C3 De Lank Quarries

[SX 101 755]

Highlights

These quarries contain fresh, coarse-grained, poorly megacrystic biotite granite, characteristic of the Bodmin Moor intrusion, strongly foliated and jointed, and containing pegmatitic patches, minor granitic veins and xenoliths. They also incorporate typical Cornubian, fine-grained, megacrystic biotite granite and granite porphyry dykes ('elvans').

Introduction

The De Lank Quarries provide a rare opportunity to see really fresh, coarse, Cornubian biotite granite of the type classified by Dangerfield and Hawkes (1981) as the 'small megacryst variant'. This is typical of Bodmin Moor, much of Carnmenellis and the Isles of Scilly, but uncommon elsewhere. This rock type is often foliated and this feature is particularly conspicuous at De Lank. Although the officers of the Geological Survey (Reid *et al.,* 1910; Reid *et al.*, 1911) noted these features, they did not classify the rocks as a separate type, and the 'Godaver' type of Ghosh (1927), found in the extreme east of the pluton, is not distinguished by these criteria. Indeed, the present author's research indicates that the Godaver Type is a minor variant of the main granite.

Although subhorizontal jointing is characteristic of surface exposures, its change in frequency with depth cannot usually be seen: the deep quarries at De Lank provide an invaluable demonstration of such jointing. Similarly, although surface exposures often display such phenomena as xenoliths, pegmatitic segregations and small veins of later, intrusive granite, these are usually weathered and of poor quality compared with fresh examples found in the quarry.

A major occurrence of fine-grained, megacrystic biotite granite is found a short distance to the north of the site, and an apophysis of this, exposed in the De Lank River in the north-east corner of the site, is one of the very few of this type in a fresh condition in Devon and Cornwall.

The remains of three substantial outcrops of dykes of granite porphyry ('elvan') are also present; although the bulk of the central parts of these dykes has been worked out, unusually good specimens are available in the ends of the cuttings and the contact facies remain excellently preserved.

Description

The De Lank Quarries are part of a group, few of which are now working, on the western margin of the Bodmin Moor Granite about 9 km NNE of Bodmin. This granite mass is one of the major cupolas on the Cornubian batholith. For the most part, it is composed of the small megacrystic biotite granite (Type B, (Table 5.1); Exley and Stone, 1982) which is well seen in the quarries, but it also has four small areas of fine-grained granite (Type C, (Table 5.1); Exley and Stone, 1982), one of which is just to the north of De Lank. The mass as a whole has been dated by the Rb/Sr method at 287 ± 2 Ma BP (Darbyshire and Shepherd, 1985).

Within the main quarries, the granite contains abundant megacrysts, mostly about 10–20 mm in length; these are of orthoclase microperthite, while the potash feldspars of the groundmass include microcline (Edmondson, 1970). There is a conspicuous, nearly vertical, foliation with an approximately north–south strike which is emphasized by the megacrysts. Although foliation is not rare in Cornubian granites, it is seldom as strongly developed as it is here.

In addition to the main rock-forming minerals, De Lank Granite contains about 1% tourmaline, contrary to the Geological Survey's assertion (Reid *et al.,* 1910), and it is thus similar to the rest of the mass.

The rock is well jointed in several directions, the chief subvertical orientations being about 075° and 340° and close to the mean for the northern part of the outcrop, with subordinate joints between these. Dip directions and amounts are variable. Subhorizontal joints are most prominent in the topmost 20 m where they undulate in approximate conformity with the land surface, but the granite becomes very massive at depth.

