Blacknor Cliffs, Isle of Portland, Dorset

[SY 677 715]

R.G. Cooper

Introduction

The cliffs on the western coast of the Isle of Portland (Figure 6.57) and (Figure 6.58) exhibit probably the best British examples of toppling failures. This type of failure involves the separation of a monolith or slab of hard rock from the surrounding rock, usually by jointing. At a cliff edge, the monolith or slab will be isolated between the cliff-face and the joint(s). Eventually the slab will fall. This site shows various stages of the process.

Toppling failure, which involves forward rotation of the mass, is classically preceded by a period of accelerating creep, which may last for several years. This may involve slow outward movement of the slab away from the surrounding rock, widening the joints, over some underlying incompetent horizon (Schumm and Chorley, 1964).

Portland is traversed by a series of NNE–SSW-trending major joints. These have been mapped by Coombe (1981). The joints are in the hard, often oolitic or shelly Portland Stone, running upwards into Purbeck Marls and downwards into Portland Sands (all Upper Jurassic).

Description

There are three distinct lines of evidence that this type of failure is occurring on the Isle of Portland. Firstly, the NNE–SSW joints are almost all widened to a greater or lesser degree. Some of them in the interior of Portland have been entered and explored, via the quarries on its plateau surface (Ford and Hooper, 1964; Churcher *et al.,* 1970; O'Conner and Graham, 1996). It is likely that the joints owe both their existence and their widening to Alpine Earth movements (Cooper, 1983a,b). Around the coast of Portland, the joints are wider than in the interior, presumably due to seaward movement of the huge slabs of limestone isolated between them and the cliff-line. On the western side of Portland, between Blacknor and Mutton Cove, these joints have been entered and extensively mapped (Cooper and Solman, 1983; Graham and Ryder, 1983; Cooper *et al.,* 1995) (Figure 6.59) and (Figure 6.60).

Secondly, at Blacknor, the 30 m-high cliff-face bears speleothems, principally calcite flowstone (travertine) coating the limestone faces, and often developed into 'organ-pipe' formations. Unsorted assemblages of clasts ranging from sands to boulders in size are cemented to the cliff-face by this calcite, at various heights above the cliff-foot (Cooper and Solman, 1983). It is difficult to imagine how a boulder, falling over the cliff, could be arrested part-way down by a thin film of deposited calcite on the cliff-face. However, it is easy to imagine how a boulder, falling into an open fisuure, could become wedged part-way down and then coated with calcite at the same time that the walls become coated, and so be 'cemented' in place.

Thirdly, the 120 m-long debris slope below the cliffs, standing at angles of up to 40°, is littered at its lower end with large, joint-faced limestone blocks, chiefly Lower Purbeck and Portland Stone (Figure 6.61). Some of these bear patches of calcite flows. The blocks are up to 42 m long and 14 m broad, but the third dimension tends to be only a few metres, giving a marked tabular 'slab' shape. Individual units are up to 3500 m^3 in volume.

Interpretation

The wideness of the joints, particularly those near the cliff edge, is a clear indication that the blocks isolated by them have moved laterally, causing the present cliff-line itself to move seawards. Presumably the movement has taken place by bedding-plane shearing on an incompetent horizon in the 'parallel bands' of the Portland Sand, or even in the underlying Kimmeridge Clay.

The speleothem calcite deposits on subaerial cliff-faces suggest that major lengths of the present cliff-face were once the landward walls of widened joints, and that the rock masses which were once on the seaward sides of these joints have collapsed, leaving the present face with some of the joint deposits still adhering to it.

Presumably the large slabs in the talus below the present cliff-line have resulted from periodic collapse of masses of the cliff between the (then) cliff-face and joints parallel to and behind it (Cooper and Solman, 1983). It may be expected that the slabs currently isolated between the present cliff-face and the enterable widened joints behind it will eventually collapse.

