B13 Polyphant

[SX 262 822]

Highlights

This is the type locality for the assemblage of mineralogically distinctive ultramafic and mafic rocks known as the Polyphant Complex. This complex continues to play a central role in interpretations of Variscan plate tectonics in this region.

Introduction

This site, just to the north-west of Polyphant village, includes the old Polyphant Quarry and the adjacent hillside outcrops to the south of the River Inny. The quarry was the type locality for the famous Polyphant stone', a highly altered talcose rock that has been used for ornamental carvings since the eleventh century.

The locality is representative of part of the Polyphant Complex which is composed of an association of ultramafics, gabbros and dolerites intruded into Upper Devonian slates of the Tredorn Nappe (Stewart, 1981).

Geological mapping of the Polyphant Complex shows it is a fault-bounded, NW–SE-extending, ultramafic body with a maximum exposure width of 0.5 km (Stewart, 1981). The actual form of the body is difficult to determine geophysically because it is within the steep gravity gradient of the Bodmin Moor Granite. However, interpretations by Chandler *et al.* (1984) indicate that it is, in fact, a thin slice, about 32 m thick, and not the exposed part of a major, deep-rooted intrusion.

The mineralogy and alteration of the Polyphant ultramafic body was described by Dewey (*in* Reid *et al.,* 1911) who noted the presence of brown amphibole, and also the close association of 'proterobases' (potassic alkaline metadolerites) containing a similar hydrated primary mineralogy. In the early literature these ultramafic rocks were called picrites, although in recent times they have been referred to as peridotites and, according to Chandler and Isaac (1982), they are dominated by lherzolitic compositions.

Unlike some of the other minor ultramafic–mafic associations (see Clicker Tor) the Polyphant Complex as a whole has assumed importance in the study of the tectonic development of central south-west England. According to a pre-thrusting reconstruction for this region and the tectonic model of Isaac *et al.* (1982), the complex was immediately below the Greystone Nappe assemblage which contains Lower Carboniferous lavas and intrusive dolerites with a MORB-type chemistry (Chandler and Isaac, 1982). The apparently close geological and temporal association of Upper Devonian ultramafics and Lower Carboniferous oceanic basalts leads to the suggestion that they were part of a dismembered ophiolite which originally represented a small, short-lived ocean or marginal basin (Chandler and Isaac, 1982; Isaac, 1985). However, according to Sel-wood and Thomas (1986b) the facies reconstruction does not imply the presence of an ocean basin, and the interpretation of the basic rocks as MORB by Chandler and Isaac (1982), based on chemical features such as Ti–Y–Zr distributions, is open to question (Floyd, unpublished data).

Description

Although most of the ultramafic rocks in the site are serpentinized to some degree, two main lithologies can be conveniently recognized and depend on the relative degree of the secondary alteration. On fresh faces in the old quarry, a variably foliated and highly altered, blue-grey metaperidotite composed of a serpentine–chlorite–talc–carbonate assemblage can be seen. Zones rich in granular magnetite have been oxidized to brown limonite (Figure 4.33). This extreme alteration has apparently developed only at the margins of the ultramafic body due to extensive shearing as it was thrust into place. Less-altered rocks, on the slopes just south of the River Inny, show a primary assemblage of abundant olivine (invariably replaced by serpentine and tremolite) enclosed within purplish clinopyoxene or brown amphibole; the latter of which often exhibits a reaction relationship with the pyroxene (Figure 4.34). Other primary

minerals include deep-red biotite, apatite and magnetite; no plagioclase appears to be present. Both the primary amphibole and biotite may be replaced by secondary tremolite and chlorite. Some of these rocks were layered cumulates, composed of mainly olivine and clinopyroxene with inter-cumulus hydrous fluids that subsequently crystallized amphibole and biotite. A fine banding can also be seen on some weathered surfaces. The Polyphant ultramafic rocks are mainly cumulates associated with basic intrusives that are unlikely to have formed part of a dismembered ophiolitic complex.

