Ffestiniog Granite Quarry

[SH 695 453]

Introduction

The Ffestiniog Granite Quarry in the Tan y Grisiau Microgranite intrusion (Figure 5.39) exposes a rare occurrence of allanite mineralization, present both as an accessory phase in the granite itself, and more interestingly in veins and cavities in the roof zone of the intrusion.

The Tan y Grisiau Microgranite is one of a small number of silicic intrusions exposed in Snowdonia which lie outside of the, main area of Snowdon Caldera subsidence which developed during the 2nd Eruptive Cycle in Ordovician (Caradoc) times (Howells *et al.,* 1991). The intrusion invades Lower Ordovician (Tremadoc) strata comprising well-bedded, medium- to fine-grained sandstones and siltstones of the Upper Sandstone Member of the Dol-cyn-afon Formation (Howells and Smith, 1997), which show clearly the effects of contact metamorphism.

The age of the Tan y Grisiau intrusion has long been a subject of debate, being variably assigned a Caradoc or late-stage 'Caledonian' (i.e. late Silurian to early Devonian) age (see, for example, Read, 1961; Fitch *et al.,* 1963; Thomas *et al.,* 1966).. However, recent studies have helped to constrain its Caradoc age. To the south-west of Tan y Grisiau, granophyric apophyses and veins cut strata of Arenig age, and transgress both the mid-Caradoc unconformity (Smith *et* ed., 1995) and the disrupted strata within the Rhyd mélange (Bromley, 1969; Smith, 1988; Howells and Smith, 1997). Most important, however, is the fact that hornfelsing effects of the intrusion are found in rocks of the Moelwyn Volcanic Formation, of Costonian-Harnagian (Caradoc) age (Bromley, 1963, 1969), while younger strata are not affected. Thus the intrusion is constrained to the Caradoc, and is thought to be a sub-volcanic intrusion linked to the Snowdon Volcanic Group activity. Additional support for this correlation is provided by the geochemistry of the intrusion. Compositionally, taking account of trace-element concentrations, the intrusion has rhyolitic to rhyodacitic affinities, and a comparison has been drawn between the chemistry of the Tan y Grisiau Microgranite and rhyolitic lavas and tuffs of the Lower Rhyolitic Tuff Formation of central Snowdonia (Howells *et al.,* 1991). In contrast, K-Ar and Rb-Sr isotopic determinations have indicated a younger age, but these dates have almost certainly been affected by low-grade metamorphism during the Acadian Orogeny (Evans, 1991).

The Tan y Grisiau intrusion has an exposed surface area of *c.* 4 km^2, with the outcrop pattern of a truncated ellipsoid. However, the broad area of rocks showing the effects of contact metamorphism, combined with geophysical evidence, suggests that the intrusion is in fact a much larger body at depth (Howells and Smith, 1997). Available geophysical data have been interpreted as demonstrating a steep-sided, sub-vertical body, stretching some 10 km to the north-east and 5 km to the south-west of the main exposed area, with a roof that dips to the NNW (Cornwell *et al.,* 1980; Campbell *et al.,* 1985).

The intrusion is best exposed in the Ffestiniog Granite Quarry at Cefn Bychan, where its roof zone is exposed, along with its contact with the overlying Tremadoc sedimentary rocks (Figure 5.40). The contact dips to the north-west at 40°.

The presence of allanite mineralization at the quarry was first noted as early as 1908, by W.G. Fearnsides during a Geologists' Association field excursion to North Wales (Fearnsides, 1910). However, he could not identify the mineral that he had found in a narrow pegmatite-like vein in the north-west face of the quarry, and forwarded the 'peculiar mineral' to H.H. Thomas, of the Geological Survey. Thomas (1909) reported that the mineral was in fact 'orthite' (now called 'allanite'). Little further attention was paid to this occurrence until the area around Blaenau Ffestiniog was investigated by Bromley (1963). As part of a broad investigation into the Ordovician geology of the area, and in particular of its igneous history, he noted that not only does allanite occur in the veins and pods of the roof zone of the Tan y Grisiau intrusion, but that also it is an important accessory mineral in the microgranite itself (Bromley, 1964). Subsequently, Roberts (1979) made a brief reference to the allanite mineralization in the Ffestiniog Granite Quarry.

Description

The Tan y Grisiau Microgranite chiefly comprises a homogenous, equigranular, grey-green rock, with an average grain-size of between 2 mm and 4 mm. It is composed mainly of plagioclase (albite–oligoclase), microperthitic alkali feldspar, quartz, dark clots of chloritized biotite and rare ferrohastingsite (Bromley, 1964, 1969). Accessory minerals include magnetite, zircon and allanite, along with minor titanite, monazite and fluorite. Bromley (1964) noted two occurrences of allanite in the body of the granite. Firstly, it is present as small, euhedral crystals up to 1 mm in length, partly or completely surrounded by chlorite, which apparently crystallized at a late stage, and secondly replacing the orthoclase component of microperthite crystals, resulting in intergrowths of plagioclase and allanite.

