HILL OF CREAGDEARG

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OS Grid Reference: NJ453259

Introduction

In addition to the main cumulate fractionation sequence of the 'Younger Basic' intrusions, as seen in the Insch, Belhelvie and Huntly intrusions, there are other igneous rocks that are spatially associated with the cumulates and may be genetically related to them. These are particularly characteristic of the western end of the Insch intrusion and of the Boganclogh intrusion, which is the westward continuation of the Insch intrusion (Busrewil *et al.*, 1973; Gould, 1997). The Boganclogh area contains three principal igneous rock types: a northern strip of ferrodiorites, a central region of quartz-biotite norites, and a southern belt of heavily serpentinized ultramafic rocks (Figure 3.2). The ferrodiorites are broadly equivalent to the Insch Upper Zone; the quartz-biotite norites are also represented in the Insch mass, but are very poorly exposed there; serpentinites occur sporadically along the western part of the southern margin of the Insch mass (Read, 1956), but reach their maximum development in the Boganclogh area (Blyth, 1969).

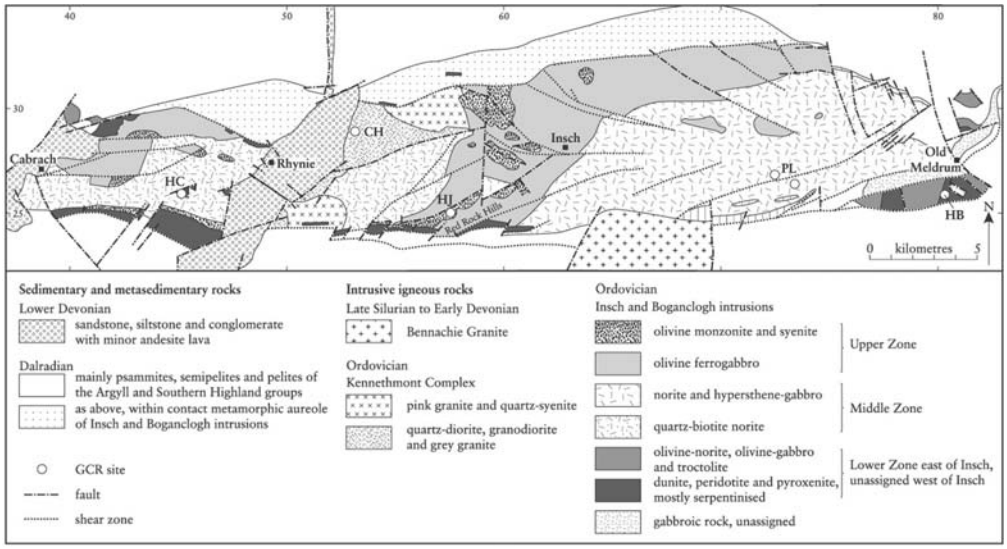

Figure 3.2: Map of the Insch, Boganclogh and Kennethmont intrusions, adapted from Gould (1997). GCR sites: CH Craig Hall; HB Hill of Barra; HC Hill of Craigdearg; HJ Hill of Johnston; PL Pitscurry and Legatesden quarries.

The central belt of quartz-biotite norites at Boganclogh contains smaller areas of the other components. Two such areas occur at Hill of Creagdearg and at nearby Red Craig (Figure 3.13). In each case, well-exposed ultramafic rocks (peridotites) with an unusually high proportion of fresh olivine, are surrounded by typical quartz-biotite norites. The names of the two hills are derived from the characteristic reddish-brown colour of the weathered surfaces of the peridotite (Figure 3.14) which stand out in marked contrast to the grey-weathering norites.

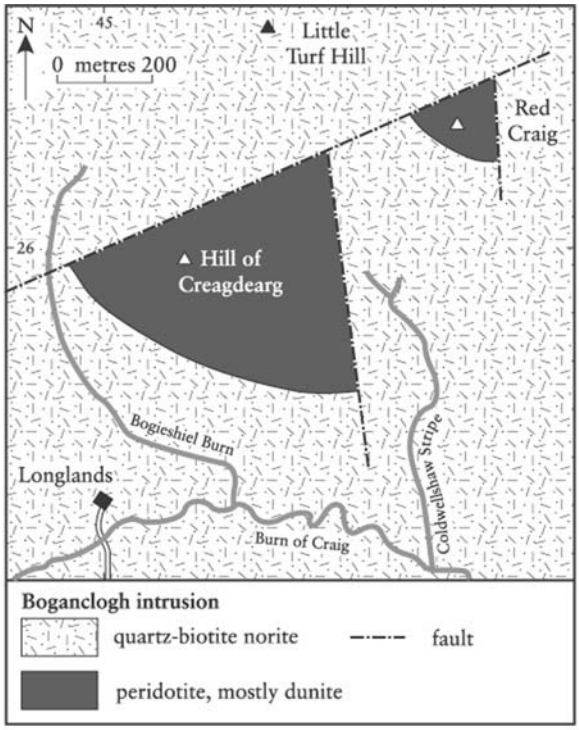

Figure 3.13: Map of the Hill of Creagdearg and Red Craig area, Boganclogh intrusion, from BGS 1:10 000 sheets NJ42NW (1991) and NJ42NE (1991).

