Brimham Rocks

[SE 210 650]

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Introduction

The tors at Brimham Rocks, North Yorkshire, are significant for studies of rock weathering, periglacial processes and landscape evolution. The tors are a classic example of the scarp-edge tors that characterize the Millstone Grit of the northern Pennines. The Pennine tors are at the heart of a controversy concerning the nature of deep weathering and tor formation in the British Isles. There are currently two widely accepted theories that can account for tor formation. The first entails a two-stage model of weathering and stripping (Linton, 1955, 1964) and the second requires only a single cycle of denudation under periglacial conditions (Palmer and Radley, 1961; Palmer and Nielson, 1962). Most of this debate has centred on the tors of the northern Pennines, including those at Brimham Rocks, which are developed in Millstone Grit. One of the characteristics of the Pennine tors is that they commonly are developed on the edge of escarpments. Palmer and Radley (1961) termed these features 'edge tors', although they are also widely known as 'scarp-edge tors'. The tors at Brimham Rocks have been referred to by Mackintosh (1869), Ramsay (1872) and Versey (1948). Palmer and Radley (1961) used the tors here to propose a model for tor formation during the periglacial phases of the Pleistocene Epoch. Linton (1955, 1964) cited the tors at Brimham Rocks as evidence for a two-stage cycle of development involving deep weathering followed by stripping.

Description

Brimham Rocks is the collective name for a large group of tors fringing the summit of Brimham Moor. The tors are developed on the massive, pebbly, arkose sandstones of the Kinderscout Grit Group of the Millstone Grit Series. Tors occur in various locations around the summit of the moor, but are preferentially developed close to the edge of the escarpment. Many of the tors at Brimham Rocks are over 10 m high (Figure 7.10) and are located up to 100 m from the scarp edge, whereas others lie immediately in front of the scarp crest line and clearly were once part of the escarpment face. Tor morphology is strongly controlled by the density and spacing of joints in the Millstone Grit. Boulders derived from the scarp face litter the slopes in front of the escarpment.

Interpretation

The tors at Brimham Rocks have been interpreted in various ways. During the 19th century, when marine denudation was though to have created great planation surfaces across Britain, the tors were interpreted as sea stacks formed by marine erosion (Mackintosh, 1869). Subsequent to this, Ramsay (1872) and Versey (1948) attributed the form of the tors to wind-etching processes, although in the light of modern evidence this origin now seems unlikely. Palmer and Radley (1961) suggested that Brimham Rocks formed as buttresses on the scarp face as it retreated during the periglacial phases of the Pleistocene Epoch. Frost shattering along joints was considered to be the process of rock disintegration, with solifluction transporting frost-shattered debris downslope. The tors were then left as residual landforms marking the end of a 'one-cycle' phase of landform development.

Linton (1955, 1964) argued that tors are the products of a two-stage cycle of development. In this model, the Millstone Grit of the Pennines was deeply weathered during pre-Pliocene subtropical climates. During this time chemical weathering was able to penetrate to great depths in the rock so that at the onset of the Pleistocene Epoch the landscape was one of pockets of deep weathering surrounding more competent rock masses at depth. The weathered regolith was then removed by glacial and periglacial processes to leave the more resistant rock masses standing as isolated tors. Linton (1964) cited Brimham Rocks as a site that demonstrates many of the aspects of his model. Whereas Linton (1964) interpreted the boulders in front of the scarp face as rounded corestones, Palmer and Radley (1961) regarded them as

