A5 Coverack Cove–Dolor Point

[SW 784 187]–[SW 785 181]

Highlights

This is the best section through the contact between the peridotite and gabbro units; this contact is thought to be the Mohorovi■i■ discontinuity between the mantle and oceanic crust of the Lizard Complex.

Introduction

This has been a classic area of Lizard geology since the intrusive relations of the various rock types were described from here by Flett and Hill (1912). These authors demonstrated the intrusive sequence of peridotite, troctolite, gabbro and basic dykes, and produced several field sketches and a map to illustrate this. Green (1964a) showed that the peridotite was a mantle rock and thought that the gabbro was a later ring-intrusion following emplacement and uplift of the peridotite. The area became of great significance after ophiolite models for the Lizard had been proposed (Bromley, 1979; Kirby, 1979b; Styles and Kirby, 1980), as this was then considered to be the transition zone from the crust to the mantle, and thus represent the Moho. This was addressed particularly by Kirby (1979b), who studied the zone in detail and drew attention to the troctolites and associated rocks that are probably representative of a thin sequence of transition zone cumulates. Davies (1984) carried out a Sm/Nd isotope study of a gabbro sample from Coverack and produced a mineral–rock isochron that showed a crystallization age of 375 ± 34 Ma (mid-Devonian).

Description

The section at Coverack is a broad sweep of beach that is covered at high tide, but numerous, low, rounded, rocky outcrops are seen at low water (Figure 3.13). The magmatic stratigraphy consists of three main divisions, an ultrabasic division to the south, a central interbanded division and a northern gabbro division (Figure 3.13).

The ultrabasic division consists largely of the primary type peridotite, the tastite serpentine' of Flett and Hill (1912). The peridotites exposed here, particularly around Dolor Point, are some of the freshest on the Lizard, being only around 30% serpentinized in some cases. They are dark-green, coarse-grained rocks that consist largely of olivine with conspicuous orthopyroxene. Clinopyroxene is also present; its abundance varies from 5–10% . Thus there are both harzburgites and lherzolites, but they form part of a continuous spectrum and are not significantly different rock types. Many samples contain a brown chrome spinel and a few exhibit a small amount of plagioclase. The peridotites have a coarse subvertical foliation that trends roughly north-south. This is a high-temperature porphyroclastic texture that here, as in many other ophiolites, is ascribed to solid-state flow that occurred in the upper mantle beneath the spreading centre. Dunites occur as pods several metres in size around the west side of the harbour and also as a series of veins on the south side of Dolor Point. The dunites are conspicuous by their lack of orthopyroxene and reddish colour as the olivine is usually totally serpentinized. The origin of the dunites will be discussed in detail under 'Lankidden' below, but essentially they are thought to have been formed by the passage of picritic melts through the mantle.

At the northern part of this division, some 50 m north of the harbour, is the famous Coverack troctolite. This is a very distinctive rock com$_{7}$ posed of white plagioclase and red serpentinized olivine. Rarely, the olivine has survived alteration and then the rock is dark green and black and actually looks more like the gabbros than the 'typical' troctolite. Thin-section examination shows that many of the rocks are not true troctolites, as they contain more than 10% clinopyroxene and are, in fact, olivine gabbros, but they are still distinctly different from the main gabbro. The proportion of feldspar to mafics also varies substantially from 20 to 80% feldspar, although most have roughly equal proportions. The troctolite forms two sheet-like bodies, but it and the peridotite are cut by numerous sheets of pegmatitic gabbro and fine basic dykes. The intrusive sequence of these rocks is superbly displayed in the classic locality, close to the sea wall beneath the graveyard, described and figured by Flett and Hill (1912). Here it can be seen that the troctolite intrudes the peridotite (Figures 3.14 and 3.15), and is itself cross-cut by the gabbro sheets, and all three are intruded by the basic dykes.