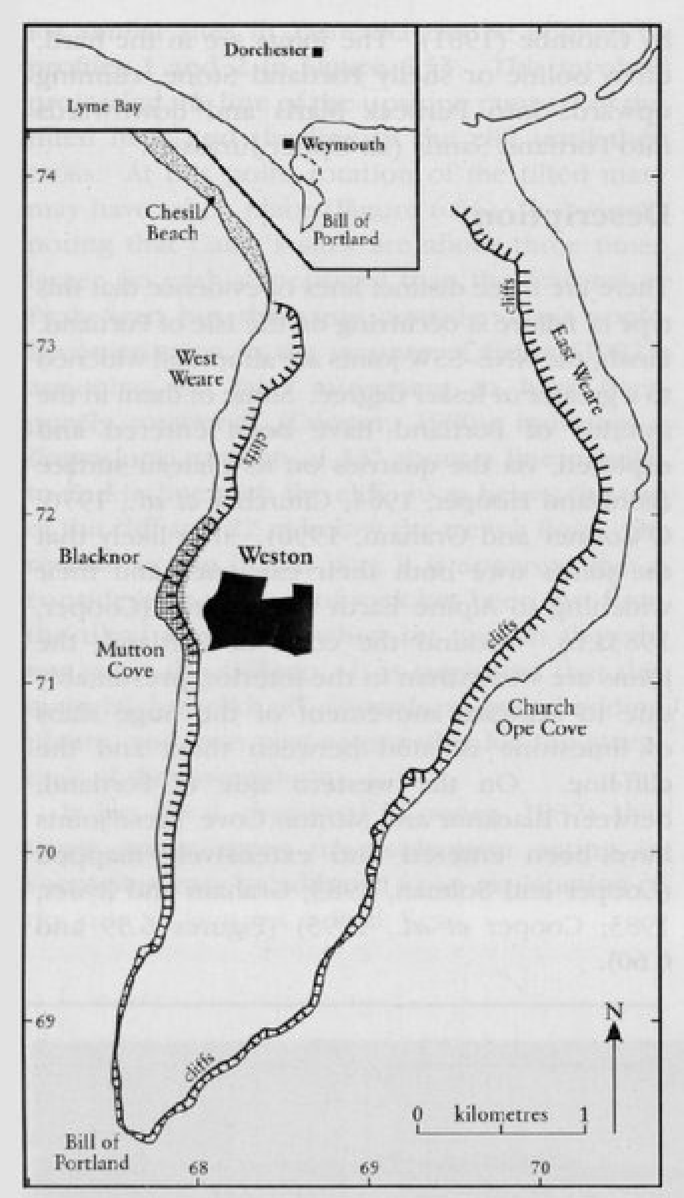
Brunsden *et al.* (1996b) associate the joint widening with a large-scale process which accounts for the 2 km-long physiographic 'low' in part of the interior of Portland. Applying to Portland the ideas developed by Cancelli and Pellegrini (1987) in a study of the Northern Appenines in Italy, they propose differential settling of the 'prisms' of rock separated from each other by the major joints. This model 'has not been tested by sub-surface exploration' and needs to be checked against the observable features within the fissures (Brunsden, 1996b).

