
Outwoods–Hangingstone Hills

[SK 520 157]

J.N. Carney

Introduction

This site occupies a large area of forested hills and heathland and in its southern part, around the Hangingstone Hills, includes the Charnwood Forest Golf Course (Figure 2.15). It is of international importance in terms of Precambrian palaeontology, in that it contains two horizons with fossil impressions, described in Chapter 8. The site additionally exposes extensive sequences in the upper part of the Maplewell Group, and in particular through the overlying Brand Group whose age is currently controversial (see introduction to this chapter). The base of the Brand Group is not exposed but is believed to be an unconformity on which rests pebble beds of the Hanging Rocks Formation (McIlroy *et al.*, 1998), formerly the 'Hanging Rocks Conglomerate Member' of Moseley and Ford (1985). This unit, which represents a significant change in the style of sedimentation, has its type section in the south of the site. It is there overlain by the Swithland Formation, which is now thought to be Lower Cambrian in age, as discussed in the section on 'The Brand' GCR site (Chapter 9).

Description

In the Outwoods area of the site, east-dipping beds are correlated with the lower part of the Bradgate Formation, since they overlie the Outwoods Breccia Member, referred to the upper part of the Beacon Hill Formation. This correlation is further suggested by the occurrence of fossil impressions [SK 5153 1604], which lie in a similar stratigraphical position to the fossil horizon at the Memorial Crags (Bradgate Park) GCR site. This is based on the supposition that the Outwoods Breccia Member is a thickened, lateral correlative of the sequence containing the Sliding Stone Slump Breccia exposed in the Memorial Crags. Strata at the Outwoods consist of laminated to thinly bedded, pale grey, volcanoclastic mudstones and siltstones with subordinate beds of massive volcanoclastic sandstone up to 0.4 m thick. Graded bedding and slightly disturbed, gently wavy bedding occur sporadically.

To the south of Hanging Stone, the stratigraphically lowest beds are tentatively correlated with the upper part of the Outwoods Breccia Member. This is regarded as the topmost component of the Beacon Hill Formation (Carney, 1994), although its content of arenaceous beds suggests it could also represent a local base to the Bradgate Formation. At Locality 1 [SK 5218 1501]; (Figure 2.15)) these strata comprise c. 6 m of massive, medium- to coarse-grained, very thickly bedded, volcanoclastic sandstone. Many beds are separated by centimetres-thick intercalations of mudstone and siltstone, but these layers are commonly impersistent, due to scouring at the base of the next overlying sandstone; they also show disruption, slump-folding and incorporation as rafts within an invading sandstone matrix. The sequence fines upwards about 100 m to the north, where thinly interbedded siltstones and sandstones represent a transition to the overlying Bradgate Formation.

Beds of the Bradgate Formation exposed at the Hanging Stone crag [SK 5223 1525] are up to 4 m thick (Figure 2.16), internally massive, and composed of very coarse-grained to granule-grade volcanoclastic sandstone. In thin sections there are lapilli of microdiorite and feldsparphyric andesite, but these are subordinate to abundant, irregular-shaped clasts showing relict microcrystalline and spherulitic textures. Individual sandstone beds are separated by thin layers of laminated, normally graded, volcanoclastic siltstone; deeply penetrating load structures are developed at some of these junctions, and slivers or folded rafts of siltstone, up to 0.3 m long, are enclosed within the lower parts of many sandstone beds. The succession fines down, up-section from the Hanging Stone; for example, at Locality 2 [SK 5218 1542], the stratigraphically higher sandstones are medium- to coarse-grained and well-sorted, although still containing sedimentary rafts. About 40 m to the north, younger beds occur as graded sandstone–siltstone–mudstone packages. The culminating beds of this fining upwards sedimentary cycle are seen at North Quarry [SK 5222 1554], where the sequence mainly consists of parallel-sided beds of alternating volcanoclastic mudstone and siltstone, with subordinate sandstones (Figure

2.17). The mudstone beds are commonly internally structureless, whereas siltstones are well laminated, with sporadic 10–100 mm-thick, sharp-sided beds of fine- to medium-grained, graded volcaniclastic sandstone. The principal bedding plane shown in (Figure 2.17) surmounts a sequence consisting of massive to faintly laminated mudstones and siltstones. This is the bedding plane that contains the diverse assemblage of Precambrian fossils described in Chapter 8.

