Peak Scar, North Yorkshire

[SE 530 883]

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Introduction

Peak Scar is a north-facing cliff 290 m long and about 30 m high, containing widened vertical joints. It is located at the head of the north-facing slope on the south side of Peak Scar Gill, which joins Gowerdale, a tributary valley of Ryedale in the Hambleton Hills of North Yorkshire. It is in the Lower Calcareous Grit Member of the Corallian (Upper Jurassic) strata. Between 9 m and 21 m downslope from the foot of the cliff is a row of massive detached blocks of rock, tilting away from the cliff and towards the valley, with an apparent valley-ward dip of 26°. The main mass is 130 m long and nearly 30 m broad. The crest of the ridge formed by these detached blocks rises 15 m above the floor of the trough that separates it from the cliff-face. The slope on the downslope side of the detached blocks is steeper than adjacent slopes to the west and east of Peak Scar (Figure 6.53).

Description

The sequence of features, on moving down-slope, at Peak Scar is (Cooper, 1982):

Vegetated plateau top/crest of slope

Vertical cliff-face in bedrock

Poorly vegetated trough or trench with large boulders; upper sides of detached blocks, in bare or moss-clad rock with pronounced downslope tilt

Vegetated top and downslope sides of detached blocks

Undulating slope to stream course at the slope foot

This sequence is remarkably similar to one of the sites described by de Freitas and Watters (1973) in their landmark paper on toppling failure. The site in Nant Gareg-lwyd, in the Rhondda Valley near Blaenrhondda, Powys, shows a joint-controlled vertical cliff-face in hard rock, at the foot of which lies a large toppled mass dipping downslope, and separated from it by a hillside trench. Peak Scar displays all of these features far more clearly, and with greater vertical development (see (Figure 6.53)).

The Corallian strata are a predominantly horizontally bedded, alternating series of calcareous sandstones and oolitic limestones (the Hambleton Oolite). The areal distribution of two kinds of features on the slopes of the Hambleton Hills suggest that a particular type of landsliding is taking place in this area. Firstly, enterable widened joints, locally termed 'windypits' are found on the slopes and on the surface of the plateau, close to its edges (Fitton and Mitchell, 1950; Cooper *et al.,* 1976). Secondly, ridge-and-trough features (Briggs and Courtney, 1972), hillside trenches and uphill-facing scarps (Radbruch-Hall, 1978) are found on the slopes. Sites of enterable widened joints, and of ridge-and-trough features are shown in (Figure 6.54).

At Peak Scar, the cliff-face is intersected by joints running sub-normal to it, which offset its line towards the valley at several places. These joints, and a series of pronounced horizontal bedding planes, divide the cliff-face into large sub-cuboidal blocks. Many of the blocks appear to be loose as they are separated from the main mass of the rock by joints that run sub-parallel to the cliff-face, but behind it. About 70 m from its eastern end the line of the cliff-face is offset 8 m away from the valley by a joint. At the point of the inner corner produced by this offset is the entrance to Murton Cave, which is an enterable fissure running sub-parallel to the cliff-face.

Murton Cave (Cooper *et al.,* 1976) has been formed by the widening of a joint. Its upslope wall is continuous with the set-back face of the cliff. Between the fissure and the cliff-face in front of it (i.e. on its valley-ward side) is a tower of Corallian limestone 8 m thick and 30 m high, the upslope side of which forms the downslope wall of the fissure. The downslope wall of Murton Cave does not appear to have been displaced upwards or downwards, and appears to have undergone no tilting with respect to the upslope wall.

Some of the tilted rock-masses seem to be made up of several towers of rock, each tilted and leaning against the next one downslope (Figure 6.55). Thus different readings of apparent downslope dip were obtained from different parts of the tilted mass. This internal structure, and numerous bedding planes that have opened as a result of the tilting, are indicative of the shattered condition of the rock, which is broken up by many short fissures. Peak Scar Windypits 1 and 2 (Figure 6.53) (Cooper *et al.,* 1976) are merely two of these that happen to be wide enough to be entered.

