
B9 Chipley Quarries

[SX 807 712]

Highlights

This is a classic site for the study of pillow lavas. Unusually, these vesicular, shallow-water, pillowed alkali basalts can be dated precisely here from their association with fossiliferous sediments.

Introduction

This site includes the two small disused quarries on the wooded hillside adjacent to the Chipley–Bickington road. The site is situated in a classic late Devonian region which is now recognized as allochthonous and as forming part of the southerly derived Chudleigh Nappe (Selwood and Thomas, 1986a).

Some of the earliest descriptions of the volcanic rocks of this region of south Devon were made by Champernowne (1889). The detailed petrography of the Chipley pillow lavas was initially described by Flett (*in* Ussher, 1913), and he included a single major-element analysis. The lava sequence here is situated within the grey Gurrington Slate Formation which has yielded ostracods (*hemisphaerica–dichotoma* biozone) indicative of a Famennian age (Middleton, 1960). Although part of the major late Devonian extrusive activity in south-west England this contrasts with the Frasnian age of similar pillow lavas at Pentire Point (discussed above). Geochemical work indicates that the Chipley lavas are also intraplate alkali basalts, although they can be distinguished from the Pentire sequence by different incompatible-element ratios and light-REE-enrichment patterns (Floyd, 1982a, 1983). Both occurrences, however, are characteristic of the 'spilite suite' which has counterparts within the Rhenohercynian zone of northern and central Europe, and whose origin and composition have long been debated (for instance, Juteau and Rocci, 1974; Wedepohl *et al.*, 1983).

Description

The Chipley pillow lavas (Figure 4.26) are similar in many respects to those at Pentire Point and are excellent examples of extrusive submarine activity. Both of the quarries in the site exhibit a c. 30 m sequence of tectonically flattened, but well-formed, closely fitting lava tubes with negligible interpillow sediment. Good ovoid cross-sections are visible, displaying the highly vesicular (up to 50% volume) nature of the lavas (Figure 4.27). Vesicles are smaller at the margins than towards the core, although central vacuoles are uncommon. The high degree of vesicularity of the pillows suggests extrusion into relatively shallow water (<500 m depth). However, the basalts were originally alkaline and, as such magmas often contain a relatively high volatile content, the degree of vesiculation may not always be a reliable guide to the depth at which extrusion occurred.

The pillow lavas were originally plagioclase-phyric alkali basalts, but are now completely degraded to low-grade metamorphic assemblages with no primary minerals remaining. Both phenocrystic and matrix plagioclase are now converted to secondary albite, set in a matrix composed of variable chlorite, quartz, carbonate, epidote, prehnite, sphene, magnetite and leucoxene – a typical spilite assemblage. Plagioclase microlites may be skeletal or form long, curved crystals, sometimes with tuning-fork terminations; features which are indicative of rapid quenching in a submarine environment. Much of the fine-grained chloritic matrix probably represented original glass. Vesicles are infilled with chlorite or more rarely prehnite, both of which may be replaced by quartz or carbonate.

Interpretation

Owing to the low-grade, altered nature of the lavas, it is only possible to determine their original magma type by using incompatible elements that are stable during secondary alteration. These indicate that the lavas are alkali basalts with an overall composition similar to other extrusives and intrusives within the north Cornwall and Devon magmatic province

