C13 St Mewan Beacon

[SW 985 534]

Highlights

This site displays a rare exposure of quartz-topaz-tourmaline rock of hydrothermal origin, formed immediately under the metamorphic rocks of the granite roof.

Introduction

St Mewan Beacon is situated on the southern margin of the St Austell Granite, 3 km WNW of St Austell and just outside the Blackpool china-clay pit (Figure 5.10).

The St Austell Granite was emplaced in three episodes, the second of which cuts across the first, near St Dennis (Figure 5.4). Both the first and the second consist of megacrystic biotite granite of typical Cornubian type (Type B, (Table 5.1); Exley and Stone, 1982). A third intrusion of Li-mica–albite–topaz granite (Type E, (Table 5.1)) was emplaced within the second boss, and this is now exposed between St Dennis and St Stephen and near Hensbarrow Beacon. It is believed to have been derived from biotite granite at depth (see 'Petrogenesis' section and site descriptions) and upon emplacement to have metasomatized much of the second intrusion, albitizing the oligoclase, converting biotite to zinnwaldite and introducing topaz. It is this type of granite (Type D, (Table 5.1)) which is adjacent to St Mewan Beacon. Accompanying and following these intrusions, the introduction of boron gave rise to extensive tourmalinization which preceded greisening, metalliferous mineralization and kaolinization (Manning and Exley, 1984).

Field relations, textures and composition have, in the past, been used to suggest either a 'pneumatolytic' (Ussher *et al.,* 1909) or 'magmatic' (Collins and Coon, 1914) origin for the rocks of the Beacon, but Manning (1981) and Pichavant and Manning (1984) have concluded, from fluid-inclusion and other experimental data, that the rock was formed by complex hydrothermal processes.

Description

The rocks exposed at St Mewan make up a line of low crags along the south-facing slope. Storage tanks now occupy a small quarry at the western end, from which rock was formerly taken to pave grinding mills for china stone.

For the most part, the rocks are equigranular, fine- to medium-grained and made up of quartz and topaz with subordinate tourmaline, but banded quartz-tourmaline rock occurs in the southern side of the quarry, the banding dipping at about 40° to the south. The suite forms a contact facies between the main part of the granite, which is very kaolinized here, and its country rock consisting of tourmalinized pelites, semipelites and psammites of the Lower Devonian Meadfoot Group (Collins and Coon, 1914).

Interpretation

In addition to the quartz, topaz and tourmaline, the rocks of the Beacon contain accessory muscovite (sometimes as a replacement for topaz), apatite and opaque ore. The proportions of the main minerals vary to give rocks which may be very quartz- or tourmaline-rich, especially near the margins of the outcrop, but the average composition is about 60% quartz, 25% topaz and 15% tourmaline. They therefore fit into the St Austell sequence after the main intrusions and metasomatism, and before the main post-magmatic tourmalinization (between Stage III and Stage IIIb of (Table 2.2)). However, not only are these unusual rocks very hard, but experiments on melting relations and fluid-inclusion composition suggest that they are too refractory to have been produced from a straightforward magmatic melt, although they could have crystallized in equilibrium with saline hydrothermal fluid at about 620°C (Manning, 1981). The latter

would link them to the hydrothermal (i.e. high-temperature, low-pressure) mineralization stage; occasional exposures of comparable rocks are found in clay workings and mines, although these are seldom long-lived enough and accessible enough to be examined. Manning (1981) concludes that 'multistage and complex processes' were involved, but that more work is required on stability relations in highly saline systems containing B, F and OH in order to advance knowledge of these systems and processes further. The commencement of such work is reported in Pichavant and Manning (1984), where it is concluded that in the H_2O -saturated system Q_2 -Ab-Or- H_2O added B partitions into the vapour phase while added F partitions into the melt, and that added B effects little change in the minimum melt compositions.

St Mewan Beacon provides a rare chance to see an unusual topaz-rich rock of high-temperature hydrothermal origin arising in the change from late- to post-magmatic conditions and providing a link in the evolutionary continuum. It is unlikely to have crystallized from an ordinary melt, and is probably the result of interaction between magma and a volatile phase rich in F, B and OH.

