Corsiehill Quarry, Perth and Kinross

[NO 135 235]

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Introduction

The extensive swarm of Late Carboniferous east- to ENE-trending tholeiitic basic dykes that crosses the Midland Valley and southern Highlands of Scotland is well represented in the area around Perth. The dykes have featured in several detailed accounts of the swarm and many have been used as type examples and are well known by name. One such dyke is the Corsiehill Dyke, which crops out on the northern slopes of Kinnoull Hill, 2 km to the east of Perth city centre. A complete cross-section of the dyke is well exposed in a disused quarry that has been converted into a car park for a local nature trail and is frequently visited for both educational and recreational purposes. The quarry is at the northern end of a larger SSSI that has been notified for its flora.

The dyke was shown on the first edition of the Geological Survey one-inch Sheet 48 (1883). At this time, all the E–W-trending dykes were considered to be of Tertiary age (e.g. Geikie, 1897). It was described, with an analysis, in definitive works on the swarm by Walker (1934, 1935), who included a comprehensive list of previous work in his 1935 paper. The geochemistry of the whole swarm was reviewed by Walker (1965) and subsequently by Macdonald *et al.* (1981), who included three analyses of the Corsiehill Dyke. A general description of the dykes in this area was also included in the Geological Survey district memoir (Armstrong *et al.,* 1985).

The tholeiitic dykes were divided petrographically by Walker (1930, 1934, 1935) on the basis of their texture. Those with an overall coarser grain-size but with microcrystalline areas of intergrown quartz and alkali feldspar (micropegmatite) were classed as quartz-dolerites. Dykes with a finer grain-size commonly have an interstitial groundmass that is either cryptocrystalline or consists of glass in various states of devitrification. These were termed 'tholeiites', as had become common practice in central Scotland, and the term persisted on Geological Survey maps, including Sheet 48W (Perth), until the early 1980s. It has now been abandoned as unnecessary ('basalt' or 'glass-bearing basalt' are sufficiently descriptive terms) and because of confusion with the term 'tholeiitic', which is now applied to magmas or suites of rocks defined by specific geochemical and mineralogical characteristics.

Walker further divided the 'tholeiites' into several named types, based mainly on the proportion and nature of the glassy ground-mass. His 'Corsiehill' type is relatively coarse grained with only small areas of interstitial glass and grades into quartz-dolerite; other 'tholeiite' types are much more distinctive, with up to 20% of interstitial microlitic glass. However, more recent investigations (Stephenson in Armstrong *et al.,* 1985) have concluded that a spectrum of textures exists, from quartz-dolerite through the various types of 'tholeiite', and it is difficult to fit many individual rocks precisely into Walker's classification. All types share a common mineralogy in which similarities in mineral relationships outnumber the subtle differences, and Macdonald *et al.* (1981) identified no significant differences in geochemistry. Several dykes exhibit changes along their length through various 'tholeiite' types to quartz-dolerite and this close spatial relationship supports a genetic connection. Hence, although the textural variations provide valuable information on the crystallization and cooling histories of the dykes (see 'Interpretation', below), their classification has little practical value and is mainly of historical interest.

Basalt ('tholeiite') dykes are particularly abundant in the northern sector of the swarm that passes through the Perth area, but apart from this there is no geographical distribution pattern to any of the various textural varieties. Both quartz-dolerite and basalt can occur as long persistent dykes, though, as would be expected, there is a tendency for basalt to occur as thinner dykes and also as a marginal facies of thicker quartz-dolerite intrusions (Walker, 1935; Francis *et al.,* 1970; Armstrong *et al.,* 1985).

Description

Corsiehill Quarry (also known as Kinnoullhill Quarry) was in existence in 1855 and was probably worked until 1925. The basalt dyke cuts lavas within a Lower Old Red Sandstone succession and both the dyke and the more massive parts of the lavas were worked, presumably for road metal. The dyke has been quarried away completely over a length of about 150 m, but complete cross-sections are exposed at both the east and west ends of the quarry. The northern and southern quarry walls expose only lavas, apart from a thin skin of basalt at one point on the northern wall (Figure 6.20).