The roof zone of the intrusion shows particular characteristics. Exposed in the northern face of the Ffestiniog Granite Quarry, the granite here is fine grained, and highly vesicular. The original mineralogy has mostly been replaced, with the orthoclase component of the microperthite converted to muscovite and the plagioclase component replaced by albite, granular calcite and quartz. All mafic phases are pseudomorphed by chlorite. This zone is also characterized by veins with graphic pegmatites and granite apophyses, and contains rounded metasomatized xenoliths. It is in this zone that the richest allanite mineralization occurs.

In the roof zone of the intrusion, allanite is also present in narrow (up to 3 cm wide) veins and broad (30 cm diameter) cavities which have a drusy character. Allanite crystals are prismatic to tabular in character, are orientated parallel to the *b* crystallographic axis, and reach up to 10 mm in length. The crystals are typically compositionally zoned and are usually twinned. Epidote, occurring as crystallographic overgrowths, is common. The mineral assemblage also contains quartz, chlorite, pyrite, molybdenite, pyrophyllite (Roberts, 1979) and calcite. Bromley (1964) also noted the presence of strong pleochroic haloes in chlorite surrounding allanite crystals, as well as possible alpha particle tracks as dark lines in surrounding calcite crystals, suggesting that the allanite crystals may contain significant radiogenic element concentrations.

Interpretation

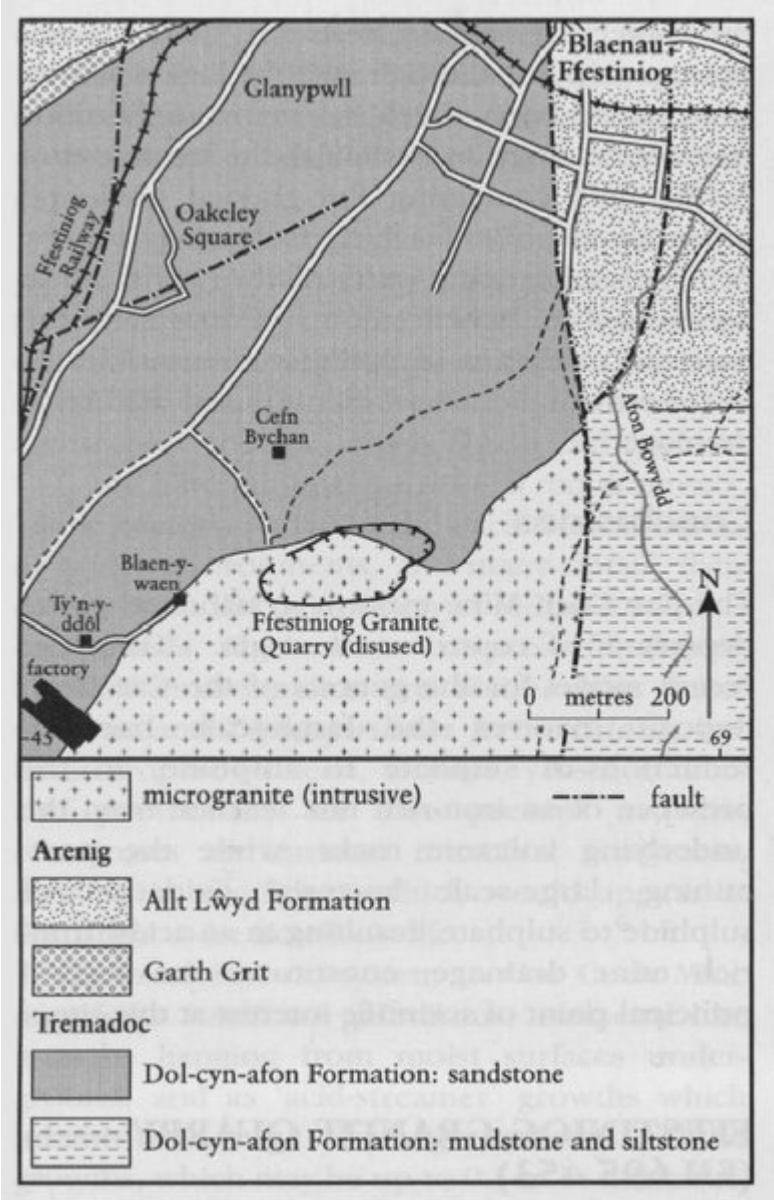
Bromley (1964) considered that the allanite (and presumably the other minerals present in the veins and cavities) crystallized during a period of post-magmatic hydrothermal activity, in which volatiles were concentrated preferentially in the roof zone of the intrusion, a contention supported by Roberts (1979).