Conclusions

St Mewan Beacon consists of an igneous rock made up predominantly of the minerals: quartz, tourmaline and topaz, believed to have formed within the topmost portion (roof) of part of the St Austell granite intrusion. It has been suggested that it formed by the modification of solidifying granite magma by hot (hydrothermal) solutions containing fluorine, boron and water, through the alteration and reorganization of the chemistry and mineral content of the crystallizing granite. The fluids were a legacy of the waning igneous activity which formed the Cornubian granites. The site provides a rare chance to see an unusual rock of high-temperature origin arising in the change from late- to post-magmatic conditions and providing a link in the evolutionary continuum.

References



(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.



(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.

Type	Description	Texture	Minerals (ap	proximate mean Plarrioclase	n modal am	Other names in literature				
A	Basic microgranite	Medium to fine; ophitic to hypidiomorphic	(Amounts vary)	Olipoclase- andesine (amounts vary)	(Amounts vary)	Biotite predominant; some muscovite	Othen present	Hornblende, apatite, zircon, ore, gazzet	Basic segregations (Reid et al., 1912); Basic inclusions (Brammall and Harwood, 1923, 1926)	
B	Coarse-grained megacrystic buoite grantle , 11 cm hypitionsorphic, grantlar		Euhedral to subhedral, mibhedral to microperfiliation and the subhedral Offen (32%) AngrAng, rims AngrAng, (22%)		Irrequiar (34%) ciantes (6%); mascovite (4%)		Exhedral to ashedral. Often socied. Primary' (1%)	Zirron, ere, spatin, undabasto, etc. (total, 1%)	Includes: Giant or tor grazzie (Brammall, 1826; Brammall and Barwood, 1023; 1853) = big is foldspar grazine (Edmonds et al., 1863), coarse megacrystic grazite (Brawnall, 1866; Brammall and Barwood, 1863; 1853) = poorly megacrystic grazzie (Giamonds et al., 1986; coarse megacrystic grazzie (mesocrystic type) (Barwall megacrystic trained (Damperfold and Reviews, 1991). Alar medium-grazzie (Giamonds, 1992) (Barwall megacrystic trained (Damperfold and Reviews, 1991). Alar medium-grazzie (Barwise and Damperfold, 1978), medium-grazzie (Barwise, 1981). Barwise, 1991). Mar- medium-grazzie (Barwise, 1981). Barwise, 1991). Mar- medium-grazzie (Barwise, 1981). Barwise, 1991), marc (Damperfold and Braines, 1981). Barwise, 1991), diotic grazzie, 1993). Biotic grazzie, equiprendat (Biotic grazzie, end globular quarts grazzie (Fill and Mezening, 1987).	
c	Pine-grained biotite granite	Mediam to fine, sometimes megacrystic, hypidiomorphic to splitic	Subhedral to anhedral; sometimos microperthitic (30%)	Bahedral to subbedral. Often aoned: cores An ₁₀ -An ₁₃ (26%)	hrægslær (33%)	Biotite 3%; muscovite (7%)	Exhedral to anhedral. Primary' (1%)	Ore, andalusite, fluorite (total, <1%)	Fine granite, megacryst-rich and megacryst-poor types (Hawkee and Dangerbeld, 1978; Dangestield and Hawkee,	
D	Megacrystic lithurs-mica granite	Medium to coarse; menucrysta 1-8.5 cm, mean about 2 cm. Hypidiomorphic, granular	Euhedral to subhedral; microperthitic (87%)	Eshedral to subbedral. Unaoned, Any (26%)	hrregular; some aggregates (36%)	Lithiurs-mica (6%)	Eubodral to anhedral "Primary" (4%)	Pluorite, ore, apatite, topaz (total, 0.5%)	Lithionite gnanite (Pichardson, 1923), Early lithionite gnanite (Earley, 1969), Porphyritic ithionite gnanite (Earley and Stone, 1964), Mogacrystic lithium-mics gnanite (Earley and Stone, 1982)	
E	Equigramlar lithium-mica granite	Medium grained; hypidiomorphie, granular	Anhodral to intentitia'; microperthitic (24%)	Enhodral. Unzoned, An ₄ (32%)	hrregular; some aggregates (30%)	Lithium mica (9%)	Euhedral to anhedral (1%)	Phonete, apartite (total, 2%); topaz (3%)	Late lithiosite grazite (Edey, 1989). Nos-porphytic lithiosite grazite (Edey and Stone, 1946). Median-grained. non-meso-projectic lithium-mics grazite (Edewises and Dangerfield 1978; Equipramile lithium-mics grazite (Edey and Stone, 1962; Topagrazite (Hand Manning, 1967)	
r	Pluorite granite	Medium-grained; hypidiomorphic, granular	Sub-anhedral; microperthitic (27%)	Eshedral. Unsoned, An ₄ (34%)	hregular (30%)	Muscovite (6%)	Abeent	Phoorite (2%), topaz (1%), apatite (<1%)	Gulbertite granice (Richardson, 1923)	