The lavas comprise the upper part of the Ochil Volcanic Formation on the northern limb of the Sidlaw Anticline, and form the dip-slope of Kinnoull Hill. They dip generally at about 10° to the north-west. They have a greyish-purple to greenish hue, contain conspicuous feldspar phenocrysts, with pyroxene, hornblende and biotite in the groundmass, and are probably basaltic andesites. They are amygdaloidal and commonly scoriaceous with large flattened vesicles, particularly on the northern side of the quarry. Collections of amygdaloidal material from the quarry in Perth Museum and Art Gallery include quartz, agate, amethyst, calcite, aragonite and chlorite. Acicular and hemispherical forms of goethite within quartz are particularly notable. Although visible contact effects due to the dyke are limited to minor baking, Shand (1908) noted the development of grossular garnet in lava adjacent to the dyke.

The dyke trends east–west, like most others of the same swarm in the immediate area around Perth, and can be traced for about 500 m. The contacts are vertical and the dyke is 20 m wide in the quarry. Both contacts can be observed at both ends of the quarry, where the dyke is seen to be chilled against baked lavas, and a thin skin of glassy basalt is preserved at one point on the northern quarry face. Joints perpendicular to the contact form crude hexagonal columns across the whole width of the dyke and these are the focus for well-developed spheroidal weathering that dominates the end walls of the quarry. The dyke is traversed by thin quartzo-feldspathic veins.

Despite the brown-weathering outer crust, the basalt is very fresh, particularly at the east end of the quarry. The rock varies from glassy to fine grained to medium grained, with plagioclase laths up to 2 mm long; the central part could be termed a dolerite. It comprises plagioclase (50%); subhedral to euhedral serpentine-carbonate pseudomorphs after early orthopyroxene and olivine (8%); sub-ophitic augite (30%); skeletal iron-titanium oxides (6%); and small amounts of interstitial microlitic glass (6%). Analyses show that it is quartz-hypersthene-normative with about 2% normative quartz.

Interpretation

The similarity of the basalts and quartz-dolerites of the dyke-swarm to the Midland Valley Sill-complex in all main aspects of geochemistry and petrography, and their close spatial relationships leave no doubt that they are comagmatic. The mantle origin and subsequent evolution of the high-Fe-Ti tholeiitic magmas was discussed by Macdonald *et al.* (1981) and is summarized in the 'Introduction' to this chapter. Individual dykes reveal only slight geochemical variation along their length, despite changes in texture, although fractionation is recorded between the margin and core of some thicker dykes and is noticeable in the three analyses from Corsiehill. Trace-element variation within individual dykes is much less than that observed between dykes so geochemical 'fingerprinting' is possible in some cases; however the Corsiehill Dyke is not particularly distinctive in this respect.

The basalt dykes of the swarm provide much useful petrological information that is not available from the coarser-grained quartz-dolerites. For instance, the early crystallizing phases such as olivine are preserved only in the finer-grained rocks, particularly in dyke margins, and the interstitial glass is a 'frozen' sample of the residuum that remains after the main phases have crystallized. The presence of residual Fe and Ti in this late liquid, a feature of tholeiitic magmas, is indicated by the abundance of ilmenite needles in the glass of many of the dykes. An analysis of glassy groundmass separated from a dyke near Kirkintilloch (Walker, 1935) demonstrates the high concentrations of SiO_2, K_2O and volatiles in the residuum. A few dykes have a tholeiitic andesite composition, but more evolved compositions occur only as aplitic veins and patches. These occur mainly in the associated sills but also in some of the thicker dykes and the Corsiehill Dyke is one of few where these can be observed.