The central division, some 200 m wide, consists of peridotite cut by numerous sheets of gabbro pegmatite. The thickness of these sheets varies from a few centimetres up to tens of metres. The thicker gabbro sheets tend to form the lower ground between the more prominent peridotite rocks. There are many small bodies of dunite within this area and, in the centre of the zone roughly in front of the store, is a much larger dunite body around 20 m in diameter (Figure 3.13). Many of these gabbro sheets are somewhat deformed and foliated, and, in several places, discrete high-temperature shear zones are seen with a streaky mylonitic fabric. Basaltic dykes are quite abundant, and at one location a dyke cuts through the shear zone, showing that magmatism continued after the onset of deformation.

The northern division is composed of gabbro with a few xenoliths of very altered peridotite and a few basic dykes. The peridotite blocks are all very altered being serpentinized and carbonated. Where the foliation can be seen, it varies from block to block, which contrasts with the very consistent N–S trend in the peridotites further south and implies that these blocks are detached xenoliths. The gabbro, generally referred to as the Crousa Gabbro, is a coarse-grained rock composed largely of plagioclase and augite with olivine, minor ilmenite, brown hornblende and rare biotite as primary constituents. When fresh, the gabbro is very dark coloured, almost black, as the feldspar is very dark purple in colour and thus can easily be mistaken for an ultrabasic rock. Many of the rocks have undergone some hydrothermal alteration which saussuritized the feldspar, turning it white and giving the rocks a typical mottled gabbro appearance. In many rocks, augite is partially or extensively altered to green hornblende. There are shear zones within the gabbro which have a NW–SE trend. At the northern end of the section, in the low cliffs and small outcrops sticking out through the beach boulders, two distinct generations of dykes can be seen. Early dykes have been pulled apart and broken up in the gabbro, whereas the late dykes have sharp planar margins, although even these are affected by late faults. There is a particularly good example at the northern end of the beach with distinct phenocryst-free, chilled margins. This dyke contains fresh olivine which is rare in dykes on the Lizard.

Interpretation

The principal interest of the site at Coverack is the excellent exposure of the transition from mantle to crust in an ophiolite sequence. It is not, however, a typical ophiolite succession, as the substantial cumulate sequence of dunites and pyroxenites separating the mantle peridotites from the gabbros, is missing. Such a sequence only seems to be present here as a very minor constituent represented by the dunites and troctolites. At this junction, but inland to the west, there is the Traboe cumulate complex which could represent a much thicker development (Leake and Styles, 1984). It does not reach the coast, but seems to be cut out laterally by the intrusion of the Crousa Gabbro, which is a later intrusion. The section at Coverack is therefore atypical for an ophiolite, due to the intrusion of later gabbro; possibly off-axis magmatism occurred as suggested by Badham and Kirby (1976). The chemistry of the gabbro was studied by Kirby (1979b), who showed that it was progressively fractionated when traced from south to north, with such features as Fe/Mg ratio and Ti and P contents increasing in that direction. The overall chemical features were consistent with it forming from a magma with MORB-type chemistry.