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

S:age	Process	Age (millions of years)*	Depth (km)	Temperature (°C)	Salinity of Buids	Source of beat	Direction of least stress	Main changes in mineralogy			Associated	Comments
								Feldspar	Quartz	Mica	mineralization	Condonnis
1	Emplacement of biorite graxite, ferming main batholith	290-285	73	500-800	•	Magmatic	Variscan (E-W)	-				Biotite granite which now forms eastern part of the St Asseed granite
ш	First phase of post-magmatic absention and mineralization	285-225	2-3	500-1900	Moderate	Magnatic	Initially E - W. then N - 5	Limited greasenination alongside weins			Sn, W	Early greisenization and superalization e.g. Castle-an-Dinas (W
Ша	Emplacement of evolved lithium rich granines and biotite granines in western part of St Austell granice	239-230	2-3	500-600		Magmatic	N - 5					Grazites belonging to this phase may underlie much of the bacholith. Grazites hydraulically fractured
шь	First part of second phase of post-magmatic alteration and mineralization	271-270	72	650-380	Moderate	Mainly migmatic, some radiogenic	N - 5 or NW - SE	Geninemiation converted to quarts, mice and topas by F-rich Buids, mice of gilbertite type. Tournalministics reglaced by tournaline	Repeatedly Inscruzed and Discruzes annealed by Deals growths of quarts	Some re-crystallisation, biotite loses iron which is taken up by isoamaline growth	Sn, W, Cu	Main phase of metalliferous mineralization
Ille	Emplacement of felaitic oburn dylena	278-270	72	600-500	Moderate	Magnatic	N - S				Sa, W. Cu	Further input of magnatic heat
IV	First phase of argilic observation and NW-SE or N-5 quarth-hematike veine and faulting	270-240	71-2	360-300	Moderate to high	Mainly radiogenic, possibly some magmatic or mastle heat	E-W	Na indepent abreed to emection time assemblage, little kacitotie Edidaput: absend to Ulton, maybe some smecthe	Pres siles released by argillation, forms overgrowth on quarts and now iron-stained non-tournaline beauing lodes (NW - SE and N - S)	Mach inos liberated from biotile which is carried out of the grashe to form iron lockes. Some mice hydrated to gilbertile	PerU/Pb/Za	Note: Salinity, lack of kaolinite and change in stress direction. Low importance matalillarous mineralization
				65231		Quies	cent period?					
v	Second phase of anglile alternation. Main period of keolinization Rheep Meansaic apergene alternation?	200 to present	0.2-1.5	50-150	Low	Radiogenic	Variable E. W or N - 5, later becoming vertical	Na deklapna: altered readily to kaolinite <u>K faldmar</u> sitered less readily to kaolinite <u>Reserve</u> altered readily to kaolinite	Free silica released by argillation, forms overgrowths on quarks and some minor quarks veine	Same izor. Eberand from botto, not carried out of grazile so colous merita. Is areas of intense kaolinization mica/lible absend to kaolinite	Pe/U (minor)	Note: Fresh water and main opiasche of keclin formatien. Isositatic uplift may have played a part
VI	Early Teetiary chemical weathering (also Missosotic?)	25-60	0.0-0.3	20-50	Low	High surface temperature	Vertical	Altered kaolinile, is b-azis diaordered in Eccens/Okpcome weathering	Some solution of allice from quarta grains	Some intri liberated from bostne, not carried out of the granite no colours matrix. In areas of intense keofinization moica/files absend to kaolimite		Tertiary weathering material for ball clays and associated sediments

(Table 2.2) Main evolution and alteration stages of the St Austell Granite (after Bristow et al., in press)