Croft Quarry, Leicestershire

[SP 510 964]

Introduction

Croft Quarry is one of Leicestershire's 'super-quarries', generating over 2 million tons of aggregate per annum. This and the adjacent Huncote Quarry (currently not in use, see (Figure 4.4) for location map) expose an outcrop of the 'South Leicestershire diorites' (Le Bas, 1968), which forms an arcuate shape trending roughly north–south to north-east-south-west. The rocks were emplaced on the margin of the Midland Microcraton, south-west of Leicester, described in the *Caledonian Igneous Rocks of Great Britain* GCR volume (Stephenson *et al.,* 1999), and specifically in the Croft Hill GCR site report, which identified the Croft pluton as being tonalitic rather than dioritic in composition.

Hill and Bonney (1878), Harrison (1885), and Fox-Strangeways (1900, 1903) carried out much of the initial work on these intrusive rocks in the later quarter of the 19th century, and Eastwood *et al.* (1923) provided a summary of the geology of south Leicestershire. A more up-to-date review of the igneous rocks of the area is given by Worssam and Old (1988). Other local exposures of the South Leicestershire diorites crop out north-east of Croft and Huncote, at Enderby and Narborough, and to the south-west at Stoney Stanton and Sapcote, most of which are also quarry sites that were mapped by Bosworth (1912).

The age of the South Leicestershire diorites remained unconstrained for some time; their protrusion as monadnocks (like Croft Hill) through a covering of Triassic rocks (Le Bas, 1968) confirmed their age simply as pre-Triassic. Hill and Bonney (1878) compared slates found enclosed within the igneous rocks at nearby Enderby to the slates of Billa Barrow (part of the Brand Group of the Neoproterozoic

Charnian Supergroup). Bonney (1895) later correlated the Enderby slates with those exposed at Brazil Wood into which the Caledonian rocks of Mountsorrel are intruded, suggesting that the South Leicestershire diorites were Precambrian. Harrison (1885), and later Lowe (in Bennett *et al.,* 1928), and Butterley and Mitchell (1946) suggested that the slate was Cambrian and related to the Stockingford Shale Group of Nuneaton, implying that the south Leicestershire igneous rocks were Cambrian to early Ordovician. The tonalitic Croft pluton was suggested by Snowball (1952) to be post-Cambrian and Caledonian in age. This has been confirmed by Pidgeon and Aftalion (1978), who determined a radiometric age of 452 ± 5 Ma (Caradoc, corresponding to Ordovician Stage 5).

The tonalite is cut by E–W-trending and NE–SW-trending joint-systems that, are reported to dip both to the north and south (Eastwood *et al.,* 1923). Associated with the joint systems, alteration of the tonalites is evident; fresh unaltered grey surfaces are observed to grade into dirty-pink altered rock that shows varying degrees of decomposition, from early sercitiz..ation of feldspars to their entire kaolinization. Altered rock zones are also characterized by the replacement of mafic minerals with epidote. End stages of alteration of the rock are characterized by the formation of 'rammel' rock; this comprises completely disaggregated minerals (usually breakdown products and residual quartz and feldspar) and resembles coarse sand (Le Bas,1968). By analogy with alteration of the Southwest England granites, the 'rammel' rock may originate through surface weathering (cf. Worssam and Old, 1988), prior to deposition of the overlying Triassic sequence. Some of the rammel units are up to 12 m thick, and in the past were used for footpath gravel. Vein structures are commonly recognized within the centre of the thicker rammel units; these are dominated by white analcime, which stains pink when in close proximity to hematite or other associated iron oxides. Other minerals of interest associated with the vein analcime include chabazite, quartz, rhombic calcite, chalcopyrite, galena, pyrite, fluorite, goethite, pyrolusite and quartz (and also laumontite at nearby Huncote) (Le Bas, 1968). Rarer members of this assemblage include prehnite, datolite, dolomite and molybdenite. The presence of molybdenite in close association with analcime in the vein system renders interpretation difficult, as molybdenite is thought to belong to a high-temperature environment, whereas analcime belongs to mesothermal and lower environments. It has been suggested that the partial substitution of sodium by potassium may stabilize analcime in a hydrothermal environment and may possibly be a reversion and an inversion process, with leucite as an end member (Le Bas, 1968).

