Blackstone Edge

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Introduction

Blackstone Edge, 8 km north-east of Rochdale, is one of the best exposures of weathered regolith (grus) in northern England and is important for the study of weathering processes, landscape evolution and tor formation. The site provides evidence that the grus is derived from in-situ weathering of Millstone Grit. The nature of this regolith is important because of the role ascribed to the grus by the chief protagonists in the debate concerning the processes of tor formation in the Pennines (Linton, 1955, 1964; Palmer, 1967; Palmer and Radley, 1961; Palmer and Nielson, 1962). The site exhibits some of the key elements that have featured in papers on the development of tors in the British Isles, namely the age and palaeoenvironmental significance of weathered bedrock. Exposures of grus such as that at Blackstone Edge were considered by Linton (1964) and Cunningham (1965) to represent deep chemical weathering of bedrock during Tertiary times in a subtropical climate. Palmer and Radley (1961) on the other hand insisted that no deep rotting existed in the Pennines and that the grus represents mechanical weathering under periglacial conditions. The site has been described in detail by Wilson (1980), who used a scanning electron microscope (SEM) to examine the surface texture of individual grains in the grus.

Description

The site is a disused quarry on a scarp-edge to the south of the A58 Littleborough–Ripponden road. Here a 2 m thickness of coarse sandy detritus (grus) lies beneath blanket peat. The lower surface of the grus rests directly on a platform of unweathered Millstone Grit bedrock (Figure 7.9). Wilson (1980) describes how this weathered detritus is widespread throughout the southern Pennines, although in some localities the peat rests directly on bedrock and the weathering cover is absent. Elsewhere, the peat cover is absent and the weathering cover forms the upper horizon in exposures. Wilson (1980) examined the surface texture of grains from the Millstone Grit grus at high magnification using a scanning electron microscope (SEM). In outline, the grains in the grus are predominantly angular and subangular. Mechanically produced surface features such as cleavage traces, conchoidal fractures, semi-parallel step-like fractures and arc-shaped steps are common on the quartz grains. Wilson (1980) notes that these surface features are extremely sharp and fresh in appearance, suggesting recent formation. Striations and straight or curved grooves and scratches were observed on a small proportion of the grains examined. Many of the surface features are seen to be developed on top of older crystallographically orientated etch pits, which are the product of chemical weathering.

Interpretation

The work of Wilson (1980) clearly demonstrates that evidence for glacial, subaqueous, or aeolian transport, along with high-energy chemical weathering, is absent. Comparisons of quartz grains from the Millstone Grit samples with those in the unweathered parent bedrock strongly suggest that the material is, in all cases, derived from the underlying bedrock formations. Weathering of the grus at Blackstone Edge therefore was demonstrably an in-situ event. Furthermore, the examination of surface textures on individual grains shows that weathering proceeded in two distinct phases. The first phase of weathering is indicated by the chemically produced etch pits and the second by the mechanically produced fracture patterns on the quartz grains. There is no evidence for the advanced mineral alteration indicative of prolonged weathering under a pre-Pliocene subtropical climate as Linton (1964) envisaged. This accords well with subsequent studies on weathering covers elsewhere in Britain, such as those developed on the granites of north-east Scotland (Hall, 1985, 1986a, b). These weathering covers display limited mineral alteration and they probably developed under humid temperate conditions in Pliocene and early Pleistocene times. The products of true , deep chemical weathering in pre-Pliocene subtropical conditions are in fact very rare in the British Isles (Hall, 1985, 1986a, b).

Wilson's (1980) chronology for the sequence of weathering events at Blackstone Edge (chemically produced etch pits followed by mechanically produced fracture patterns) has important implications for models of landscape evolution. In an earlier experiment, Wilson (1979) proved that etch pits could be produced on the surface of quartz grains by the acid contained in peat solutes. One possible interpretation is therefore that etch pit development began only after solutes derived from the overlying peat became available. Thus the etching developed some time after peat development commenced (around 7500 ka). It therefore is possible to speculate that the Pennine grus is much younger than normally supposed. This is an important point because the mechanically produced surface features such as cleavage traces, conchoidal fractures, semi-parallel step-like fractures and arc-shaped steps are, in turn, developed upon these etched surfaces. The period of mechanical weathering therefore must post-date the period of chemical weathering and both could be Holocene in age.

The suggestion of Wilson (1980) that the weathering may be entirely Holocene is controversial because pollen studies by Tallis (1964a–d) throughout the Pennines suggested a Late Devensian age for the grus. Wilson (1980) recognizes the uncertainty of his chronology and admits that a Late Devensian to early Holocene age is also possible for the period of mechanical weathering. Elsewhere in the south Pennines, exposures of grus displaying cryoturbation structures have been reported and the weathering responsible for the formation of the grus has been attributed to Late Devensian periglacial climates (Johnson, R.H., 1967; Palmer, 1967). Whatever its exact age, the grus at Blackstone Edge is indicative of in-situ mechanical weathering and lacks direct evidence of deep chemical weathering.

Conclusions

Three important conclusions can be drawn from studies of the surface texture of quartz grains in the grus at Blackstone Edge. The first conclusion is that weathering was an in-situ event. The second conclusion is that two distinct phases of weathering are indicated by the chemically produced etch pits and the mechanically produced fracture patterns. Thirdly, the surface features developed on the quartz grains do not support the argument of Linton (1964) that the Pennine grus is the remnant of a regolith produced during a period of widespread, deep chemical weathering. Instead, the surface features suggest that mechanical weathering, presumably by macrogelivation under periglacial conditions is more likely. The grus at Blackstone Edge therefore indicates that deep rotting may have been limited in the Pennines, as first suggested by Palmer and Radley (1961). The site therefore is crucial to the debate concerning the nature of the Pennine weathering covers, landscape evolution and tor formation.

References

(Figure 7.9) Coarse sandy detritus (grus) resting on unweathered Millstone Grit. (Photo: N.F. Glasser).