Morley Quarry

[SK 4765 1785]

Potential GCR site

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Introduction

The selection of Morley Quarry as a GCR site is justified by accessibility (Figure 2.2), local conservation status, and the fact that it displays strata belonging to the oldest exposed Charnian unit, the Ives Head Formation, which is a component of the Blackbrook Group (Figure 2.1). The type section for the Ives Head Formation is on the summit of Ives Head, about 850 m to the south (Moseley and Ford, 1985), and it is there that the oldest fossil-like impressions are found (Chapter 8). Morley Quarry contains a diverse volcaniclastic succession of some 40 m thickness, which is very similar to that of the type section and thus furnishes an important reference section for the Ives Head Formation (Carney, 1994).

An added dimension to this site is provided by the findings of research drilling carried out in the quarry by the BGS as part of an investigation into the geothermal potential of the UK. The borehole section, described by Pharaoh and Evans (1987), encountered a further 541 m (apparent thickness) of strata belonging to the Ives Head Formation and then entered a sequence consisting mainly of massive, grey, feldspar-phyric dacite, interpreted as lava flows. This lower unit extends between 541 m and the base of the borehole at 835.5 m; named the Morley Lane Volcanic Formation by Carney (1994), it is nowhere exposed in Charnwood Forest.

This site also offers excellent conserved exposures of an extremely sharp unconformity surface developed upon the Precambrian rocks where overlain by Triassic strata of the Mercia Mudstone Group.

Description

The succession on the eastern quarry face (Figure 2.3) represents the upwards continuation of the strata cored in the Morley Quarry Borehole. The fine-grained lithologies are variegated in the dark grey and grey-green colours typical of the Blackbrook Group. They comprise packages, up to 3 m thick, of volcaniclastic mudstone and siltstone displaying millimetre- to centimetre-scale parallel-stratification. Other features include repetitive normal grading, shown by successions with beds consisting of fine-grained sandstone passing up to silty or muddy tops with convoluted or wispy lamination.

The lower part of the Morley Quarry succession contains beds up to several metres thick (Figure 2.2) which are graded from bases composed of massive, very coarse-grained to granule-grade volcaniclastic sandstone with sporadic, subangular, volcanic and sedimentary clasts up to 30 mm across. The grading generally becomes apparent a few metres upwards and is revealed by a gradual increase in the degree of sorting, a corresponding slight decrease in grain size and the development of a diffuse, parallel stratification. The graded cycles culminate in laminated mudstones and siltstones, although these may rest sharply on the underlying stratified volcaniclastic sandstone component. In thin sections, the matrix of the coarse-grained lower parts of the graded beds contains abundant irregular-shaped grains and granules composed of fine-grained 'felsitic' volcanic lithologies, some glassy with relict spherulitic textures and many with small quartz and plagioclase phenocrysts. The same crystals also occur in isolation, forming the larger part of the matrix.

The NNE dip of strata in the quarry contrasts with the westerly dip in the smaller quarry farther west (Figure 2.2); a complex local structural situation is suggested, perhaps due to flexuring and/or faulting. The ubiquitous Charnian cleavage is seen here as a faint, millimetre-spaced, WNW-trending penetrative foliation. On the western quarry face, however, the cleavage is accentuated and shows crenulation both within and adjacent to a NW–SE trending complex of faults, indicative of a second, non-penetrative phase of deformation.

Details of the Triassic unconformity are magnificently displayed along the southern quarry face. The Charnian rocks are unweathered beneath the unconformity, which shows sharp, step-like irregularities indicating that erosion had preferentially picked out sub-vertical joints in the Precambrian basement. The Triassic strata pinch out in the direction of Morley Hill, through which the eastern quarry face is excavated, indicating that this hill represented an important local feature of the Triassic palaeotopography. The lowermost Triassic beds consist of a *c.* 1–2 m-thick breccia of angular Charnian fragments within a red, silty sandstone matrix. The high matrix content suggests these beds are mainly accumulations of finer-grained material derived from weathering ('sanding') processes, with a relatively small input from talus aprons (angular fragments) that mantled the Triassic forerunner to Morley Hill.

