Beacon Hill

[SK 510 148]

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Introduction

Beacon Hill is a local landmark and public viewpoint, with excellent exposures that collectively serve as the type section for the Beacon Tuff Member of the Beacon Hill Formation (Moseley and Ford, 1985). This member, about 740 m thick, occupies a significant stratigraphical position since it is in part contemporaneous with the Charnwood Lodge Volcanic Formation farther north-west (Figure 2.1), which contains the principal record of primary pyroclastic activity in the Charnian Supergroup (Carney, 2000). Pyroclastic lithologies occur in the Beacon Tuff Member about 1 km north of Beacon Hill, forming about 180 m of very coarse-grained to lapilli-grade, massive dacitic tuff (Carney, 1994). At Beacon Hill the sequence is finer grained and the range of sedimentary structures suggests a considerable degree of secondary reworking. Accessibility of the exposures and the occurrence of well-polished rock surfaces are special features of the Beacon Hill site (Figure 2.6). They are important for demonstrating the relative significance of pyroclastic and epiclastic sedimentation processes during a period of raised volcanic activity in the Charnian arc.

Description

In the lower series of crags that form the base of the type section ((Figure 2.6), Locality 1), about 6 m of these strata consist of white to grey, very fine-grained volcaniclastic rocks. These are mostly massive, but where bedding planes are seen they are in places highly irregular and convoluted; in one case, the contorted strata are truncated at the base of the overlying bed. Near the top of this section, parallel-laminated tuffaceous mudstones and siltstones show laminae disrupted into pencil-like rafts. Other laminae show evidence of incipient slumping in the presence of asymmetric drag-folds, whose direction of vergence is consistently towards the west.

The overlying beds, in the middle series of crags (Locality 2), consist of thinly bedded to parallel-laminated, tuffaceous siltstones with minor sandstones. An unusual occurrence, in the northern part of this exposure, consists of a 0.2 m-thick bed displaying what appear to be profiles through symmetrical ripples.

The youngest beds are exposed on the prominent crag by the footpath to the south-west of the trigonometric point (Locality 3) ; their eastwards dip, compared to the south-eastern dips of localities 1 and 2, outlines gentle synclinal folding of the Beacon Hill sequence at this site. In this predominantly fine-grained succession (Figure 2.7), the lowest bed, at least 2.8 m thick, consists of white-weathering, very fine-grained tuff or tuffaceous mudstone. It is devoid of bedding or lamination, similar to the basal tuffaceous rocks at Locality 1 (Figure 2.6), but careful examination of favourable surfaces shows a highly heterogeneous texture reminiscent of extensive intermixing between mud and silt-grade sediment. Spectacular sedimentary load structures characterize a prominent undulating bedding plane in the middle part of these crags, and are continued a few metres to the south where completely detached, ball-shaped masses of sediment are enclosed within a lower bed. The overlying bed responsible for the loading is 0.2 m thick and shows slight grading from tuffaceous siltstone at the base to a porcellanous, white-weathering mudstone at the top. The uppermost, laminated beds have highly lenticular geometries, due to a combination of large-scale slumping and intraformational scouring. The youngest exposed strata are best seen around and to the east of the trigonometric point; they are thinly bedded to laminated, with many examples of undulatory bedding, rafted or truncated lamination, normal grading and load structures.

Although Beacon Hill is not recognized as a major Precambrian fossil locality, the highest bedding planes surmounting the crags at Locality 3, west of the trigonometric point (Figure 2.6), nevertheless display one prominent discoid fossil characterized by a concentric internal structure. This fossil resembles a detached 'hold-fast', or float, of the type discussed in Chapter 8.

