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# TOR CAVES: A NEW CLASS OF NON-LIMESTONE CAVE, EXAMPLES FROM THE NORTH OF ENGLAND

by

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## ABSTRACT

Some caves are described from the upland tors of northern England. The passages are joint aligned between the stacked blocks which form the tors. There is no relative offset between the passage walls and evidence of dissolutional processes are absent. The passages are generally square or rectangular in cross section and do not reduce in size away from the entrance. The name tor caves is proposed for these features and an origin due to differential weathering of the rock mass, weathering being concentrated along the joint network is suggested. The recognition of tor caves expands the geographical range where speleological, archaeological and paleoclimate studies routinely undertaken in karst caves into periglaciated terrains where karst caves may be lacking.

## INTRODUCTION

A tor was defined by Ballantyne and Harris (1994) as "a residual mass of bare rock that rises conspicuously above its surroundings, is isolated by free faces on all sides and owes its formation to differential weathering and mass wasting". They exist on many hill slopes and upper summits of mid latitude landscapes. In Britain they are found primarily in upland locations and on massive, resistant bedrock. Tor development is taken as indicative of previous cold climate conditions and tor development is widespread on the Carboniferous aged sandstones of the Millstone Grit Group forming much of the Pennine uplands of northern England. Though relatively unreported compared to tors developed on the granites of the south west of England they are major landforms and are often important rock climbing localities (e.g. Nicholson, 2012). Many of the Pennine tors are scarp edge features (e.g. Brimham Rocks, Nidderdale) though summit tors do also occur (e.g. Almscliff Crag or Simons Seat, Wharfedale) (Figure 1).

The Pennine tors have been at the centre of debate regarding the processes of tor formation between the two stage model of weathering and stripping (Linton, 1955, 1964) and the single stage model of denudation under periglacial conditions (Palmer and Radley, 1961). Tors have also been explained in terms of chemical weathering and wind abrasion. Modern studies have shown that geomorphological processes operating in modern day cold climate regimes are more complex than traditionally thought and the exact climate significance of tors is still not well understood but they are at least in part periglacial features. Whatever the details of their development differential weathering along a joint network is a requirement and blocks of intact rock, referred to as corestones, are left between the joints. Very little detailed analysis has been undertaken on these features in the north of England in recent years though a number of sites are described in Huddart and Glasser (2002).

The correspondence of tor development with previously periglaciated terrains indicates a likely cryogenic weathering origin, this being a combination of mechanico-chemical processes which cause the in situ breakdown of rock under cold-climate conditions (French, 1976). Such weathering results in the destruction of rock and the production of sand and silt sized particles. Rocks with high porosity and well developed fracture networks are most

