Waberthwaite Quarry

[SD 112 944]

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Introduction

Waberthwaite Quarry, located between Broad Oak and Waberthwaite in west Cumbria, provides one of the very few exposures of the biotite granodiorite facies within the generally poorly exposed southern granodiorite of the Eskdale pluton (Figure 4.36). The northern well-exposed granite has been described in the Beckfoot Quarry GCR site. Important descriptions of these rocks include those by Dwerryhouse (1909), Simpson (1934), Trotter *et al.* (1937), Firman (1978b), Ansari (1983), Young (1985), Young *et al.* (1988) and Millward *et al.* (in press). The biotite granodiorite facies is shown separately from the granodiorite on the Geological Survey 1:50 000 Sheet 38 (1996), though this distinction is not made on the 1:25 000 special sheet (1991). The presence within the granodiorite at Waberthwaite of almandine-rich garnet in the granodiorite and associated aplitic microgranites, and within some of the xenoliths is noteworthy.

Description

Though very poorly exposed the Eskdale granodiorite includes a number of lithologies (Figure 4.36). Microgranodiorite is commonly developed adjacent to the margin of the intrusion. The main mass of the body appears to be composed of a pink medium-grained granodiorite in which some biotite and amphibole are generally present. Both of these rock types are commonly altered with extensive sericitization and saussuritization of feldspar, and chloritization of mafic constituents. In the vicinity of Waber-thwaite Quarry a distinctive grey, biotite-rich granodiorite occurs, though the relationship of this to the main body of granodiorite is not clear. This rock is best seen in Waberthwaite Quarry. Alteration is less intense in this rock than in much of the granodiorite body.

Though Waberthwaite Quarry has effectively been disused for many years (Figure 4.37), small quantities of rock have been extracted in recent years for use as dimension stone. These have been marketed as 'Broad Oak Granite'. Despite these small-scale workings, the quarry faces at the time of writing are rather weathered and the site is considerably overgrown. The granodiorite exposed in the quarry is a grey medium-grained biotite-rich facies. Mafic xenoliths are common and a few narrow (up to 15 cm) aplitic veins are present.

Typically the biotite-rich granodiorite consists of plagioclase, orthoclase, some perthite and quartz with abundant, commonly fresh, biotite. Almandine garnet is locally conspicuous, both in the main mass of the granodiorite and in some biotite-rich xenoliths and aplitic veins. Ansari (1983) described its presence in equant crystals 1–2 mm in diameter intergrown with quartz and feldspar. Firman (1978b) noted that the garnets range up to 5 mm in diameter and that they commonly appear to be broken fragments of euhedral crystals. A little amphibole is also present and tourmaline occurs both in the granodiorite and as clusters in aplitic veins. Accessory minerals include apatite, zircon and opaque oxides. Saussuritic alteration of plagioclase is common and perthite is extensively sericitized. Biotite is in places chloritized with the development of some secondary titanite and anatase.

The aplitic rocks are typically fine grained, equigranular and contain chloritized biotite together with more perthite than plagioclase. Almandine garnet and tourmaline are locally present.

Interpretation

The relative abundance of almandine garnet within the biotite-rich granodiorite has long been known. Simpson (1934) suggested that the garnet may be the result of a late-stage concentration effect in the crystallization of the granodiorite. Trotter *et al.* (1937) favoured assimilation of Borrowdale Volcanic Group rocks in the formation of the granodiorite, though they discounted the possibility of the garnets being derived from a garnetiferous lava. Firman (1978b) noted that many of

the garnets appear to be broken fragments of euhedral crystals and their xenocrystic origin was advocated by Ansari (1983).

