Trelavour Downs Pegmatite, Cornwall

[SW 960 575]

Introduction

The Trevalour Downs Pegmatite GCR site exposes a coarsely crystalline pegmatite containing large sheaves of Li-rich biotite (up to 0.15 m in length), originally worked for its lithium content. Compositionally the pegmatite lies at the boundary of the D- and E-types (according to the classification of Exley *et al.,* 1983) of lithium-mica granite making up the St Austell Granite pluton. This pegmatite contains zinnwaldite, a lithium biotite (Selwood *et al.,* 1998). Elsewhere in the surrounding china-clay area similar exposures do occur but are rapidly disappearing. The preserved Trelavour Downs Pegmatite is therefore important to our understanding of the relationship between the volatile, metal-rich late granites and the megacrystic, metal-poor early granites of the Cornubian Batholith.

The Trevalour Downs Pegmatite is located in rough wasteland on the south side of the St Dennis to Whitemoor road, adjacent to extensive china-clay workings and tips, southeast of St Dennis. A shallow circular pit exposes the central quartz-feldspar portion of the pegmatitic body, which was worked for lithium in the early 1900s, as described by Davison (1926a,b). It is important as the selvages of the pegmatite are of 'biotite-rock', with some individual crystals reaching up to 0.15 m in length.

There is little literature specific to the site; Hosking (1952) briefly mentioned the locality, as did Edmonds *et al*. (1975). It was again briefly described by Cundy *et al.* (1960), while Stone *et al.* (1988) presented a single analysis of a Li-rich mica from Trelavour Downs. The pegmatite is not mentioned by Dines (1956), which is probably due to the fact that the pegmatite was not that well-exposed. However, in the 1970s the site was trenched during a mineral exploration exercise, which provided fresh in-situ exposures. Alderton (1993) reported on the likely temperature of the fluids responsible for the Trevalour Downs Pegmatite (500°–600°C), which has a bearing on proposals for its petrogenesis.

Description

Zonation of the rocks, described by Davison (1926b) from the then available exposures, was noteable with a central portion consisting of coarse feldspar and quartz with large 'books' of biotite, surrounded by massive, coarse-grained biotite, in turn surrounded by an outer zone of zinnwaldite and feldspar. Today this zoning cannot be observed due to the current limited exposures.

The important mineralogical and petrological features of the Trevalour Downs site relate to the nature of the micas, and the formation of the pegmatite and its relationship to metallogenesis. Lithium contents of the worked mica were reported by Hosking (1952) as being 1.5 wt%, which is extremely low for zinnwaldite, the figure therefore presumably referring to the biotite, which forms the bulk of the mica content in the deposit. Examples of ferroan zinnwaldite, originally described as biotite, from similar bodies in Gunheath China Clay Pit [SX 005 571] have been documented by Stone (1984), and Stone *et al.* (1988). It therefore seems that micas intermediate in composition between zinnwaldite and biotite may be widespread. Alternatively the 1.5 wt% Li_2O may refer to the overall grading of all mica in the pegmatite, for it is unlikely that the two types would have been readily distinguished at the time of extraction.

The analysis by Cundy *et al.* (1960) of zinnwaldite from Nanpean [SW 961 559] contains 4.10 wt% Li_2O, 5.7 wt% FeO and 6.80 wt% F. Zinnwaldite from type-E granite in Rostowrack Quarry [SW 953 566] contains 4 wt% Li_2O, 9.9 wt% FeO and 6.3 wt% F, but that from type-D granite in Gunheath China Clay Pit contains 2.9 wt% Li_2O, 10.5 wt% FeO and 5.75 wt% F (Stone *et al.,* 1988). The mica from the Trelavour Downs Pegmatite analysed by Stone *et al.* (1988) contained 1.6 wt% Li_2O, and 19.8 wt% FeO. Stone *et al.* (1988) stated that 'specimen E259 is the so-called zinnwaldite from the Trelavour Downs Pegmatite, but despite its high Li and F contents it is actually a lithian "sidero-phyllite" body.' In this discussion it should be remembered that the pegmatite has been described as zoned, the bulk of the mica being biotite. The Trelavour Downs mica analysed by Stone *et al.* (1988) is, in most respects, intermediate between biotite and zinnwaldite. It contains much less-mafic and resitite mineral components than biotite, namely Cr, 'V, Ti, Zr, Ce and Th, but much higher contents of Rb, K, Li, and F.