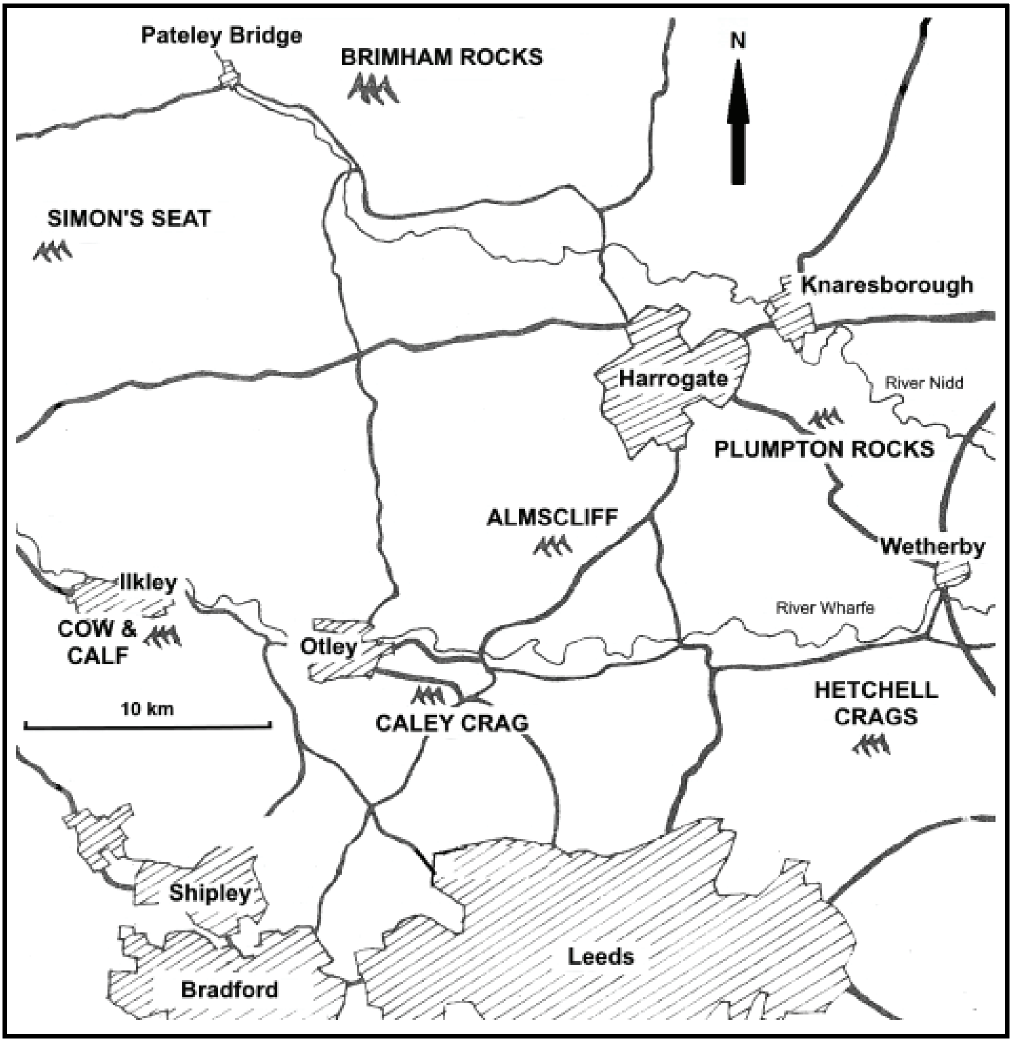


**Figure1.** *Map of the study area after Lesniak (1982).*

sensitive, both features of the Millstone Grit sandstones. The freeze-thaw cycling of water is pivotal for cryogenic weathering which could be due to simple freeze thaw processes or ice segregation processes as a result of water migration to form growing ice lenses (French, 2007). This results in rock breaking due to the progressive expansion of micro fractures and pores which are wedged open by ice growth. Freeze-thaw cycles can also result in the breakdown of individual mineral grains. Quartz and feldspar grains, both major constituents of the Millstone Grit sandstones, being particularly unstable under cold conditions. A study of quartz grain surface textures by Wilson (1980) revealed evidence of both mechanical and chemical weathering on detritus from Millstone Grit outcrops in the Derbyshire Pennines. Following weathering the resulting debris is then removed by mass wasting processes leaving the stacked core stones.

**Figure 2.** *The impressive tor of Almscliff Crag viewed from the south*.

Caves occur in tors developed on the coarse sandstones characteristic of the Millstone Grit Group which outcrops across the north of England. They are joint aligned though no relative offset can be seen between the cave walls and characteristics of both dissolutional and mass movement caves are absent. The blocks do not exhibit the random orientations of blocks forming talus caves but remain in the original orientation of the rock mass. The passages are generally square or rectangular in section, do not have a tube like morphology, do not reduce in size away from the entrance, have no indications of relative movement between the passage walls and show no evidence of water flow.

## THE CAVES

Caves have described in caving literature from the tors of Yorkshire (table 1). In the past these have been thought of as having a mass movement origin, however, as noted in Murphy and Cordingley (2010) for Almscliff Crag Cave there is no sign of relative movement between the passage walls and fit features, where a ledge on one wall corresponds with an overhang on the opposite wall (Halliwell, 1980; Self, 1986), are absent. They also differ from talus caves (e.g. Cooper and Mylroie 2015, chapter 4) which are formed by the openings among large boulders that have fallen down into a random heap, often at the bases of cliffs, as usually the corestones are still in or close to the original orientation of the rock mass. These caves have been generally ignored in the cave and karst literature. There are no entries for "tors" or "periglacial" in the indexes of Culver and White (2012), Gunn (2004), or Klimchouk *et al*. (2000), all standard reference works on cave and karst science.

