Castle Hill Quarry (Mountsorrel Granite Quarry), Leicestershire

[SK 577 148]

Introduction

Castle Hill Quarry occupies the exposed and north-eastern limits of the pluton of the Caledonian (Caradoc) 'Mountsorrel Complex' (Lowe, 1926; Mencisy and Miller, 1963; Le Bas, 1968, 1972), cropping out as part of the Midlands Microcraton, described in the *Caledonian Igneous Rocks of Great Britain* GCR volume (Stephenson *et al.,* 1999), and is closely related to the Buddon Hill GCR site, described in that volume. This GCR site is situated in the village of Mountsorrel, 7 km south-east of Loughborough, Leicestershire (see (Figure 4.2)).

Early work at Mountsorrel (Hill and Bonney, 1878; Lowe, 1926; Taylor, 1934) showed that the principal rock-type, granodiorite, is increasingly hybridized in a westerly direction until gabbroic rocks occur at the contact with possibly Tremadocian hornfelsed sedimentary rocks. This area is adjacent to the Soar Valley Fault, which drops down the eastern limits of the igneous mass below the younger sedimentary rocks.

Miller and Podmore (1961), and Pidgeon and Aftalion (1978) established the age of the Mountsorrel Complex to correspond to the Caledonian Orogeny, forming as part of Ordovician subduction-related magmatism.

This site (see (Figure 4.3)) represents a fine example of granite-related high-temperature mineralization characterized by molybdenite, allanite and topaz, with later modification by dolomite, sulphides and recrystallized chlorites (King, 1959). Late-stage igneous rocks include swarms of aplite dykes and a rare pegmatitic facies. Hercynian tectonic movements in the complex have produced faults subsequently occupied by olivine-dolerite dykes. The latter carry a unique mineral assemblage characterized by asphaltite, dolomite-calcite and pyrite. This occurrence of fracture-bound asphaltite (bitumen) was described by Pering (1973).

It is believed that Castle Hill Quarry was worked for building materials by the Romans. Industrial quarrying has taken place at Mountsorrel since the late 18th century. The quarrying industry grew rapidly, having between 500 and 600 employees by 1870. During the industrial revolution, this area represented the nearest source of hard rock to London. Consequentially, Mountsorrel 'granite' can be found throughout many Roman sites and in the buildings of London. Quarrying ceased at Castle Hill Quarry in 1964. Tipping of waste has taken place at Castle Hill Quarry since the 1960s. Landfill operations have now ceased, preserving key aspects of the site as a Site of Special Scientific Interest (SSSI).

Description

The granodiorite at Mountsorrel is represented by a series of isolated outcrops, situated approximately 10 km north of Leicester (Miller and Podmore, 1961). These exposures are part of a large intrusive boss more than 1.5 km in diameter.

Many characteristics of granitic and granodioritic igneous rocks have been recorded at Castle Hill Quarry. Two varieties of coarsely crystalline granodioritic rock exist and are distinguished by their pink and grey feldspars (Miller and Podmore, 1961). Hill, and Bonney (1878) first characterized the 'microscopic structure' of the 'red' and 'grey' varieties of the Mountsorrel Complex. They described the mineral assemblage to consist of: quartz, feldspar (mostly orthoclase with some plagioclase), biotite, hornblende (replaced by epidote) and magnetite, with minor amounts of apatite. They suggested that a section of the rock had been melted to form a distinct assemblage rather than co-formation of the two from separate magma types. Hill and Bonney (1878) reported a 20 cm-thick dyke of 'compact pinkish-red felstone' or rhyolite, striking north-east and dipping at 60° to the eastern side, located to the west of the principal quarry at Mountsorrel.

In addition to the principal minerals listed above, accessory minerals present within the granodiorite at Castle Hill Quarry were observed by Taylor (1934) to include zircon, titanite, pyrrhotite, magnetite, illmenite and orthite (allanite). Taylor

(1934) noted that zircon is 'abundant, varied and extremely interesting' in most of the Mountsorrel rocks. Other accessory minerals include chlorite and epidote, and also two 'pneumatolytic' accessory minerals, anatase and rutile (Taylor, 1934). Hydrothermal mineralization related to granitic processes ranges from a high-temperature suite of minerals, with molybdenite, topaz and allanite, to a mesothermal suite, characterized by dolomite, sulphides and epidote.

Tectonic movements in the complex have produced faults subsequently occupied by olivine-dolerite dykes. These dykes are host to a unique asphaltite hydrocarbon compound mixture, and a dolomite-calcite and pyrite mineral assemblage. The hydrocarbons occur particularly in calcite-dolomite veins, at the margin of cross-cutting dolerite dykes, and as vein-like masses within the dolerite (Parnell, 1988a). A similar association of hydrocarbons with mineralization is seen at the Windy Knoll GCR site, in Derbyshire.

