Charnwood Lodge and Warren Hills

[SK 465 155]

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Introduction

This site (Figure 2.11) occupies an area of undulating heathland and rocky knolls within the Charnwood Lodge Nature Reserve. It is important in containing the type area for the Charnwood Lodge Volcanic Formation (Carney, 1994), a unit formerly termed the 'Charnwood Lodge Member' and placed within the Beacon Hill Formation by Moseley and Ford (1985). This is a distinctive sequence, about 1000 m thick, characterized by very coarse-grained to block-rich pyroclastic rocks thought to have been formed in close proximity to active Charnian volcanic centres (Bennett *et al.,* 1928; Watts, 1947). The site also includes good exposures of the Benscliffe Breccia Member (see (Figure 2.1)), which is an important marker horizon at the base of the formation. A unit named the Grimley Andesite (Carney, 1994), is also represented; it is typical of massive andesites in the Bardon and Whitwick volcanic complexes, and thus may represent a satellitic intrusive sheet. The study of these rocks requires large, accessible and well-lit exposures, weathered sufficiently to emphasize the subtle textural relationships at all scales; this site satisfies all of these criteria.

Description

The Benscliffe Breccia Member (Moseley and Ford, 1985) achieves its greatest thickness, of around 100 m, in this north-west part of Charnwood Forest, where it is exposed in crags around the Hanging Stone [SK 4673 1593]. It consists of apparently massive lapilli tuffs and andesitic volcanic breccias whose rough weathering surfaces reflect a very coarse-grained to lapilli-grade matrix. Andesite blocks in the breccias are subrounded to highly angular, and across the regional strike they vary in size and in their abundance relative to the matrix. This suggests that the Benscliffe Breccia is stratified, although on a scale that is generally outside the limits of most exposures.

The knoll dominating the central part of the site [SK 4631 1570] is the classic 'Bomb Rocks' locality of Watts (1947). Although this is clearly a fragmental lithology, true volcanic bombs are not seen and, instead, most of the fragments are blocks with rectangular, diamond or disc shapes; the rock is therefore better classified as a volcanic breccia (e.g. Fisher, 1961). The blocks constitute up to 60 per cent of the rock and range from a few centimetres up to 1.7 m in size, standing out boldly on weathered surfaces (Figure 2.12). They all appear to be of an iden tical grey, moderately plagioclase-phyric andesite. Thin sections of similar blocks sampled from volcanic breccias north of Charnwood Lodge show microcrystalline groundmasses devoid of vesicular or amygdaloidal texture, although much detail is obscured by metamorphic recrystallization. Intrinsic to the blocks are deeply weathered, coarse fractures which, rarely, displace the block margins and produce angular corners. Most corners, however, show moderate to low degrees of rounding (Moseley and Ford, 1989), with only a small percentage of blocks having truly angular outlines. Marked changes in clast size and matrix proportions occur around this locality; for example in exposures a few metres to the south-west blocks are smaller and less abundant. Such variations demonstrate that the 'Bomb Rocks' volcanic breccia is part of a thickly stratified sequence. Some flattening and alignment of blocks is seen in the plane of the Charnian cleavage, here sub-vertical and with a sinuous course, deflected around the blocks.

Grimley Andesite forms the crags to the south of High Tor Farm [SK 4594 1542]; farther north it is up to 450 m thick within the Whitwick Volcanic Complex (Carney, 2000). Here, it is largely a homogeneous, grey, fine-grained andesite, but on the south-west side of the crags weathered surfaces are rougher and many show narrow, anastomosing zones that divide the andesite into decimetre-size, diamond-shaped lozenges. Freshly hammered samples show that this andesite variant is an autobreccia with a dark green-grey matrix crammed with pale cream, centimetres-size, rounded to angular enclaves that commonly display in-situ breakdown into 1–2 mm slivers. In the small exposure immediately west of Colony Reservoir [SK 4622 1536], lapilli tuff contains irregular screens of massive 'Grimley-type' andesite, suggestive of a contact zone between the two.

The dominating ridge of Warren Hills uniquely exposes the passage from the Charnwood Lodge Formation into overlying strata tentatively equated with the Bradgate Formation. The top part of the Charnwood Lodge Formation, seen on the easternmost knoll of the ridge, is in massive to stratified, coarse-grained tuff and lapilli tuff e.g. [SK 4586 1518]. These lithologies are poorly sorted and have crystal-rich matrixes enclosing sporadic (but locally up to 20%) andesite blocks up to several centimetres in size. Farther to the west, and within a few metres of its top, the Charnwood Lodge Formation fines downwards to a massive, very coarse-grained tuffaceous sandstone. This lithology contains a persistent horizon of sediment-raft breccia, 3–4 m-thick, carrying clasts of laminated siltstone which vary from centimetres-size slivers to contorted rafts up to 1 m long [SK 4574 1516]. The base of the overlying Bradgate Formation is unexposed, but is placed just below the first appearance of a thickly bedded sequence dominated by white-weathering, crystal-rich, medium-grained, volcaniclastic sandstones [SK 4573 1515]. The bases of individual sandstones are loaded into thin, graded intercalations whose muddy tops locally show folded and disrupted lamination.