The Hanging Rocks Formation has its type section in the crags to the west of the 18th hole of Charnwood Golf Course (Locality 3). McIlroy *et al.* (1998) suggest two informal divisions, a 'conglomeratic member' at the base, and an overlying pelitic member. The unit's basal contact is now overgrown, but in the sketch by Watts (1947, p. 48), it is shown to sharply overlie 'coarse green hornstones'. The lowest bed presently seen is in massive to plane-stratified, medium-grained sandstone containing a 0.3 m-thick layer of very poorly sorted granule-conglomerate with sporadic, well-rounded larger pebbles (approximately 30 mm size). Resting on this sandstone is a parallel-bedded sandstone about 1.3 m-thick with loaded base. Above this is the main conglomeratic member, about 18 m thick. Its lower part, several metres thick, is composed of matrix-supported granule or small-pebble conglomerate beds c. 0.2 m thick, which are separated by similar thicknesses of planar to lenticular sandstone. In thin sections, the conglomerate matrix contains abundant crystals of quartz and plagioclase in a micaceous, mud-rich base. The more common pebbles are of dacite, which shows microcrystalline to fluidal and shardic textures suggestive of derivation from both welded and non-welded pyroclastic rocks. The other clasts are of single or aggregated quartz crystals, some exhibiting internal foliation and sutured grain boundaries; single crystals or aggregates of K-feldspar (microcline and perthite) also occur. A stratigraphically higher bed, about 5 m thick, shows variations in the dominant pebble size, which impart a very crude stratification. Its coarse-grained upper part contains dark grey, intraformational mudstone clasts, 50 mm to 0.1 m across. A polished slab (Figure 2.18), from the middle part of this conglomerate, shows the dominance of the matrix, which is composed of medium- to coarse-grained sand; the clasts range from granules to pebbles up to 35 mm across.

The highest exposed beds of the conglomeratic member are seen north-eastwards across the green from Locality 3. They are predominantly composed of medium- to thinly bedded, massive or normally graded sandstones resting, with loaded bases in places, on laminated tuffaceous siltstone. Conglomerate persists as sporadic layers averaging 40 mm thick, some with pebbles of quartz-phyric tuff up to 20 mm in size. Thin sections of the tuffaceous siltstone matrix to these conglomerates show sporadic crescent- and sliver-shaped shards of recrystallized glass. McIlroy *et al.* (1998) describe a further 30 m of tuffaceous 'red-purple pelites' and greywacke sandstones, which represent a predominantly fine-grained capping to the formation.

Moseley and Ford (1985) note that the base of the Swithland Formation, which may now be referred to the Lower Cambrian (Chapter 9), is exposed on Charnwood Forest Golf Course. They suggest that the top part of the Hanging Rocks Formation is succeeded by '54 m of pelites and very fine-grained greywackes', and, although exposure is not continuous, no sharp junction or obvious unconformity appears to be present within this passage. The Swithland Formation proper is exposed in the old slate quarries at Locality 4. It consists of grey to maroon or purple, slaty mudstones punctuated by thin beds (up to 0.15 m thick) of pale grey sandstone containing mudstone clasts.

Interpretation

This site provides an important record of the sedimentation events leading up to the major hiatus represented by an unconformity inferred between the Maplewell and Brand groups (e.g. McIlroy *et al.*, 1998). At the top of the Beacon Hill Formation, the Outwoods Breccia Member contains coarse-grained strata and sediment-raft breccias. The breccias suggest instability within the sedimentary pile and it is possible that the rapid supply of coarse material, perhaps as pyroclastic flows, increased the local basinal slope angle and created preconditions for plastic deformation within the finer-grained, mechanically weaker layers. The overlying Bradgate Formation shows a phase of coarse-grained sediment deposition, seen as the strata at the Hanging Stone. Those beds are interpreted as the proximal deposits of a turbidite apron, possibly supplied by large-volume pyroclastic flows, that had prograded across this part of the basin. Waning sediment supply, perhaps due to a decline in volcanic activity, is then reflected by upwards fining culminating in the fossiliferous beds of North Quarry. There, the common occurrence of decimetres-thick massive or faintly laminated mudstone suggests deposition dominated by the fall out of suspended clay or silt particles.

Although the base of the succeeding Hanging Rocks Formation is not seen, its content of well-rounded pebbles — the first to be recorded in the Charnian sequence — suggests deposition as a conglomeratic lag overlying an eroded surface on the Bradgate Formation. Rounded pebbles indicate a significant history of transport and reworking such as, occur in fluvial or shoreline environments. Against this is the poor sorting and matrix-supported nature of the conglomerates, their general lack of organization, and the presence of parallel stratification and grading at the top of the unit. These are features reminiscent of the gravelly sand facies (Ghibaudo, 1992), and could indicate a final episode of transport by debris flows or turbidity currents, perhaps in submarine fan or fan-delta environments.