The rock is cut by aplite and microgranite veins and sheets up to 0.10 m thick, which have strikes parallel with those of the joints. The rock also encloses veins and pockets of quartzo-feldspathic pegmatite, as well as xenoliths which are sometimes stretched into *schlieren.*

The quarry area is limited on the north by an ENE–WSW fault zone dipping towards the south and with easterly dipping slickensides. This fault, the surfaces of which are coated with tourmaline, is a major structural feature, being one of a number which separate the outcrop of the Bodmin Moor mass into large blocks (Exley, 1965), and it controls the course of the adjacent De Lank River. It also separates the De Lank and Hantergantick quarries, the granites of which have perceptibly different compositions. Although similar block faulting almost certainly exists in other Cornubian granite masses, it is not as well demonstrated as it is on Bodmin Moor.

North of the De Lank Quarries, centred on Lower Penquite, is an area of fine-grained granite (Type C), which has an outcrop about 1 km in diameter and a long, narrow apophysis leading south. The latter is exposed in the De Lank River, close to the fault mentioned above, and is clearly intrusive, while the presence of the main outcrop is revealed by boulders in the fields. This variety is younger than, and intrusive into, the coarse granite.

Immediately south of the northern working quarry at De Lank, two granite-porphyry dykes ('elvans') striking ENE–WSW, about 10 m thick, are exposed in road cuttings and quarries on both sides of the river, and there is a third in a quarry on the south-west side. Much of the rock has been removed, but the chilled margins and faces at the ends are accessible and show the distinctive features of this rock which is fine-grained and often megacrystic. It is not clear whether the De Lank elvans are all single intrusions or multiple like that at Praa Sands.

Interpretation

This site provides a superb example of typical Cornubian, coarse, small-megacrystic biotite granite which is extensive elsewhere only at Carn-menellis. Here, however, it has a strong tectonic foliation. There is well-developed jointing and pegmatitic patches which, together with minor granitic veins, illustrate the effects of late magmatic fractions. The exposure of typical Cornubian fine-grained megacrystic biotite granite and granite-porphyry dykes indicate subsequent intrusive phases, while xenoliths provide examples of material incorporated by the magma during its ascent. Opportunities to see all these phenomena, and their relationships within such a small area and in such a fresh state, are rare.

As is usual in batholiths, the separate intrusions which comprise that in Devon and Cornwall vary somewhat in age (Table 2.1). The oldest is Carnmenellis (290 ± 2 Ma) and the youngest Dartmoor and Land's End (280 ± 1 and 265 ± 2 Ma, reset) with St Austell and Bodmin Moor between these at 285 ± 4 and 287 ± 2 Ma respectively (Darbyshire and Shepherd, 1985).

Textures also vary between individual plutons, and while the granites of Dartmoor, the eastern (oldest) part of St Austell and Land's End have relatively large megacrysts, those of Bodmin Moor and most of Carnmenellis are relatively small, although abundant (Dangerfield and Hawkes, 1981). Since the development of large megacrysts is a feature of the upper and outer regions of Cornubian plutons, it is possible that their absence from the Bodmin Granite indicates a deeper level of erosion, as is suggested also by the regular shape of their outcrops.

The foliation often seen locally in the Cornu-bian granites seldom extends for more than a few metres and is frequently curved, sometimes showing 'swirls' reminiscent of eddies in liquids. They have often been ascribed to magma movement, and some may have originated in this way, although some of the minerals, especially the feldspar megacrysts, are subsolidus and must therefore owe their alignment to pre-existing structures. The foliation at De Lank is quite different, and textural relations and extensive strain in the quartz, which is largely segregated into bands, show that it has a deformation, not igneous, origin. It is clearly different from that seen, for example at Haytor Rocks, Luxulyan Quarry or near Cape Cornwall, and is presumed to be associated with movement along the neighbouring St Teath–Portnadler Fault system (Dearman, 1963).

It has been argued, in the 'Petrogenesis' section above, that the granites are predominately 'S-type' (Chappell and White, 1974), and one of the pieces of evidence for this is the nature of the xenoliths. Excellent examples of these, often seen now as *schlieren,* are present at De Lank and are of 'restite' origin, comprising largely biotite and andalusite.