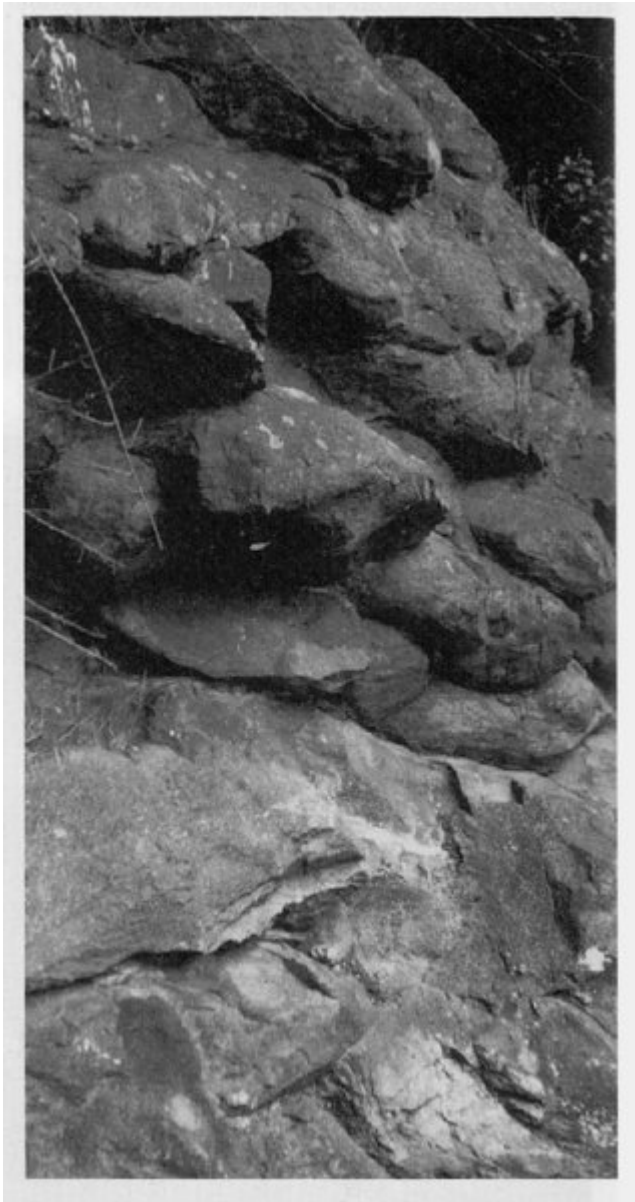
(Floyd, 1982a; Rice-Birchall and Floyd, 1988).

Late Devonian basaltic activity was often associated with the development, especially the deepening of basins, although there were environmental differences between north Cornwall (with the Pentire lavas) and south Devon (with the Chipley lavas) during this period. For example, the latter area saw the extensive development of carbonate-dominated facies, with thin, condensed sequences of Upper Devonian, pelagic, nodular carbonates and mudstones developed on submarine rises (House, 1963, 1975). These grade into adjacent, deeper-water, basinal argillites which contain the local pillow lavas encompassed by this site. Their development near a submarine rise is different from broadly similar lavas at Pentire Point in Cornwall, which developed on the northern margin of a deepening fault-controlled trough (Selwood and Thomas, 1986b). Chemically, the pillow lavas are also characteristic of the north Cornwall and Devon magmatic province of alkali volcanics (Chapter 2).

Conclusions

This locality has been studied since the late nineteenth century when it was realized that the peculiar pillow-shaped masses were the result of the eruption of basalt lava into sea-water. At Chipley the pillow lavas are shot through with voids (vesicles) which were originally the site of gas bubbles. As a result of the sudden release of pressure and rapid chilling on the extrusion of individual pillow flows, gas was forced out of solution in the volatile-rich lava, leaving the solidified rock full of voids. The Chipley basaltic lavas have been altered and their original mineralogy replaced by secondary minerals (cf. Pentire Point), although textures still preserve evidence of rapid chilling. Laterally the lavas may be traced out into the sedimentary rocks which were deposited as mud on the deep sea-bed. Volcanic activity occurred here at the very end of the Devonian period around 360 million years ago. Chipley differs from the pillow-lava site at Pentire Head (of about the same age) in terms of the chemical composition of the basalts and its eruptive setting.

References



(Figure 4.26) Upper Devonian pillow lavas of alkali-basalt composition. Chipley Quarries, Devon. (Photo: PA. Floyd.)



(Figure 4.27) Cross-section through two pillows showing the high degree of vesicularity and its concentric disposition. Chipley Quarries, Devon. (Photo: P.A. Floyd.)