C17 Praa Sands (Folly Rocks)

[SW 573 280]

Highlights

This site contains fresh exposures of an unusually large granite-porphyry dyke with evidence of multiple intrusion, chilled margins and flow banding. Microscopic features provide evidence for a complex emplacement mechanism involving solid, liquid and gas phases.

Introduction

Praa Sands is a 1.5 km long beach between Marazion and Porthleven. The site (Figure 5.12) is at its western end (Folly Rocks) and consists of a major granite-porphyry ('elvan') dyke, and its country rocks which are Mylor Slate Formation metasediments. The structure of the dyke, the main body of which has a narrow, banded, chilled margin outside an even narrower non-banded rock, has led Stone (1968) to postulate that it was a multiple intrusion, and that its textures and chemistry showed it to have contained liquid magma, solid fragments and a gas phase, all of which interacted. This explanation of the mechanism, although more complex than the simple magmatic intrusion suggested by Reid and Scrivenor (1906), was supported by Goode (1973). Henley (1972, 1974), following a study of other elvan dykes, pointed out their potassium enrichment, and Exley and Stone (1982), Exley *et al.* (1983) and Stone and Exley (1986) gave accounts of their possible derivation. They have been dated at about 269 Ma BP by the Rb/Sr method (Hawkes *et al.,* 1975).

Description

The country rocks at this site are folded and cleaved black and grey Mylor Slate Formation pelites with numerous contorted quartz veins, and they have been hardened by contact metamorphism for a few centimetres adjacent to the dyke. This dips at about 80° to the north-east and, by analogy with other dykes in Cornwall, has an Rb/Sr age of 269 ± 8 Ma (Hawkes *et aL,* 1975). The dyke is about 18 m wide overall and strikes approximately 128°, which is parallel with the local mineral veins but divergent from the general trend seen inland. Such large, multiple intrusions are unusual in south-west England.

Three rock types are discernible, the first being a banded, very fine-grained felsitic variety which forms an outer selvedge some 0.30 m wide. This rock contains rounded megacrysts of quartz and alkali feldspar up to about 1 mm in diameter. Within this selvedge, on both sides of the dyke, is a zone about 0.15–0.20 m wide in which the rock is again fine grained but not noticeably banded. This also includes rounded quartz and feldspar megacrysts but these are rather sparsely distributed. Finally, separated from the second variety by a very narrow zone in which the grain size increases markedly but gradationally, there is the main, central body of the dyke which, although relatively coarse, is still microcrystalline. Here, quartz and alkali feldspar megacrysts are common, the latter being mostly subhedral, sometimes zoned, and aligned subparallel with the contacts. There are also rather rounded, fine-grained, poorly megacrystic xenoliths. In thin section, the rock is seen to contain fragments of granite and compound crystals of quartz and alkali feldspar, as well as broken xenocrysts of quartz and feldspar.

Interpretation

Stone (1968) believed that the outer, felsitic rock constituted the first phase of a two-stage intrusion, the main central part being a second phase with either fine-grained chilled margins or a progressively intruded magma filling a slowly opening fissure, as suggested earlier by Reid and Scrivenor (1906), and giving a rock of increasing coarseness. The textures of all these granite-porphyry types show evidence of reaction and recrystallization of early-formed mineral phases and xenocrystic and probably xenolithic fragments as well.

Chemically, the Praa Sands elvan is both potassium rich and has a high K:Na ratio; this led Stone (1968) to propose that there had been extensive ion exchange among the components of the fluid phase which must have been present at the time of its emplacement to effect both alteration and recrystallization of minerals. Moreover, such a fluid phase probably provided the medium for transportation of both solid and magmatic particles in a fluidized system. Goode (1973) supports this view, adding that, in general, Cornish elvans also show evidence of having drilled channels for themselves by their own hot gases (gas coring) and having brecciated the adjacent rocks during intrusion.

Exley and Stone (1982), Exley *et al.* (1983) and Stone and Exley (1986) argue, from detailed chemical and other evidence, that the granite-porphyry magma might have been derived from biotite granite magma of the type which supplied the main batholith rocks. This evidence includes enrichment in K and Rb, impoverishment in Na, and a statistical clustering with granite types B and C.

A number of elvan dykes in the Perranporth area were examined by Henley (1972, 1974), but these are not as well exposed as that at Praa Sands. Nevertheless, Henley was able to conclude, from both textural and chemical features, that elvans solidified from a magma that was already enriched in potassium as a consequence of leaching of sodium and silicon from pre-existing solid granite by late-magmatic fluids. Such aqueous residual fluids, rising rapidly from deep-seated reservoirs because of fracturing, might be stable only with K-feldspar and mica, and would incorporate fragments of granite and corroded crystals from it. An interesting feature of this concept is its dependence on a sufficient time interval between the main period of granite crystallization and dyke emplacement to permit erosion of the granite and stress relief, thus allowing deep fracturing. On the evidence then available, Henley put this at 55–75 Ma, but it is now thought to be nearer 20 Ma (Table 2.1).

