Red Craig

[NO 293 758]

S. Robertson

Introduction

Red Craig lies at the eastern margin of the Glen Doll pluton, a member of the South of Scotland Suite of late Caledonian intrusions. The pluton has long been recognized as providing well-exposed and easily accessible evidence of the interaction between component magmas of a basic to intermediate intrusion (Barrow and Cunningham-Craig, 1912). The Red Craig area exhibits transitions from quartz-diorite through quartz-monzodiorite to granite. The igneous rocks are predominantly xenolithic and provide excellent examples of the interaction between the intermediate part of the pluton and the host Dalradian metasedimentary rocks.

The Glen Doll pluton occupies approximately 12 km^2 astride the Glen Doll Fault in the upper part of Glen Clova. The pluton is dominated by intermediate rocks of dioritic to tonalitic composition, although with a significant component of gabbro (Jarvis, 1987; Mahmood, 1986). Local olivine-pyroxenite (Mahmood, 1986) was previously referred to as serpentinite or picrite (Barrow and Cunningham-Craig, 1912). Barrow and Cunningham-Craig originally described a 'narrow fringe of encircling granite'; Jarvis, however, only recognized a marginal facies of medium-grained xenolithic granite along much of the southern and eastern part of the pluton.

The pluton was emplaced into dominantly semipelitic metasedimentary rocks assigned to the Argyll and Southern Highland groups of the Dalradian Supergroup (Figure 8.20). Little has been reported on the contact metamorphic effects of the intrusion, although Barrow and Cunningham-Craig recognized a zone of alteration at least 70 m-wide at the eastern margin but failed to detect any mineralogical alteration of the regional sillimanite zone rocks under the microscope.

Description

The GCR site at Red Craig provides a section through the eastern part of the Glen Doll pluton. Medium- to coarse-grained diorite and quartz-diorite, some of which is xenolithic, is typical of a large part of the pluton and passes east into a heterogeneous marginal zone of xenolithic quartz-diorite with areas of quartz-monzodiorite, granodiorite and granite. Xenoliths are mostly of high-grade hornfelsed semipelite, some of which show evidence of partial melting and assimilation into the diorite. Appinitic meladiorites are developed locally as are sheets and dykes of fine-grained felsite and quartz-feldspar porphyry.

Diorites and quartz-diorites are well exposed in a small roadside quarry near Braedownie [NO 2882 7572] and on hillslope exposures to the NE on Dùn Mòr [NO 290 759]. Farther north there are numerous exposures although access is more difficult because of forestry plantations. The diorite on the south slopes of Dùn Mòr is cut by both granite veins and felsite sheets. The granite veins are typically only 5 cm thick, sinuous and generally steeply inclined, whereas the felsites are vertical and up to 1 m thick. Both have sharp margins with the host diorite. East of Dùn Mòr; an appinitic meladiorite contains large (4 mm) euhedral hornblende megacrysts within a finer-grained quartz-diorite or quartz-monzodiorite groundmass. The contact relationships of this unit cannot be seen on the steep and loose slopes. Appinitic rocks also occur farther north towards the Cald Burn [NO 295 770]. Xenoliths of hornfelsed semipelite occur quite widely within the diorite although many are only a few centimetres long. However, a xenolith at [NO 294 766] is at least 100 m long.

The diorites are separated from the host Dalradian rocks to the east by a 500 m-wide het-erogenous zone of intermediate to acid igneous rocks and hornfelsed semipelite. Felsite and quartz-feldspar porphyry sheets and dykes ranging from a few centimetres to 15 m across and small bosses up to 50 m across occur widely. Within this zone, lithology, texture and grain size vary over short distances. Grey fine-grained diorite is net-veined by, and occurs as xenoliths within,

medium-grained quartz-monzodiorite on the crags SW of Red Craig [NO 2941 7558]. Textural observations indicate that the fine-grained rocks were incorporated within and veined by the medium-grained rocks before crystallization was complete. Both are cut by veins and sheets of pink leucocratic granite up to 3 m thick. Craggy exposures to the SW of Red Craig reveal an eastward increase in interstitial to poikilitic perthitic orthoclase together with the appearance of biotite megacrysts, as quartz-diorite passes into quartz-monzodiorite. The quartz-monzodiorite forms a near continuous outcrop (Figure 8.20) and is typically grey and medium grained with biotite megacrysts up to 5 mm across comprising approximately 5% of the rock. In thin section, the quartz-monzodiorites show evidence of the addition of a potassic component to a parent diorite or quartz-diorite magma. The biotite megacrysts, together with perthitic orthoclase megacrysts that comprise up to 30% of the rock, poikilitically enclose areas with a dioritic texture that is typical of diorites to the west.