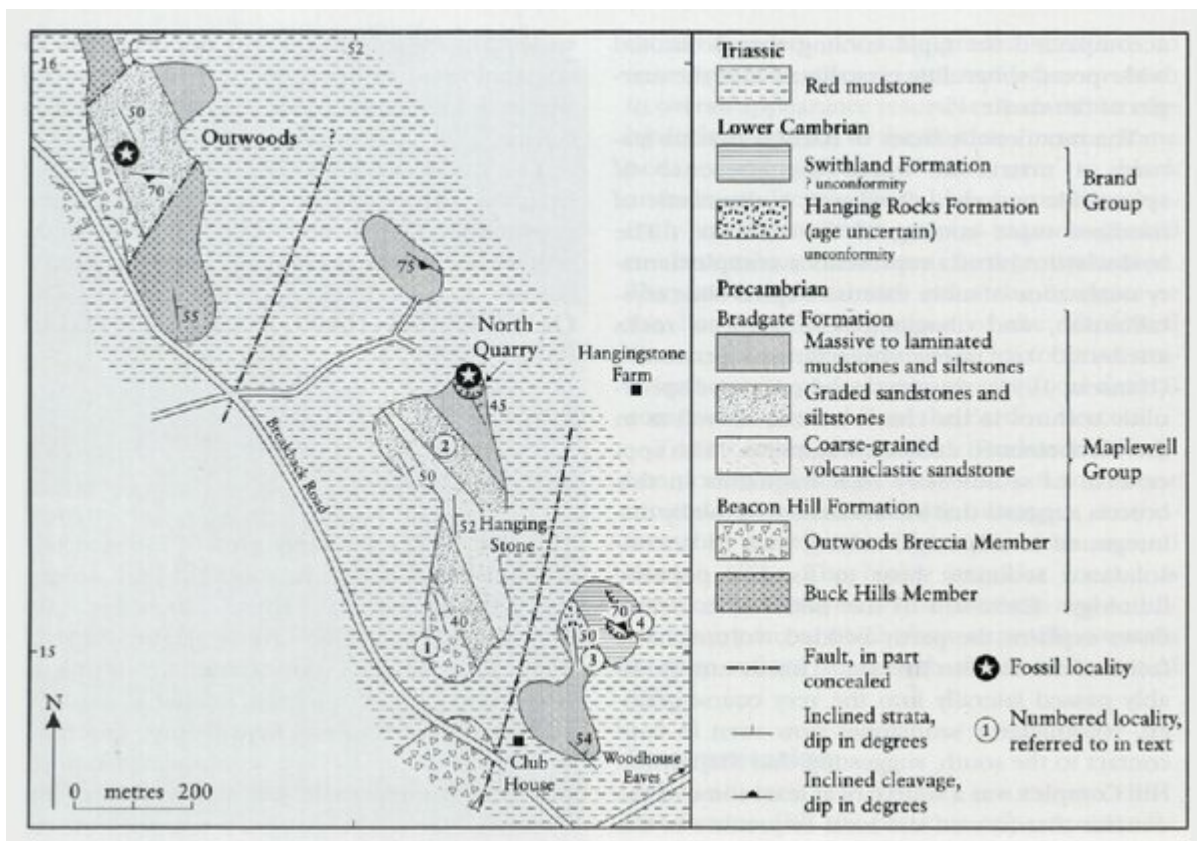
The Hanging Rocks Formation was attributed by Moseley and Ford (1989) to the encroachment of high-energy, shallower water environments following the cessation of magmatism along the Charnian volcanic arc. Individual glass shards have nevertheless been found in siltstones from the unit's upper part, Worssam and Old (1988) noted them in the matrix of some conglomerates, and they have also been reported by McIlroy *et al.* (1998). Volcanism therefore accompanied deposition, but whether this was a continuation of Charnian magmatism, or represents a much later event, depends upon the outcome of a debate over whether the Hanging Rocks Formation is Precambrian or Cambrian in age. Sandstone provenance studies by McIlroy *et al.* (1998) suggest that the formation is more related to true Charnian sequences (Bradgate Formation) than to strata of the Brand Hills Formation that are now believed to be Lower Cambrian (Chapter 9). Against this, the conglomerates contain grains of perthitic K-feldspar and microcline not found in the underlying Charnian strata. Furthermore, the volcanic pebbles differ from typical Charnian acid tuffs both in petrography (Carney, 1994) and geochemistry (unpublished analyses, British Geological Survey). These observations imply that a different volcanic source region now lay adjacent to the Charnian volcanic arc, and that this was sampled by the Hanging Rocks Formation. There is little evidence of the nature of the junction with the Swithland Formation, now believed to be Lower Cambrian, although an unconformity was favoured by McIlroy *et al.* (1998).

