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## B17 Pitts Cleave Quarry

[SX 501 761]

### Highlights

The section here exposes a massive, uniquely columnar-jointed, multiple greenstone body showing an intrusive relationship to early Carboniferous sediments. The greenstone is a typical example of a mildly metamorphosed dolerite within the aureole of the Dartmoor Granite.

### Introduction

The site includes all the levels and faces of the old, now disused, roadstone quarry about 3 km to the north-east of Tavistock. In all, a nearly continuous horizontal section of about 400 m is here exposed in a massive greenstone.

Within the early Carboniferous country rocks along the western margin of the Dartmoor Granite between Tavistock and Peter Tavy, many massive intrusive greenstones ranging in thickness from a few to one hundred metres can be found. As with many of the volcanics in central south-west England they are confined to the Greystone Nappe. They are predominantly lenticular sill-like intrusions emplaced in mainly Viséan (Lower Culm Measures) argillites and cherts. In the Survey Memoir (Reid *et al.*, 1911) two types of greenstone were recognized depending on the degree of deformation suffered, such that 'albite diabases' still have their original ophitic texture preserved, whereas 'diabase schists' are foliated. Some of the intrusions have been subsequently contact metamorphosed to hornfelses by the adjacent Dartmoor Granite. The diabases are now recognized as variably degraded, low-grade regionally metamorphosed and deformed dolerites and basalts. Metamorphism within the allochthon of the Tavistock–Launceston area was generally syndeformational and low-grade, with temperatures of between 200–300°C and pressures in the range 0.3–1.0 kbar (Isaac, 1982).

The greenstone suite in the area around Peter Tavy differs in petrography and time of emplacement to similar intrusives found in the Meldon district to the north. The former suite (within which the site is situated) were intruded prior to the main deformational episode and they have been sheared and folded, whereas the Meldon group are post-deformational, but pre-granite in emplacement (Dearman and Butcher, 1959). Butcher (1958) considered that all the various greenstones were related via a single process of magmatic differentiation (such as fractional crystallization, although this view is no longer tenable on chemical grounds). However, little recent chemical work is available for the Petertavy suite of greenstones, although a few analyses from the Pitts Cleave greenstone (Parker, 1970) show it to be a moderately evolved Ti-rich alkali dolerite. The particularly high  $IC_2O$  content probably reflects the effects of potassium metasomatism from the nearby Dartmoor Granite.

### Description

Within the N–S-trending long face of the quarry can be seen the lenticular form of the sill, as well as large elongate rafts of hard, baked and spotted argillite (Figure 4.41) that divide the body into an upper and lower portion (Dearman and Butcher, 1959). The southern face shows spectacular curved columnar jointing in the upper sill, a feature rarely seen in the massive greenstones where most joints are more irregular (Figure 4.42). The change in attitude of the contact between the sediments and the sill from the southern end (nearly horizontal) towards the north (nearly vertical) suggests that a single limb of a recumbent fold may be exposed in the quarry (Dearman and Butcher, 1959).

The sill was originally a medium-grained, ophitic dolerite with finer-grained, often vesicular, margins. Owing to the effects of regional metamorphism it is strictly a metadolerite, with primary textures and minerals still discernible in the less-altered central part of the body. Typical alteration effects include a uralitic fringe of actinolite to primary, purple, titaniferous augite and the partial replacement of calcic plagioclase by albite, epidote and sometimes carbonate. Mafic

minerals in contact zones can be completely pseudomorphed by chlorite and/or actinolite. Apatite and ilmenite are common accessories, although the latter may be skeletal and leucoxenized. The development of minor biotite after secondary chlorite is probably the only manifestation of the effects of contact metamorphism at a horizontal distance of c. 3 km from the granite. At the northern end of the quarry (upper 150 m level) have been found rare 'cognate inclusions' of clinopyroxene and brown amphibole megacrysts together with sporadic fragments of enclosed sediment (Butcher, 1982).

## Interpretation

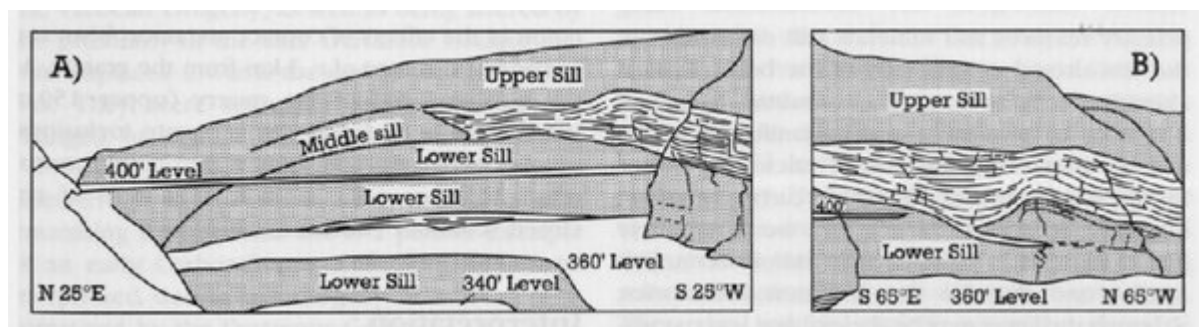
This site typifies a deep-level emplacement of major greenstone bodies into the early Carboniferous of the Greystone Nappe of central southwest England. Relative to the chemically similar alkali dolerite sills intruded at high levels into late Devonian strata in north Cornwall, many of the bodies in this area were apparently emplaced at a greater depth and into consolidated sediments. Together with extrusive lavas and volcanoclastics, these sills represent one of the major effects of volcanism associated with basinal sedimentation. In the example here, intrusion appears to have been relatively deep in the sedimentary pile, with the massive dolerite sill enclosing rafts of consolidated argillites that were subsequently baked and thermally spotted. The site is unique among south-west England greenstones in exhibiting curved columnar jointing that may be related to a curved or undulating upper cooling surface.

Apart from typical secondary assemblages produced by regional metamorphism, the metadolerite also shows the initial effects of contact metamorphism by the Dartmoor Granite, with the development of biotite after regional chlorite.

## Conclusions

The massive 'greenstone' intrusions seen here have been profoundly affected by later geological events. They were originally dolerite sheets that intruded muddy sediments at a deep level beneath a Carboniferous sea, around 340 million years ago. The sediments were consolidated and lithified before they were intruded and substantial fragments ('rafts') were disrupted and incorporated into the body of the penetrating magma. Sediments in direct contact with the hot magma were thermally baked and underwent localized recrystallization which produced a spotted texture. The dolerites were subsequently involved in the Variscan Orogeny, as well as being altered by the proximity of the later Dartmoor Granite that was emplaced towards the end of the Carboniferous. They were texturally and mineralogically changed by the development of new minerals (biotite, amphibole) superimposed on the original fabric in response to the hot granite body and fluids emanating from it. This site is a perfect example of an early Carboniferous mafic intrusion metamorphosed during the orogeny and then metasomatized by the Dartmoor Granite.

## References



(Figure 4.41) Diagrammatic sketch of intrusive dolerite bodies in the Pitts Cleave Quarry, near Tavistock (after Dearman and Butcher, 1959). A) main face (c. 230 m long) and B) southern face (c. 85 m long).



*(Figure 4.42) Well-developed columnar jointing in dolerite. Pius Cleave Quarry, Tavistock, Devon. (Photo: P.A. Floyd.)*