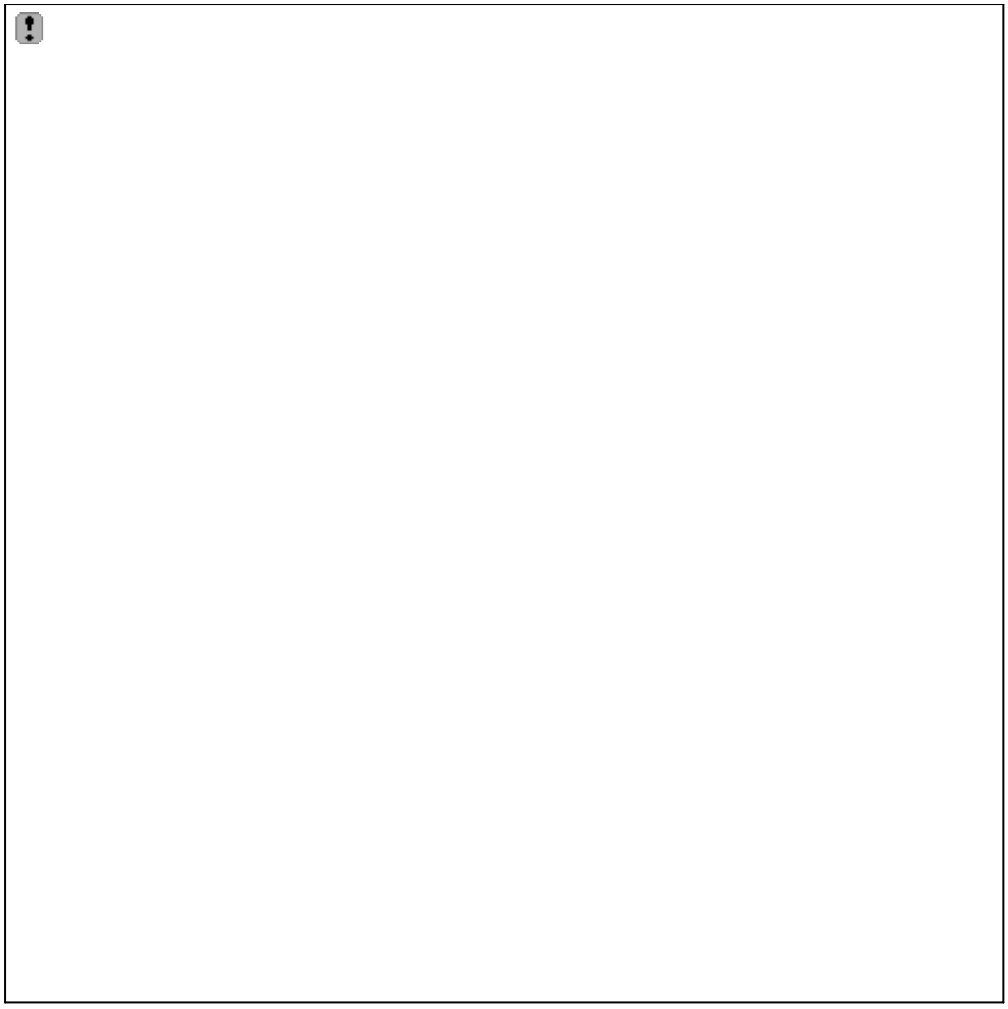

Figure 3.14: Fresh peridotite (dunite) with brown-weathering crust, Red Craig, Boganclogh intrusion. (Photo: BGS no. D4532.)

Description

The two areas of peridotite (Hill of Creagdearg and Red Craig) can be clearly delineated, because of the excellent exposure and the obvious colour contrast between the main rock types in the field. The northern and eastern margins of both peridotites appear to be steep and faulted, but towards the SW the junction with the norites is believed to be gently dipping and is probably an original igneous contact (Gould, 1997). Despite this, there is no unambiguous evidence of relative age. The peridotites appear to be totally unaffected in proximity to the norites, and there is no evidence of inclusions or veining of one rock type by the other. The only hint of age relationships is a slight reduction of grain size in the quartz-biotite norite towards its contact with peridotite, although this is not very pronounced and may be unrelated to marginal chilling, since the norite shows considerable variations in grain size throughout its outcrop.

The peridotites appear to be essentially massive and structureless in the field, with no evidence of small-scale layering such as is seen in the Insch Lower Zone cumulates at the Hill of Barra GCR site. They consist of a high proportion (80 to 95%) of olivine, together with minor spinel and scattered orthopyroxene crystals. The degree of serpentinization is variable, but in general these rocks are remarkably fresh compared with the ultramafic rocks along the southern margin of the Insch–Boganclogh mass.