Campbell *et al.* (1987) identified five geochemically distinct groups of high-level rhyolites associated with the (Ordovician) Snowdon Caldera. Contents of certain trace elements vary markedly between the two groups, including the rare earth elements (REE), with the highest REE concentrations being in the B1 rhyolites, exposed for example at Bylchau Teyrn [SH 6170 5076], and it is possible that the Tan y Grisiau Microgranite intrusion represents a deeper-level representative of the Group B1 rhyolites. Unfortunately, there are no published REE analyses for the Tan y Grisiau intrusion.

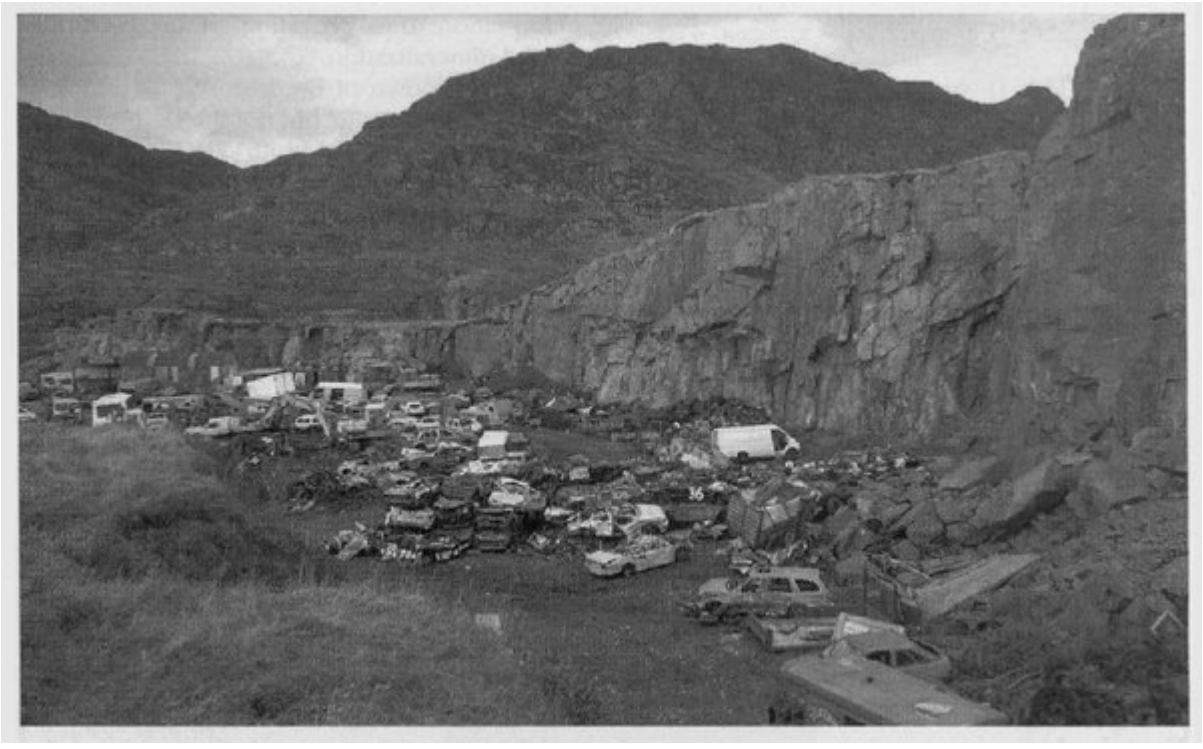
Conclusions

Allanite, a comparatively uncommon rare-earth-element-bearing hydrous silicate mineral, is found in the Tan y Grisiau Microgranite intrusion, exposed at the Ffestiniog Granite Quarry: It occurs not only in the body of the granite, replacing K-feldspar and as small, well-formed crystals in chlorite, but also in veins and cavities cutting the intrusion. It is thought to have been generated at a late stage in the history of magma cooling, when volatiles were trapped in the roof zone of the intrusion.

References



(Figure 5.39) Map of the Ffestiniog Granite Quarry GCR site. After British Geological Survey 1:50 000 Sheet 119, Snowdon (1997).



(Figure 5.40) Photograph of the Ffestiniog Granite Quarry GCR site, exposing the roof zone of the intrusion. (Photo: R. Mathews.)