Interpretation

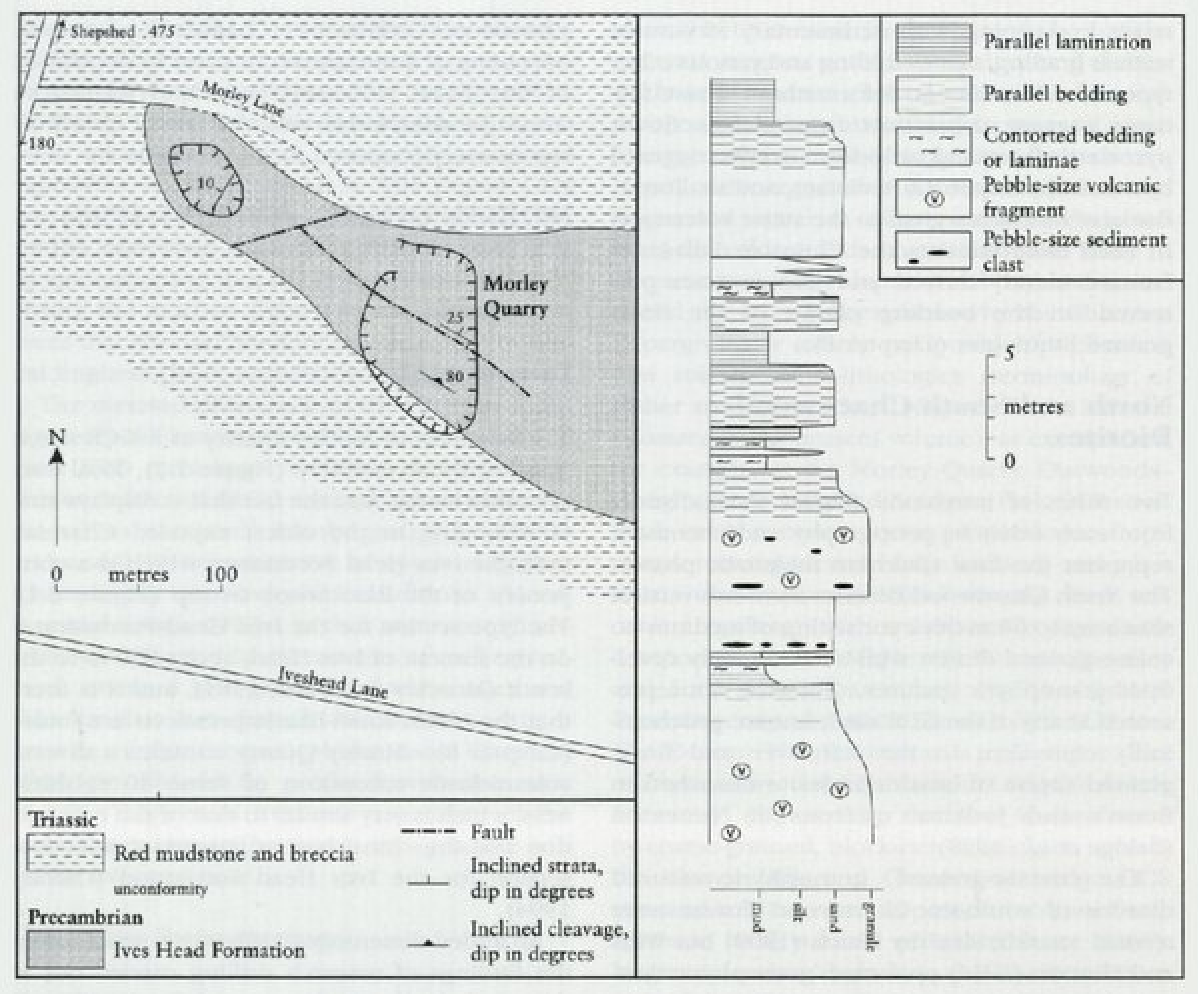
The Morley Quarry exposures illustrate well the processes of sedimentation within the Ives Head Formation. Normal grading and convoluted lamination are indicative of rapid subaqueous deposition, whereas the general absence of cross-bedding suggests there was little influence from wave or current action and therefore moderate to deep water environments of accumulation. The graded volcaniclastic sandstone beds are interpreted as the deposits of proximal-facies turbidites (e.g. Walker, 1967), representing sediment gravity flows in which grains were suspended by turbulence. Such flows were possibly initiated by instability within unconsolidated sediments previously deposited along the basin margin, but may also represent the distal, subaqueous continuations of volcaniclastic debris flows (Fisher, 1984), or even pyroclastic flows. There is little evidence to show their true ori gins, however, since all of the textures and fabrics seen here are the result of depositional processes. The structureless lower parts of the graded beds correspond to the suspension-sedimentation stage of deposition in high-density turbidites, when sediment fall-out was occurring at a high rate and there was no time to form structures such as bedding. The upper, parallel-stratified facies of the beds indicates a greater degree of sedimentary 'organization' and represents the traction-sedimentation stage, when flowage of the sediment became less steady and grains settled out progressively on deposition, forming a series of parallel beds (Lowe, 1982).