Interpretation

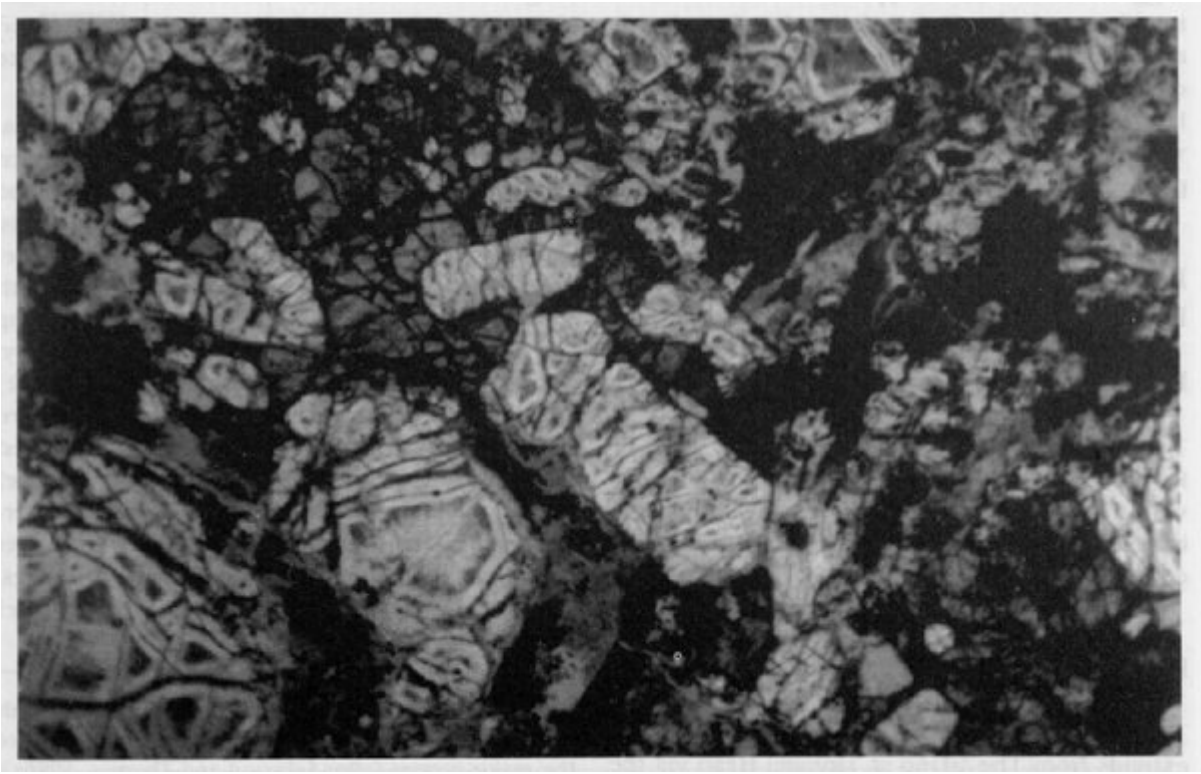
Apart from representing an example of the alteration of Variscan ultramafic rocks, the most interesting mineralogical feature at this site is the presence of primary hydrous phases. In this respect they resemble the so-called 'proterobases', or hydrous potassic suite of greenstones, in containing magmatic amphibole and biotite. The significance of the presence of similar hydrous phases could imply that the hydrous ultramafic Polyphant rocks represent the olivine + pyroxene-rich cumulates of a differentiated hydrous greenstone body. Although there are little supportive chemical data available, the Ni and Cr contents (unpublished data, Floyd, 1988) are comparable with cumulates genetically associated with layered or stratiform mafic–ultramafic bodies (Figure 4.4). The mineralogical and chemical evidence mentioned above is important in the light of some studies which interpret these rocks as part of a dismembered ophiolite complex (Chandler and Isaac, 1982). This seems unlikely on the available data and derives also from the misinterpretation of associated Lower Carboniferous lavas and intrusives as MORB – rather than intraplate alkali basalts.

