C6 Burrator Quarries

[SX 549 677]

Highlights

Burrator Quarries contain a rare contact between Dartmoor Granite and Upper Devonian sediments, showing slight mobilization, tourmalinization and vein intrusion. As the site of early investigation of compositional relationships between granite and country rocks, it is important in the development of hypotheses about the origins of Cornubian granites.

Introduction

This pair of small quarries lies 3 km east of Yelverton and 300 m south-west of the dam at Burrator Reservoir. It is one of the few places where the coarse, megacrystic biotite granite of Dartmoor can be seen in contact with the Devonian country rocks. This contact was a key feature in the evidence used by Brammall and Harwood (1932) in their petrogenetic study of the Dartmoor Granite, for they were able, by a series of analyses taken across it, to draw conclusions about the effects of assimilation on the granite magma. The significance of assimilation is now seen differently in the light of experimental work on the 'granite system', and more recent observations (Stone, 1979; Stone and Exley, 1986; Bromley and Holl, 1986; Bromley, 1989), but the changes discussed by Brammall and Harwood remain unchallenged.

Description

The country rocks on the west of the Dartmoor mass are essentially pelites and semipelites of Famennian age belonging to the Kate Brook Formation of the 'Kate Brook Tectonic Unit', the autochthonous component of the complex nappe structure found between the Dartmoor and Bodmin Moor granites (Isaac *et al.,* 1982; Isaac, 1985). These basinal sediments were first regionally metamorphosed to slaty rocks, and subsequently thermally metamorphosed by the granite. At Burrator they are spotted and banded cordierite-and andalusite-bearing hornfelses with a conspicuous flat-lying cleavage and extensive tourma-linization. Corundum, found in the Land's End contact aureole at Priest's Cove, has not been reported from here, and the tourmaline is chiefly a patchy yellow-brown and blue-green variety. The presence of much biotite probably indicates a degree of potassium metasomatism, and, certainly, the movement of potassium is recorded by the occurrence of perthitic feldspar close to the contact. Fine-grained granite and siliceous veins up to 0.3 m wide occur within the hornfelses, both concordantly and discordantly.

The contact itself, illustrated by Brammall and Harwood (1932), although very irregular, is sharp, and it shows evidence of some mobilization of the metasediments with attendant segregation of felsic and mafic constituents (Figure 5.11); Bram-mall and Harwood described this as a 'migmatic zone' although there is much less evidence of mobilization than at Leusdon Common (discussed above).

Tourmalinization has affected not only the contact homsfelses but also the outer parts of the intrusion, and the granite in both quarries is considerably reddened by this process, especially adjacent to joints.

Interpretation

The Dartmoor Granite was emplaced at about 280 Ma BP, as dated by the Rb/Sr method (Darbyshire and Shepherd, 1985) making it the youngest Cornubian intrusion except for Land's End, and most of the rock is coarse grained and megacrystic, although a non- or poorly megacrystic variety also occurs. These were called 'giant' and 'blue' granite respectively by Brammall and Harwood (1923), who argued that the latter was intruded into the former: it has subsequently been recognized that the variation is gradational (Dangerfield and Hawkes, 1981; Hawkes, 1982), with both types corresponding with the Type B (Table 5.1) of Exley and Stone (1982) and Exley *et al.* (1983). It is often the case that the coarse and megacrystic nature of the granite persists right to its contact with the country rocks, as, for example, near Cape Cornwall, and this is seen in the Burrator Quarries, although the number of megacrysts is rather few and the crystals are only about 50 mm in length.