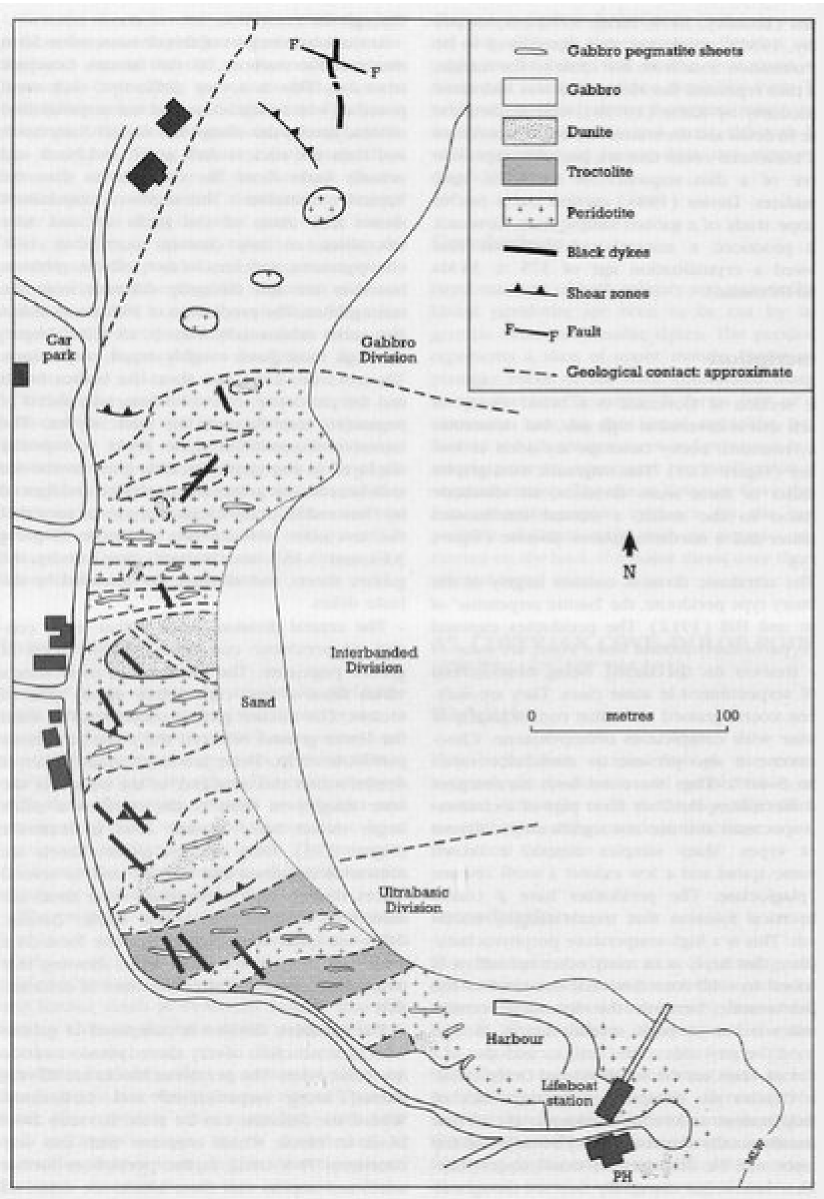
The basic dykes are an important part of the geological framework at Coverack, but as they form the main feature of the following Porthoustock site, they will be discussed in detail there. The chemistry of the dykes suggests that they are not derived from the same magma as the gabbro, that is, they are not cogenetic. The trace-element ratios of such elements as P, Zr, Y and Ti, V are distinctly different and show they are not derived from the same source. However, this is not surprising: there is field evidence that some dykes cut shear zones through the gabbro, showing a clear time gap between the two intrusive phases.

Overall, the site at Coverack is one of the most important on the Lizard; it shows clearly the intrusive relations and hence time-sequence of many of the main rock types. The difference in fabrics between the peridotites and gabbros shows they were deformed at different times, in totally different regimes. The peridotites have a pervasive porphyroclastic texture that is typical of that formed by solid state 'creep' in the mantle at very high temperatures, perhaps 1000°C. The gabbros, in contrast, have deformation in discrete shear zones with amphibolite-facies metamorphic assemblages showing temperatures of 500–600°C, formed after the gabbros had crystallized and cooled in the ocean crust. The section as a whole records the transition from mantle to crustal rocks in an oceanic-type sequence, a fossil Moho.

Conclusions

The dominant basic and ultrabasic rocks at this site represent a sequence or section through ancient oceanic lower crust and upper mantle respectively, and is thus equated with the oceanic crust–mantle boundary – the Mohorovi■i■ Discontinuity. The gabbro, with a radiometric age of around 370 million years before the present, represents the consolidation of a deep crustal magma chamber emplaced below a spreading ridge; a very different environment to many of the basic rocks in the rest of south-west England. Basaltic dykes cut both each other and the gabbros and peridotite, enabling a sequence of events to be determined for this part of the Lizard Complex.

[References](#)



(Figure 3.13) Geological sketch map of the Coverack site (A5).