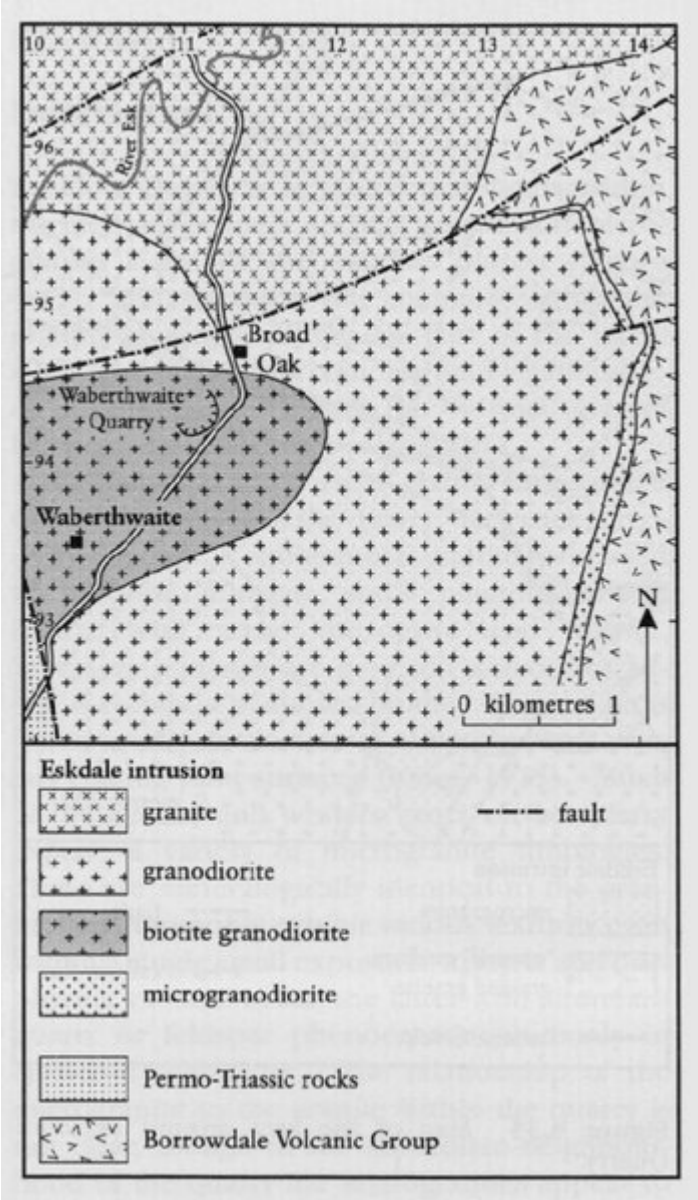
In his description of the Eskdale pluton Simpson (1934) referred to the presence of abundant xenoliths in the rock exposed in the higher parts of Waberthwaite Quarry, apparently overlying 'grey granite'. He interpreted the abundance there of xenoliths as evidence for the nearness of the roof of the intrusion. The exposures available today do not support Simpson's suggestion of an upper xenolith-rich zone. However, evidence from recent mapping of the Eskdale pluton by the British Geological Survey (Millward *et ed.,* in press) is consistent with much of the exposed part of this body lying close to the original roof zone of the intrusion.

A geochemical comparison of the granite and granodiorite parts of the Eskdale pluton has been summarized in the Beckfoot Quarry GCR site (Ansari, 1983; O'Brien *et ed.,* 1985; Millward *et al.,* in press). The Eskdale intrusion was originally linked, on petrogenetic grounds, with the late Caledonian Skiddaw and Shap granites (e.g. Firman, 1978b). The recognition of cleavage within the Eskdale granite (Allen, 1987) together with a Rb-Sr age of 429 ± 4 Ma (Rundle, 1979) suggested an early, pre-deformation date of emplacement. Though less precise, the iso-chron age of 429 ± 22 Ma obtained by Rundle (1979) for the granodiorite indicates that this part of the pluton may be of closely similar age. Field evidence of the age relationships is unclear though Young (1985) suggested that the granodiorite may be the earlier intrusion. The U-Pb zircon age of 452 ± 4 Ma for the Eskdale granite (Hughes *et al.,* 1996) has been discussed in the Beckfoot Quarry GCR site report, but an accurate age for the granodiorite is not available. However, if the very limited evidence of field relationships suggested by Young (1985) is accepted, the granodiorite must pre-date this slightly.