Conclusions

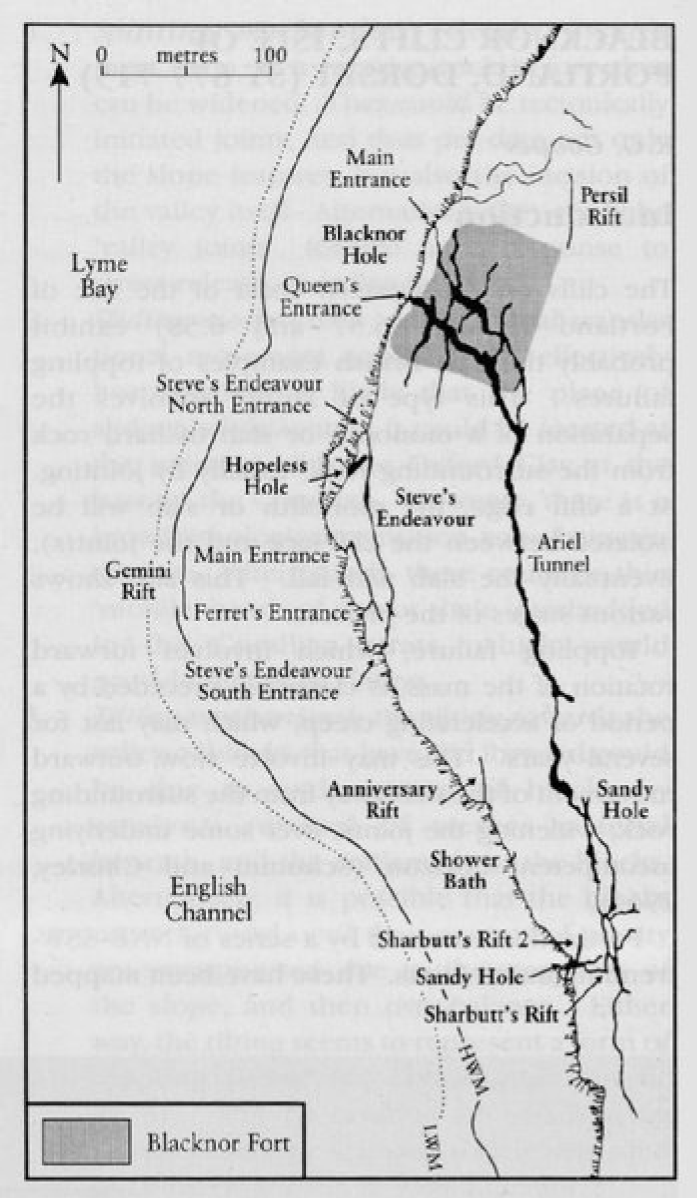
The site illustrates the sequence of events more clearly than any other site of toppling failure in Great Britain. The joint control of the process is very apparent. The intact collapsed slabs are much larger than those found elsewhere. The fortuitous preservation of unsorted debris up to boulder size, cemented to the once underground (but now subaerial) cliff-face by exhumed cave calcite formations, adds to the interest of the site, and provides clear evidence of the processes involved in cliff retreat at the site.

[References](#)

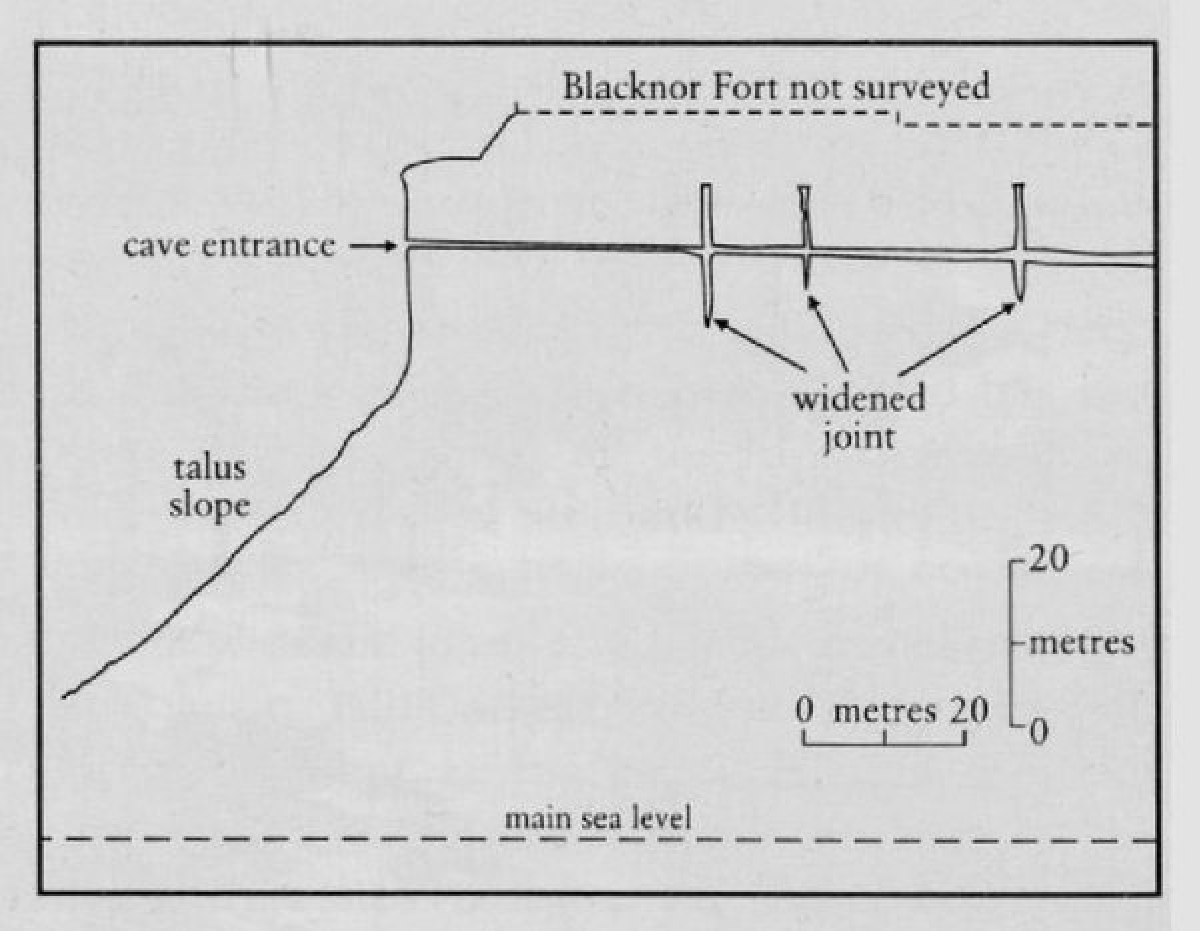
(Figure 6.57) Blacknor Cliffs, Isle of Portland. (Photo: R. Edmonds, Dorset County Council.)