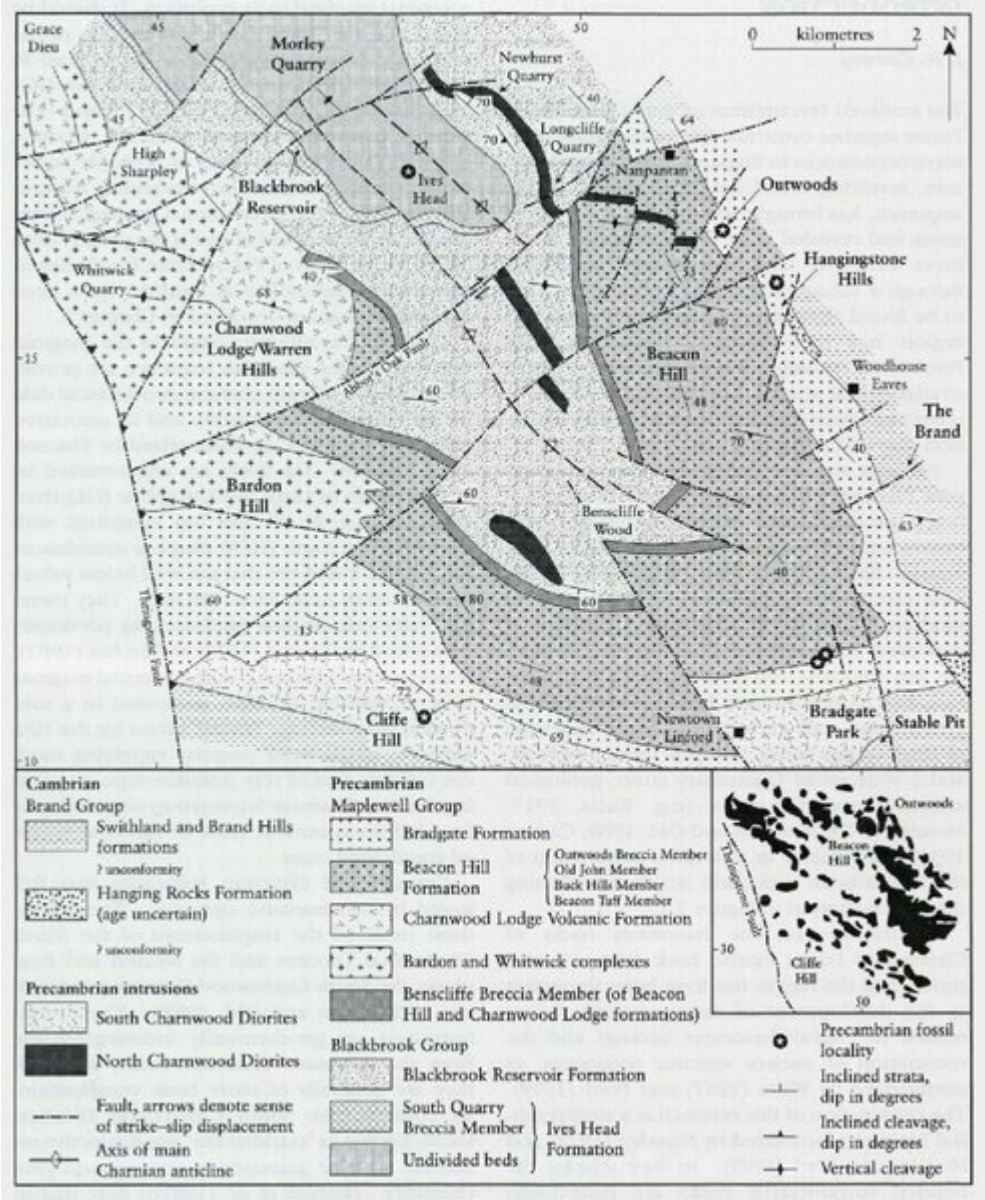
Interpretation

The Beacon Hill exposures provide an opportunity to examine lithologies that are clearly of a distal facies with respect to the volcanic centres known to be active at that time in north-west Charnwood Forest (see the Charnwood Lodge GCR site report). Contemporary volcanism is strongly suggested by thin sections of these rocks, which show locally abundant juvenile pyroclastic material such as y-shaped glass shards (Moseley and Ford, 1985; see (Figure 5.23) for typical examples). In such fine-grained lithologies it is commonly assumed that the unresolvable matrix surrounding the shards, and constituting most of the rock when seen in thin section, represents the highly comminuted, fine ash-grade equivalents of the shards, and that consequently the rock is a vitric tuff. As pointed out by Moseley and Ford (1989), however, the delicate textural details necessary to confirm such an origin were largely masked by subsequent devitrification of the glassy material. The resultant textures would in turn have been overprinted during consolidation of the sequence, producing the extremely hard, porcellanous character of these rocks, which have an unusually high silica content (79.81%; Moseley and Ford, 1989). The distinctive, very thick beds of fine-grained tuff in the sequence appear to be internally structureless, but it is possible that an earlier lamination may have been obliterated by liquefaction consequent upon large-scale movement within the sequence. Such a complex pre-diagenetic history is further suggested by undulatory and lenticular bedding, the extensive downward penetration of load structures, and incipient asymmetric slump folding of laminae. These features are also indicative of water-saturated conditions. Normal grading suggests the introduction of reworked pyroclastic material in low-density turbidity currents, but fine-scale lamination could also reflect a direct contribution by fall out during spells of waxing and waning pyroclastic activity in the volcanic source region(s). Turbidity currents generally imply moderately deep waters; however, the occurrence of symmetrical ripples, possibly indicative of oscillating wave action, may suggest that at times the depositional basin had shoaled to relatively shallower depths, above storm-wave base.