Interpretation

L. Haynes (pers. comm.) comprehensively reviewed work on the pegmatites of this area, and this report takes account of those studies.

A 'plan' of the geology of the St Austell Granite is shown in (Figure 7.10). The mega-crystic lithium-mica granite (type-D) is now regarded as a metasomatic alteration of biotite granite by a type-E, volatile, lithium-mica granite magma (Manning and Exley, 1984). However, Stone (1984) has argued that textural evidence shows that metasomatism has not simply replaced one mica with another, because the zinnwaldite replaces both the feldspars as well as biotite. Furthermore, residual andalusite in the biotite granites was replaced by topaz at the same time. The conversion therefore represents a total impregnation and re-texturing of biotite granite by largely volatile components.

It has been recorded that in Gunheath China Clay Pit (in the St Austell Granite) a pegmatitic roof-zone is developed in the type-E granite, and its contact with a type-D granite is marked by curved-crystal pegmatites ('stockscheider pegmatite' of Baumann (1970), and Halls (1987)). These pegmatites are also exposed at what has been interpreted by Halls (1987) as the same contact in Goonbarrow Pit, and therefore it is argued that the type-E granite forms an intrusive cupola into the type-D granite, with a pegmatitic margin.

The significance of rhythmic pegmatite crystallization in relation to pulses of mineralization has been discussed at length by Halls (1987) (see (Figure 7.11)). The argument is that the layers of pegmatite represent periods of volatile build-up under the crystallizing cupola, and that the release of the volatiles into simple dilation fractures results in the sheeted-vein complexes of greisen-bordered veins so typical of many Cornish tin deposits. The best examples are found above granite cupolas, as seen at the St Michael's Mount and Cligga Head GCR sites; such a complex is also seen in the Old Beam Mine at Goonbarrow. Further discussion of the pegmatites in the St Austell area is given by Manning and Exley (1984).

Hill and Manning (1987) determined a more complex picture by recognizing several new varieties of granite in this area, beside the normal B-, D- and E-types. How many of these varieties can be argued to represent separate intrusions, as distinct from compositional variations, is not clear, but if the principle that each pulse of magma is roofed by a stockscheider pegmatite is valid then there may be many different granites, albeit resulting from a single period of fractional crystallization.

Not all pegmatites are of a stockscheider-type. In the pegmatite veins in Gunheath China Clay Pit, microcline, quartz and zinnwaldite are the major constituents, but accessory apatite, topaz, opal and columbite are also present. The columbite is particularly rich in tungsten and scandium, and it is best developed in a vertical lens of unusual composition, consisting entirely of quartz, 'gilbertite' (secondary white mica) and apatite, with rare accessory torbernite.

The above observations made from other sites of pegmatite formation raise questions concerning the nature of the Trelavour Downs Pegmatite. It does not have the shape or attitude of a stockscheider pegmatite, for its alignment is not parallel to the supposed contact of the type-E granite. However, as it was targeted for mineral exploration in the 1970s, it was probably thought to be related to late-magmatic phenomena and tin mineralization (see Badham *et al.,* 1976). Perhaps the full lateral extent of the pegmatite has not been recognized, or perhaps it is part of a general pegmatite zone along the contact.

The Trelavour Downs Pegmatite was originally described as a zoned body with an outer selvage containing zinnwaldite. This might suggest that an original biotite pegmatite has been metasomatized by intrusion of adjacent type-E granite, and that an outer zinnwaldite-feldspar selvage was formed at this time, in addition to modification of the original biotite composition.

Hosking (1952) classified pegmatites temporally in relation to granite emplacement and their content of ore minerals. It is possible that those pegmatite-like bodies carrying mineralization (dominantly W and As but occasionally Sn and Cu) were zones of barren pegmatization (sometimes of stockscheider-type) which had been subjected to later mineralization (Hosking, 1964).

Manning (1983) noted the presence of disseminated tin sulphides in the high-lithium varieties of the St Austell Granite, while arsenic minerals are present in the roof complex of the other lithium-mica granite at Tregonning–Godolphin. Stone (1984) argued that minute cassiterite grains are probably ubiquitous inclusions in lithium micas, although there is no evidence that they are more abundant in pegmatite micas than in the micas of normal type-E granite. Most pegmatites may be mineralogically interesting, in containing large feldspar or tourmaline crystals, occasionally topaz, columbite and other rare minerals; but they are not usually metallogenetically important.

