Funtullich

[NN 750 265]

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Introduction

The Comrie pluton (Figure 8.25) is a member of the South of Scotland Suite. It is somewhat unusual among the Scottish late Caledonian intrusions in its isolation from other plutons, and by the fact that the strike of its long axis runs counter to the main NE–SW Caledonian trend. The pluton is a fine example of a normally zoned pluton, with a dioritic outer member pierced by a granitic core. In most of the Scottish late Caledonian granite plutons diorite tends to be a minor component whereas more acid rocks are more abundant. The Comrie pluton is unusual in that diorite is the dominant lithology (see also the Craig More GCR site report). There is considerable heterogeneity among the diorites, and a sharp contact can be observed between the granitic rocks and the outer dioritic envelope. This is important, as in similar plutons elsewhere in Scotland the contacts are not usually exposed and gradational changes are often described. In this case the sharp contact and xenolithic inclusions clearly demonstrate the importance of multiple pulses in the construction of some of the late Caledonian plutons. An age of 408 ± 5 Ma has been obtained using Rb-Sr on whole rock-mineral pairs (Turnell, 1985).

Many of the late Caledonian 'granites' of Scotland are diorite–granodiorite–granite complexes in which the central and youngest magmatic member is located in the centre of the pluton. It has been long debated whether this disposition is the product of in-situ fractional crystallization, with early higher temperature minerals forming first near the cooler walls, or whether such plutons represent separate pulses of magma intruded either directly from the source of melting, or from an intermediate magma chamber. Many such plutons have been described from around the world and the form is known as normal zoning. Just how such plutons are constructed is the subject of considerable debate (e.g. Paterson *et al.,* 1996; Petford, 1996), and the question of whether plutons are constructed from single or multiple magmatic pulses is important in understanding the mechanisms involved. The Comrie pluton is one of the few good examples of multiple pulses in the British Caledonian igneous province.

The Funtullich GCR site displays many of the key features of the Comrie pluton in one small area. The main interest of this site is igneous, with all principal members of the pluton exposed and showing internal contact relationships. In addition, the contact effects of the pluton on the more psammitic lithologies of the Ben Ledi Grit may be examined and contrasted with the effects on the Aberfoyle Slate, seen in the Craig More GCR site. For reasons of outcrop quality and accessibility this site is widely used for instructional purposes, and the site is included in the excursion guide of MacGregor (1996).

Description

Diorites form much of the outer part of the pluton (see the Craig More GCR site report) but the central area, forming the high ground SW of Cam Chois, is formed of pink microgranite. An extension of this microgranite cuts through the diorites in the Funtullich area, and dioritic xenoliths are abundant close to this internal contact. A sheet of similar microgranite occurs in contact with the Ben Ledi Grit.

The diorites around Funtullich farm (Figure 8.26) are compositionally and texturally highly variable. A dark fine-grained variety seen near the road comprises hornblende and biotite with slightly altered plagioclase and minor quartz. Biotite generally occurs with opaques or in clusters with hornblende. Farther to the east of the road the rock becomes coarser grained with large crystals of hornblende (sometimes obviously after pyroxene) and plates of biotite within a matrix of altered plagioclase. Other varieties of diorite contain fresh pyroxenes, commonly both ortho- and clinopyroxene. These rocks range from 53–60% SiO_2, and geochemical characteristics suggest that some may be mafic-rich cumulates. Compositional heterogeneity in the diorites extends them into the granodiorite field, and some more evolved types reach about 65% SiO_2.

Intruding these various diorites is a mass of pink medium-grained granite (microgranite) which is best displayed in the nearest crags to the ENE of Funtullich. At the western end of these crags is a coarse-grained diorite with pink aplitic veins, and a solitary tree marks the line of contact with the microgranite. Eastwards from this contact the microgranite contains abundant dark xenoliths, including some of dioritic composition. The mineralogy of the microgranite comprises principally plagioclase, orthoclase and quartz with biotite as 'the principal mafic mineral, together with aggregates of amphibole and biotite. This microgranite has an SiO_2 content of about 71% and it is depleted in most trace elements except Rb, relative to the outer diorites (Mahmood, 1986).

The outer contact of the pluton can be seen about 100 m NW of Funtullich, on the SW side of the road. Here a sheet of pink microgranite with prominent sub-horizontal joints is in contact with the Ben Ledi Grit. The contact can be located to within a metre or so, but here the psammitic rocks of the envelope show no obvious signs of contact metamorphism. The relationship of this sheet to the main granite mass is not known but it is of a similar facies and appears to be detached.