Interpretation

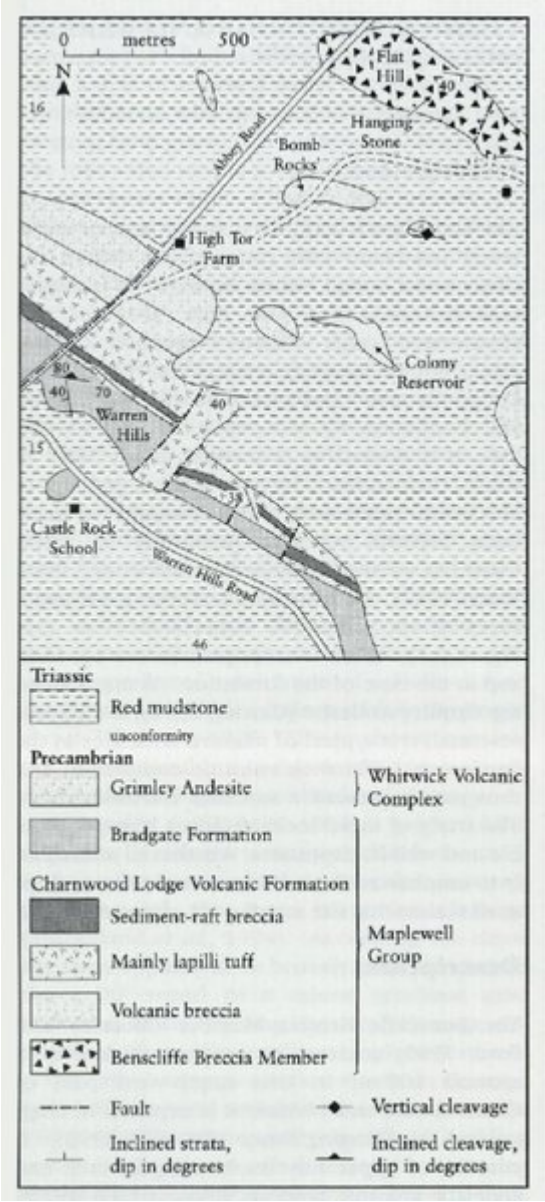
Previous workers have suggested that the predominance of volcanic breccias in strata of the Charnwood Lodge Volcanic Formation indicates deposition close to active Charnian volcanic centres. In the Benscliffe Breccia, the thick stratification of the breccias, coupled with their matrix-supported texture and evidence for clast abrasion are consistent with an origin as pyroclastic block and ash flows (e.g. Williams and McBirney, 1979), or as debris flows representing the distal parts of such flows (Carney, 2000). Subaqueous flowage cannot be proved, but would be compatible with the depositional environment proposed for most other Charnian units (Moseley and Ford, 1989). It is a particularly effective mechanism for inducing size grading of clasts in pyroclastic flows according to Cas and Wright (1991), and would thus account for changes in the block-to-matrix ratio, or produce the apparent crude stratification in these Charnian breccias. In north-western Charnwood Forest, there has long been observed a close spatial relationship between the volcanic breccias and more massive lithologies, here represented by the Grimley Andesite (Hill and Bonney, 1891). Recent studies further suggest that blocks in the breccias are comparable in chemistry and petrography to Grimley Andesite. This unit, and its analogue the Bardon Breccia, exposed at the Bardon Hill GCR site, could therefore represent 'feeder' bodies, perhaps lava flows or volcanic domes, their commonly autobrecciated textures reflecting an incipient stage in the process of disintegration that contributed blocks to the surrounding volcanic breccias (Carney, 2000). The Charnwood Lodge Formation is therefore envisaged as a subaqueous volcaniclastic apron surrounding original Charnian volcanic centres.

During the waning phase of volcanic activity, erosion of the edifices was more important than direct pyroclastic contribution, producing deposits of a more epiclastic character. These include the volcaniclastic sandstones at the top of the Charnwood Lodge Formation and base of the overlying Bradgate Formation. This datum is characterized by sediment-raft breccias, seen here and farther east, at the Outwoods and Bradgate Park GCR sites, suggesting that the event causing instability within the volcaniclastic pile was related to the decline in activity of the north-western Charnwood volcanic centres.

