# C16 Meldon Aplite Quarries

[SX 567 921]

## Highlights

Meldon Quarries is a classic site which contains a unique, late-stage aplitic dyke with a variable texture and composition, and a very wide range of unusual minerals both within the dyke and in associated veins. There has been metasomatism of semipelitic and calcareous sediments by elements introduced in association with the dyke.

## Introduction

This site is about 4 km south-west of Okehampton, and comprises two small quarries in the Meldon 'Aplite' Dyke and adjacent metasediments, together with much older quarries in nearby calcareous metasediments. It is famous for the variety of lithium-, beryllium-, boron-, fluorine-, sulphur-and rare-element-bearing minerals occurring in both the dyke, which has a unique composition (Edmonds *et al.,* 1968), and the metasediments (Worth, 1920; Dearman and Butcher, 1959; Kingsbury, 1961, 1964, 1970; Mackenzie, 1972; Chaudry and Howie, 1973, 1976; Hawkes, 1982; von Knorring and Condliffe, 1984).

The dyke was intruded into the Carboniferous Lower Cu1m sediments lying within the metamorphic aureole of the Dartmoor Granite mass. These form steep, overturned folds (Dearman and Butcher, 1959; Edmonds *et al.,* 1968), which are now thought to be linked with the northward thrusting of a nappe from the south (Selwood and Thomas, 1984). The mineralogy of these metasediments varies not only with their original composition and its modification by thermal metamorphism, but also with the degree to which they suffered metasomatism associated with the intrusion of the dyke.

## Description

The Meldon Dyke is probably at least 3 km long, running north-east from Sourton Tors to the Meldon Railway Quarry (Worth, 1920; Hawkes, 1982), but outcrops are intermittent, and thickness is variable both along the strike and vertically. The dyke often splits into smaller veins and apophyses and does not always reach the present surface. In the larger of the two quarries on the site, south of the Red-a-Ven Brook, the dyke is about 20 m wide at the lowest level, but it separates into several branches at higher levels, where the thickest member is some 10 m thick. The dip is about 50° to the south-east. In the smaller quarry, on the north side of the brook, the dyke is made up of several branches, the thickest being only about 4 m. In the Railway Quarry, 500 to 600 m away, only thin stringers of aplite are found (these thicknesses refer to those in the former working faces).

The dyke is parallel with and about 1.5 km distant from the margin of the main Dartmoor Granite intrusion, and it is of the same age, i.e. about 280 Ma (Darbyshire and Shepherd, 1985). It is not quite parallel with the strike of the aureole metasediments, and cuts obliquely across the junction between the Meldon Chert Formation and the underlying Meldon Shales-and-Quartzite Formation, both of which are of Lower Culm Measures (Namurian) age (Dearman, 1959; Dearman and Butcher, 1959). The structure of this area is complex, consisting of a pair of antiforms overturned against the granite to the south-east and separated by a shallow, asymmetrical synform. The antiforms occur in the Meldon Shales-and-Quartzite Formation, the Meldon Chert Formation forming the core of the intervening synform. Formerly thought to be an overturned fold (Dearman, 1959; Dearman and Butcher, 1959; Edmonds *et al.,* 1968), the structure has been reinterpreted from evidence along strike by Selwood and Thomas (1984), who believe the Meldon Shales-and-Quartzite Formation and part of the overlying Crackington Formation to be allochthonous and to have been thrust into their present positions as a nappe from the south, before the intrusion of the dyke. The remaining Crackington Formation was subsequently thrust up from the north. All of the beds have northwesterly dips at various angles, however, and the aplite is situated on the south-easterly limb of the synform where a fault has developed and the dip of the metasediments is about 30°.

The Meldon Shales-and-Quartzite Formation was originally composed of interbedded mudstones and siltstones with, towards the top, a volcanic sequence of spilitic and keratophyric agglomerates and tuffs, and an uppermost group of shales and quartzites. The sedimentary nature of the pyroclastic deposits is emphasized by Dearman and Butcher (1959). As a consequence of thermal metamorphism by the granite, these rocks have been hornfelsed, the semipelitic varieties being characterized by biotite, chiastolite and andalusite, and the metavolcanic rocks by amphibole, pyroxene and garnet.

The Meldon Chert Formation originated as a series of bedded limestones and cherts (hence the old term Weldon Calcareous Group') whose relationships are well seen in the bank of the West Okement River in the north-west corner of the site. Depending on composition, they have been thermally metamorphosed into more-or-less pure marbles and 'calc-flintas', the latter predominating, with the development of wollastonite and grossularite. However, it is not possible entirely to separate purely thermal from metasomatic effects in the vicinity of the dyke and many other minerals occur in the metasediments. They include axinite, andradite, idocrase, hedenbergite, hornblende and tourmaline.