Interpretation

The Comrie pluton was constructed in two separate stages. An early diorite, intruded as a single (or possibly multiple) magma pulse(s) had crystallized before a pulse of more evolved granitic magma pierced the centre, picking up xenoliths of the diorite, as shown by the Funtullich outcrops.

The diorites began to crystallize at about 1100°C, but most crystallized at somewhat lower temperatures (see the Craig More GCR site report). Cumulates of mafic-rich minerals formed from these magmas, driving the magma(s) to more evolved dioritic and granodioritic compositions. Relationships between the different varieties of diorites (and granodiorites) are not known. Their heterogeneity appears to be due to gradual facies changes rather than to separate intrusive pulses, but critical field evidence is not available.

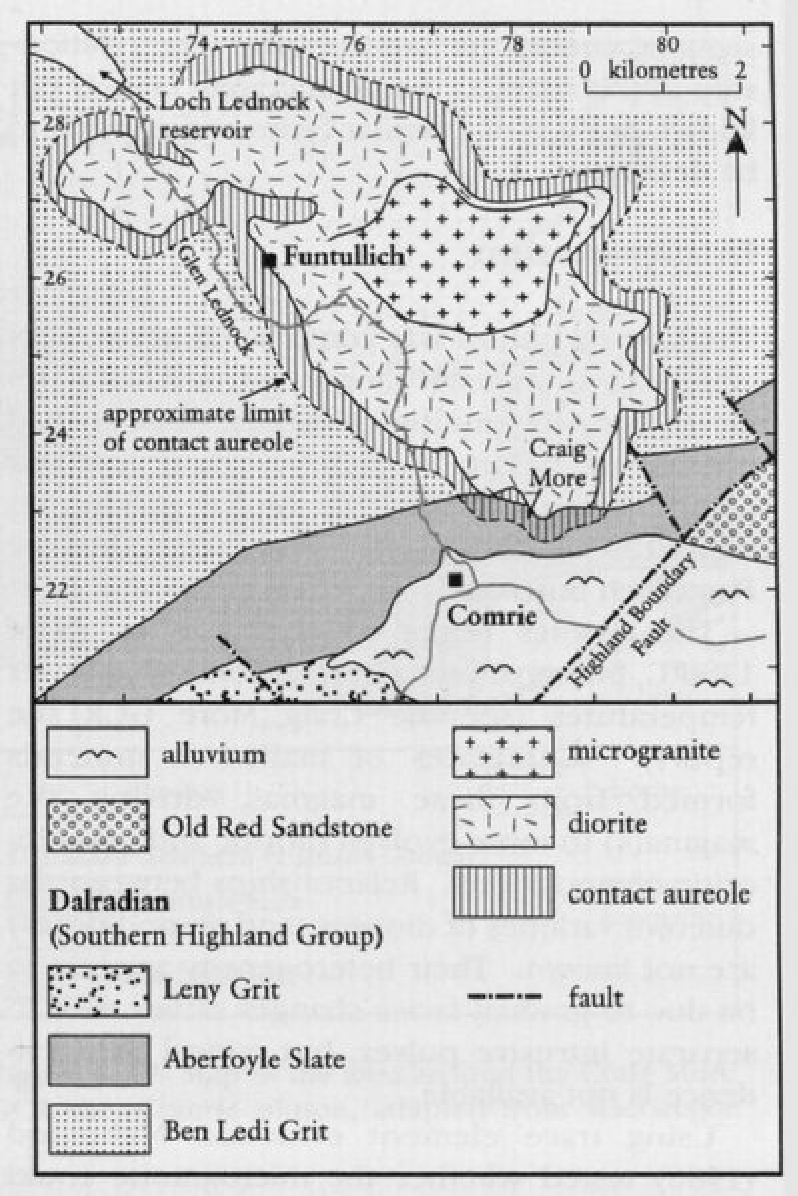
Using trace element evidence, Mahmood (1986) tested whether the microgranite could have been derived directly from the dioritic parental magma through fractional crystallization. The data show that this model is not tenable as no incompatible trace element (not even Rb) in the microgranite exceeds abundances found in the granodiorites. Hence, the central microgranite appears to have formed from the crystallization of a separate single pulse of magma.

