A9 Mullion Island

[SW 660 175]

Highlights

The best-developed pillow lavas (submarine basalts of mid-ocean ridge type) in the Lizard area can be dated here by their association with fossiliferous cherts of Devonian age.

Introduction

Mullion Island is situated about 0.5 km southwest of Mullion Cove, off the west coast of the Lizard. It is one of the classic areas of Variscan greenstone and, although depicted on early nineteenth century maps of the region, little was known about the rocks and their association with the Lizard mainland. The morphology of the volcanics and their recognition as pillow lavas, together with their association with cherty sediments, were initially described by Fox (1893) and Fox and Teall (1893). Whereas basic volcanics and minor intrusives occur in the choatic Meneage Zone to the north of the Lizard Complex, Mullion Island was the best example of pillow lavas in the area, and possibly represented part of the same tectonic province faulted off from the Lizard (Flett, 1946). Modern ideas extend this view, whereby the lavas represent either a megaclast or a thrust slice incorporated within the tectonosedimentary *mélange* of southern Cornwall (Barnes and Andrews, 1981). Mullion Island thus forms part of the Roseland Breccia Formation (Holder and Leveridge, 1986) that incorporates all the *mélange* rocks within a thrust slice directly below the Lizard thrust segment.

A Frasnian age for the Mullion Island pillow lavas was reported by Hendricks *et al.* (1971) on the basis of conodonts extracted from the associated siliceous limestones. This is the same as the age of the *mélange* matrix of the Roseland Breccia Formation, which contains many basaltic clasts of generally similar chemistry to the Mullion Island pillow lavas (Floyd, 1984; Barnes, 1984).

Description

The site comprises the whole of the island and exposes about 30–35 m stratigraphical thickness of pillow lava (Figure 3.24). On the basis of the draping of pillows over each other and their interrelationships, the sequence is the correct 'way up'. The lava tubes are orientated approximate east–west, although in view of their likely disorientation during incorporation into the *mélange,* this cannot be used to infer the direction of lava flow. Most of the lavas are fractured and a number of subhorizontal shear or movement zones cut through the sequence. At a high point on the island is a *c.* 100-cm-thick sedimentary sequence of alternating siliceous argillite and intermittent, irregular, pinkish radiolarian chert (recrystallized), conformable with and overlying the pillows.

The pillow lavas are elongate, draped tubes, with nearly circular or ovoid cross-sections ranging from 0.15 to 1.2 m in diameter. Although some pillows have virtually no vesicles, most exhibit concentric zones of small vesicles 1–2 mm in diameter that hardly diminish in size towards the rim portions. Vesicle infillings are generally chlorite with a little quartz or calcite. A few pillows have a large, central, unfilled vacuole, left after the tube had been drained of lava. Interpillow material may not always be present, but is generally either cherty argillite or a grey carbonate. As well as the pillow lavas, thin, intrusive sill-like bodies may also be seen forming part of the low, sea-swept platforms on the south of the island.

The lavas look relatively 'fresh' compared with many similar exposures in south-west England with the interiors being bluish, although the fine- grained and originally glassy margins are pale green and heavily altered and fractured. Microscopic examination indicates that the lavas are aphyric tholeiites with variable, fine-grained quench fabrics that grade from the rims to medium-grained subophitic textures within the cores of large tubes. Primary minerals – plagioclase, brownish (sometimes zoned) clinopyroxene, ilmenite – are relicts set in a secondary mineral matrix (Figure 3.25) indicative of the pumpellyite facies of regional metamorphism (Floyd and Rowbotham, 1979). It is the development

of the secondary phases (chlorite, pumpellyite, amphibole) that give the outer portions of the tubes their greenish tinge.

Interpretation

The significance of this site within the magmatic framework of south-west England mainly concerns the importance of the pillow lavas in the tectonic development of southern Cornwall. Although there are other good exposures of Upper Devonian pillow lavas, the Mullion Island basalts are distinctive in that they are:

1. relatively fresh, retaining primary quench-textured clinopyroxene with enhanced contents of Al, Ti and Na (Floyd and Rowbotham, 1979),
2. tholeiites with a mildly enriched MORB-like chemistry (Floyd, 1984), and
3. were subsequently metamorphosed in the pumpellyite facies.

These features distinguish them from the highly altered (no primary phases present), alkali-basalt pillow lavas of north Cornwall and the incompatible-element-enriched tholeiites in the Mylor Formation of the Penwith Peninsula to the north. In terms of relict and secondary mineralogy, and their particular chemical composition, they have an affinity with the other MORB-like clasts within the *mélange* of the Roseland Breecia Formation of southern Cornwall. In the context of the tectonic model for this area during the late Devonian, they are therefore representative of the volcanic portion of the tectonically disrupted oceanic crust of the Gramscatho Basin. Along with the Lizard ophiolite, they are among the remaining segments of the oceanic floor of the Rhenohercynian zone of northern Europe.