Conclusions

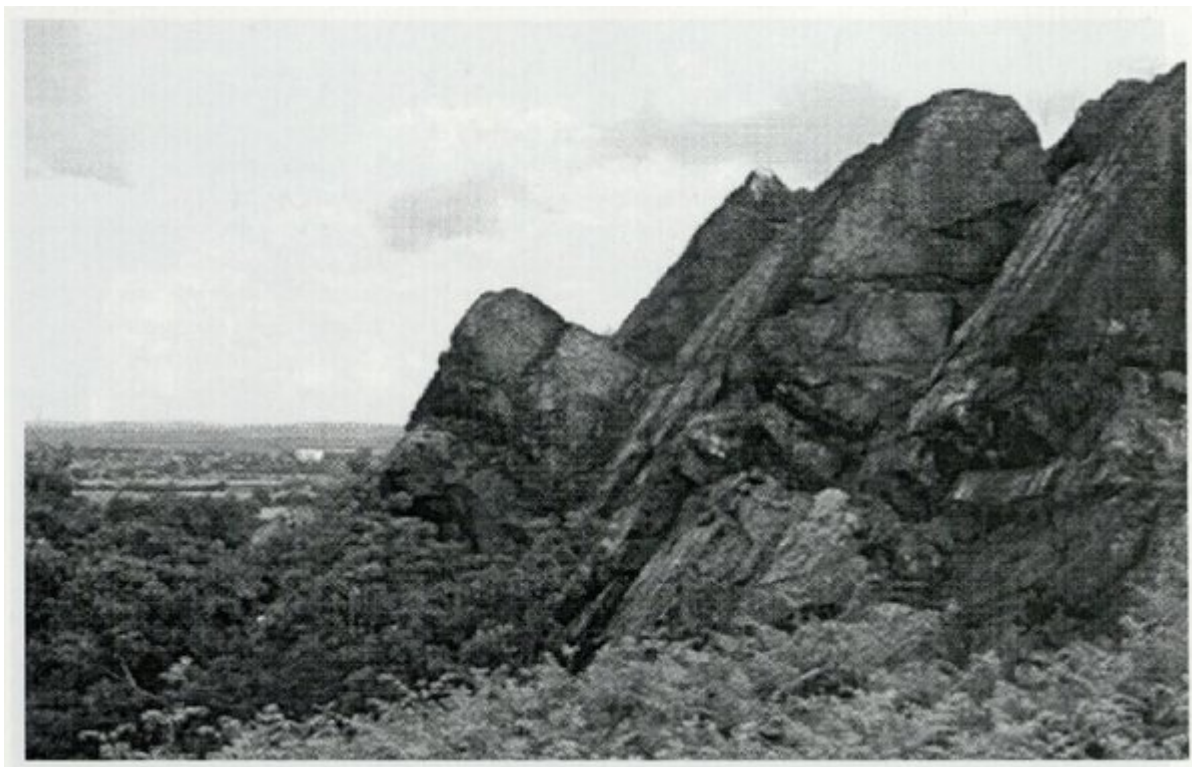
This is one of the most important sites in Charnwood Forest, partly because it contains two fossil localities, but also because it provides many exposures vital to interpretations of geological events at the very top of the Charnian sequence. The sedimentary character of the Beacon Hill and Bradgate formations demonstrates that there was an abundant supply of coarse, volcanic-rich, sandy detritus, which was probably introduced to the Charnian basin as sediment-charged turbulent flows triggered by pyroclastic volcanism and/or tectonism. The Bradgate Formation features successive, metres-thick, upwards-fining sedimentary cycles. Two of the finer-grained beds contain important Precambrian fossil horizons (Chapter 8).

These events were succeeded by uplift resulting in the deposition of beds containing the first examples (in Charnwood Forest) of well-rounded pebbles, represented by the Hanging Rocks Conglomerate Formation. Further studies may show whether this pebbly detritus was eroded from the Charnian Supergroup, or from a different volcanic sequence, perhaps that of the Fenland Terrane (Figure 1.1). This major change in sedimentation must be placed in the context of the transition between the unequivocally Precambrian volcanic sequences of the Maplewell Group, and the Lower Cambrian (?) mudrocks of the overlying Swithland Formation. The precise nature and position of this important stratigraphical break is still not known, but further clues may be found in the sequence exposed at this site.