The trench or trough between the cliff-face and the row of tilted rock-masses varies from 9 m to 21 m in width. Its floor slopes down from the cliff-foot towards the tilted rock-masses, with an overall fall varying from 2 m to 6 m, at angles of up to 20°, but more commonly about 10°. The surface is covered with hummocks and strewn with large angular boulders that appear to have fallen from the cliff and the tilted rock-masses. There is a clayey soil, with a vegetation of scrub and young deciduous trees. Neither the cliff-face nor the upslope-facing rampart of the tilted rock-masses bear any indication of solutional activity on the rock surfaces, or of fluvial erosion or deposition. The material in the intervening trough has not been deposited by water action.

The slope below the row of tilted rock-masses is afforested, and frequently stands at angles in excess of 30°. It incorporates short vertical exposures of rock up to 1.0 m in height. There are zones of loose scree material, and of scree that is grassed over or buried in leaf mould.

Interpretation

It is clear that the rock tower between Murton Cave and the cliff-face has moved toward the valley by a distance at least equal to the width of the fissure. Since this has happened without vertical displacement or tilting, it is reasonable to suggest that the movement took place over some horizontal plane in the bedrock. Since the bedrock is effectively horizontal in its bedding, a bedding plane seems to be an obvious candidate for the failure surface.

It is possible that the tilted rock-masses were originally flush against what has now become the cliff, from which they were separated by a joint. A procedure developed by Caine (1982) for similar sites in Tasmania can be applied to 1. profiles 1 and 2 in (Figure 6.53). This involves projecting the line of the upslope rampart of the tilted mass and the line of the cliff until they cross. At this point rotation of the tilted mass may have taken place (Figure 6.56). It is worth noting that Caine's sites are about three times larger (in each dimension) than the features at Peak Scar, but the same considerations apply. 2. Reconstruction in the manner of Caine (1982), assuming the later movement to have been purely rotational (Cooper, 1980), indicates a downslope rotation of 33° about a line parallel to and in line with the cliff, 40 m below the top of the cliff and 22 m below the trench floor. On reconstruction in this way, it is apparent that a considerable amount of rock has been lost from the tilted masses, as when set upright they do not reach the cliff-top. It is suggested that this material has slid off downslope over bedding 3. planes, and is in part responsible for the steepness of the lower slope.

It has been suggested (Cooper, 1982) that three major types of mechanism acting in succession may be adduced as an explanation of the suite of features at Peak Scar.

Splitting mechanisms: clearly, fissures must form in a massive rock before they can be widened. They could be tectonically initiated joints, and thus pre-date not only the slope features, but also the incision of the valley itself. Alternatively they could be 'valley joints', formed as a response to stress-release on valley incision.

