C10 Wheal Martyn

[SX 003 556]

Highlights

This site is exceptional in that it contains relatively fresh Li-mica granite, generated by metasomatic alteration of biotite granite, which forms the greater part of the western intrusion at St Austell and provides the main source of china clay.

Introduction

As described in the 'Petrogenesis' section of this chapter, the St Austell Granite comprises two main intrusions. That in the east is centred on Luxulyan and consists of coarse-grained biotite granite (Type B, (Table 5.1)), while that in the west is chiefly made up of megacrystic granite of variable grain size (mostly coarse) and characterized by the Li-mica zinnwaldite (Type D, (Table 5.1)). Formerly thought to have been a magmatic differentiate, this latter granite is now considered to have resulted from the metasomatic alteration of large parts of an earlier biotite granite by an intruding Li-mica granite magma (Richardson, 1923; Exley, 1959; Hawkes and Dangerfield, 1978; Dangerfield *et al.,* 1980). Other varieties within the western intrusion include the Li-mica granite product of the crystallization of this magma and fluorite granite derived from it (respectively Types E and F, (Table 5.1); Manning and Exley, 1984; Hawkes *et al.,* 1987; and (Figure 5.4)). There are also small remnant patches of biotite granite, suggesting that the western intrusion was multiphase, and these have been interpreted as constituting a sequence of fractions of magma representing stages in the cooling history (Hill and Manning, 1987; Bristow *et al,* in press).

The western intrusion is the area in which kaolinization has been most intense and from which the great majority of china clay is extracted, so that fresh examples of the original rocks are hard to find; the Wheal Martyn site provides these rare examples. The nearby china-clay pits of Greensplat, seen from the China Clay Museum's viewing point, demonstrate the severity of the alteration and show the manner of working china-clay rock.

Description

The Wheal Martyn site is roughly in the middle of the St Austell Granite outcrop, about 3 km north of St Austell. It is towards the eastern side of the second, western intrusion which has a diameter of about 11 km and is centred just to the northeast of St Dennis. Its northern part underlies the Lower Devonian metasediments and the superficial deposits of Goss Moor (Figure 5.10).

The excavation at Wheal Martyn contains relatively fresh Type-D granite ((Table 5.1)). In this, there are rather few megacrysts of subhedral feldspar, 10–15 mm long; rounded composite quartz grains 5–7 mm in diameter; and tourmaline needles up to 5 mm long, all set in a groundmass with an average grain size of 1–2 mm. Flakes of pale-brown Li-mica, identified as zinnwaldite by Stone *et al.* (1988) are also visible. It is probable that this rock would be classified as 'globular quartz granite' by Hill and Manning (1987). There is also a small patch of fine-grained biotite granite (Type C, (Table 5.1)), suggesting that in this area some fine-grained granite was emplaced relatively early.

Interpretation

Following the intrusion of a biotite granite (Type B, (Table 5.1)) boss in the east, a series of biotite-bearing granites, variable in texture, was emplaced on its western side. Owing to its coarse, megacrystic texture and its composition (Type D, (Table 5.1)), which includes albite (An_7) and Li-mica, the bulk of this rock was thought to be a magmatic differentiate from the main biotite granite magma (Exley, 1959). However, the realization that the non-megacrystic Li-mica granite (Type E, (Table 5.1)) was intrusive into megacrystic rocks led Dangerfield *et al.* (1980) to conclude that the surrounding Type-D granite had originally been biotite granite (Type B) and that it had been metasomatized. This conclusion is now widely accepted, although Bristow *et al.* (in press) consider that some is of magmatic origin. The metasomatism was achieved in the presence of an aqueous fluorine-rich fluid, by introducing lithium which replaced iron to form zinnwaldite, and sodium which replaced calcium in oligoclase to give albite: adjustments in other constituents balancing these changes. Surplus calcium was combined with fluorine into fluorite, and surplus iron, together with boron, crystallized as tourmaline. The introduction of the lithium, sodium and some of the fluorine and water, was effected by the intrusion of the Type-E magma which had separated at deeper levels from biotite granite magma with which it had undergone some ion exchange. The rock, formed directly from this magma, is now seen as a non-megacrystic Li-mica granite (Type E), containing patches of fluorite granite (Type F) in the Nanpean area and near Hensbarrow (Stone, 1975; Dangerfield *et al.,* 1980; Exley and Stone, 1982; Manning, 1982; Exley *et al.,* 1983; Manning and Exley, 1984).