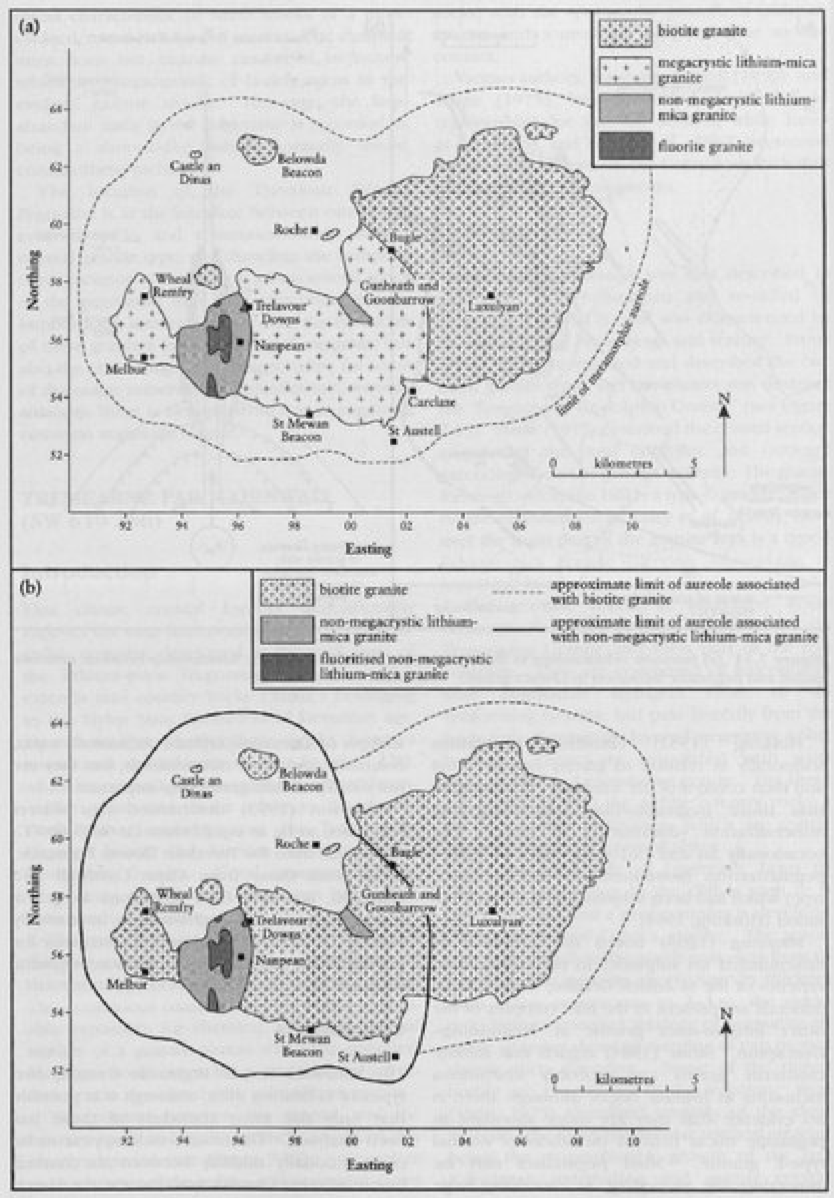
Alderton (1993) determined that waters calculated to be in equilibrium (at 500°–600°C) with micas from the Trevalour Downs Pegmatite, along with those from Cape Cornwall and Halvosso, and also fluid inclusions in quartz from a pegmatite at Goonbarrow Pit, have widely varying 'D' contents but show a similar range for granitic fluids, suggestive of a common magmatic source.