[References](#)



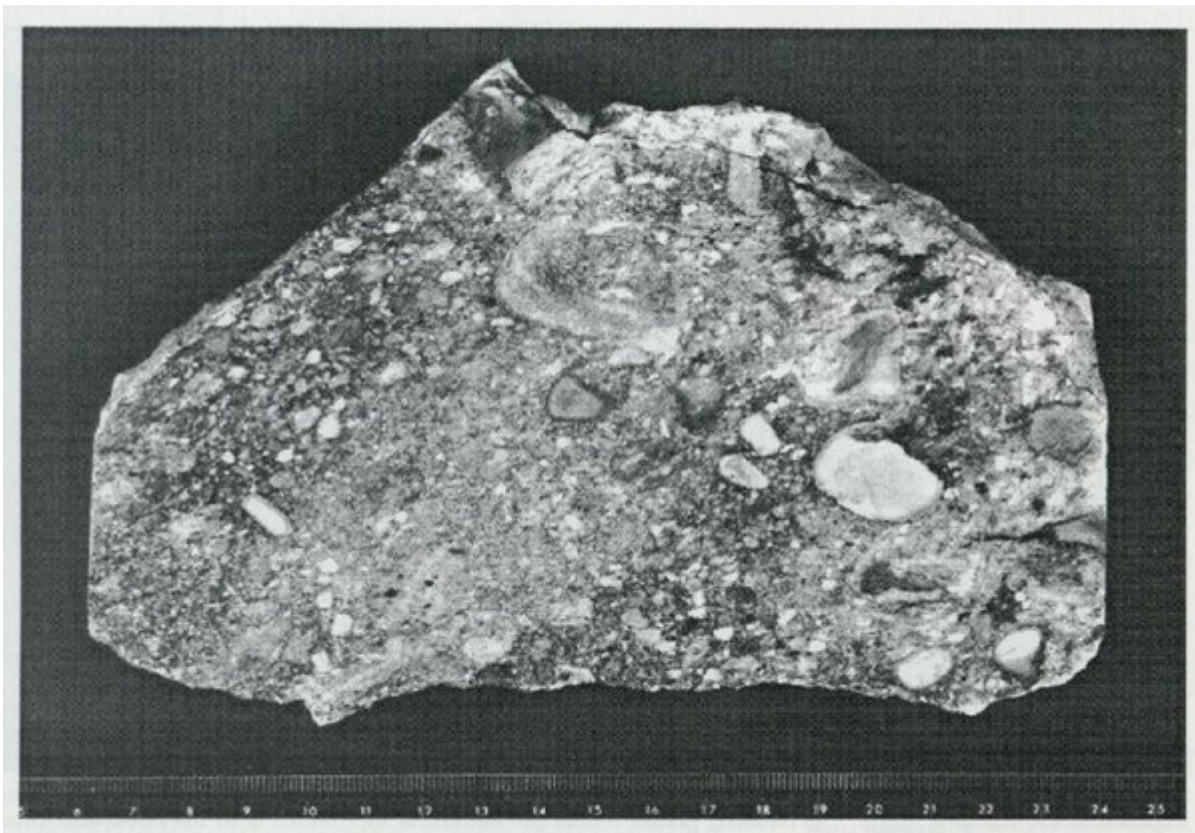
(Figure 2.15) Geological map of the Outwoods–Hangingstone Hills GCR site