Description

The rocks at Croft Quarry (and other nearby localities such as Huncote, Sapcote and Stoney Stanton in south Leicestershire) were classed incorrectly as syenites as part of the Charnwood Forest Group, and they are referred to as this on the Geological Survey of Great Britain one-inch sheets 155 (1932), and 156 (1903), respectively. Eastwood *et al.* (1923), however, observed that the rocks at Croft and the other sites showed a distinct mineralogical resemblance to basic marginal modifications of the nearby Mountsorrel granites. This likeness is apparent in the predominance of feldspars and their range in composition, in the dominance of hornblende rather than augite as the principal ferromagnesian minerals and the general absence of granophyric groundmass in the rocks at Croft, when these are characteristic of the 'Southern Syenites' of Charnwood Forest (Eastwood *et al.,* 1923). Jones (1934), and Snowball (1952) also later suggested that the South Leicestershire 'granites' were in fact diorites; Jones and Langley (1931) had stated that the rocks at Croft were probably the most siliceous members of the diorite-porphyries which protruded from the Triassic rocks *in* south Leicestershire. The classification of the rocks at Croft was later refined to hornblende-tonalite by Le Bas (1968), then to quartz diorite (Worssam and Old, 1988), and finally to tonalite by Carney and Pharaoh (in Stephenson *et al.,* 1999).

Fresh surfaces of the rocks at Croft are grey; plagioclase phenocrysts are evident (approximately 2 mm in diameter) and some show zoning throughout from andesine to oligoclase, with occasional albite at the grain margin (Le Bas, 1968). These rocks are notably more porphyritic than those to the south at Sapcote, which are part of the same intrusive complex (Eastwood *et al.,* 1923). The groundmass comprises laths of more calcic plagioclase compared to the phenocrysts (Eastwood *et al.,* 1923). Hornblende is also present as green-yellow and pale-brown crystals (approximately 1 mm in diameter) enclosing clear colourless augite in the fresh rocks at Croft Quarry. Hornblende comprises around 10% of the rock, and grains are pleochroic and occasionally twinned and euhedral (Le Bas, 1968). Biotite is also present in the Croft rocks, although in lesser quantities compared to the hornblende. Perthitic orthoclase mantling plagioclase is evident; perthitc comprises up to 5% of the rock, and interstitial quartz is also common, forming between 15% and 20% of the rock volume. Opaque minerals, apatite and titanite, are present as the normal accessory minerals (Le Bas, 1968).

In the altered varieties of the tonalite the mafic minerals are chloritized, the feldspar shows signs of sericitization and kaolinization, and secondary epidote is abundant. Also present in the quarry exposure are pegmatites, consisting of large albite–oligoclase crystals which show albite twinning and which are slightly sericitized (Le Bas, 1968). Occasional inclusions of optically continuous quartz are evident in the rock, which has a granophyric texture. Large crystals of interstitial quartz are present, and intergrowths of quartz together with fine-grained orthoclase are found enclosing plagioclase. Epidote and apatite are present together with cavity-filled chlorite rosettes (Le Bas, 1968). Numerous small xenoliths of augite-microdiorite occur in the tonalite at Croft Quarry. Most of the microdiorite (75%) comprises sericitized and zoned oligoclase, colourless augite, pale-green hornblende, opaque mineral grains and a little quartz (Le Bas, 1968).

The vein-style mineralization at Croft Quarry (see (Figure 4.5)) is controlled by joint sets. The joint-sets trend east-west and north-east-southwest, and are generally less regular than those exposed in the Sapcote quartz diorites to the south of Croft (Eastwood *et al.,* 1923). A large single vein rises vertically from below the quarry floor level, splits into two and then fans out into a great number of thinner veins (Le Bas, 1968). These take the form of shallow arcs which pinch out laterally and appear to follow an irregular joint pattern. The altered country rock affected by the mineralization has been of economic importance in the past, and its characteristic dirty-pink staining contrasts with the unaltered 'clean' igneous rocks which are a bluish-grey colour. The degree of alteration of the country rocks appears to be controlled by the proximity and thickness of the veins carrying the mineralization (Le Bas, 1968).

The earliest description of the occurrence of zeolites at Croft Quarry is that of Jones and Langley (1931). Zeolites (chabazite) were first found in a widened joint-cavity (50 cm in length and 15 cm wide), and were initially mistaken for quartz or calcite crystals. The cavity appears to be some 25 m deep into the rock, and is associated with a low-angle red stringer beyond the cavity. Closer inspection of this cavity shows that analcime is the dominant infill (crystals have been measured at diameters of 1 cm) and appears colourless, milky-white and also orange-or red-tinged, due to iron oxide staining (Jones and Langley 1931). The chabazite is opaque white and translucent on fracture surfaces, and appears as only small fragments (Jones and Langley, 1931).