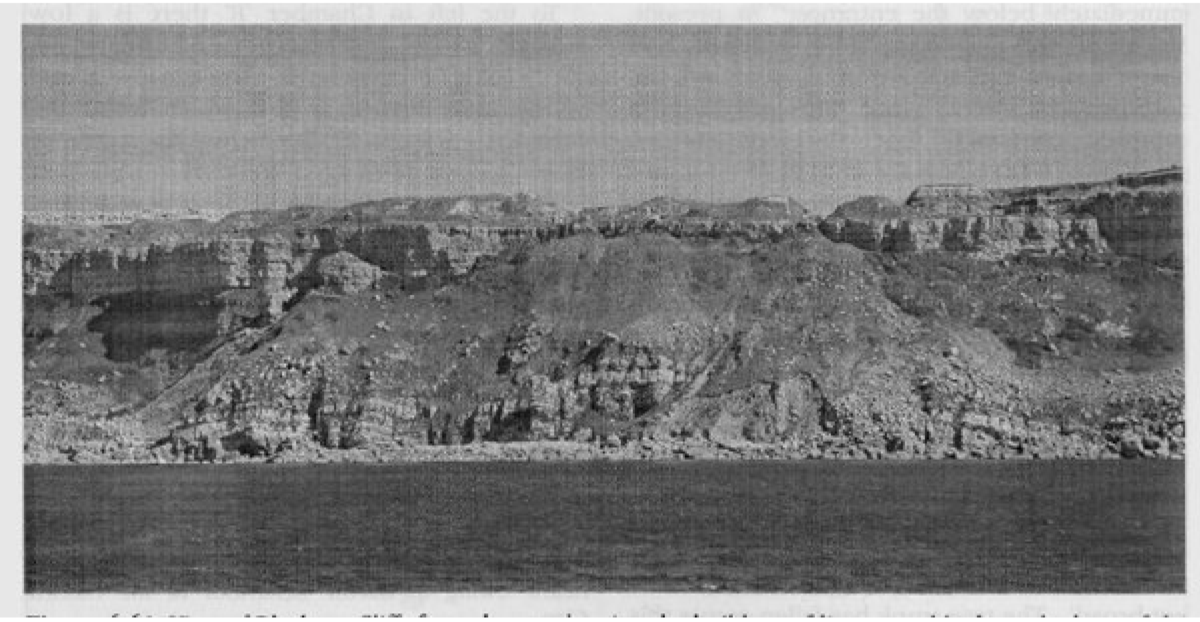
(Figure 6.59) The fissures of Blacknor, Isle of Portland.



(Figure 6.58) Location of the Blacknor Cliffs GCR site.



(Figure 6.60) Cross-section through the cliff at Blacknor. After Cooper et al. (1995).



(Figure 6.61) View of Blacknor Cliffs from the sea showing the build-up of limestone blocks at the base of the debris slopes. (Photo: R. Edmonds, Dorset County Council.)