Great Almscliff Crag

[SE 268 490]

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Introduction

Great Almscliff Crag is an important geomorphological site for studies of tor formation, rock weathering and landscape evolution. Rising 15 m above the surrounding land, it is one of the largest and most massive gritstone tors in the Pennines. It is significant for two main reasons. First the tor demonstrates the close association between unweathered and weathered bedrock. Second the tor lies within the limits of the Late Devensian ice sheet and therefore has been subjected to glacial erosion. Although the main body of the tor is composed of solid Millstone Grit it is surrounded by a variable thickness of weathered rock (grus). The site was described in detail by Linton (1964) because it exhibits many of the features predicted by his two-stage model of tor formation (Linton, 1955). Linton cited Great Almscliff Crag as a good example of a tor emerging from beneath a formerly more extensive weathering cover in much the same way as those of Dartmoor.

Description

The tor known as 'Great Almscliff Crag' is located 1 km to the north of Huby on the north side of Wharfedale (Figure 7.17). The main body of the tor is developed on Millstone Grit dipping at a relatively high angle of *c.* 20°. On the west side its main face rises from a bench, which itself falls away in a second, lower cliff. Linton (1964) describes how the upper part of this cliff provides evidence of sound, unweathered bedrock passing upward into more friable and weathered material. The same transition is observed laterally, with weathered bedrock towards the extremities of the tor giving way inward to solid gritstone. Bands of competent gritstone at low levels in the tor are composed of hard blocks surrounded by incoherent sand. Near the base of the tor the blocks are tessellated within the weathered grit. This is a characteristic of the deep chemical weathering described by Linton (1955), where weathering is best able to penetrate along joints and bedding planes. In places, the sandstone is represented by flags or slabs largely reduced to an ochreous sand with friable particles, resting on a bedding plane of sound rock. Flags more than 15 cm thick are fairly hard but those thinner than this are fragile and can be broken by hand (Linton, 1964). The upper layer of these flags is a limonitic sand, and the sequence is capped by podsolized hillwash (Linton, 1964).

Interpretation

Great Almscliff Crag exhibits evidence of both weathered and unweathered bedrock in close proximity. This weathering can be observed on three sides of the tor and is seen to penetrate deepest along vertical joints and horizontal bedding planes in the gritstone. The nature of this weathering is central to arguments about the formation of tors in the Pennines. In Linton's model of tor formation, Great Almscliff Crag represents a large core stone — or group of core stones — emerging from beneath a formerly more extensive cover of deeply weathered bedrock. This weathering would have taken place under subtropical conditions in pre-Pliocene times. In contrast, Palmer and Radley (1961) argued that no deep chemical weathering existed in the Pennines and that this type of regolith is the result of mechanical rather than chemical weathering under periglacial conditions. Preferential weathering along joints and bedding planes therefore is a result of frost shattering along these lines of relative weakness.