The textural variations within the dyke-swarm that occur particularly in the area around Perth, were most likely induced by variations in the conditions of late-stage crystallization and cooling. Thus the glassy, quenched textures of many of the basalts ('tholeiites') contrast strongly with the interstitial crystalline intergrowths of the quartz-dolerites, which suggest slower cooling in the generally larger intrusions, possibly under the influence of trapped volatiles (see various GCR site

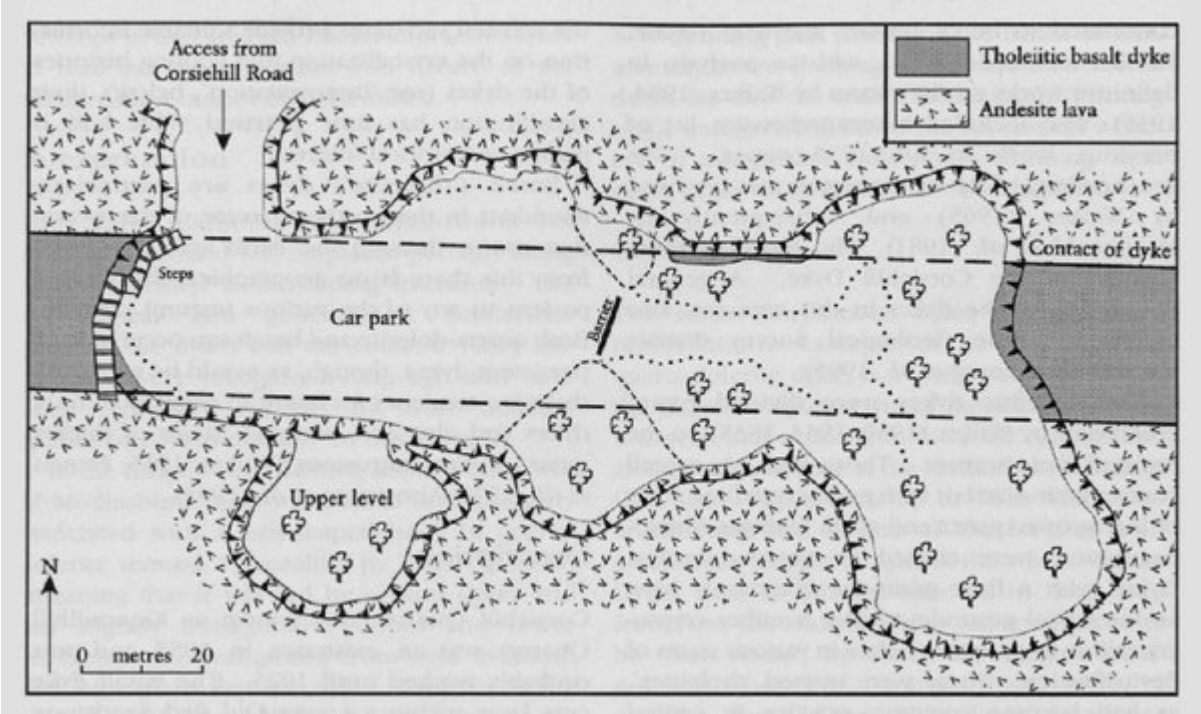
reports describing the associated sills).

Conclusions

The Stephanian tholeiitic dyke-swarm that traverses central Scotland is dominated by medium-grained quartz-dolerites, but it also includes finer-grained basalts that are particularly abundant in the Perth area. At the Corsiehill Quarry GCR site one of these basalt dykes is particularly well displayed in a landscaped car park that serves a local nature trail. The 20 m-wide, E–W-trending dyke is intruded into lavas of Siluro-Devonian age that have yielded museum specimens of various minerals from infilled gas bubbles (amygdales). The chilled contacts of the dyke are well seen, as are horizontal columnar joints and spheroidal weathering, all in an ideal setting for demonstration to educational parties.

The basalt at Corsiehill Quarry is very fresh and consequently has been used in many microscopic and geochemical studies; it was the type example for a textural variety that formed part of a local classification of some historical interest. Like most of the basalt dykes in this swarm, it contains small areas of glass between the component crystals. These represent the liquid that remained after the magma had almost completely crystallized. It was 'frozen' as glass when the dyke rose rapidly through the Earth's crust and cooled very quickly. A study of this glassy material can yield much information about the nature of the original magma and its potential to evolve other, more fractionated magmas.

References



(Figure 6.20) Map of the tholeiitic basalt dyke exposed in the Corsiehill Quarry GCR site. Adapted from an interpretive handout prepared by the Countryside Ranger Service, Perth and Kinross District Council (1990).