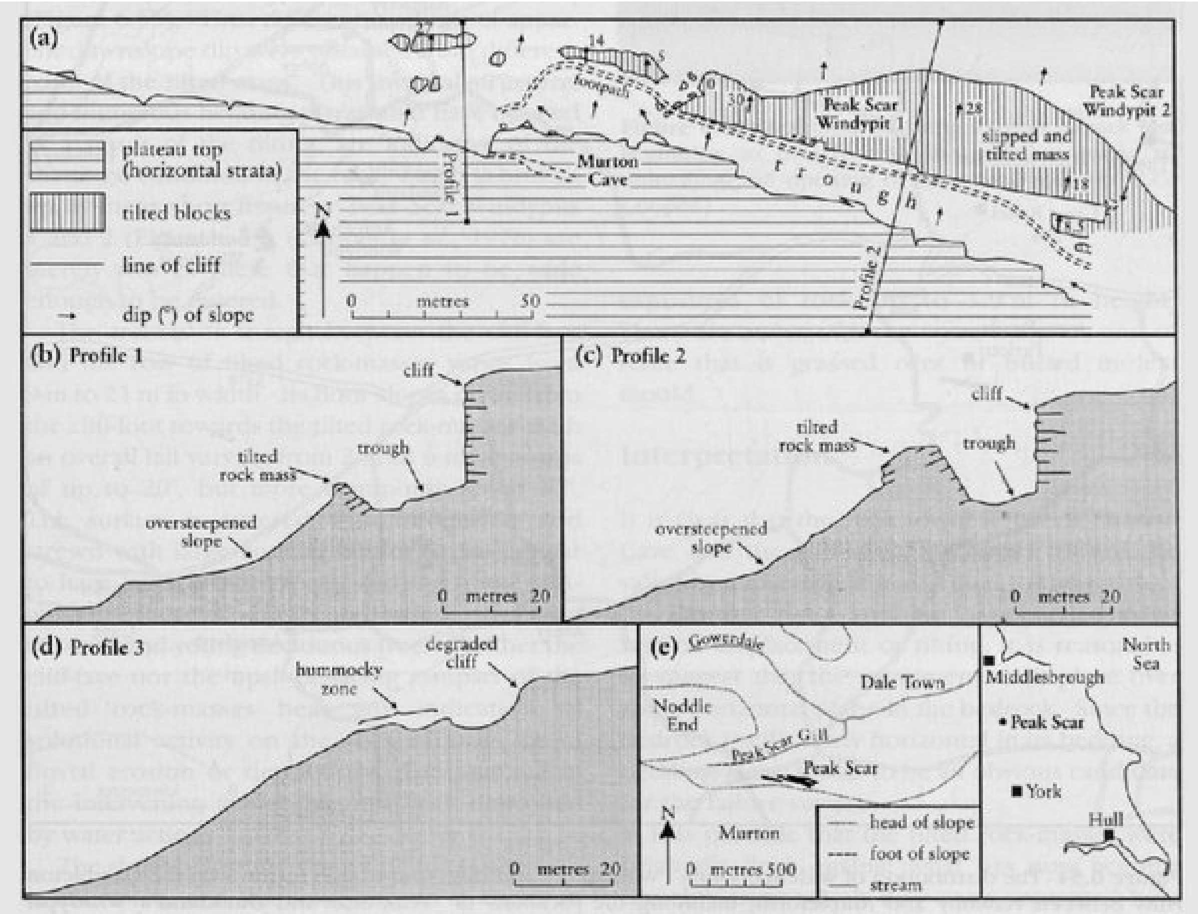
Sliding mechanisms: as the initial translational movement seems to be effectively horizontal, it is likely that the plane of sliding is horizontal. It could be located at the junction with the Oxford Clay at the base of the Corallian. However, there is a broad lithological transition zone between the two. Alternatively, there could be thin 'mobile' bands of clay or shale interbedded in the Corallian strata, which would provide planes of sliding.

Tilting mechanisms: the tilting towards the valley of blocks that have slid forward could be due to undermining of blocks by erosional removal of weaker material beneath, and the settlement of the blocks. Alternatively, it is possible that the blocks move forward until their centres of gravity are unsupported due to the steepness of the slope, and then over-balance. Either way, the tilting seems to represent a form of toppling failure (de Freitas and Watters, 1973). The observation of uphill-facing scarps describes features widely regarded as being diagnostic of 'sagging failures'.