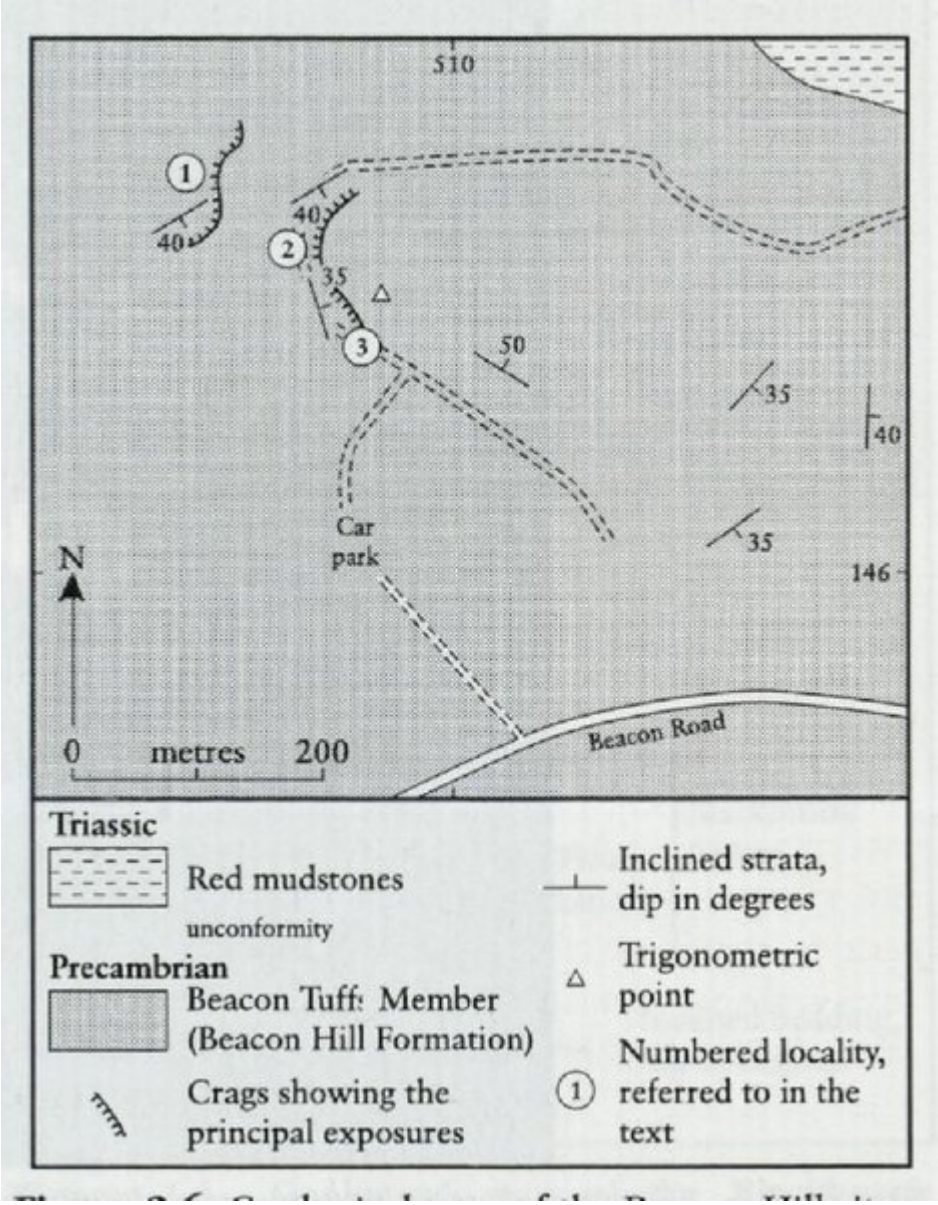
Conclusions

The Beacon Hill site exposes excellent examples of strata made up of material that has been ejected or eroded from distant volcanoes and then accumulated at moderate to shallow depths in the surrounding sea. The abundance of juvenile pyroclastic constituents, such as glass shards, is evidence for contemporary explosive volcanism, and justifies terms such as 'tuff' or 'tuffaceous' being applied to these rocks (e.g. Fisher, 1961; (Table 1) of the Glossary, in the present volume). Processes of devitrification have largely obliterated the more delicate textural details of the finer-grained glassy material, however. In addition to this primary pyroclastic component, it is probable that many of these beds contain material that has been secondarily reworked, rather than representing the in-situ products of direct pyroclastic fall out. Good evidence for this is provided by sedimentary structures such as the normal grading of thinly-bedded or laminated layers, which indicate final deposition from turbidity currents. Even the thickest and most massive beds occur in sequences that have been disturbed prior to their consolidation, resulting in spectacular examples of soft-sediment disruption.