The aplite itself is a predominantly fine grained, equigranular rock with euhedral to subhedral laths of albite, anhedral orthoclase, quartz and a small amount of lepidolite. It is considerably more sodic, less potassic and less siliceous than the average Dartmoor Granite and these features, combined with the presence of lithium, were said by Edmonds *et al.* (1968) to make it unique in Britain. The chief accessory minerals, amounting to about 5% , are topaz and elbaite. The last mineral is usually pale green, but often has pink zones suggestive of the rubellite which is present in later hydrothermal veins and their metasomatized aureoles. The dyke is mostly white and consists of albite, quartz and pinkish lepidolite. There are, however, bluish marginal facies containing quartz, albite and accessory orthoclase, tourmaline, apatite and colourless lepidolite. There are also patches of a coarser brown rock, with an increased quartz and pink or brown lepidolite content and tourmaline, topaz, fluorite and apatite. It often shows mineral banding (Chaudry and Howie, 1976) and also includes streaks and pockets of pegmatite in which orthoclase is a significant phase and, in addition to the rock-forming minerals already named, such species as petalite, fluorite and apatite occur.

Chaudry and Howie (1973) have separated the pegmatites into two types, one containing albite and elbaite, and the other containing topaz and petalite. The lepidolite in the pegmatites is of a lower-temperature variety than that in the aplite proper (Chaudry and Howie, 1973), and there are resemblances to lepidolites found at Megilig-gar Rocks (Stone *et al.,* 1988). Many other minerals occur, either sporadically as accessories or in a more concentrated fashion along joints, in veins or in drusy cavities. Axinite is particularly well developed in cross-cutting 'reaction veins' (Mackenzie, 1972). Lithium-bearing varieties include, in addition to the micas, amblygonite and spondumene; and beryllium-bearing species include not only beryl, but also beryllonite, chrysoberyl, eudidymite, milarite, rhodizite and bavenite. There are also the zeolites heulandite and stilbite, the clay montmorillonite, the boron-bearing species datolite, and others such as pollucite (caesium), palygorskite, prehnite and columbite (niobium). Moreover, the late sulphide mineralization, which was extensively developed in the area of the nearby Red-a-Ven Mine, has given rise to the presence (especially in the metasediments) of pyrite, chalcopyrite, pyrrhotite and arsenopyrite.

## Interpretation

This site illustrates both the normal development of an aplitic dyke associated with a granite in the metamorphic aureole, and the unusual concentration of minor elements and volatile constituents characteristic of the Cornubian batholith. As with the aplites of the Tregonning Granite roof complex, so well seen at Rinsey Cove and Megiliggar Rocks, the Meldon Aplite formed at a late stage when Li, Be, Rb, B, F and OH were highly concentrated, and it provided a route by which S compounds could travel out of the parent granite at a later stage. While no direct link between the dyke and the Dartmoor Granite has yet been identified, clearly there was one; it may still exist at depth or it might have been broken by tectonic activity.

The relations between aplite and pegmatite and their dependence on the partitioning of K into an aqueous phase and Na into a silicate liquid phase, have been noted in other site descriptions, for example, Megiliggar Rocks. These are all roof complexes, however, whereas the Meldon Dyke, showing similar phenomena, has developed away from the granite body.

There have been virtually no recorded discussions as to why and how the aplite magma, with its remarkable composition and range of unusual mineral phases, should have developed so locally and asymmetrically with respect to the main granite. It seems certain that it evolved in a cusp on the side of the batholith where volatiles were concentrated. It was noted in the 'Petrogenesis' section that mineralization and lithium enrichment are thought to be associated with a second major intrusive event at about 270 Ma and the resemblance between the Meldon Aplite and the Kinsey Cove and Megiliggar aplites and pegmatites strongly suggests that it belongs to this episode. Although no conclusive evidence of the 270 Ma event has been found on Dartmoor, and, as stated above, the Meldon Dyke has been dated at 280 Ma, Knox and Johnson (1990) have described post-main granite intrusions including fine- to medium-grained leucocratic topaz- and tourmaline-granite from the Lee Moor area.

The site demonstrates the metasomatic development of minerals carrying the various elements noted above and the sequential crystallization of some of them in various rock types, both igneous and metamorphic. Minerals with such elements as Be tend to precede those with Li, Rb, B and F, while those with much OH, such as zeolites and clays, are the youngest. Although groups of these minerals are to be found commonly elsewhere in the mineralized zone of the batholith, nowhere else is there so wide a variety in so small an area.

## Conclusions

Here a steeply dipping igneous intrusion, the Meldon Aplite Dyke, 20 m wide at its maximum, cuts through the baked sedimentary rocks which surround the Dartmoor Granite. The aplite, a fine-grained, pale-coloured granitic rock consisting normally of the minerals quartz and feldspar, was intruded at the end of the last major phase of igneous activity in this part of Britain, between 280 and 270 million years ago. Like the main Dartmoor Granite mass, the aplite baked and chemically altered the surrounding rocks into which it was injected: thus the chemical changes wrought by the granite were overprinted by further metamorphism imposed by the dyke. The aplite, which was one of the final products of the magmas which had formed the granites of the south-west peninsula, was responsible for a uniquely diverse suite of minerals both within itself, and through the reactions of the penetrative hot solutions which flowed outward from it, with the surrounding metamorphosed sediments.

**References**