B19 Ryecroft Quarry

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Highlights

Ryecroft Quarry shows an intrusion which is representative of the massive alkaline greenstone sills intruded into autochthonous early Carboniferous successions. It illustrates internal lithological variation and cryptic mineral variation due to fractional crystallization.

Introduction

This site is situated in the disused and now heavily overgrown quarry set in the hillside of Ryecroft Copse opposite Ashton Mill weir and 0.6 km north-west of Lower Ashton. The quarry face has an horizontal extent of about 500 m.

The geological setting for the massive greenstone of this site is the same as for Trusham Quarry, about 4 km due south. It is characteristic of the larger intrusives found in the autochthon-ous basinal sediments of the early Carboniferous (Selwood and Thomas, 1986b) and the tectonic Foundation Unit of Waters (1970). In common with the other greenstones of the area, which were described by Flett (*in* Ussher, 1913) as diabases, it is now a low-grade metadolerite. The only detailed chemical work on the Ryecroft sill. is that of Chesher (1969) and Morton and Smith (1971). Morton and Smith (1971) analysed various primary and secondary mineral phases; they also record that contact metasomatism is common at the contacts of the local sills, with the production of adinoles (up to 1 m wide) composed of quartz–albite–calcite assemblages and chlorite–sericite replacing andalusite.

Description

The Ryecroft Quarry greenstone is one of the thickest doleritic intrusives in this part of the early Carboniferous, varying from about 130 m to 150 m thick. It is generally sill-like in its attitude and, in the quarry, dips to the south-east, although over its full extent it has been gently folded. The lower contact is not exposed and only the uppermost one-third of the sill is readily seen in the quarry site.

The bulk of the exposed sill is a slightly metamorphosed dolerite with a melanocratic, cumulate lower portion that grades upwards through normal dolerite to quartz-bearing variants and minor, leucocratic syenitic segregations (Morton and Smith, 1971). This internal litho-logical variation is characteristic of large intrusive basic bodies that have undergone crystal fractionation with the production of late, acidic liquids. The primary assemblage of the dolerite was olivine, titanaugite, plagioclase, apatite, ilmenite and possibly K-feldspar, with quartz, albite and K-feldspar characterizing the late segregations. Large, sometimes cored, apatites are a characteristic feature. Common secondary minerals include chlorite (generally 20–30 modal percent), calcite, albite, prehnite and white mica. Biotite (0.5–3 modal percent), commonly nucleated on ilmenite, also appears to be secondary and may be partially replaced by chlorite. Low-temperature hydrothermal alteration is also indicated by the variable pinking of the plagioclase.

The vertical lithological differentiation exhibited by the sill is mirrored by minor cryptic variation in both primary and secondary phases (Morton and Smith, 1971). The clinopyroxenes are salitic augites with high contents of Ti, Na and Al which are characteristic of alkali basalts, and show a change in Mg/Fe ratio up through the sill from 0.99 (near the base) to 0.84 (20 m from top). Most of the plagioclase is now almost pure albite, although the least differentiated lithologies still retain some An and Or components in their plagioclase. The chlorite exhibits a range of compositions from brunsvigite to pycnochlorite, which reflects the compositional variation of the primary host and position in the sill. The modal and chemical mineralogical variation is (shown in (Figure 4.43)) is characteristic of differentiated sills.

Chemically the Ryecroft sill is an alkali dolerite (Chesher, 1969; Morton and Smith, 1971), again characterized by high incompatible element abundances typical of the sodic alkali greenstone suite of north Cornwall and Devon. Major- and

trace-element chemical variation mirrors the vertical lithological variation and modelling (Floyd, 1983) indicates that the sill evolved via a combination of *in situ* olivine, clinopyroxene and ilmenite fractionation.