Conclusions

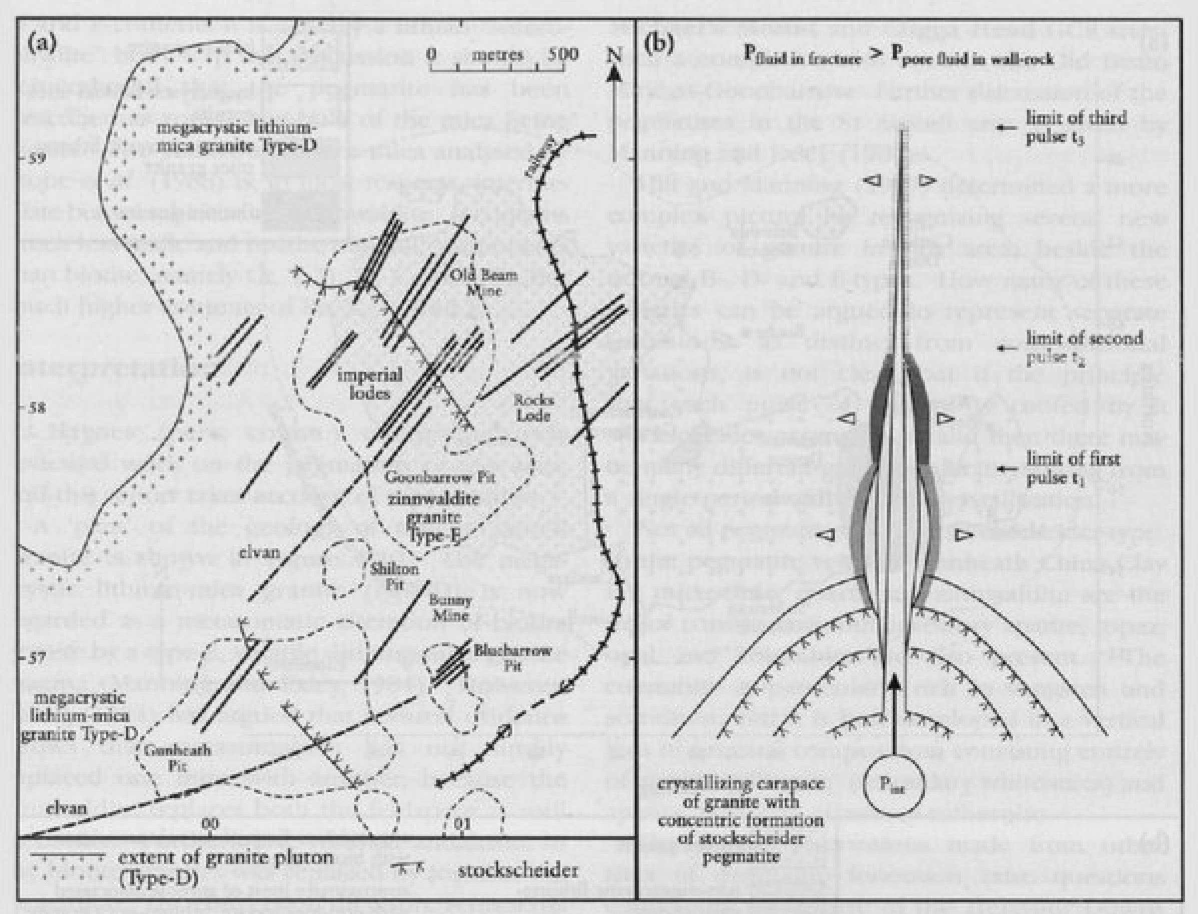
The Trelavour Downs Pegmatite contains two types of Li-bearing mica, although it is possible that only the most abundant of these has been analysed. This mica would appear to lie compositionally midway between the normal biotite of most Cornish granites and the Li-rich micas characteristic of small stocks of a more evolved, metal-rich type of granite. The analysed mica does not contain cassiterite inclusions which are characteristic of Li-rich micas in the evolved granite stocks. However, the less-abundant mica in the pegmatite is recorded as being a zinnwaldite, which normally would contain these inclusions.

The location of the Trevalour Downs Pegmatite is at the interface between one of the evolved stocks and a metasomatically altered normal granite type, and therefore the compositional variation of these micas across several zones of the pegmatite may have important genetic implications, concerning not only the evolution of these granites from volatile-rich magmas, but also the evolution of fluids responsible for some of the major mineralizing episodes in Cornwall, although there is isotopic evidence to suggest a common magmatic source.

References



(Figure 7.10) 4 (a) Distribution of the granite varieties in the St Austell area (after Exley and Stone, 1982). (b) Simplified map of the primary granite varieties of the St Austell area and their metamorphic aureoles (new interpretation after Manning and Exley, 1984).



(Figure 7.11) (a) Intrusive relationships in the Hensbarrow Granite stock. (b) Relationship between mineralization and pegmatite formation in Li-mica granite. After Halls (1987).