To the east, with increasing proportions of orthoclase and quartz, the quartz-monzodiorite grades into granodiorite and granite in which rafts and xenoliths of hornfelsed metasedimentary rocks are widespread (Figure 8.21). Many of the rocks in this zone are texturally heterogeneous; patches with dioritic texture are enclosed by areas with granitic features, including graphic intergrowths of quartz and alkali feldspar. The largest area of homogeneous granite is seen around [NO 2967 7620], in a 150 m-long section beside a track, 200 m NE of Red Craig. The granite is pink to red, medium to coarse grained and rather weathered with some disseminated pyrite. The neighbouring metasedimentary rocks are cut by granite sheets, although more commonly granite contacts are gradational and marked by transition zones in which granite contains numerous xenoliths in various stages of assimilation.

Widespread xenoliths and larger rafts of hornfelsed metasedimentary rock form some of the most spectacular features of the GCR site. The largest crops out on, and immediately west of, Red Craig and covers an area of 250 m x 200 m. This is not a roof pendant since the inclination of the lithological layering is rotated with respect to the country rock envelope. Xenoliths and rafts are predominantly either hornfelsed semipelite or interlayered psammite and semipelite typical of the envelope rocks. The exception is a 1 m xenolith of metacarbonate rock at [NO 2922 7584]; the nearest metacarbonate rocks outside the pluton belong to the Loch Tay Limestone Formation, which is not recorded in the Glen Doll area. Clean exposures on cliffs south of Red Craig [NO 294 757] show transitions over a few metres from hornfelsed semipelite, through a zone containing veins of granodiorite or monzodiorite, into a zone where the proportion of igneous material progressively increases and the semipelite becomes detached and re-orientated. This is followed by quartz-monzodiorite or granodiorite with heterogeneous grain size and texture, choked with randomly orientated xenoliths and schlieren in various stages of assimilation, ranging from a few millimetres to many centimetres long. Some xenoliths contain lenses or veins of pink granite, commonly less than 1 cm thick, which both permeate and cross-cut the lithological layering. They are mantled by biotite and encircled by leucocratic haloes with more orthoclase than the surrounding intrusive rocks (Figure 8.21). Locally, psammites are present as discrete xenoliths whereas the semipelitic interbeds have been largely assimilated and are preserved only as dismembered mafic-rich schlieren.

Semipelitic xenoliths, whether a few millimetres or tens of metres across, typically contain the assemblage: cordierite + perthitic orthoclase + plagioclase + sillimanite + biotite + quartz + minor spinel + minor corundum. Most are compact dark bluish-grey rocks, typified by rusty and in places gossanous weathering. Pyrite is abundant and occurs either in discrete lenses or with quartz segregations. Transitional contacts between the semipelites and igneous rocks show decreasing abundance of cordierite, sillimanite and spinel. Perthitic orthoclase occurs along with plagioclase, larger biotites and some quartz; the perthite poikilitically encloses biotite, aggregates of spinet and cordierite. Biotite is locally embayed by orthoclase and may include pinite after cordierite, suggesting the local breakdown of biotite.

Interpretation

Whole-rock geochemical and isotopic data have been interpreted as indicating heterogeneous crustal contamination of the parent magma to the Glen Doll diorite (Jarvis, 1987). Jarvis suggested that the partially assimilated rafted metasedimentary xenoliths 'provide an observable source of contamination'. The evidence from Red Craig indicates that most xenoliths are derived from the immediate envelope. However, some xenoliths are exotic, such as those of metacarbonate rock, which have probably been brought to the present level from deeper in the intrusion. None are roof pendants. Field evidence clearly demonstrates a link between the distribution of xenoliths and contamination of the