An early form of alteration resulting from the presence of OH- and F-rich fluids was a pervasive greisening which attacked the K-feldspar, replacing it by a secondary white mica and quartz. The extent of this is very variable and the granite at this site shows it to a limited degree.

The whole area surrounding the site has been affected by intensive kaolinization. This was a consequence of Cretaceous or Palaeogene sub-aerial weathering initiated by hot water circulating through the joint system in the granite (Exley, 1959, 1964; Sheppard, 1977; Durrance *et al.,* 1982; Exley and Stone, 1982; Exley *et al.,* 1983; Manning and Exley, 1984; Bristow *et al,* in press). That closely spaced joints produced pervasive kaolinization can be seen in many clay pits, including those visible from the Museum viewing area, as can also the relationship between this process and tourmaline veins and greisen-bordered veins. The latter provide evidence for the movement of late fluids through the solidified granite and for the way in which these replaced the feldspar in the joint walls with aggregates of mica and quartz – an identical process to that seen in the body of the rock and noted above. Where they occur, ore minerals are usually found in greisen-bordered veins of this type. (See also the 'Petrogenesis' section of this chapter and the description of Tregargus Quarries.)

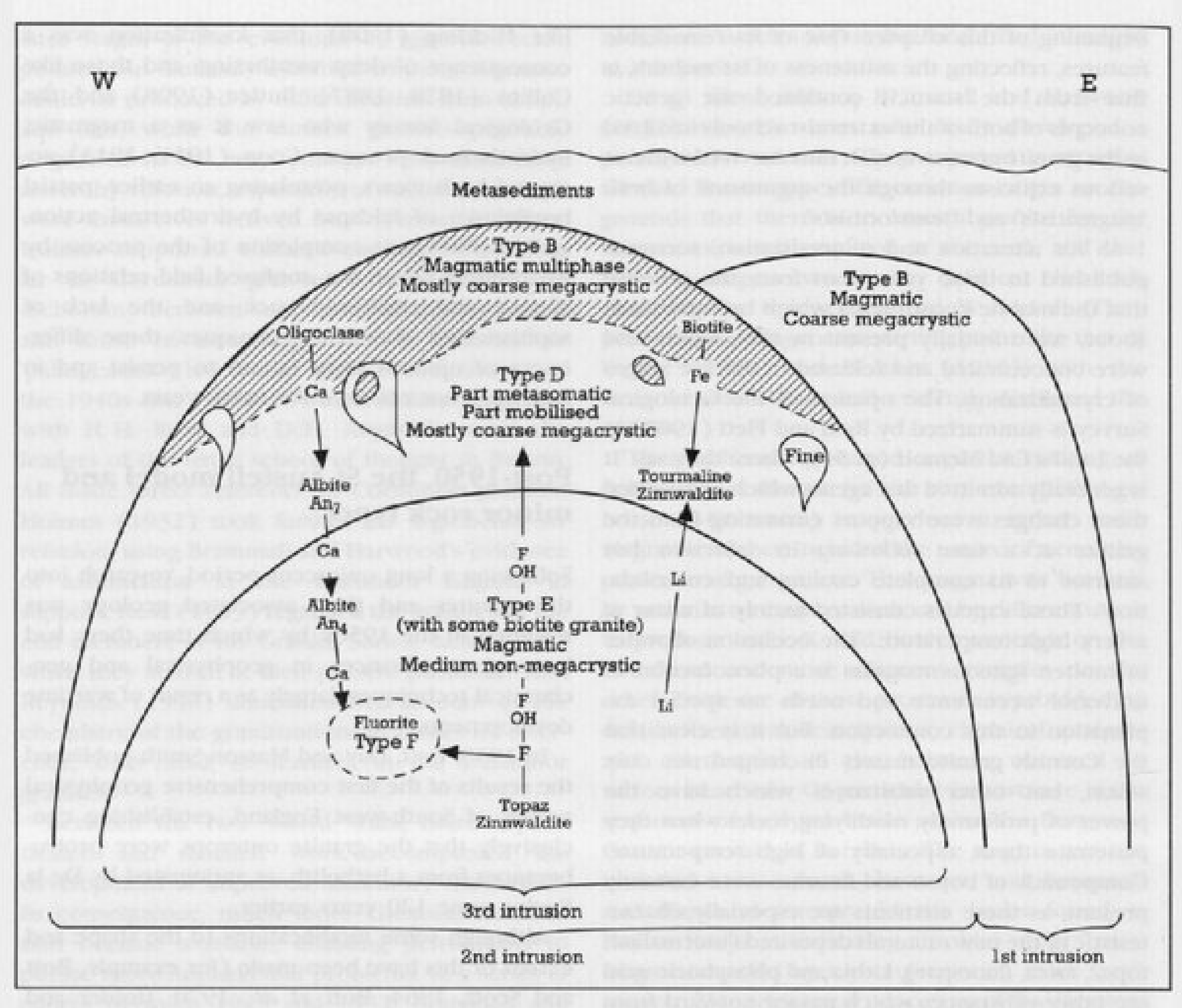
Conclusions

This site provides a rare exposure of relatively fresh, metasomatically originated, megacrystic Li-mica granite, which is one of the main varieties of the St Austell outcrop.

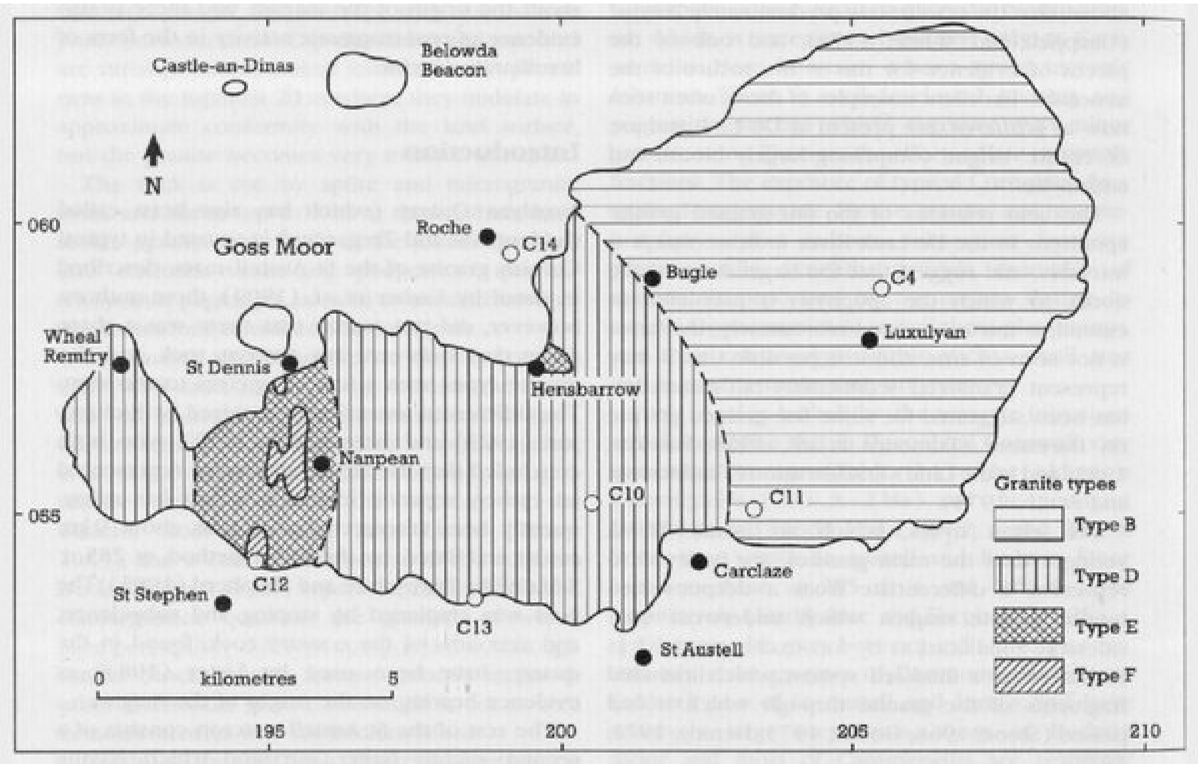
References

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_{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)



(Figure 5.4) The St Austell model. Diagram showing the first intrusion of Type-B granite (Table 5.1) cut by multiphase second intrusion of biotite granite, with metasomatic aureole of Type D caused by intrusion of Type E.



(Figure 5.10) Map of the St Austell Granite outcrop, showing the chief granite types, localities mentioned in the text (filled circles) and the following sites: C4 = Luxulyan Quarry; C10 = Wheal Martyn; C11 = Cam Grey Rock; C12 = Tregargus Quarries; C13 = St Mewan Beacon; and C14 = Roche Rock.