In thin section, the olivine crystals average approximately 2 mm in length, with polygonal boundaries showing 120° angles at triple junctions. The spinel is chromite, with translucent red-brown margins, and occurs both within and between the olivine crystals. The orthopyroxene occurs as sparse grains, similar in size and shape to the olivines, and in places

displaying exsolution lamellae of augite. Olivine and orthopyroxene are altered to antigorite and bastite respectively. The olivine (Fo_{91}) and orthopyroxene (En_{91}) are significantly more magnesian than in the LZa cumulates at Insch or Belhelvie, where olivine is typically $Fo_{87\text{-}86}$.

The adjacent quartz-biotite norites are easily distinguished from the ultramafic rocks, not only by the grey colour of their weathered surfaces, but by the prominent sub-horizontal jointing, giving rise to distinctive ‘slabby', tor-like outcrops. The norites consist of plagioclase (An_{60}), augite ($Ca_{45}Mg_{37}Fe_{18}$), orthopyroxene (En_{55}), poikilitic biotite (up to 20% by volume), hornblende, and interstitial quartz (2 to 3% by volume). Ilmenite and magnetite are typically present and are sometimes accompanied by traces of pyrrhotite.

Interpretation

Although the quartz-biotite norite is clearly part of the ‘Younger Basic' magmatic spectrum, being represented in many of the individual intrusions, the status of the ultramafic rocks at Boganclogh is more contentious. From the detailed investigations of Blyth (1969), it is clear that the peridotites at Hill of Creagdearg and Red Craig are essentially part of the main ultramafic belt which lies along the southern margin of the Boganclogh intrusion, and extends eastwards as a series of discontinuous lenses along the southern edge of the Insch intrusion (Read, 1956). It is also clear that these ultramafic rocks are associated with major shear zones, and that the southern boundary of the Insch–Boganclogh mass is tectonic. This accounts for the highly serpentinized nature of these rocks generally, but inevitably tends to obscure evidence of their primary origin. For this reason, the relatively unserpentinized peridotites from Hill of Creagdearg and Red Craig are particularly significant.

Hinxman and Wilson (1890) suggested a possible correlation between the serpentinites of the southern marginal belt, and the broadly similar rocks at the eastern end of the Insch intrusion (now referred to as LZa cumulates). Both Read (1956) and Blyth (1969) discounted this correlation, emphasizing certain differences between the two ultramafic associations. Blyth, in particular, stressed the absence of any gradations to more gabbroic lithologies in the Boganclogh peridotites and serpentinites. However, neither Read nor Blyth speculated further about the source of the strongly tectonized serpentinites, except to imply that they came ‘from depth'.

Busrewil *et al.* (1973), on the other hand, believed that the mineralogical and textural evidence, especially from the Hill of Creagdearg peridotites, supports the link between the LZ cumulates and the marginal serpentinites. The olivine compositions, in particular, appear to show overlap between the two occurrences. However, more recent investigations have shown that the Hill of Creagdearg peridotites contain distinctly more magnesian olivines (Fo_{91}) than in the LZa cumulates ($Fo_{87\text{-}86}$). This, together with the lack of feldspar, and the absence of convincing cumulate textures, now re-inforce Blyth's view that the Boganclogh ultramafic rocks are not related to the cumulate succession. Further, the olivine (and orthopyroxene) compositions suggest a close connection with mantle peridotites, either in the form of tectonically emplaced mantle fragments, or as the early crystallization products of very primitive, mantle-derived, magma, which have subsequently been involved in major tectonic disturbance.

In this connection, it is of interest to note the occurrence of similar, highly magnesian olivines in the Succoth–Brown Hill intrusion (S–BH), to the NW of Boganclogh (Gunn *et al.*, 1996), although the crystallization sequence olivine–clinopyroxene–plagioclase at S–BH is in marked contrast to the early appearance of orthopyroxene in the Boganclogh peridotites, suggesting a fundamentally different, possibly more calc-alkaline magma (Styles, 1994). Like the southern margin of the Insch–Boganclogh mass, the S–BH intrusion is also associated with a major shear zone (within the Portsoy Lineament) and the latter is believed to indicate a significant magmatic event earlier than the ‘Younger Basic' intrusions. On this basis the S–BH intrusion, and possibly the Boganclogh ultramafic rocks, provide support for Read's original (1919) idea that two main episodes (‘Older' and ‘Younger') of basic magmatism are represented in NE Scotland.

The quartz-biotite norites are certainly part of the ‘Younger Basic' activity, and therefore are probably significantly younger than the peridotites at Hill of Creagdearg, although the age

relationships are not convincingly displayed in the field. The quartz-biotite norites are generally interpreted as samples of basic magma similar to the parental magma of the cumulate succession, but which crystallized under relatively hydrous conditions (Wadsworth, 1988). They probably represent in-situ crystallization without significant crystal settling.

Conclusions

The Hill of Creagdearg GCR site provides evidence of primitive mafic magma associated with a 'Younger Basic' intrusion. The unusually fresh peridotites are believed to be quite distinct from, and possibly older than, the olivine-rich Lower Zone cumulates of the 'Younger Basic' suite, found at the eastern end of the Insch intrusion and at Belhelvie. Associated with the peridotites are quartz-biotite norites which are a significant component of the 'Younger Basic' activity in general, but are particularly widespread at Boganclogh.

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