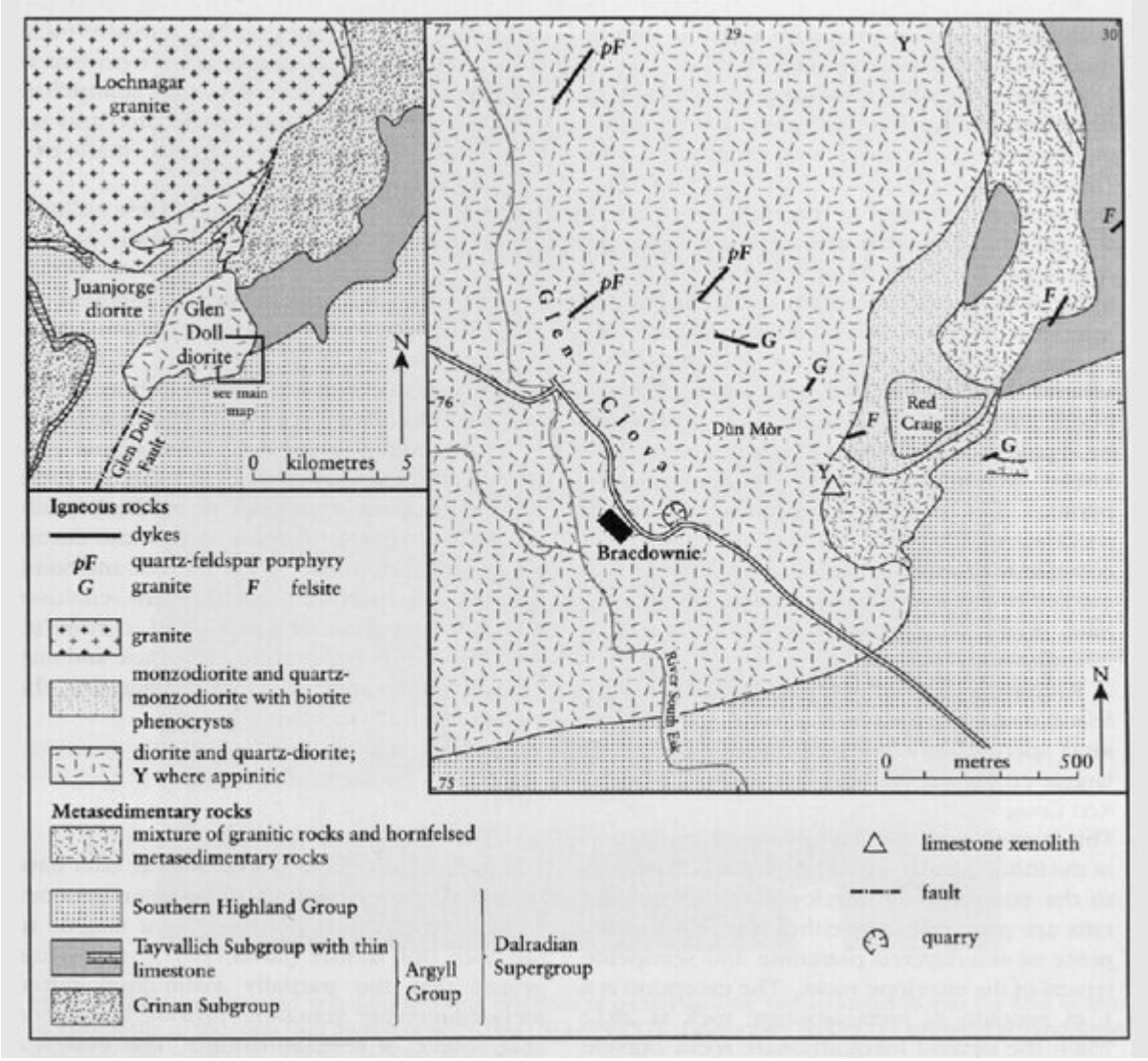
quartz-diorite melt by granitic melt. The xenolith-rich zone also coincides with a heterogeneous, hybrid igneous assemblage, ranging from quartz-monzodiorite to granite and characterized by the presence of orthoclase and biotite megacrysts. On a small-scale there is a close association between the abundance of orthoclase within the igneous rocks and proximity to xenoliths. The occurrence of interfinger-ing granitic segregations with graphic textures in the xenoliths indicates partial melting.

Taken together, these features all suggest the contamination of magmas by partial melts derived from the xenoliths. The poikilitic or interstitial nature of the partial melt component, comprising orthoclase, biotite and quartz, indicates that it was introduced into the diorites after they had partly solidified. Minor granite veins may also be derived from melting of xenoliths although their sharper margins may indicate derivation from deeper within the pluton.

Conclusions

The assimilation of country rocks, resulting in contaminated xenolithic zones, is common in the Caledonian intrusive suites and is described from several GCR sites. High-grade hornfelses are observed adjacent to many dioritic intrusions and localized melting of country rocks to produce granitic magma has been inferred. The Red Craig GCR site provides an excellent illustration of all of these processes *in situ* and hence is a site of national and possibly international importance. Here a dioritic magma has been contaminated both with xenoliths and with a granite melt that was derived locally from within the xenoliths. The largely semipelitic xenoliths range from a few millimetres to more than 200 m across. They preserve high-grade contact metamorphic mineral assemblages and some have granitic segregations indicating partial melting. Many have transitional contacts with the host dioritic rocks where their marginal parts have been spalled off and assimilated by the magma.

References



(Figure 8.20) Map of the area around the Red Craig GCR site, Glen Doll pluton, with inset showing the location of the area with respect to the regional geology.

(Figure 8.21) Disaggregated xenoliths showing evidence of partial melting and assimilation into the host quartz-monzodiorite of the Glen Doll pluton at Red Craig [NO 294 757]. Leucocratic haloes are apparent around some xenoliths and schlieren. (Photo: BGS no. D 4550.)