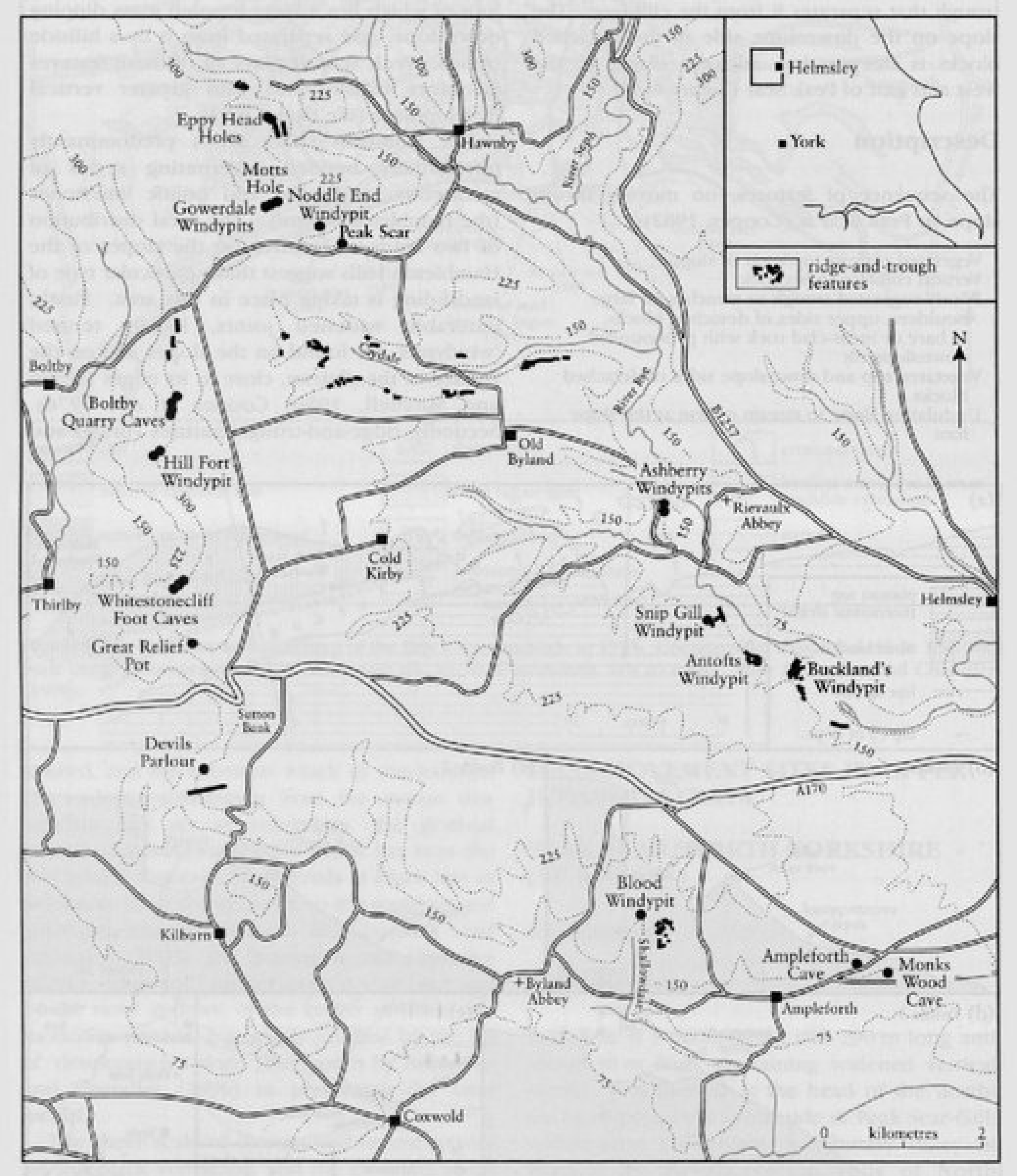
Conclusions

Peak Scar is the best British example of a de Freitas and Watters' intermediate-sized toppling failure, by virtue of its apparent 'freshness' (which may be deceptive) and its vertical range. The characteristic of the downslope wall of Murton Cave, that does not appear to have been displaced upwards or downwards, and has not rotated with respect to the upslope wall, is common to most of the other widened joints in the Hambleton Hills. The widespread distribution of both widened joints and hillside trenches in the Hambleton Hills suggests that the three-fold process evident at Peak Scar may have wider applicability than just the immediate site. Other interesting sites include the East Weare and Great Southwell slips on the Isle of Portland, Dorset, and Daddyshole Plain and Ansteys Cove, Torquay, Devon.