**Table 1.** *Tor caves recorded in the regional caving literature.*

| Name | NGR | Length | Reference |
|---|---|---|---|
| Almscliff Crag Cave | SE267490 | 67 m | Bass, 1990 |
| Druids Cave | SE205649 | 20 m | Brook, *et al.* 1988 |
| Culverlin Cave | SE205650 | 18 m | Brook, *et al.* 1988 |
| Fylfot Fissure | SE094470 | 9 m | Brook, *et al.* 1988 |
| Butlers Folly | SE079598 | 5.5 m | Brook, *et al.* 1988 |

Almscliff Crag (Figure 2) is one of the more massive and very distinctive gritstone tors in the study area and contains one of the longest and best known tor caves in the area. Lithologically the rock mass consists of coarse to very coarse sandstone, with scattered pebbles of quartz, belonging to the Pendleian aged Warley Wise Grit of the Millstone Grit Group. The tor has a complex origin involving growth faulting during deposition giving the residual mass a dip of 22° north-east as compared to the regional dip of around 20° to the south-east (Chisholm, 1981, 1994). It is within the glaciated margins of the Last Glacial Maximum and a down–ice tail of glacial material shows that it was a topographic feature before the area was last inundated. Caves and alcoves are a feature of the site and although Almscliff Crag Cave is by far the longest, many shorter caves also occur aligned along widened joints. The cave is describes as ".. a narrow entrance leading into the underworld" and the entrance is shown on the photograph at top of page 48, to right of route 5 (Toe Poke) in the current rock climbing guide (Nicholson, 2012) though not mentioned in earlier versions (e.g. Lesniak 1982). The cave consists of narrow rectangular sectioned passages following the jointing pattern (Figure 3). The presence of large amounts of weathered regolith (*grus*) is a notable feature of Almscliff Crag caves.

Druids Cave is situated in the Lovers leap buttress of the extensive tor complex of Brimham Rocks in Nidderdale. It consists of a 20 m long passage paralleling the buttress face (Figure 4). The cave's northern entrance is shown in the photograph on page 258 between routes 119 (Difficult Crack) and 120 (Enigma) in the current rock climbing guide (Nicholson, 2012). The cave is also mentioned in the route description of Lovers Leap Chimney (No.128 page 261) as "A possible scramble through the bowels of the cliff runs from the left hand side of the belay cave right through to near Secret Crack (route 144 page 262) and is good for kids (with supervision)."

Fylfot Fissure is a narrow joint aligned passage which is now occupied by a small stream which sinks into an impenetrable fissure on the moorland just above the tor. There are a number of other possible entrances nearby which are closed off by dry stone walls possibly dating from the days of fox hunting in the area. All three examples described here are developed along widened joins in tors, show no relative offset between the walls, the bedrock blocks are still in-situ or very close to being so and lack the features of typical dissolution caves.

