatively unaltered, orthopyroxene has also been recorded. The original intercumulus plagioclase has been almost entirely replaced by turbid, isotropic material, possibly hydrogrossular, but rare patches with relict multiple twinning can be distinguished. The plagioclase composition is rather variable, but is generally in the bytownite–labradorite range. Corona structures are sometimes developed at the contact between original olivine and plagioclase, and these consist typically of a zone of granular orthopyroxene, immediately adjacent to the olivine, surrounded by a zone of fibrous amphibole in symplectic intergrowth with turbid isotropic material (probably altered feldspar). These coronas are believed to be the result of reaction between olivine and plagioclase under metamorphic conditions (Mongkoltip and Ashworth, 1983).

Interpretation

The significance of the ultramafic rocks at the eastern end of the Insch intrusion as the most primitive members of an extreme fractionation series (culminating in the ‘syenitic' rock compositions found farther west; see the Hill of Johnston GCR site report), was first recognized by Read, Sadashivaiah and Haq (1961). They interpreted the layered peridotites and troctolites as basal cumulates, formed by gravitative differentiation of gabbroic magma, and recognized that the original sub-horizontal layering has been thoroughly disturbed by subsequent tectonic events. The cumulate theme was

developed and refined by Clarke and Wadsworth (1970), who recognized that the Hill of Barra peridotites are olivine cumulates, and that cumulus plagioclase and pyroxenes (both clinopyroxene and orthopyroxene) only appear higher in the succession (i.e. farther west) to give rise to cumulate troctolites and gabbros. A more detailed structural study of the eastern end of the Insch intrusion by Ashcroft and Munro (1978) identified a number of separate fault blocks of LZ cumulates, with the Hill of Barra rocks forming part of a steeply dipping cumulate sequence, younging from east to west, and locally overturned. It is on this basis that the Hill of Barra rocks are referred to LZa of the complete layered sequence (Wadsworth, 1982, 1991). It is now thought that these ultramafic cumulates are not the same as, or even closely related to, the serpentinized peridotites found along the southern margin of the Insch–Boganclogh intrusion (see the Creag Dearg GCR site report).

Conclusions

The rocks of the Hill of Barra GCR site are typical of the layered ultramafic unit found in the ‘Younger Basic' masses (Insch and Belhelvie), and believed to represent the early-formed olivine-rich cumulates. The original peridotite has been highly serpentinized, but there is some evidence of rudimentary layering, dipping steeply eastwards and indicating considerable post-

depositional tectonic disturbance. Exposures of these ultramafic rocks are generally very poor; this highlights the significance of the western slopes of Hill of Barra, which provide relatively good outcrops.

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