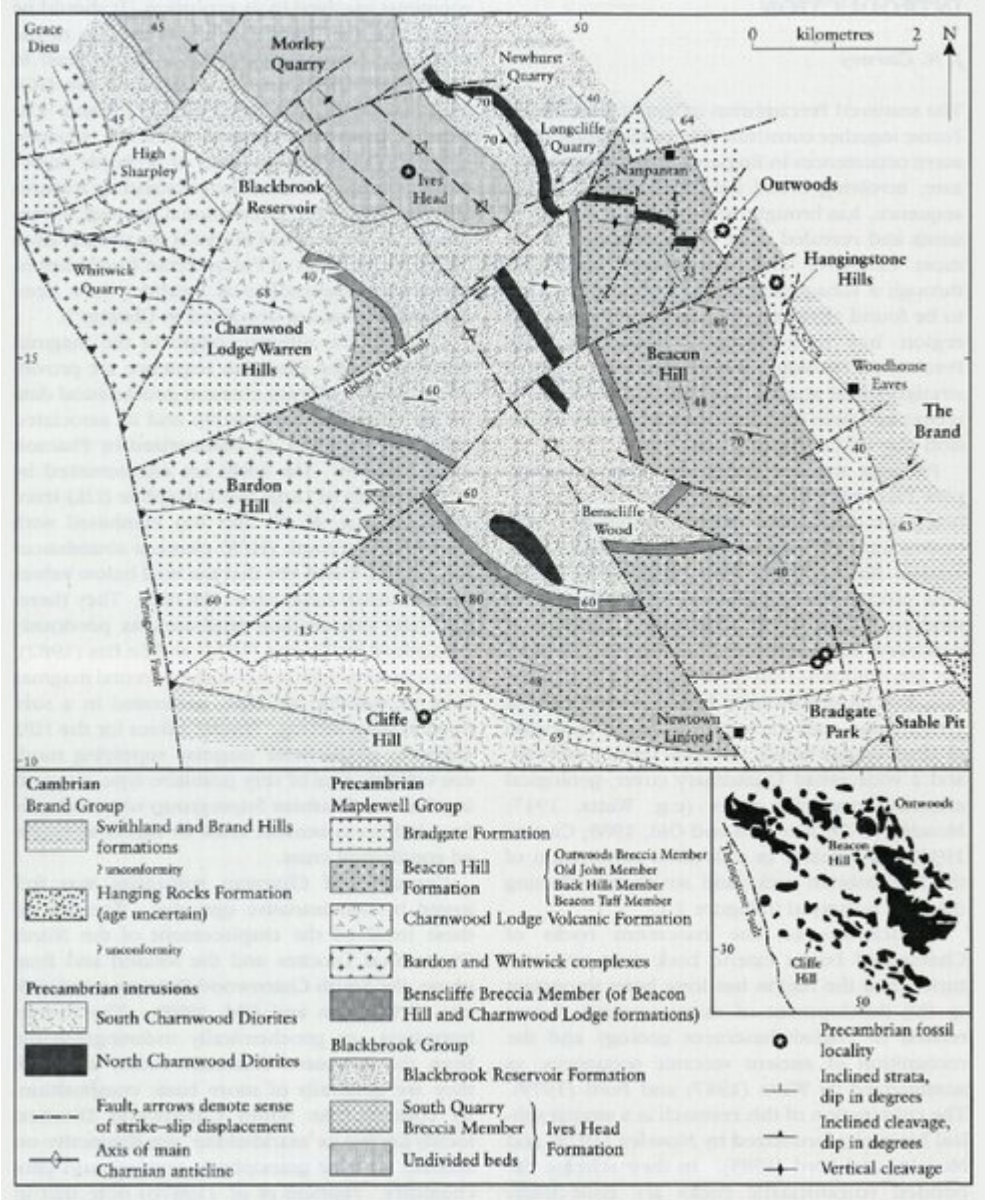
Conclusions

The exposures of the Charnwood Lodge Volcanic Formation at this site are excellent examples of very coarse-grained pyroclastic rocks formed in close proximity to the Charnian volcanic centres. The large andesite blocks in the volcanic breccias are comparable in field appearance, as well as under the microscope, to the massive or brecciated rocks represented here by the outcrop of Grimley Andesite. Such similarities suggest that the breccias had formed by the accumulation of blocky material following the collapse of 'Grimley'-type andesitic domes. These dome collapses gave rise to successive pyroclastic block and ash flows and debris flows, building up layers of volcanic breccia, so forming the thick stratification seen in this sequence. Waning volcanism is reflected by a reduced overall grain size in the upper part of the Charnwood Lodge Formation, where lapilli tuffs are dominant. It was accompanied by instability, resulting in the large-scale slumping of beds. The succeeding Bradgate Formation shows a dominantly epiclastic mode of sedimentation, with interbedded volcaniclastic mudstones, siltstones and sandstones marking its base.