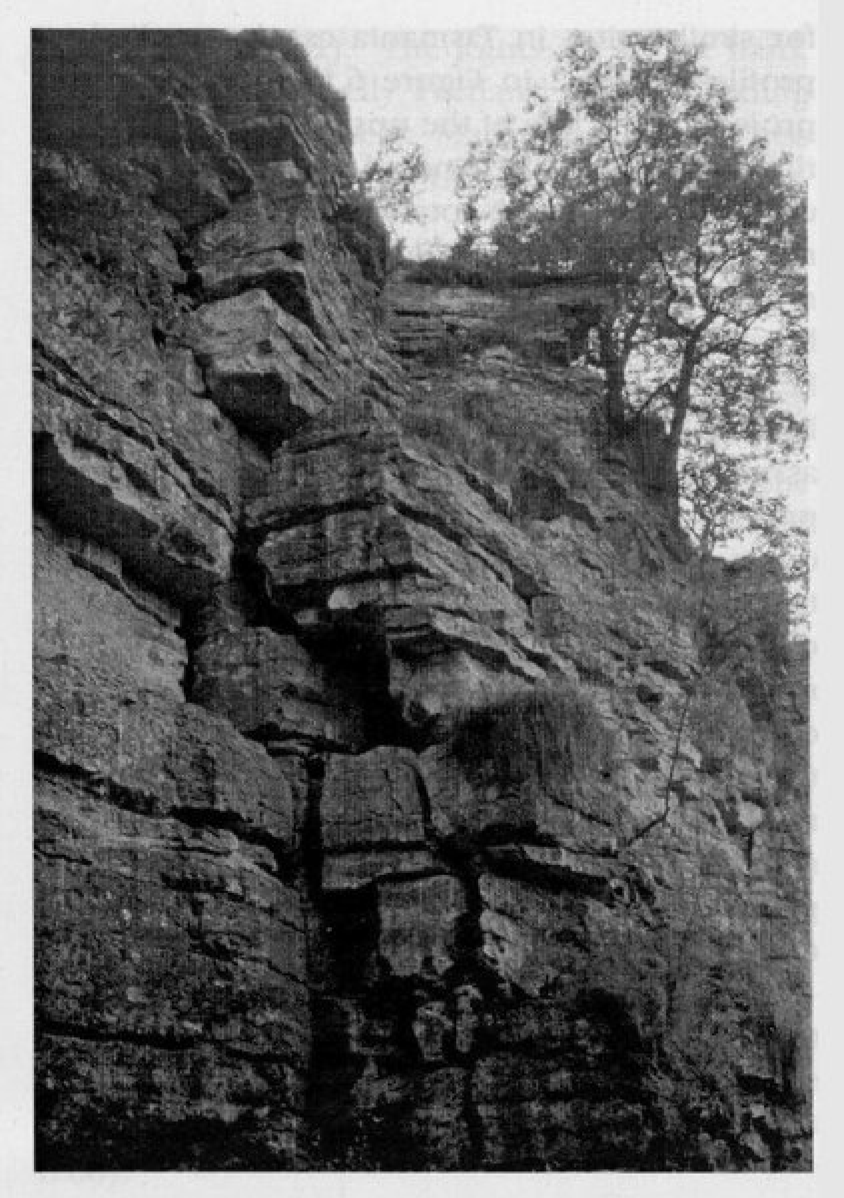
References



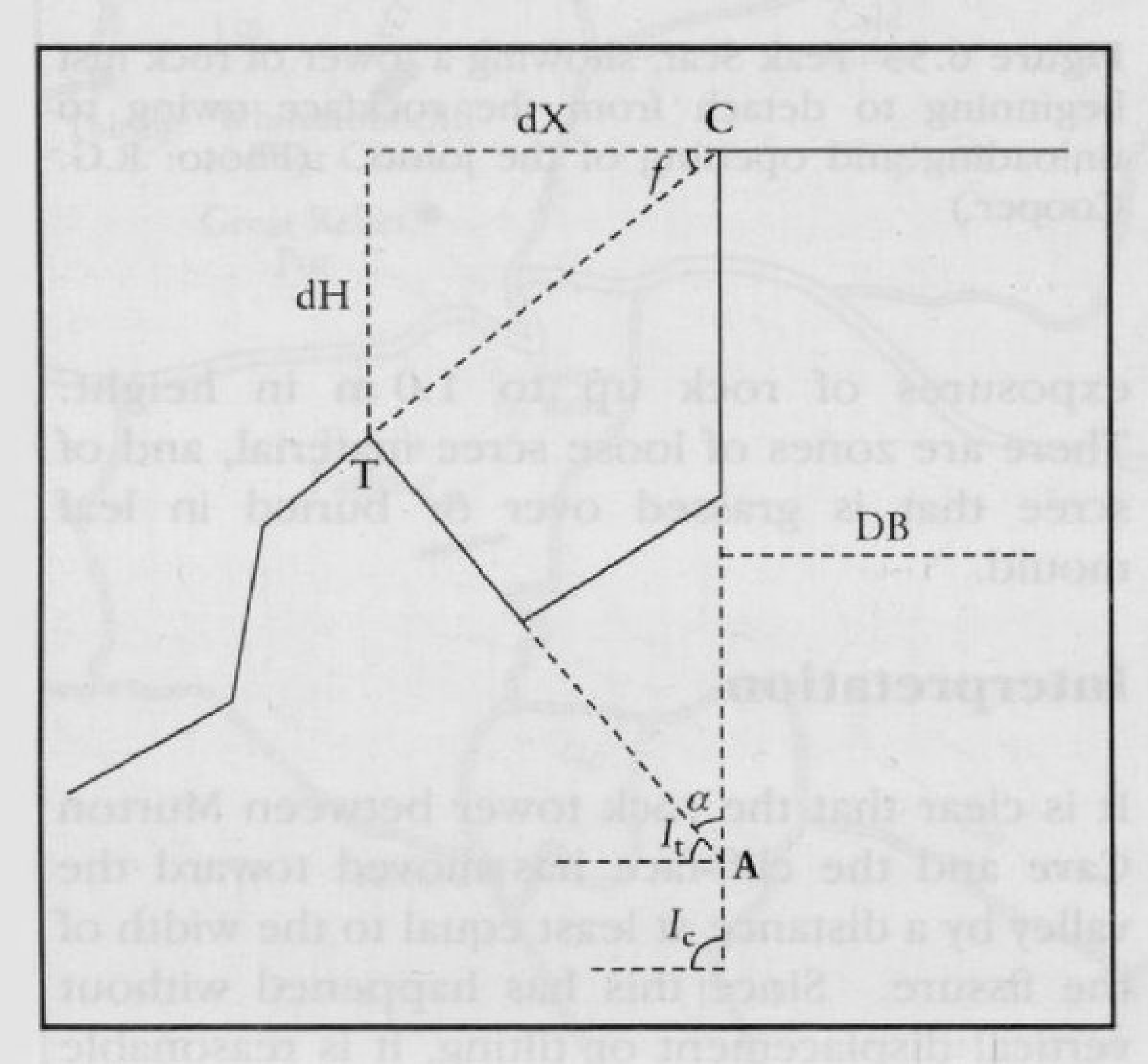
(Figure 6.53) The Peak Scar mass-movement complex. After Cooper (1980).



(Figure 6.54) The distribution of widened joints ('windypits') and ridge-and-trough features on the Hambleton Hills between Hawnby and Ampleforth, including the locations of Peak Scar and Buckland's Windypit (described later in the present chapter). After Cooper (1980).



(Figure 6.55) Peak Scar, showing a tower of rock just beginning to detach from the rockface owing to unloading and opening of the joints. (Photo: R.G. Cooper.)



(Figure 6.56) Terms and definitions used in modelling a hypothetical topple: (A: point of convergence based on extrapolation from joint surveys on the topple and the cliffs; C: cliff crest; T: crest of the topple; DB: elevation at the base of the dolerite sheet; LC: distance a–c; LT: distance a–t; I_c: joint inclination on the cliff; I_t: joint inclination on the topple; a: tilt angle of the topple (I_c–I_t); dH: vertical lowering of the topple crest; dX: lateral displacement of the topple crest; f angle from c–t). After Caine (1982).