Interpretation

The Mountsorrel Complex is older than the overlying Triassic sandstones, and is cross-cut by dolerite dykes of Carboniferous age. It is therefore pre-Carboniferous, while Miller and Podmore (1961) determined it to be younger than some of the Precambrian rocks of Charnwood Forest. Its age has been determined more accurately by Pidgeon and Aftalion (1978), who used U-Pb data collected from zircons to obtain a date for the Mountsorrel granodiorite and the surrounding plutons of 452 ± 5 Ma (Caradoc).

Taylor (1934) suggested that the granodiorite originated through the action of acid magma on basic rock (hybridization) rather than being a straightforward differentiate from a gabbroic magma. The abundant igneous inclusions in the granodiorite are generally acidic quartz-mica-diorite. It is uncertain whether the material added to the initial acid magma was gabbro, diorite or a mixture or both. A general increase in basicity westwards has been determined, noted by an increase in the proportion of mafic minerals and the presence of xenocrysts (Sylvester-Bradley and Ford, 1968).

Changes in mineralogy during the latest stages of magma crystallization (deuteric mineralization effects) included varying degrees of sericitization, with reddening of the feldspars (especially orthoclase), decomposition of biotite, and minor epidotization. The reddening or 'pinking' of feldspar occurs in the form of dyke-like bodies which are often more than 300 m thick (Sylvester-Bradley and Ford, 1968).

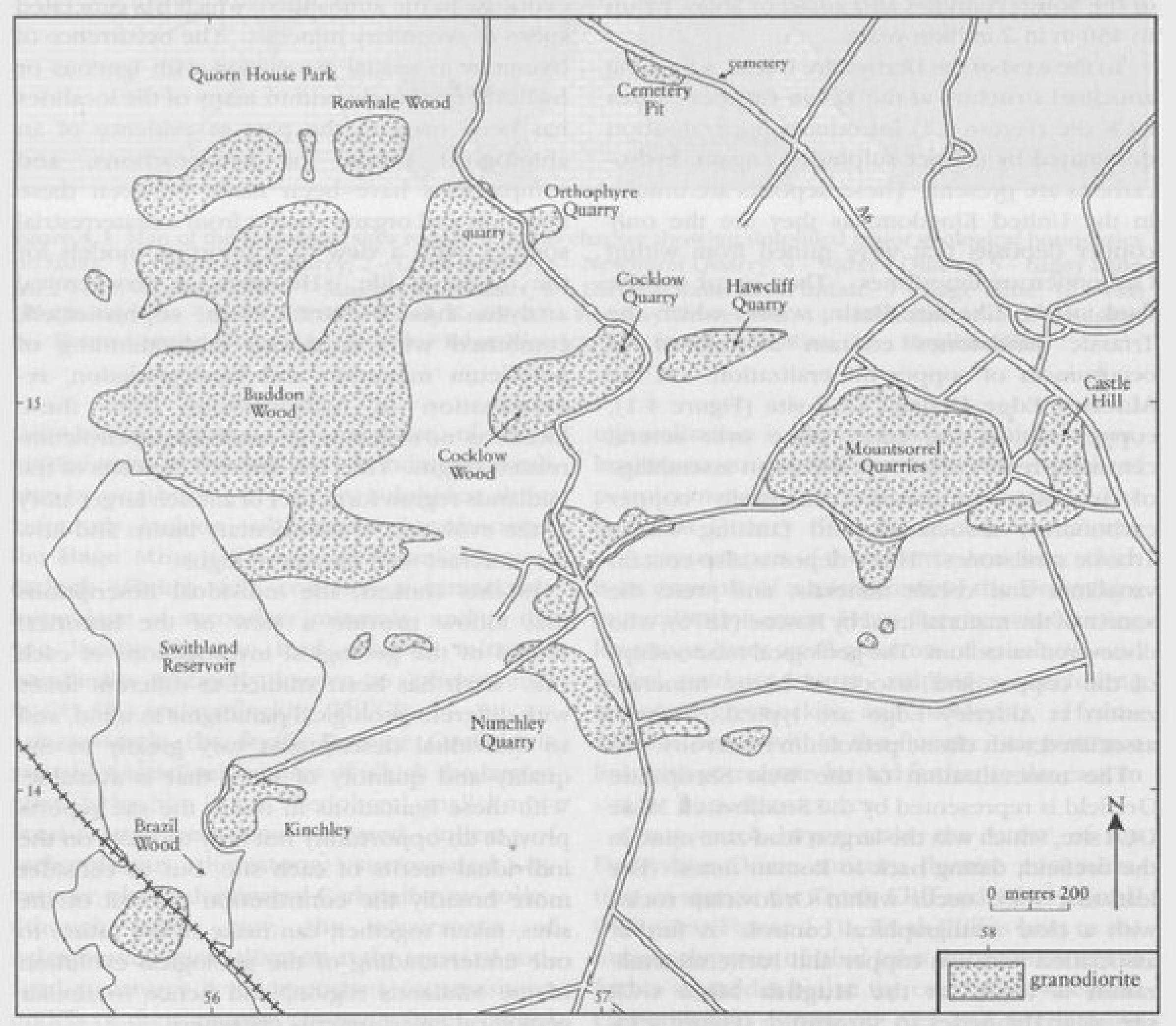
Hercynian orogenic (Late Devonian–Carboniferous) tectonic movements induced faults within the complex. These were subsequently occupied by olivine-dolerite dykes. The source of the hydrocarbons within these dolerite dykes has been investigated by several researchers.