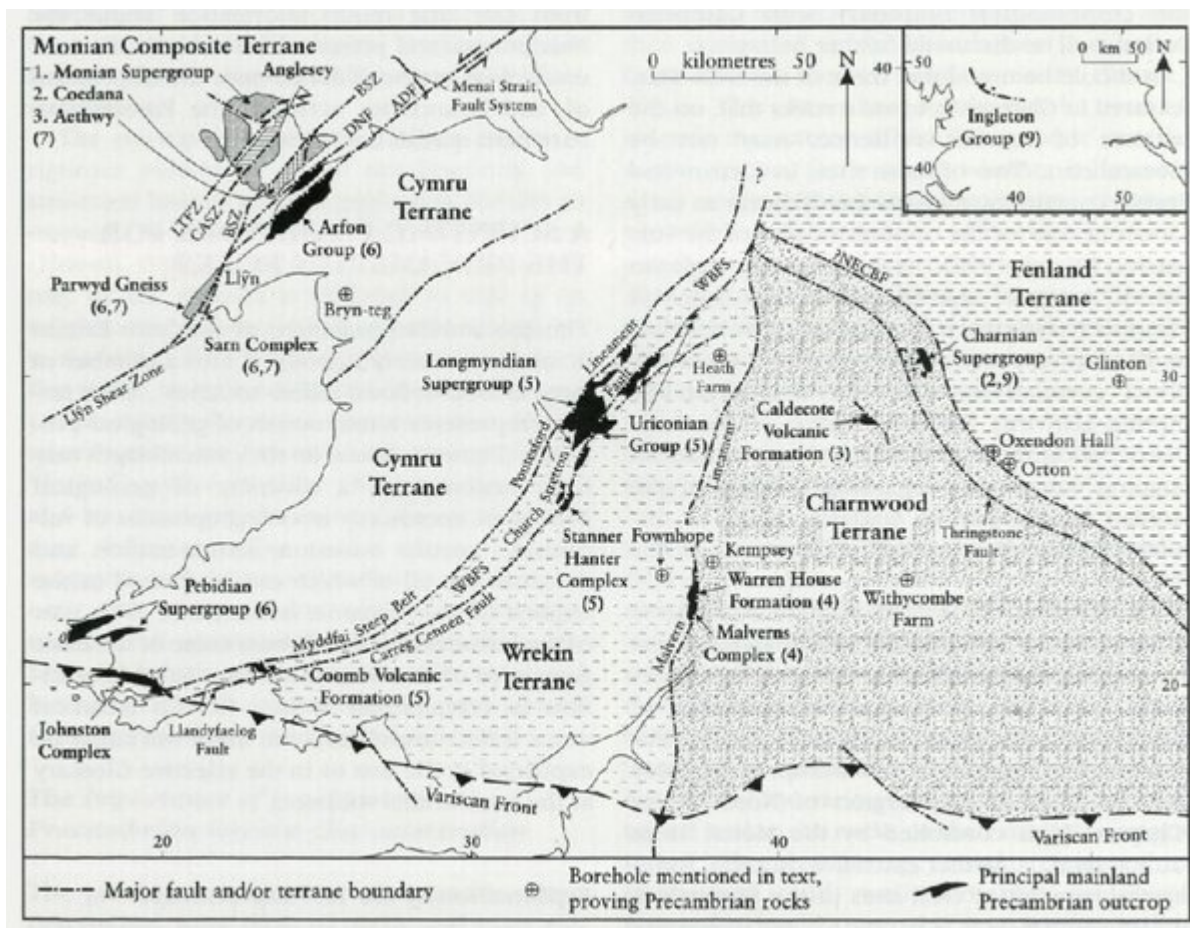
(Figure 2.16) Very thick, massive beds of coarse-grained volcanoclastic sandstone in the Bradgate Formation, exposed at the Hanging Stone. The bedding planes reflect the structural dip, which is to the north-east (from left to right). (Photo: J.N. Carney.)



(Figure 2.17) Exposures at North Quarry in laminated, volcaniclastic siltstones near the top of the Bradgate Formation. The roped-up figure on the bedding plane is examining Precambrian fossil impressions (see Chapter 8). (Photo: T.D. Ford.)



(Figure 2.18) Specimen of conglomerate from the Hanging Rocks Formation, Charnwood Forest Golf Course. Note the rounding of the pebbles and extremely low degree of sorting indicated by the range of clast sizes. (Photo: J.N. Carney.)



(Figure 1.1) Sketch map showing the distribution of Precambrian outcrop, and boreholes proving Precambrian rocks, in southern Britain. Note that the outcrops are labelled with the names of the principal geological units, followed by numbers (in brackets) of the chapters for the relevant GCR sites. Terrane boundaries are slightly modified after British Geological Survey (1996); Myddfai Steep Belt after Woodcock (1984a); Monian Composite Terrane after Gibbons and Horák (1990). Key: ADF, Aber-Dinlle Fault; BSZ, Berw Shear Zone; CASZ, Central Anglesey Shear Zone; DNF, Dinorwic Fault; LTFZ, Llyn Traffwll Fault Zone; ?NECBF, postulated NE Charnwood Boundary Fault. The boundary of the Midlands Microcraton basement domain is outlined by the NECBF and Pontesford-Myddfai lineament systems; WBFS, Welsh Borderland Fault System.