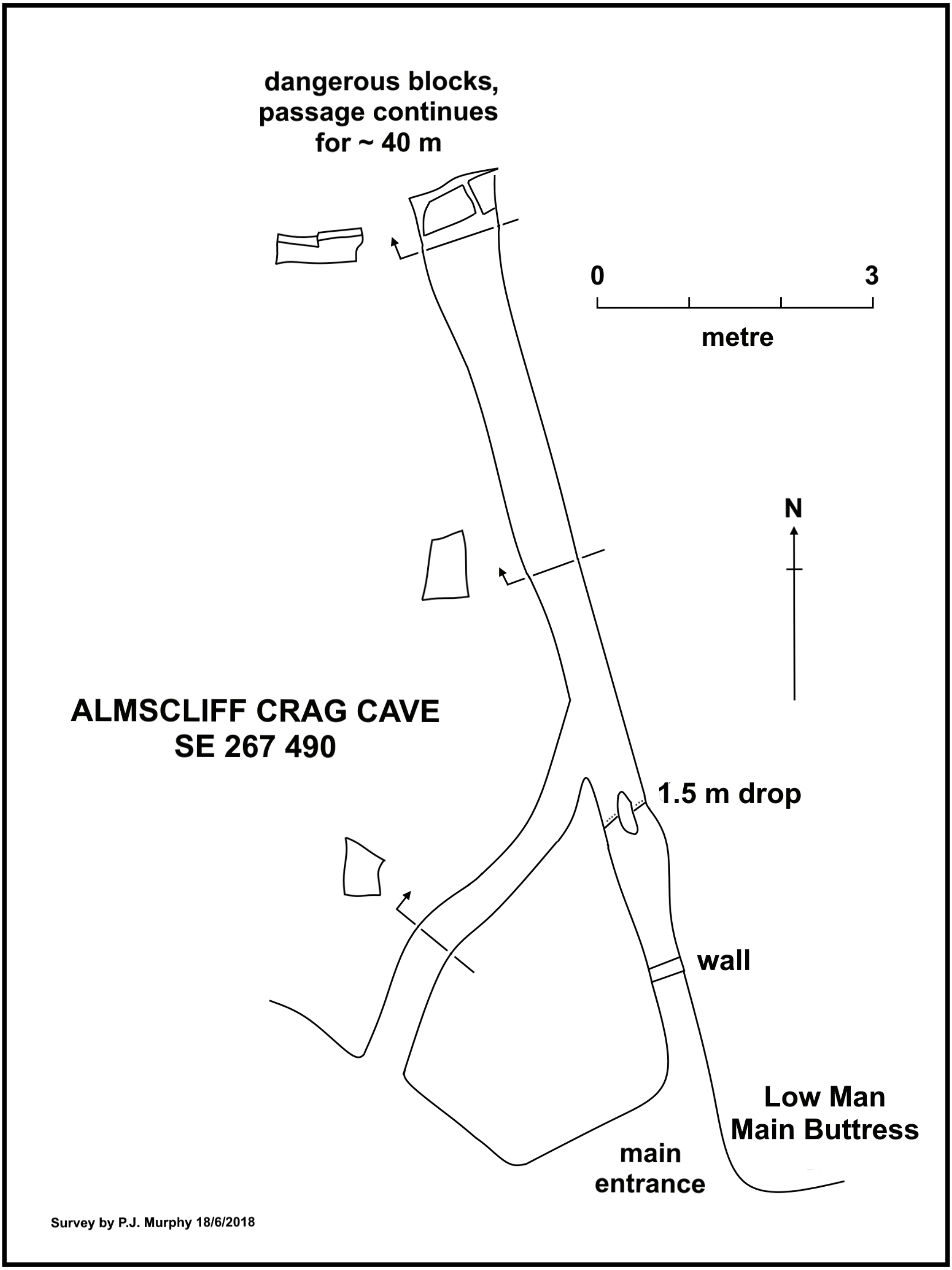


**Figure 3.** *Plan survey of Almscliff Crag Cave.*

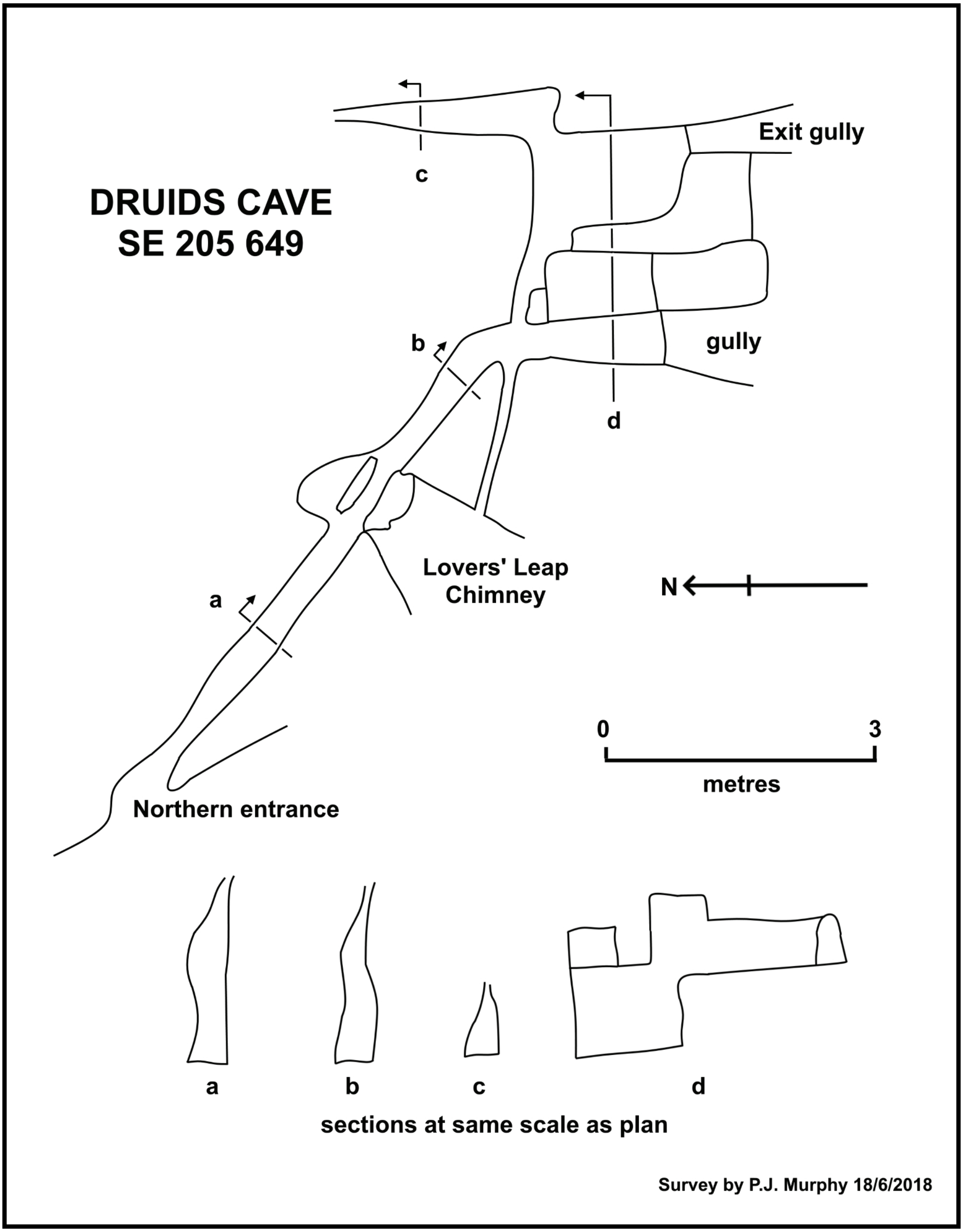


**Figure 4.** *Plan survey of Druids Cave, Brimham Rocks.*

**Figure 5.** *The northern entrance of Druids Cave*.

## OTHER POSSIBLE OCCURRENCES

Caves have been described from the Carboniferous age Fell Sandstone of Northumberland (Self and Mullan, 1996, 2006) including some mass movement caves (Murphy, 2016; Murphy and Cordingley, 2010). In addition, that formation contains a number of elliptical tubes which are interpreted as being formed due to arenisation of the sandstone followed by piping where the lose material is removed by flowing water. Tor caves differ in that they do not have a tube like morphology, do not reduce in size away from the entrance and show no evidence of water flow such as poorly developed scalloping found in the Fell Sandstone caves. Caves are also described from the Millstone Grit outcrops of north Derbyshire and Staffordshire (Barker and Beck, 2010) further study of which may show a number of them to be tor caves.

Caves have been recorded in the granite tors of south-west England (e.g. Proctor 1987 and 1988) including mass movement and talus caves but a number of sites have been described as “frost shattering” caves. The descriptions of Pixies Cave in Sheepstor are very similar to those of tor caves (Oldham *et al.* 1972). Further study of these and other sites in the area may identify examples of tor caves.

## CONCLUSIONS

Caves occur in the tors developed on the coarse sandstone outcrops characteristic of the Millstone Grit Group. They are joint aligned but no relative offset can be seen between the cave walls and characteristics of both dissolutional and mass movement caves are absent. The corestone blocks do not exhibit the random orientations of blocks forming talus caves but remain in the original orientation of the rock mass. These caves have been generally ignored in the cave and karst literature. I propose the name *tor caves* for these features and suggest an origin due to differential weathering of the rock mass, weathering being concentrated along the joint network opening enterable cavities between the intact blocks. The recognition of tor caves expands the geographical range where speleological, archaeological and paleoclimate studies routinely undertaken in karst caves into periglaciated terrains where karst caves may be lacking. Why such caves have not been describes in the speleological literature is probably due to them generally being of limited extent thus of little interest to sporting cavers and often being distant from karst areas where the exploration and scientific study of caves are concentrated.

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