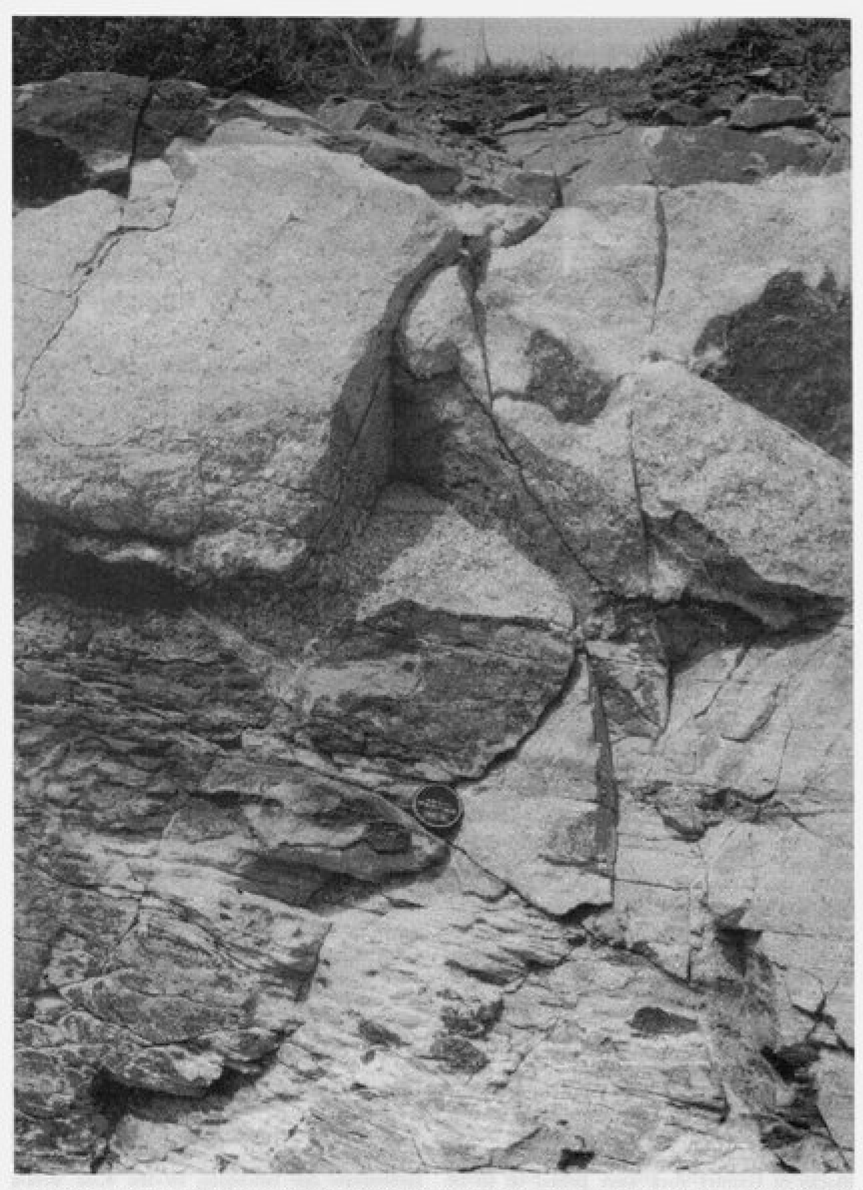
Brammall and Harwood (1932) published analyses from a sequence of 'shales' at Burrator as the contact was approached (over a distance of about 5 m) and used these, in conjunction with 'fresh' granite, to demonstrate both the chemical exchanges consequent upon intrusion and the effects upon the granite magma of the assimilation of xenoliths. In particular they concluded that the earliest of the Dartmoor magmas was 'acid' and was 'basified' by contamination at the same time as it was undergoing differentiation. The analyses remain valid and, in general terms, this view is still held, the earliest magma being envisaged as lower crustal and palingenetic in origin (see 'Petrogenesis' section above). It then rose through a pile of sediments and basic volcanics to its final high-level position where it consolidated in an essentially passive fashion, as the locally undeformed rocks show. However, it is now believed that some minerals, especially biotite, were derived from the source rocks, and that at low crustal levels the physicochemical condition of the magma prevented substantial assimilation (Stone, 1979; Bromley and Holl, 1986; Stone and Exley, 1986; Bromley, 1989) of the sort envisaged by Brammall and Harwood. The introduction of potassium from sediments was part of Brammall and Harwood's thesis, but it is now thought that late-magmatic potassium metasomatism was facilitated by an aqueous phase, and that the megacrystic texture was a consequence of this (Stone and Austin, 1961; Hawkes *in* Edmonds *et al.,* 1968; Exley and Stone, 1982; Exley *et al.,* 1983; Stone and Exley, 1986).

Although the assimilation of metasediment is not now regarded as being as important as Brammall and Harwood believed, the changes in the rocks at Burrator Quarries, and their interpretation by these authors, continue to be important to the understanding of the effects of Cornubian granite intrusion on the country rocks and the alterations which can result from assimilation.

Conclusions

This site is important both as a locality where contact phenomena of the Dartmoor (and, by implication, other Cornubian) Granite can be seen and as a place where classic work on Cornubian granite genesis was carried out. Although the conclusions from this work have been modified by subsequent findings, the data and principles still stand.

References



(Figure 5.11) Contact between Dartmoor Granite and Devonian slates, re-exposed after face cleaning by the Nature Conservancy Council in 1980. (Photo: Mj. Harley.)

