
Chapter 5 Central England

Introduction

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Occurrences of Caledonian intrusive and volcanic rocks in central England comprise a relatively small number of exposures within Lower Palaeozoic and Precambrian inliers, and provings from deep boreholes (Figure 5.1). Many of the localities and borehole sites are on the NE margin of the Midlands Microcraton, though some occur within it. For many years these igneous rocks were considered as Precambrian, along with those of Charnwood Forest. However, Le Bas (1972) proposed a Caledonian age for the igneous rocks at Warboys, Mount-sorrel, South Leicestershire, Nuneaton and Dost Hill on the basis that they all could be inferred to intrude Lower Palaeozoic rocks. Recently, geochemical data and an increasing number of accurate U-Pb zircon dates have confirmed that igneous events occurred in this area during the late Proterozoic (at c. 615 Ma) and during the Ordovician (Noble *et al.*, 1993; Pharaoh *et al.*, 1993). The Precambrian occurrences are described in the *Precambrian of England and Wales* GCR volume.

Caledonian volcanic rocks in central England are almost entirely concealed, with the exception of the Barnt Green Volcanic Formation (Old *et al.*, 1991). The lower Silurian volcanic rocks of the Mendips and Tortworth area are described in Chapter 6 along with rocks of Skomer with which they are probably associated. Volcanic rocks are known to be widespread from well-documented borehole records (Pharaoh *et al.*, 1991, 1993; (Figure 5.1)). The volcanic rocks are calc-alkaline, arc-related and have been distinguished from the late Proterozoic rocks on their trace element abundances and isotopic compositions (Pharaoh *et al.*, 1991, 1993; Noble *et al.*, 1993). Though the compositional range includes basaltic andesite, andesite and rhyolite, felsic tuff predominates; no dacite is recorded. An Ordovician age has been determined for felsic tuff from the North Creake Borehole (449 ± 13 Ma, U-Pb zircon, Noble *et al.*, 1993).

The Ordovician plutons are also calc-alkaline (Le Bas, 1972, 1982b) and one group is aligned broadly along a NW–SE belt of crust with strongly positive aeromagnetic anomalies (Allsop, 1987; Pharaoh *et al.*, 1991, 1993). The recent summary of the occurrences and geochemistry of the igneous rocks of Central England by Pharaoh *et al.* (1993) has shown that the largely Triassic cover rocks conceal a substantial magmatic province of late Ordovician age. Pharaoh *et al.* (1993) speculated that the magnetic anomaly belt may mark the magmatic core of a continental calc-alkaline volcanic and plutonic province. Le Bas (1972, 1982b) and Pharaoh *et al.* (1991) have suggested that this belt of arc-related rocks extends eastwards into Belgium. The development of the putative arc at the eastern margin of Avalonia may have been the product of the subduction of oceanic lithosphere during closure of the Tornquist Sea (Pharaoh *et al.*, 1993). The lithologies, geochemistry and timing of Caledonian magmatism have considerable similarities with the Lake District magmatic province, but the tectonic relationships are yet to be understood.

Plutonic rocks

Three groups of plutonic rocks are recognized (Figure 5.1). The first of these, known as the 'South Leicestershire diorites', crops out on the margin of the Midlands Microcraton SW of Leicester. The second group is associated with a belt of positive aeromagnetic anomalies up to 10 km wide and extending about 125 km from Hathern, near Derby to St Ives in Huntingdonshire (Allsop, 1987); examples of these plutonic rocks include the exposed Mountsorrel complex and occurrences in the Rempstone, Kirby Lane and Warboys 1 boreholes. The xenolithic granodiorite from Rempstone is petrographically similar to Mountsorrel. Farther NE, in south Lincolnshire, cleaved and altered granophyric microgranite in the Claxby borehole has been dated at 457 ± 20 Ma (Noble *et al.*, 1993). The micro-granite is geochemically similar to Ordovician intrusions of the Lake District (Pharaoh *et al.*, 1997). While it is part of a third group of silicic plutons interpreted from geophysical anomalies in the area around the Wash (Busby *et al.*, 1993), it is not considered to be a major component of that batholith (Pharaoh *et al.*, 1997).

The South Leicestershire diorites comprise diorite, tonalite and microtonalite and are, or were formerly, exposed at Stoney Stanton [SP 490 950], Croft [SP 510 967], Coal Pit Lane Quarry [SP 542 992], Enderby [SP 542 992], Red Hill

Quarry, Narborough [SP 532 975] and Narborough Quarry [SP 525 975]; the Countesthorpe borehole also penetrated these rocks (Figure 5.1). The diorite is quartz bearing and contains hornblende and sparse augite. The tonalite is described in detail from the Croft Hill GCR site. Le Bas (1972) considered that these occurrences form a composite pluton about 14 km wide, intruding the Cambrian Stockingford Shale Group. The age of the intrusions is taken at 449 ± 18 Ma (U-Pb; Pidgeon and Aftalion, 1978; recalculated by Noble *et al.*, 1993).