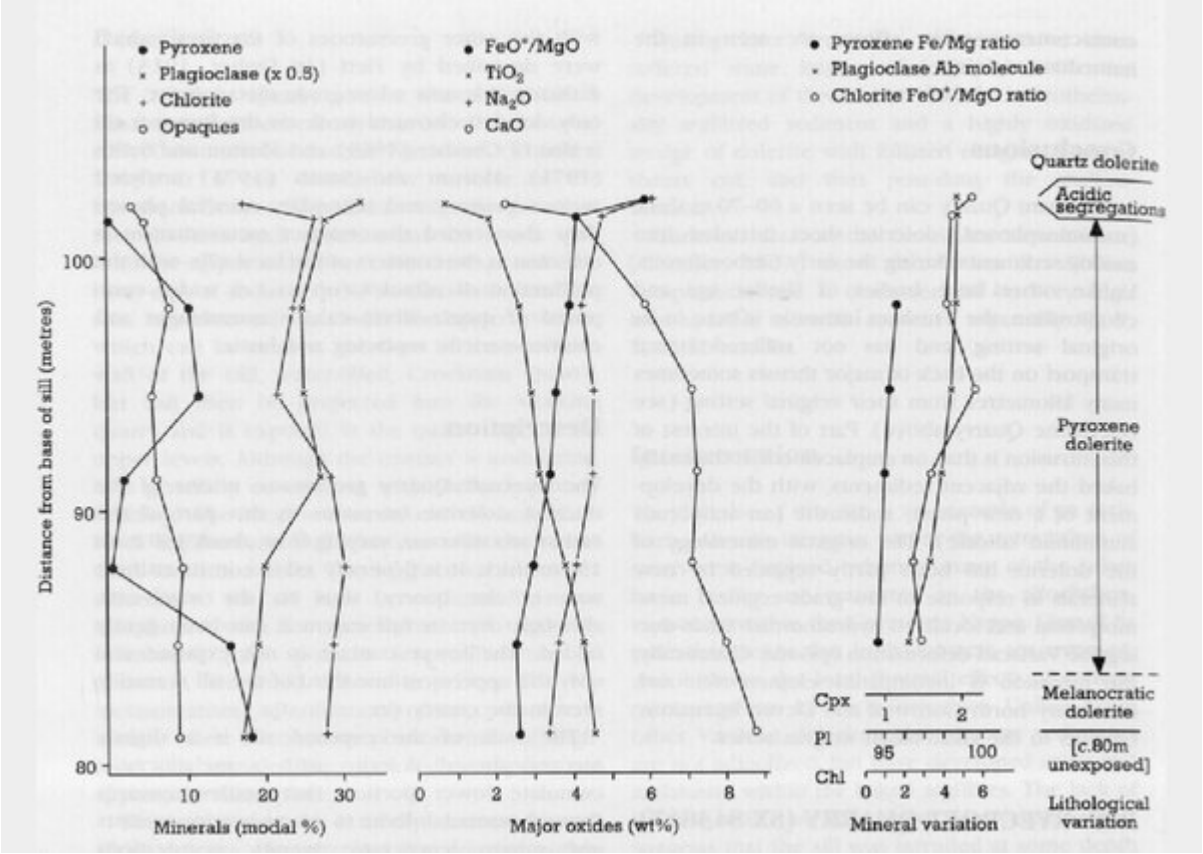
Interpretation

The value of this site is that it is representative of some of the very thick alkaline dolerites intrusive into the early Carboniferous autochthonous succession of the Teign Valley. It has a relatively well-preserved primary texture and mineralogy, as well as exhibiting vertical lithological variation due to internal fractional crystallization during cooling. Unlike similar intrusives in north Cornwall, it generally shows a granular (rather than ophitic) texture indicating contemporaneous growth of plagioclase and clinopyroxene. It is also one of the few basic intrusive bodies in south-west England from which both primary and secondary mineral phases have been analysed. This work illustrated the control of both cryptic variation in primary minerals and the nature of the host phase in influencing the composition of secondary minerals. Thus, the composition of chlorite was seen to vary according to the degree of magmatic fractionation undergone by the replaced host phase. In general terms, this body is well evolved chemically with high incompatible-element abundances, but is characteristic of, and similar to, the Upper Devonian sodic alkali dolerites of north Cornwall and Devon that define that particular chemical province of south-west England (Chapter 3). All the secondary minerals suggest very low-grade regional metamorphic conditions (greenschist or lower) during the late Carboniferous, with the growth of biotite probably representing contact K-metasomatism by the Dartmoor Granite at a later stage. The site, however, is about 650 m outside the mapped aureole of the granite, and this indicates the distance travelled by migratory solutions beyond the extent of mineralogical reconstitution of the country rocks.

Conclusions

Here a massive, 130–150 m thick, concordant doleritic intrusion (a sill) has metasomatized the adjacent marine sediments into which it was injected. This process occurred some 340 million years ago during the early Carboniferous Period. The sill is remarkable for the evidence it presents for the operation of the fractional crystallization process during consolidation. This is now represented by progressive changes in mineral assemblages and compositions from the bottom to the top of the sill, with the most-evolved portion (near the top) being the most silica rich. The same mineral from different positions within the sill also shows chemical variation from the earliest to the latest formed. The preservation here of original and later superimposed metamorphic mineral phases, has made this site the subject of much mineralogical and chemical study.

References



(Figure 4.43) Modal and chemical variation in thu• upper part of the Ryecroft dolerite sill, Teign Valley, east Devon (data from Morton and Smith, 1971).