The finer-grained beds capping many graded cycles, and also predominating higher in the quarry sequence, either represent the more distal, low-density deposits of subaqueous debris flows, or material that was mobilized directly from finer-grained accumulations when the Charnian volcanic arc was quiescent. Not all such beds are graded, but in overall lithology they are similar to the sand–mud couplet facies that Ghibaudo (1992) attributed to various Bouma-type turbidite sequences.

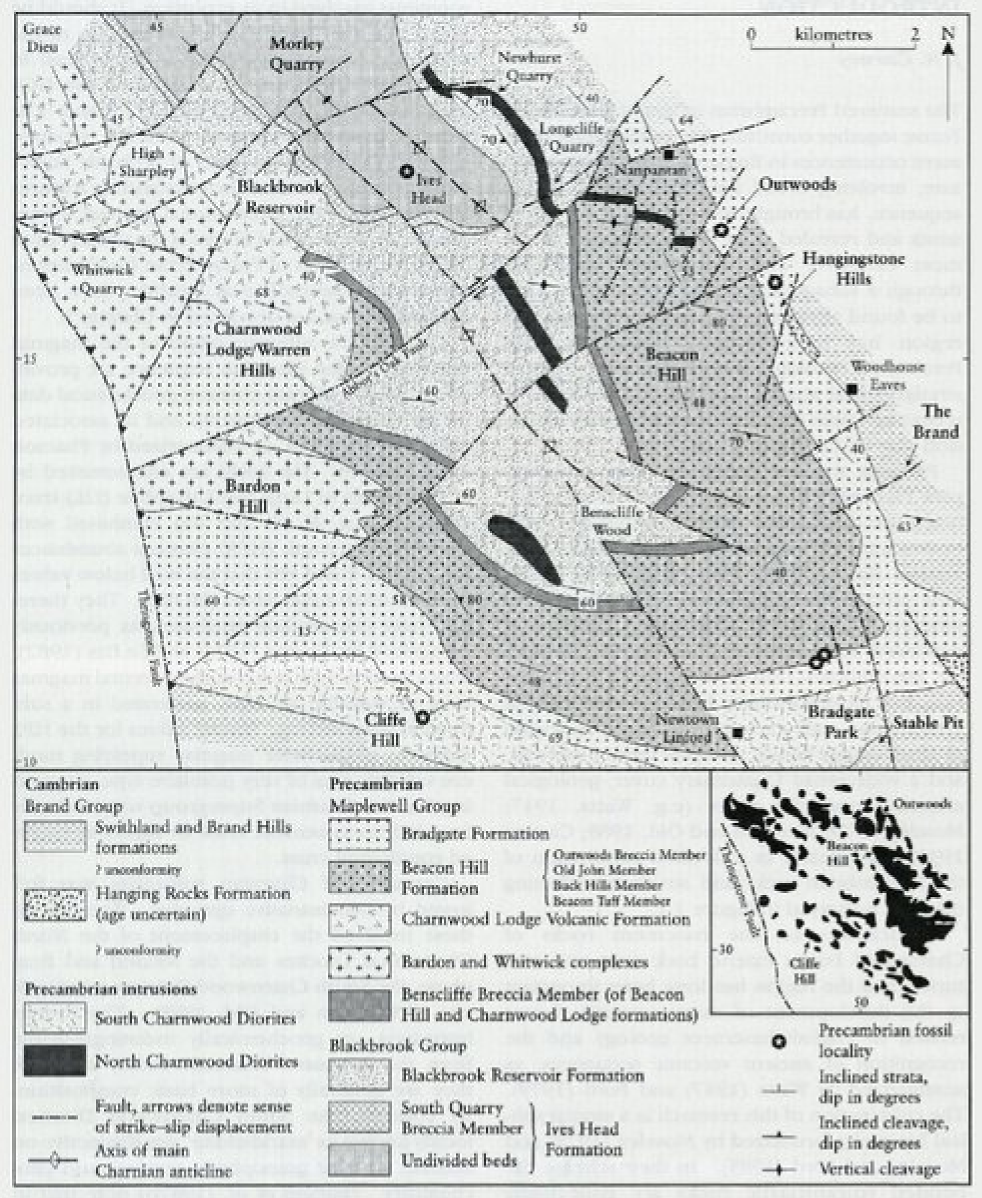
Conclusions

Morley Quarry offers highly accessible exposures of the oldest Precambrian volcaniclastic rocks in Charnwood Forest. The sedimentary structures that are well displayed indicate that the Ives Head Formation was deposited from turbidity currents, which are essentially subaqueous turbulent flows of sediment grains. The thickest turbidite beds are characterized by normal grading, being extremely coarse-grained in their basal parts and fining upwards, with increasing degrees of stratification, to laminated sandy or silty tops. The dominant grain constituents are crystals