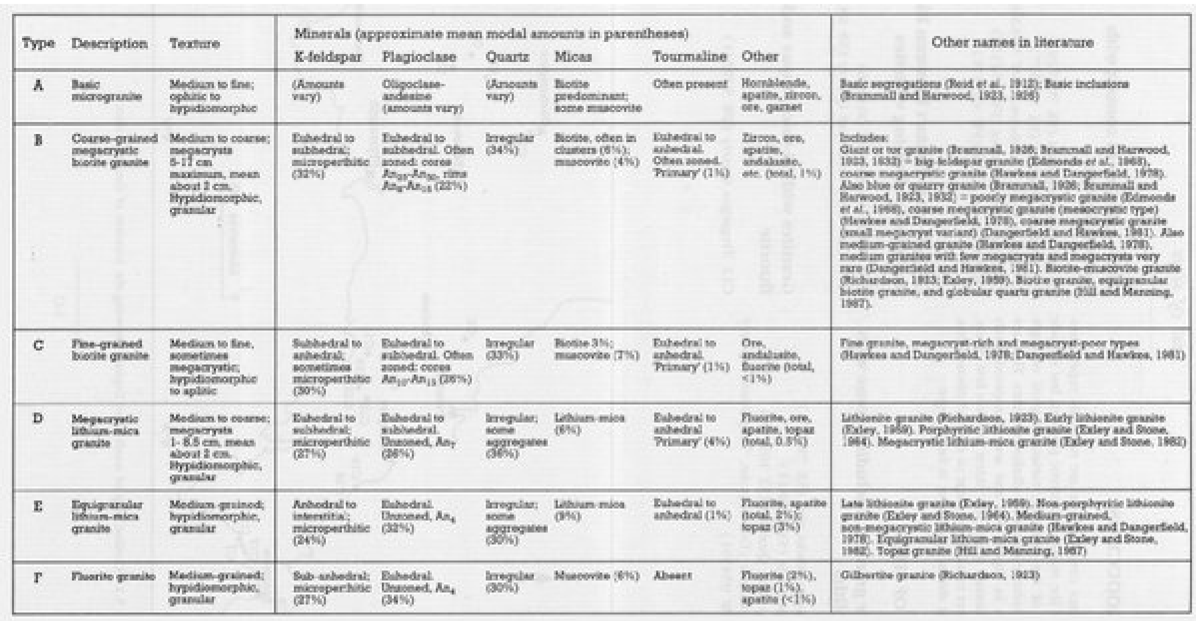
The field relations of the fine-grained granite apophysis in the De Lank River indicate that it is intrusive, and suggest that the larger mass to the north, to which the apophysis is presumed to extend, is intrusive also. Unfortunately, the latter is not seen *in situ,* and it is possible that it may represent 'granitized' sedimentary raft material as has been suggested for some fine-grained granite on Dartmoor (Edmonds *et al.,* 1968; Hawkes, 1982) and in the Land's End intrusion (Tammemagi and Smith, 1975).

The elvan dykes, which are some 10 Ma younger than the main granites, are believed to represent a differentiate from a deeper-seated biotite granite magma which underwent considerable modification by ion exchange and was emplaced as a fluidized system which included fragments of the granite through which it had passed (Stone, 1968; Goode, 1973; Henley, 1972; 1974).

Conclusions

This site provides a superb example of typical Cornubian coarse biotite granite of the small-megacryst type typical of Bodmin, Carmenellis and Scilly. It shows strong foliation and xenoliths (see 'Birch Tor' conclusion), as well as typical Cornubian fine-grained megacrystic biotite granite and granite-porphyry dykes. Opportunities to see all these phenomena and their relationships within such a small area and in such a fresh state are rare.

[References](#)



Type	Description	Texture	Minerals (approximate mean modal amounts in parentheses) K-feldspar	Plagioclase	Quartz	Micas	Tourmaline	Other	Other names in literature
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_{25}-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)

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)