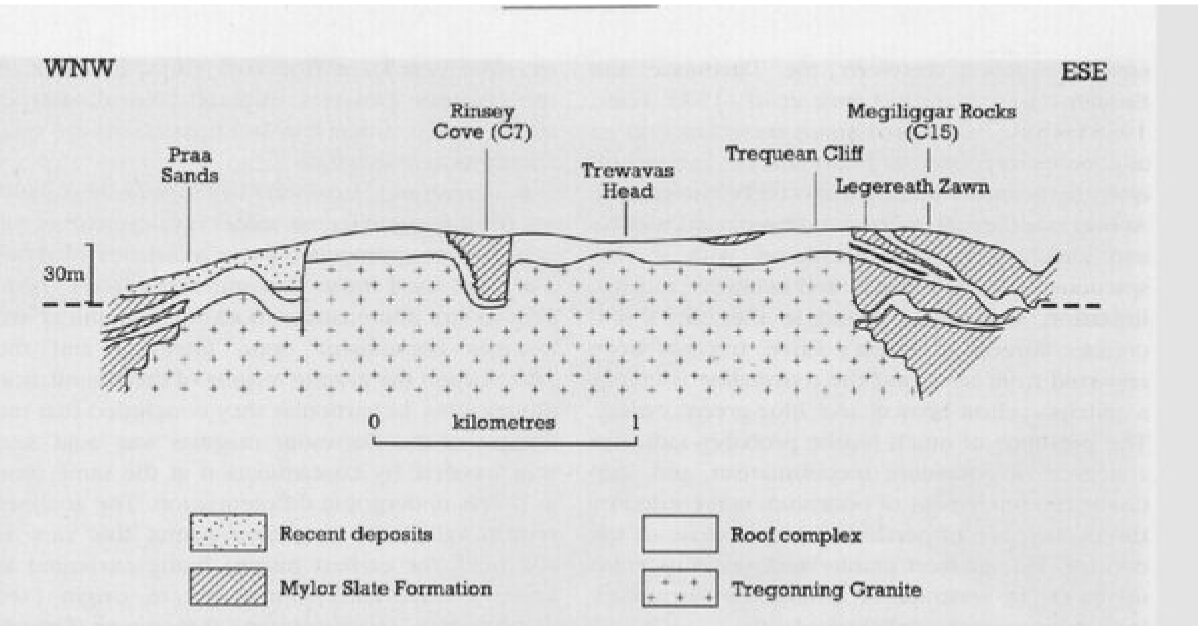
The Praa Sands elvan is a very important, fresh exposure of a granite-porphyry dyke intruded in stages by a combination of magmatic intrusion and fluidization processes and deriving from both differentiated magma, developed at depth and K■rich, and incorporating solid granite broken from the walls of the fissures through which the gas-charged material passed.

Intrusions of this type are most commonly associated with volcanic activity and are known in many parts of the world. In the case of Cornubia, they are either very late-tectonic or even post-tectonic and may indicate links with volcanoes of which there are now no traces, except, perhaps, the rhyolites of the Withnoe–Kingsand area of south-east Cornwall (Cosgrove and Elliott, 1976; see Chapter 6).

Conclusions

Here is exposed a remarkable example of one of the last products of the major igneous phase which affected south-west England around 270 million years ago. After the major granite masses of Dartmoor, St Austell, etc., smaller vertical or steeply dipping sheets (dykes) of granite porphyry ('elvans') were emplaced. The elvan dyke at Praa Sands is 18 m across, and is remarkable in that it was formed by the injection of more than one magma into an opening fracture. Its outer portion, which baked the surrounding rocks, shows banding indicating the movement of the molten rock through the fissure. The central part of the dyke is coarse grained and contains fragments of older rocks (xenoliths) broken off from rocks at deeper levels by the rising magma. It has been suggested that the fissure which hosts the dyke continued to open to make this two-phase injection of magma possible. Between the central and outer rock types is a zone made up of a third rock produced by the reaction between the gas-charged later magma and the earlier outer melt. The Praa Sands Dyke is an important one for the study of the processes of igneous intrusion and reactions between magmas with different chemical and physical natures.

References



(Figure 5.12) Diagrammatic section across the Tregonning Granite, based on coastal exposures, showing the location of sites at Rinsey Cove (C7) and Megiliggar Rocks (C15) (after Exley and Stone, 1982, figure 21.2).

Intrusive phase	Outcrop and granite type	Rb-Sr age (Ma)	Initial $^{87}Sr/^{86}Sr$ ratio	Comments
Major	Dartmoor (B)	280 ± 1	0.7101 ± 0.0004	-
	Bodmin Moor (B)	287 ± 2	0.7140 ± 0.0002	Mineral age
	St Austell (B)	285 ± 4	0.7095 ± 0.0009	-
	Carnmenellis (B)	290 ± 2	0.7130 ± 0.0020	Mineral age
	Tregonning (E)	280 ± 4	0.71498 ± 0.00381	Highly evolved, lithium-rich
	Land's End (B)	268 ± 2	0.7133 ± 0.0006	Mineralization re-set age
Minor	Hemerdon Ball	304 ± 23	0.70719 ± 0.01025	Heavily mineralized
	Kit Hill	290 ± 7	0.70936 ± 0.00228	-
	Hingston Down	282 ± 8	0.71050 ± 0.00119	-
	Castle-an-Dinas	270 ± 2	0.71358 ± 0.00122	Later intrusion re-set age
	Carn Marth	298 ± 6	0.70693 ± 0.00207	-
Dykes	Meldon 'Aplite'	279 ± 2	0.7098 ± 0.0017	-
	Brannel Elvan	270 ± 9	0.7149 ± 0.0031	Re-analysed
	Wherry Elvan	282 ± 6	0.7120 ± 0.0025	Re-analysed
Mineral veins	South Crofty	269 ± 4	-	-
	Geevor	270 ± 15	0.7122 ± 0.0012	-

(Table 2.1) Ages and initial Sr isotopic ratios of granitic rocks from the Cornubian batholith (data from Darbyshire and Shepherd, 1985, 1987)