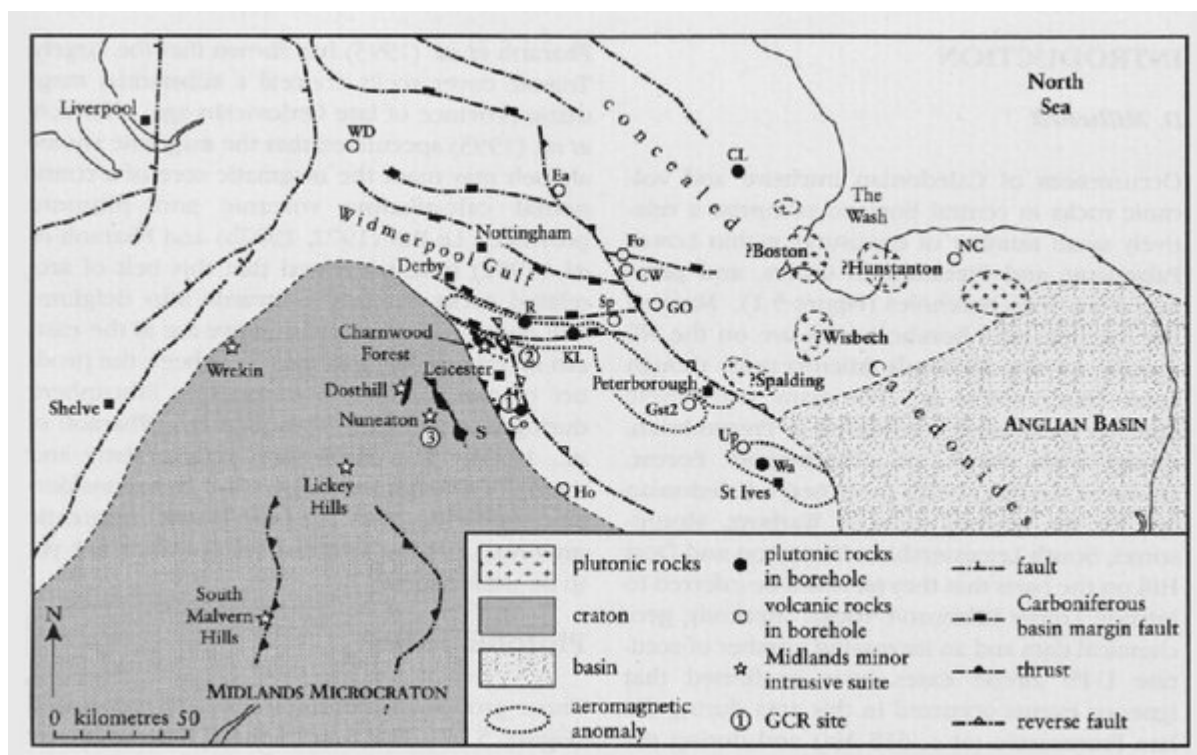
The Mountsorrel complex, about 10 km north of Leicester, comprises gabbro, diorite and granodiorite. The gabbro is exposed only on a small island in Swithland Reservoir and is composed of labradorite and ophitic brown hornblende enclosing relict augite; pseudomorphs after olivine may be present. The diorite is similar to the South Leicestershire suite (above) but contains more biotite. However, the most extensive rock type is a biotite granodiorite well illustrated by the Buddon Hill GCR site near Mountsorrel. The age of the complex is taken at 463 ± 32 Ma (U-Pb; Pidgeon and Aftalion, 1978; recalculated by Noble *et al.*, 1993).

Midlands Minor Intrusive Suite

The Cambrian and Tremadoc rocks within, and at the margin of, the Midlands Microcraton are intruded by lamprophyre (spessartite) and diorite dykes and sills. The field occurrence, petrography and geochemistry are detailed in Carney *et al.* (1992), Thorpe *et al.* (1993a) and Bridge *et al.* (1998). Exposures of these rocks are in quarries close to Nuneaton, near the Wrekin in Shropshire and in the Malvern Hills (Figure 5.1). The suite is typified by the 50 m-thick composite sill of spessartite, hornblende diorite and hornblende meladiorite described from the Griff Hollow GCR site; that sill has a U-Pb emplacement age of 442 ± 3 Ma (Noble *et al.*, 1993). In the Tremadoc Shineton Shales of the Wrekin area a single lenticular mass is exposed in an old quarry [SJ 645 087]. The mineralogy of this occurrence differs from those at Nuneaton in containing no magmatic amphibole and up to 20% clinopyroxene. The presence of olivine and absence of quartz distinguishes this group from the other Caledonian igneous rocks of central England.

A small, faulted inlier at the southern end of the Lickey Hills, south of Birmingham (Figure 5.1) comprises water-laid crystal and crystal-lithic tuffs together with other volcanoclastic sedimentary rocks of the Tremadoc Barnt Green Volcanic Formation, intruded by aphyric micro-diorite intrusions (Old *et al.*, 1991). Geochemical comparisons led Carney *et al.* (1992) to suggest that these rocks may belong to an early, extrusive phase related to the Midlands Minor Intrusive Suite, thus implying that this magma type was available over a substantial time-span.

References



(Figure 5.1) Map of central England showing locations of the occurrences of Caledonian igneous rocks and the GCR sites (after Pharaoh et al., 1993). GCR sites: 1, Croft Hill; 2, Buddon Hill (Mountsorrel); 3, Griff Hollow. Occurrences of plutonic rocks: Cl, Claxby; Co, Countesthorpe; KL, Kirby Lane; R, Rempstone; S, South Leicestershire diorites; Wa, Warboys 1. Occurrences of volcanic rocks: CW, Coxs Walk; EA, Eakring 146; Fo, Foston; GO, Great Osgrove Wood 1; Gst2, Gas Stamford 2; Ho, Hollowel; NC, North Creake 1; Sp, Sproxton; Up, Upwood 1; WD, Woo Dale 1.