and fragments of fine-grained volcanic rock, suggesting that the turbidite flows were in some way triggered by volcanic eruption. However, the extent of sedimentary reworking during turbulent flowage has masked any evidence for primary volcanic processes and has produced lithologies that are best described as 'volcaniclastic' rather than 'pyroclastic' in nature (see (Table 1) of Glossary). The site contains structures indicating that the Chamian cleavage was folded and disrupted by subsequent faulting. It also contains excellent exposures of the unconformity separating Precambrian rocks from overlying Triassic strata.

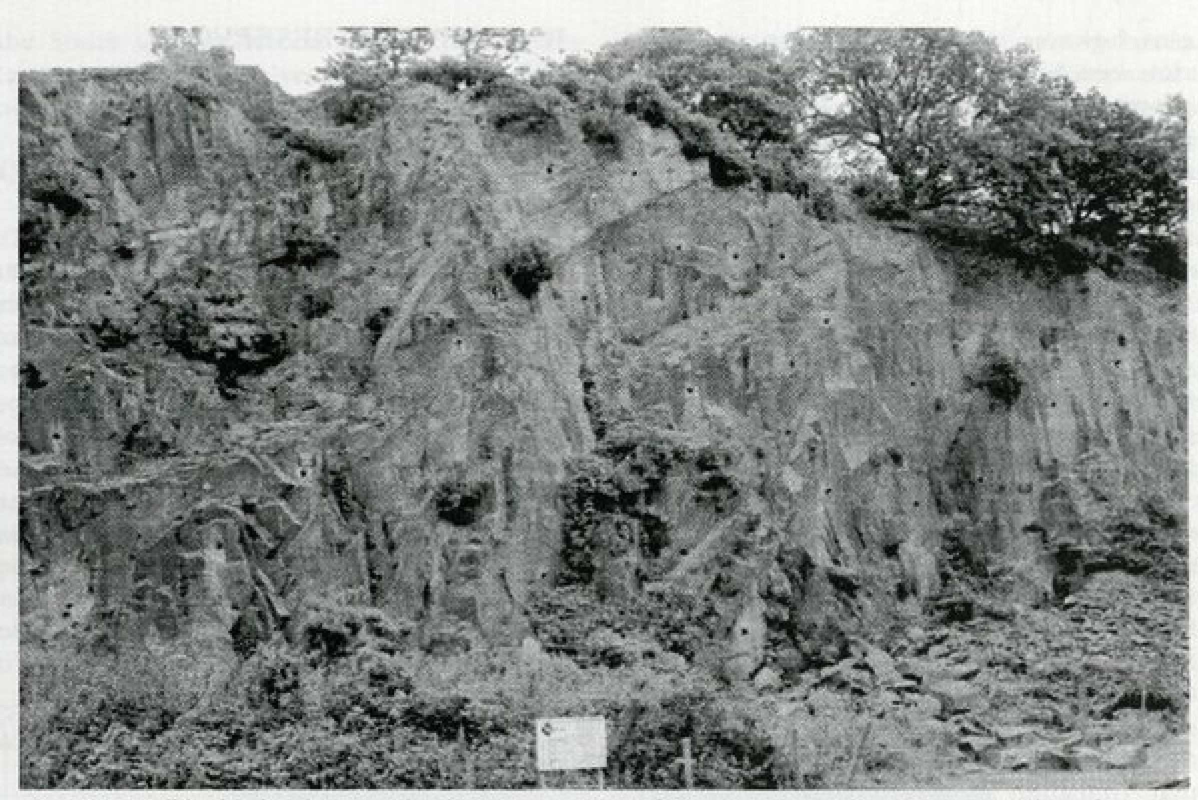
References



(Figure 2.2) Geological map of the Morley Quarry site. Column at right is based on a measured section of the beds exposed on the eastern face of the quarry (Carney, 1994).



(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 2.3) Well-bedded to laminated volcaniclastic strata of the Ives Head Formation exposed on the eastern face of Morley Quarry (Photo: J.N. Carney.)

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