The simplest explanation for the origin of fracture-bound hydrocarbons Is that they derived from Carboniferous rocks which once covered the pluton. King (1959), and Ford (1968) suggested that hydrocarbons migrated from the overlying Namurian shales during a stage of hydrothermal mineralization, and argued for an abiological origin. Other researchers (Sylvester-Bradley and King, 1963; Sylvester-Bradley, 1964; Ponnamperuma and Pering, 1966; Pering, 1973) suggested a biogenic source for the hydrocarbons. The carbon isotope ratio of the Mountsorrel hydrocarbons is similar to that of petroleum samples (Poring and Ponnamperuma, 1969). More-recent GC-MS analyses of the alkane fraction and the pyrolysate of the asphaltene fraction have yielded abundant biomarkers (Xuemin *et al.,* 1987). It seems clear that after some controversy during the early years of understanding the origin of hydrocarbons within igneous rocks, the Mountsorrel hydrocarbons originated from sedimentary petroleum and migrated into their present host.

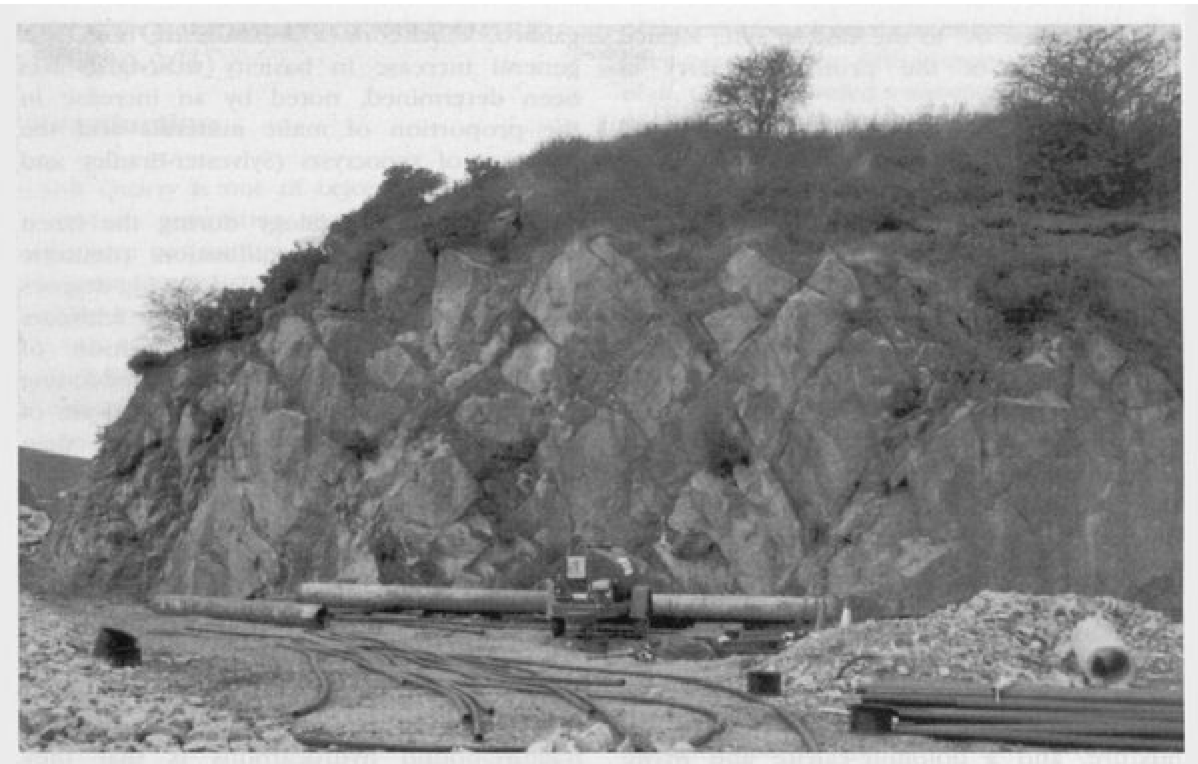
Conclusions

Castle Hill Quarry is important historically for its contribution to studies of the origin of organic geological materials, and for its unusual high-temperature granodiorite-associated mineralization.

[References](#)



(Figure 4.2) Location map of the Castle Hill Quarry GCR site.



(Figure 4.3) Outcrop at Castic Hill Quarry (Photo: M.L. White.)