Interpretation

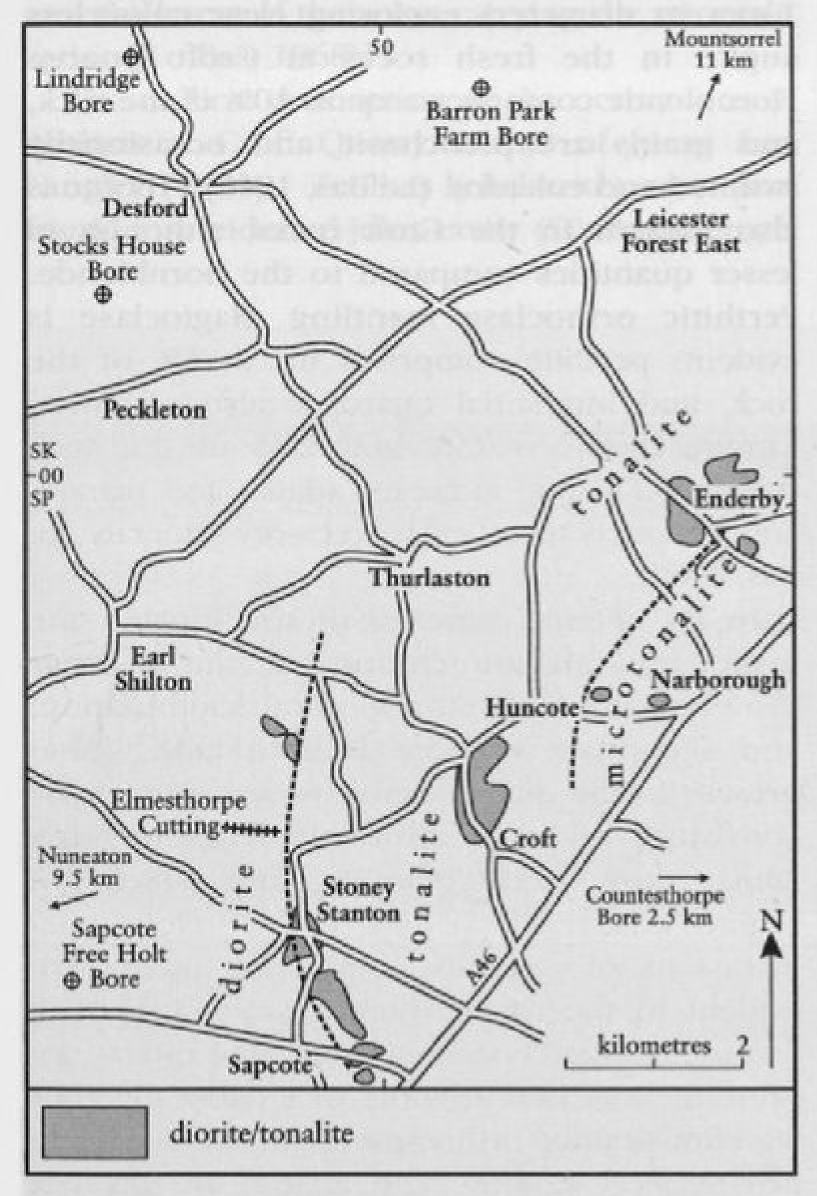
Despite early dispute over the age of the granodiorites, the rocks at Croft and Huncote are believed to be Ordovician in age. The Triassic Mercia Mudstone Group (MMG) rocks (Le Bas, 1968) unconformably overlie the intrusive rocks, and consist of deep-red loams, sandy marls and 'skerry' sandstone beds that were deposited as a wadi infill. Pre-Triassic palaeovalleys are exposed in the faces of Croft Quarry into which the lowest MMG units dip (namely the skerry bands) at an angle conforming to the slope of the valley sides (Eastwood *et al.,* 1923). These units are truncated by the unconformity surface, consistent with deposition on an irregular eroded landscape. What appears to be the lowest unit of exposed MMG rocks is a grit-bed, which comprises angular fragments of the underlying granodiorite cemented by a calcareous material, with a breccia-like appearance (Eastwood *et al.,* 1923). This unit varies in thickness and is probably the local basement-bed of the MMG (although without intersumtified marl units this cannot be confirmed; Eastwood *et al.,* 1923). The relations of the MMG rocks to the underlying igneous rocks at Croft Quarry are similar to those at Stoney Stanton (approximately 2 km south-west of Croft), which exhibits similar stratigraphical relationships. The development of a thick manganese-rich crust on the unconformity surface is consistent with a long-lived episode of desert varnish formation prior to deposition of the Mercia Mudstone Group.

Textural relationships indicate that the analcime crystallized before the chabazite (Jones and Langley, 1931). The igneous rocks at Croft Quarry are regarded as probably the most siliceous members of the South Leicestershire diorites; accordingly, the occurrence of analcime and chabazite is unexpected (Jones and Langley, 1931), as these minerals are normally associated with alkali (soda-rich) basic rocks (Jones and Langley 1931) and their appearance in the calc-alkaline rocks at Croft is therefore unusual.

Conclusions

Croft Quarry contains an Ordovician tonalite with an unusual occurrence of zeolites. The unconformity with the overlying Triassic sequence is marked by manganese mineralization. Alteration within the tonalite may be related to ancient surface weathering processes prior to the deposition of the Triassic Mercia Mudstone Group.

References



(Figure 4.4) Location map of Croft Quarry. After Le Bas (1968).

(Figure 4.5) The Croft Quarry GCR site. (Photo: M.L. White.)