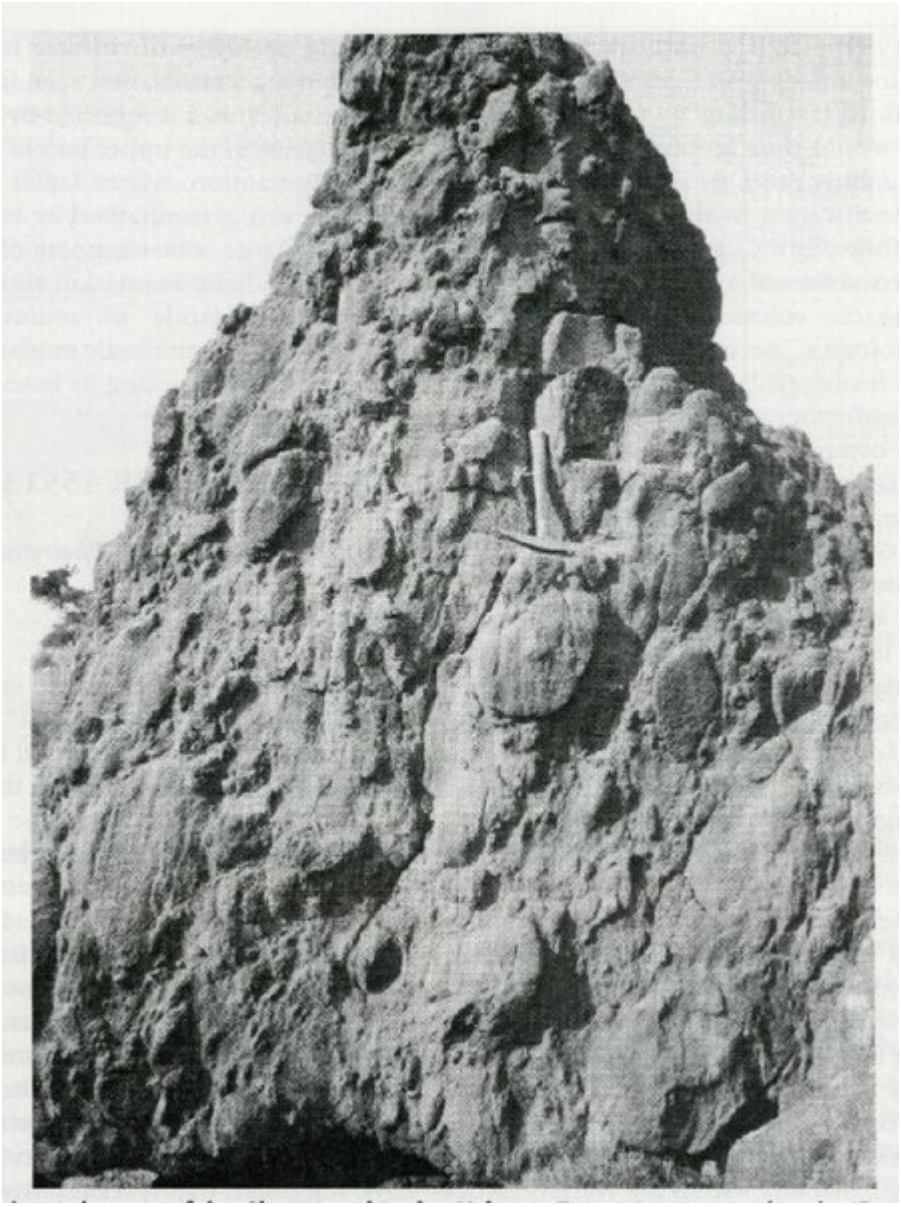
References



(Figure 2.11) Geological map of the Charnwood Lodge and Warren Hills site.



(Figure 2.1) Geological map of Precambrian and Cambrian rocks in Charnwood Forest, showing the locations of the GCR sites (in bold lettering). Note that younger rocks are omitted for clarity. The inset shows the actual extent of the 'basement' inliers (dark shading) between this younger cover. The latter mainly consists of Triassic strata, with Coal Measures included to the west of the Thringstone Fault; extensive veneers of Quaternary drift are also present (modified from Worssam and Old, 1988).



(Figure 2.12) Volcanic breccia of the Charnwood Lodge Volcanic Formation exposed at the 'Bomb Rocks' locality of Watts (1947), Charnwood Lodge Nature Reserve. (Photo: J.N. Carney.)