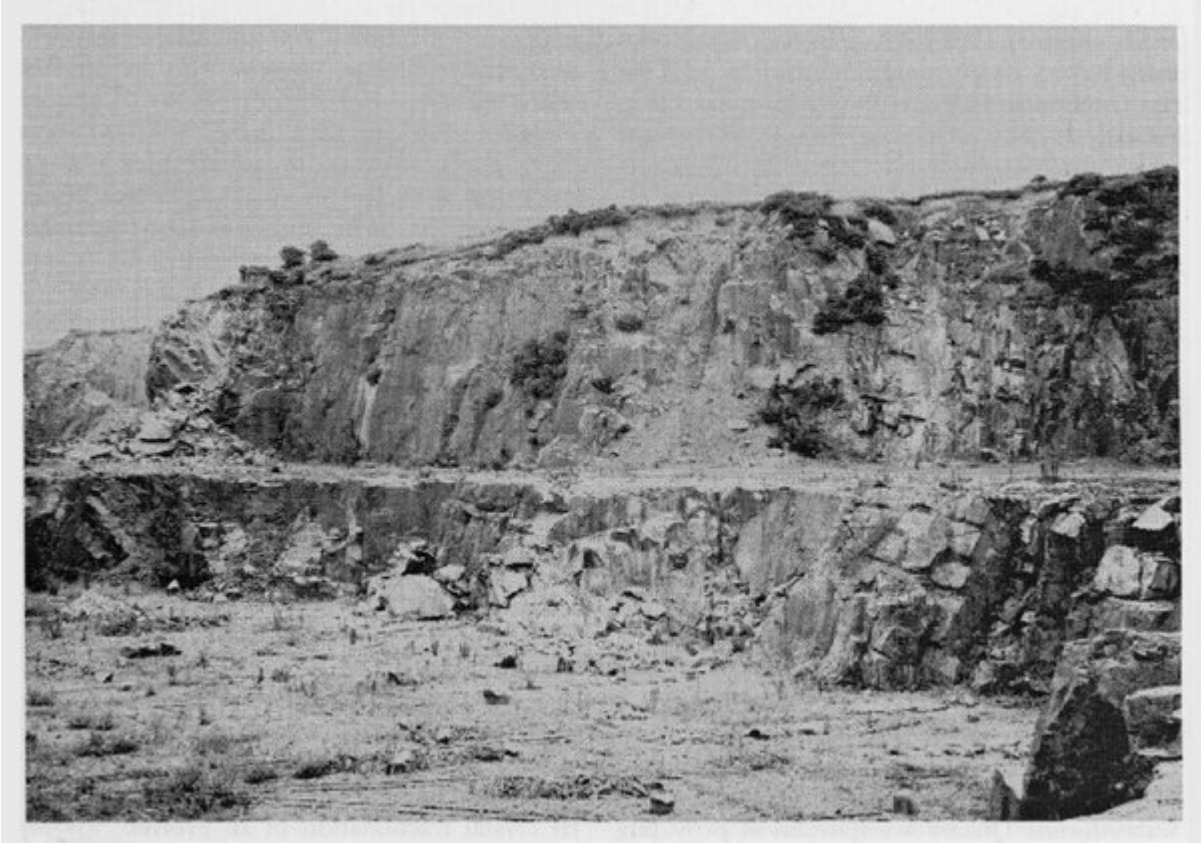
Conclusions

Waberthwaite Quarry is important in providing the best available exposures of the garnet-bearing biotite granodiorite facies of the Eskdale pluton. The quarry offers a unique opportunity to study mafic xenoliths in the intrusion, possibly derived from Borrowdale Volcanic Group. The comparative abundance of almandine garnet, at least some of which may be derived from country rocks, is noteworthy.

References



(Figure 4.36) Map of the Eskdale granodiorite around Waberthwaite Quarry.



(Figure 4.37) Photograph of Waberthwaite Quarry taken in 1935. (Photo: BGS no. A6707.)