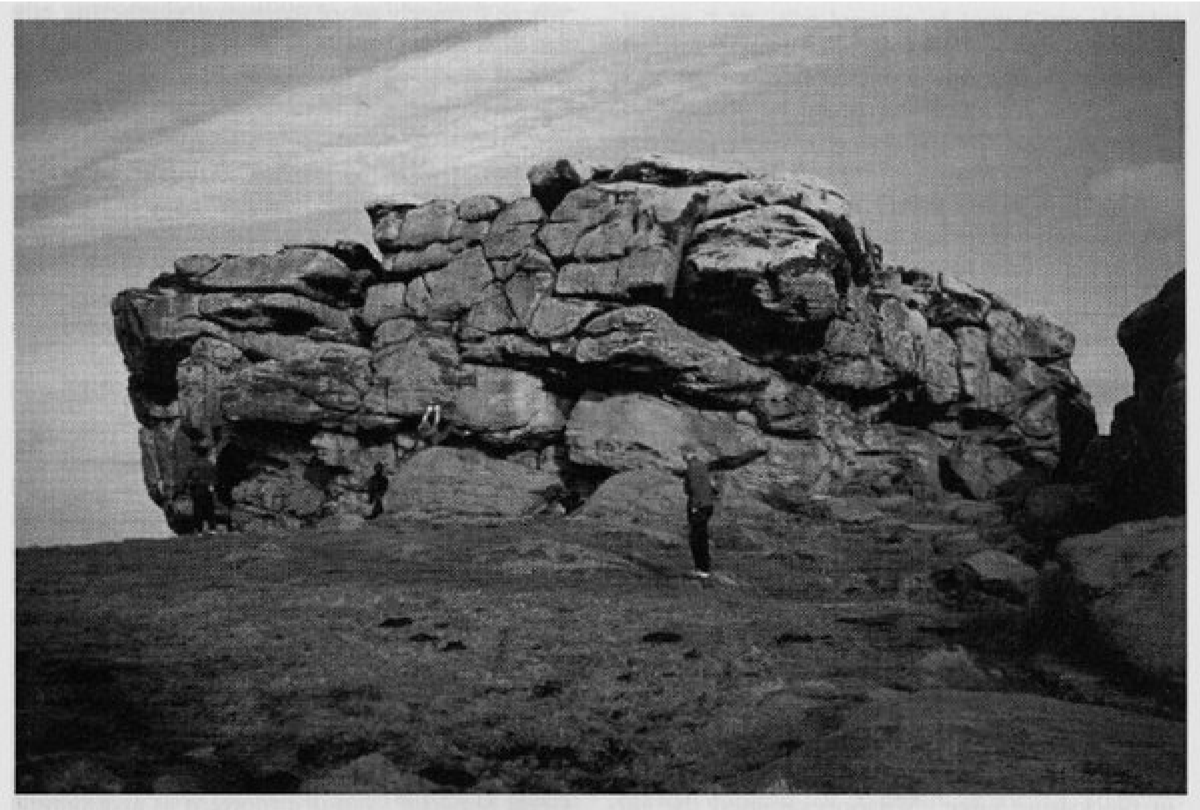
A possible clue as to the origin of this weathering is provided by the work of Wilson (1980) at Blackstone Edge. Wilson examined the surface texture of grains from the Millstone Grit grus at high magnification using a scanning electron microscope (SEM). This work clearly demonstrates that the grus at Blackstone Edge developed in two distinct phases. The first phase of weathering is indicated by chemically produced etch pits and the second by 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 for the Pennine grus. Instead the weathering is more of the style associated with a periglacial climate. If the grus surrounding the tor at Great Almscliff Crag is of a similar origin to that at Blackstone Edge then there is no need to invoke the deep chemical weathering hypothesis of Linton (1955, 1964).

The survival of large quantities of weathered material' around a tor within the Late Devensian ice limit is intriguing. Linton (1964) saw this as an indication that when the tor was glaciated it was 'still rather extensively buried in weathered material' (Linton, 1964, p. 18). Thus Linton regarded glaciation as the agent responsible for the removal of much of the regolith, exposing the central, less weathered corestones. This situation has been documented elsewhere in Britain where formerly more extensive weathering covers existed, such as those developed on the granites of north-east Scotland (Hall, 1985, 1986a, b). Here there is abundant evidence that ice-sheet erosion can be selective in its removal of former weathering covers (Fitzpatrick, 1963; Sugden, 1968, 1989; Hall, 1985, 1986a, b, 1991; Hall and Sugden, 1987; Hall and Mellor, 1988; Hall *et al.,* 1989; Ballantyne, 1994; Glasser and Hall, 1997). The survival of old landscape elements such as tors and weathering covers is related primarily to the thermal regime of the ice sheet, with preservation beneath cold-based zones of the ice sheet (Kiernan, 1994; Glasser, 1995). Unfortunately, because no detailed analysis of the nature of the grus in the Great Almscliff Crag area has been undertaken, and as former glaciological conditions in the Wharfedale area are unknown, the survival of the grus remains enigmatic. It also is difficult to assign an age to the period of grus formation.

Conclusions

Great Almscliff Crag is important as an example of a large tor exhibiting evidence of both weathered and unweathered bedrock in close proximity. The weathered grus surrounding the tor may represent either the remnants of a formerly more extensive deep weathering cover that has escaped glacial erosion, or the product of periglacial frost shattering during Pleistocene times. Whichever process dominated, the tor is important for studies of tor formation, rock weathering and landscape evolution.

References



(Figure 7.17) Great Almscliff Crag. (Photo: N.F. Glasser.)