Type	Description	Texture	Minerals (approximate mean modal amounts in parentheses)						Other names in literature
			K-feldspar	Plagioclase	Quartz	Micas	Tourmaline	Other	
A	Basic microgranite	Medium to fine; ophitic to hypidiomorphic	(Amounts vary)	Oligoclase-andesine (amounts vary)	(Amounts vary)	Biotite predominant; some muscovite	Often present	Hornblende, apatite, zircon, ore, garnet	Basic segregations (Reid et al., 1912); Basic inclusions (Brammall and Harwood, 1923, 1926)
B	Coarse-grained megacrystic biotite granite	Medium to coarse; megacrysts 5-17 cm maximum, mean about 2 cm. Hypidiomorphic, granular	Euhedral to subhedral; microperthitic (32%)	Euhedral to subhedral. Often zoned: cores An_{23}-An_{30}, rims An_{8}-An_{15} (22%)	Irregular (34%)	Biotite, often in clusters (6%); muscovite (4%)	Euhedral to anhedral. Often zoned. 'Primary' (1%)	Zircon, ore, apatite, andalusite, etc. (total, 1%)	Includes: Giant or tor granite (Brammall, 1926; Brammall and Harwood, 1923, 1932) = big-feldspar granite (Edmonds et al., 1968), coarse megacrystic granite (Hawkes and Dangerfield, 1978). Also blue or quarry granite (Brammall, 1926; Brammall and Harwood, 1923, 1932) = poorly megacrystic granite (Edmonds et al., 1968), coarse megacrystic granite (mesocrystic type) (Hawkes and Dangerfield, 1978), coarse megacrystic granite (small megacryst variant) (Dangerfield and Hawkes, 1981). Also medium-grained granite (Hawkes and Dangerfield, 1978), medium granites with few megacrysts and megacrysts very rare (Dangerfield and Hawkes, 1981). Biotite-muscovite granite (Richardson, 1923; Exley, 1959). Biotite granite, equigranular biotite granite, and globular quartz granite (Hill and Manning, 1987).
C	Fine-grained biotite granite	Medium to fine, sometimes megacrystic; hypidiomorphic to aplitic	Subhedral to anhedral; sometimes microperthitic (30%)	Euhedral to subhedral. Often zoned: cores An_{10}-An_{15} (26%)	Irregular (33%)	Biotite 3%; muscovite (7%)	Euhedral to anhedral. 'Primary' (1%)	Ore, andalusite, fluorite (total, <1%)	Fine granite, megacryst-rich and megacryst-poor types (Hawkes and Dangerfield, 1978; Dangerfield and Hawkes, 1981)
D	Megacrystic lithium-mica granite	Medium to coarse; megacrysts 1- 8.5 cm, mean about 2 cm. Hypidiomorphic, granular	Euhedral to subhedral; microperthitic (27%)	Euhedral to subhedral. Unzoned, An_{7} (26%)	Irregular; some aggregates (36%)	Lithium-mica (6%)	Euhedral to anhedral 'Primary' (4%)	Fluorite, ore, apatite, topaz (total, 0.5%)	Lithionite granite (Richardson, 1923). Early lithionite granite (Exley, 1959). Porphyritic lithionite granite (Exley and Stone, 1964). Megacrystic lithium-mica granite (Exley and Stone, 1982)
E	Equigranular lithium-mica granite	Medium-grained; hypidiomorphic, granular	Anhedral to interstitial; microperthitic (24%)	Euhedral. Unzoned, An_{4} (32%)	Irregular; some aggregates (30%)	Lithium-mica (9%)	Euhedral to anhedral (1%)	Fluorite, apatite (total, 2%); topaz (3%)	Late lithionite granite (Exley, 1959). Non-porphyritic lithionite granite (Exley and Stone, 1964). Medium-grained, non-megacrystic lithium-mica granite (Hawkes and Dangerfield, 1978). Equigranular lithium-mica granite (Exley and Stone, 1982). Topaz granite (Hill and Manning, 1987)
F	Fluorite granite	Medium-grained; hypidiomorphic, granular	Sub-anhedral; microperthitic (27%)	Euhedral. Unzoned, An_{4} (34%)	Irregular (30%)	Muscovite (6%)	Absent	Fluorite (2%), topaz (1%), apatite (<1%)	Gilbertite granite (Richardson, 1923)

(Table 5.1) Petrographic summary of main granite types (based on Exley et al., 1983)