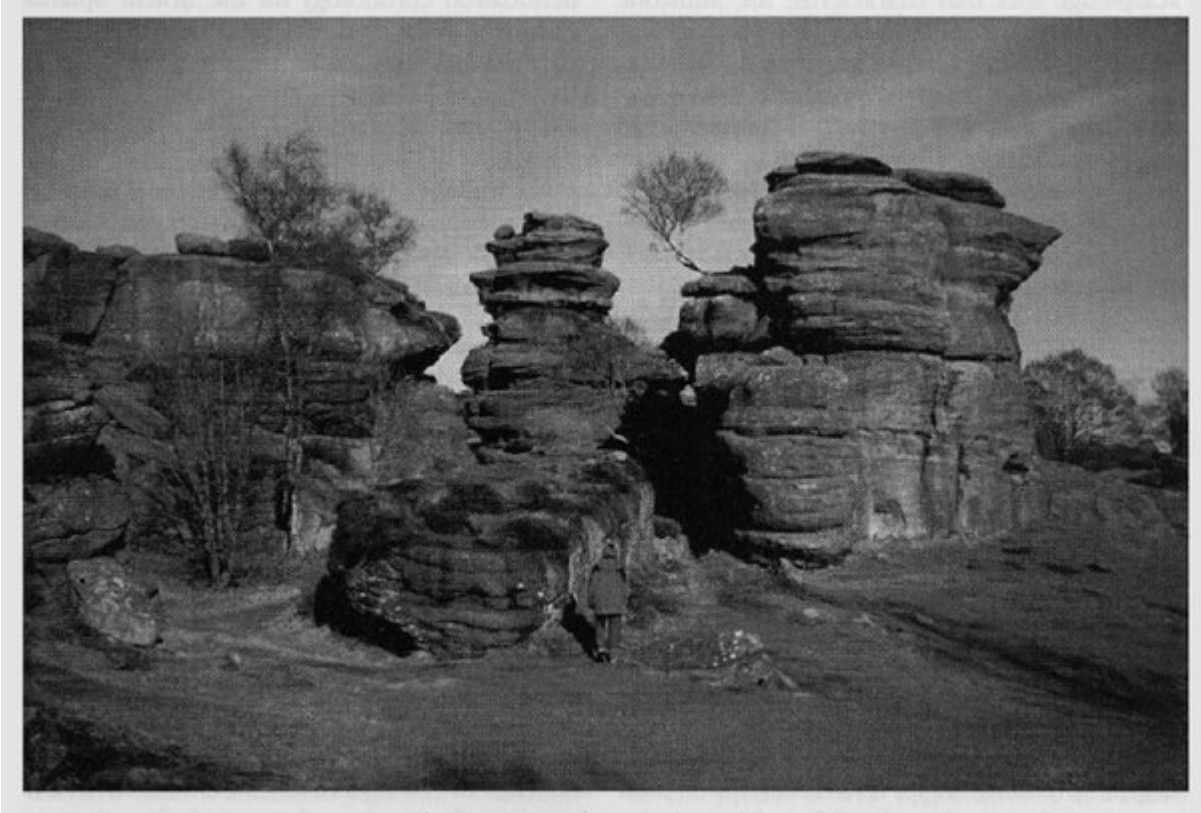
subangular blocks of unweathered sandstone broken from the scarp face by frost action.

The key to the debate over tor formation lies partly in the nature of the Pennine regolith. Wilson (1980) has demonstrated for a number of Pennine sites that this regolith developed from in-situ weathering of the underlying Millstone Grit. Using scanning electron microscope (SEM) to examine the surface texture of individual grains in the grus, Wilson (1980) identified two distinct phases of weathering (chemical followed by mechanical). He found no evidence, however, to 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. Mechanical weathering, presumably by macrogelivation under periglacial conditions, is cited as the dominant weathering process (Palmer and Radley 1961). Thus it seems likely that the tors at Brimham Rocks formed as buttresses on the scarp face during scarp retreat in a periglacial climate.

Conclusions

Brimham Rocks are an excellent example of the scarp-edge tors that characterize the Millstone Grit of the northern Pennines. The precise origin of the Pennine scarp-edge tors remains unresolved, but the morphology of the features at Brimham Rocks and the lack of a widespread deep weathering cover suggest a primarily periglacial origin for these features.

References



(Figure 7.10) The tors at Brimham Rocks. (Photo: N.F. Glasser.)