Conclusions

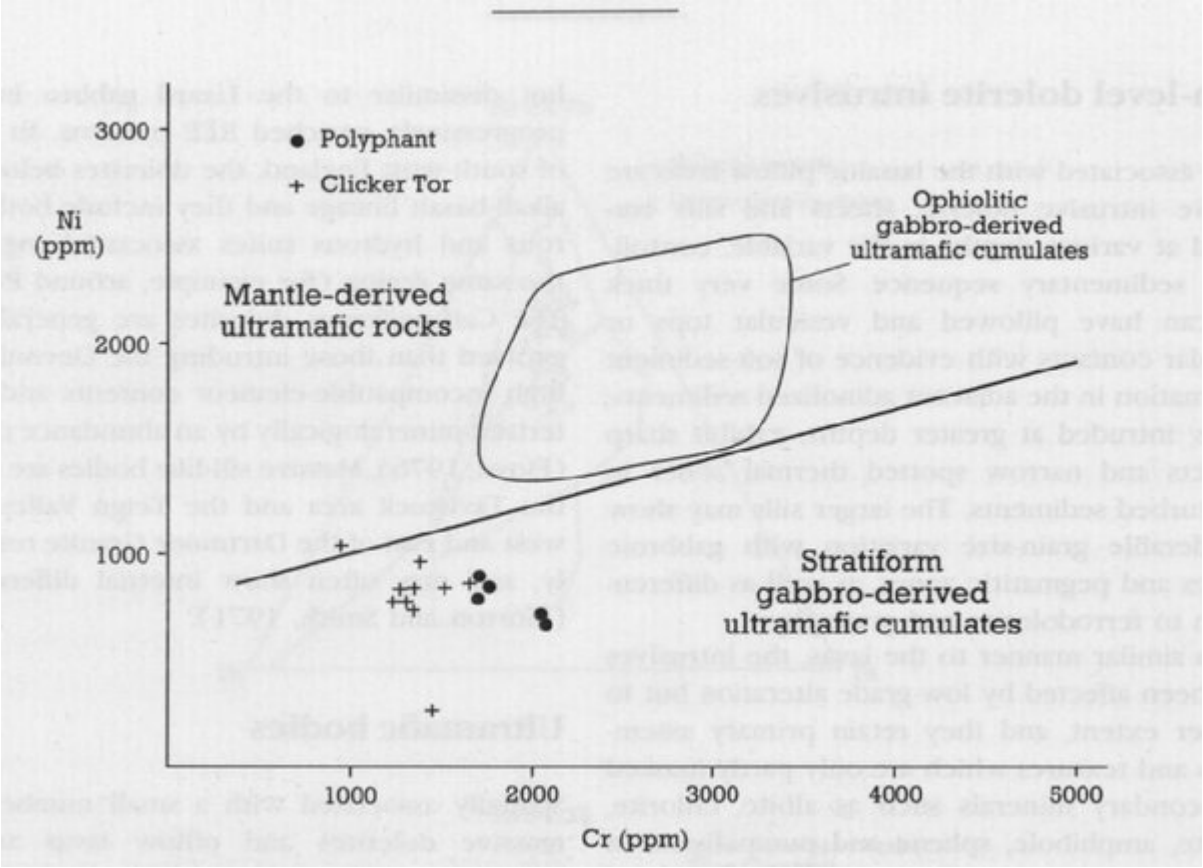
This locality exposes an 0.5-km-wide igneous sheet which, subsequent to its emplacement, has been fragmented and sliced by low-angled thrusts. The mass has been transported on one of these thrusts into its present position and thus detached from its original roots. The rock is ultramafic in composition, a variably serpentinized peridotite, containing primary olivine, clinopyroxene, amphibole, biotite, apatite and magnetite. The presence of water-bearing primary minerals (amphibole and biotite) distinguishes it from other south-west England peridotites such as in the Lizard Complex. Associated with the peridotite are gabbros and dolerites intruded into late Devonian slates. Below the Polyphant sheet is another thrust slice containing early Carboniferous volcanic rocks and intrusions, with a chemistry possibly akin to oceanic basalts. It was suggested that the Polyphant ultramafic rocks together with the Carboniferous basalt and sediments, represented a segment of ancient oceanic crust (ophiolite), now dismembered by thrusting. However, further work on the Carboniferous volcanics and sediments has led to their interpretation as oceanic crust being questioned.

References

(Figure 4.33) Weathering of the Polyphant ultramafic body (hydrous picrite) showing a core boulder of serpentinite within a highly oxidized, degraded matrix. Polyphant, Cornwall. (Photo: P.A. Floyd.)



(Figure 4.34) Photomicrograph of the Polyphant hydrous picrite, showing serpentinized olivine crystals, pyroxene and dark kaersutitic amphibole (top left). Polyphant, Cornwall. (Photo: P.A. Floyd.)



(Figure 4.4) Distribution of Ni and Cr in Variscan ultramafic bodies associated with dolerites and pillow lavas relative to ophiolitic and stratiform cumulates (boundaries from Figure 3.3).