References

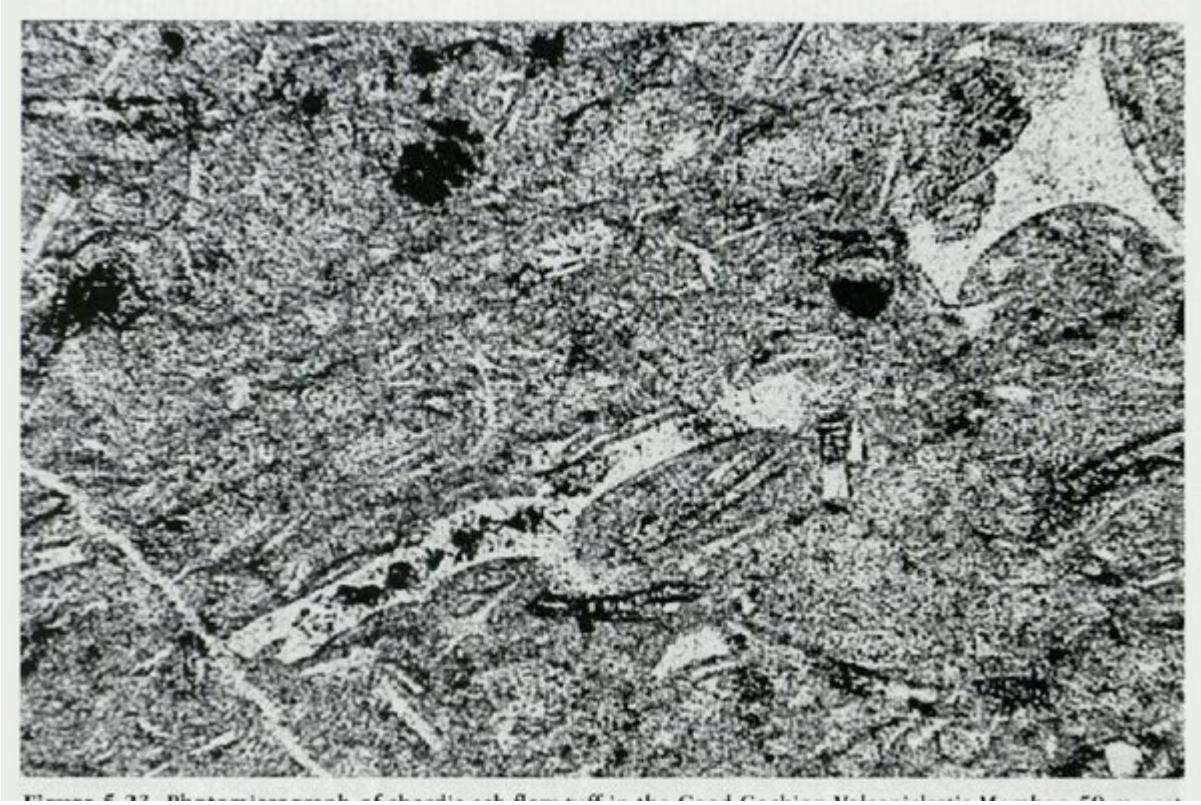


(Figure 2.1) Geological map of Precambrian and Cambrian rocks in Charnwood Forest, showing the locations of the GCR sites (in bold lettering). Note that younger rocks are omitted for clarity. The inset shows the actual extent of the 'basement' inliers (dark shading) between this younger cover. The latter 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 2.6) Geological map of the Beacon Hill site.

(Figure 2.7) Exposure of fine-grained tuffaceous strata of the Beacon Tuffs Member, to the west of the trigonometric point at Beacon Hill. (Photo: J.N. Carney.)



(Figure 5.23) Photomicrograph of shardic ash-flow tuff in the Coed Cochion Volcaniclastic Member, 50 m cast of the disused quarry at [SN 3338 1463] (from Cope and Bevins, 1993).

Grain size (mm)	SEDIMENTARY ROCKS		VOLCANICLASTIC ROCKS: Epiclastic (25-75% pyroclasts)	VOLCANICLASTIC ROCKS: Pyroclastic (>75% pyroclasts)		IGNEOUS ROCKS
256	*CONGLOMERATE* And *BRECCIA*		*VOLCANICLASTIC CONGLOMERATE, BRECCIA, GRANULESTONE* etc.	Bombs … *AGGLOMERATE* Blocks… *VOLCANIC BRECCIA*		Very coarse-grained
64				*LAPILLI TUFF*		
16						
2	*GRANULESTONE*					Coarse-grained
1-2	Very coarse-					Medium-grained
1-0.5	Coarse-					
0.25-0.5	Medium-	*SANDSTONE*	*TUFFACEOUS SANDSTONE* (coarse, medium, fine etc)	Coarse	*TUFF*	
0.125-0.25	Fine-					Fine-grained
0.032-0.125	Very fine- grained					
0.004-0.032	*SILTSTONE*		*TUFFACEOUS SILTSTONE*	Fine		Very fine-grained
<0.004	*MUDSTONE*		*TUFFACEOUS MUDSTONE*			Cryptocrystalline

(Table 1) A simplified comparative grain-size and grain-compositional chart for sedimentary, volcaniclastic and igneous rock types. The volcaniclastic rock classification is modified from Fisher (1961) and Fisher and Schmincke (1984).