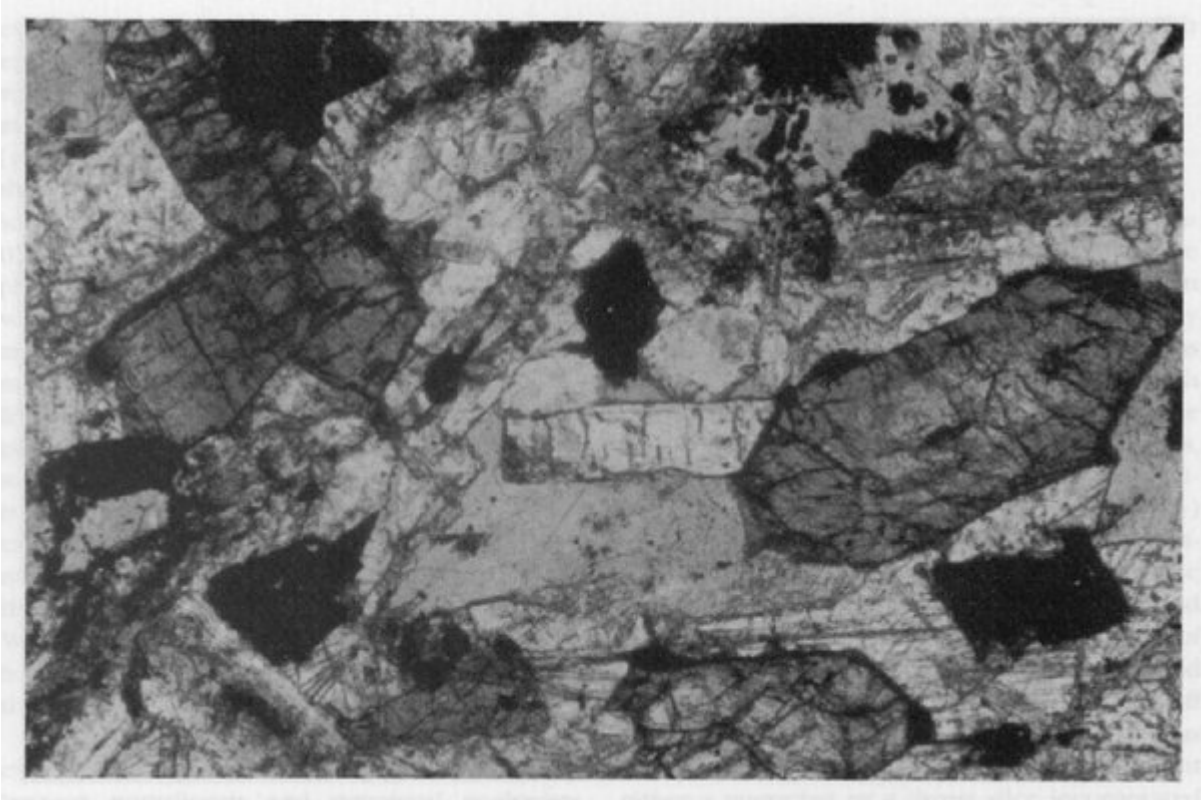
Apart from the relatively rare preservation of primary minerals in south-west England pillow lavas, the clinopyroxenes are distinctive in having abundances of minor components (Al, Ti and Na) that are more typical of alkali basalts than tholeiites. This feature emphasizes the importance of crystallization history (the relative order of phase growth) in governing the composition of pyroxenes in basalts (Floyd and Rowbotham, 1979). For MOR-type basalts the Mullion Island lavas have relatively high contents of U (>1 ppm) which is mainly resident in altered (originally glassy) matrix (Williams and Floyd, 1981) and was largely absorbed during early sea-water alteration.

Conclusions

This site represents an isolated relict of the volcanic portion of an ancient oceanic floor with basalt lava flows and minor sediments. The lavas were extruded on the sea-floor in the form of bulbous, tube-like 'pillows' and exhibit textures indicative of rapid quenching by the cold seawater. The basalts have compositions similar to some modern-day lavas formed at mid-ocean ridges and, together with the Lizard Complex, provide evidence for the existence of an ocean during the Devonian period, to the south of a continental area.

References

(Figure 3.24) A spectacular development of pillow lavas, of Frasnian age, on Mullion Island. (Photo: P.A. Floyd.)



(Figure 3.25) Photomicrograph of pillow lava from Mullion Island. Primary plagioclase, zoned clinopyroxene and ilmenite are set in a secondary pumpellyite-facies mineral matrix. (Photo: P.A. Floyd.)