Two samples from the diorites have yielded Sr isotope initial ratios of 0.7050 (Turnell, 1985). Such values can be interpreted as indicating a deep crust or upper mantle source. Whole rock-mineral separates on the same two diorite samples give concordant Rb-Sr ages of 408 Ma (Turnell, 1985), the probable minimum age of intrusion.

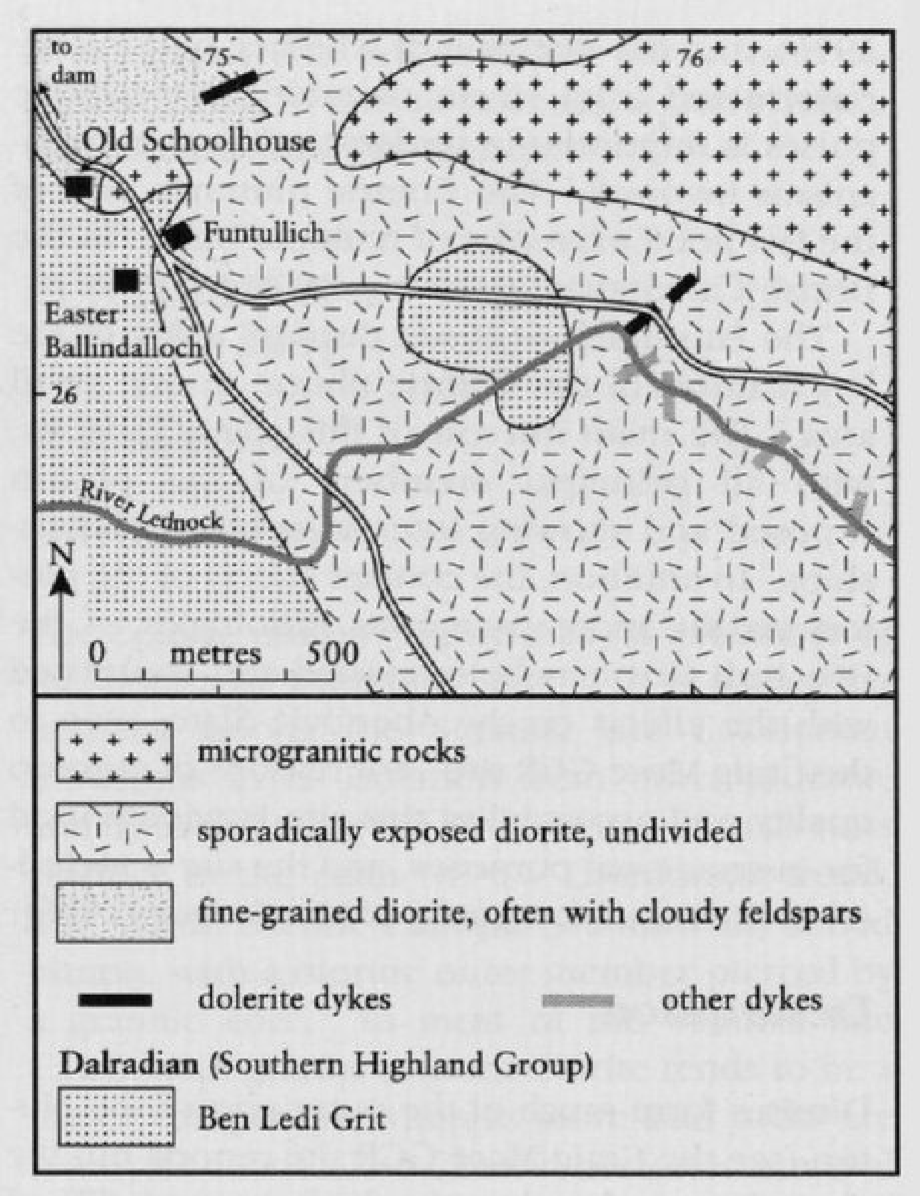
Conclusions

The Funtullich outcrops of the Comrie pluton afford an opportunity to view a wide range of rocks from diorite to granite in a small area, with an observable contact between a late granite and the host diorite, clearly establishing the age relationships. The outcrops display many of the essential field relationships that are required to understand the construction of zoned plutons, which commonly provide valuable information on the generation and evolution of deep crustal magmas.

References



(Figure 8.25) General location map of the Comrie pluton. Taken from a paper by Pattison and Tracy (1991), who drew it from data in Tilley (1924).



(Figure 8.26) Map of the area around the Funtullich GCR site, Comrie pluton, adapted from MacGregor (1996).