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CAVES IN THE FELL SANDSTONE OF NORTHUMBERLAND

by

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ABSTRACT

Caves and some possible solution features in the Fell Sandstone of Northumberland are described. One, Routin Lynn Cave, is shown to be water-formed, as are other features in the area. Mass movement caves in the same rock formation are also described.

INTRODUCTION

Fell Sandstone, a Viséan (Lower Carboniferous) formation, outcrops in an arc stretching from south east Scotland through Northumberland into the Brampton district of Cumbria. In the area studied (FIG. 1) the formation is between 240 m and 300 m thick and has a particularly uniform lithology; it is mostly made up of well-sorted, friable, fine to medium grained quartzitic sandstone, with no significant calcareous content. Cross-bedding is commonly seen. The sandstone units are often separated by thin red and green micro-crossbedded argillaceous silts, with occasional thin conglomerate bands containing pebbles up to 25 mm in diameter. The outcrop forms barren, heathery moorland hills in a distinctive craggy escarpment around the Cheviot Hills, with a gentle dip slope towards the east, south-east and south (Hodgson and Gardiner, 1971; Robson, 1956).

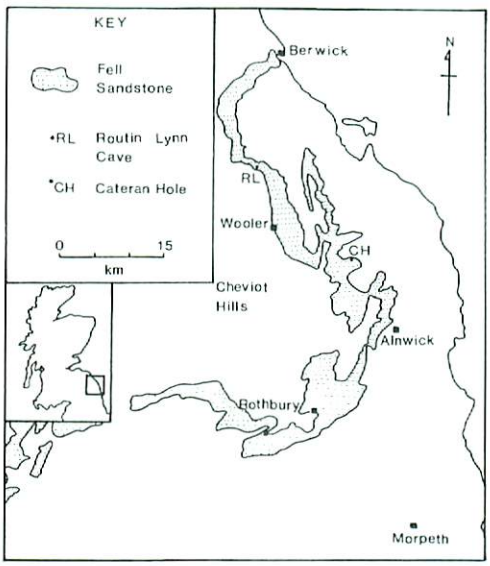

FIG. 1—THE OUTCROP OF THE FELL SANDSTONE IN NORTHUMBERLAND

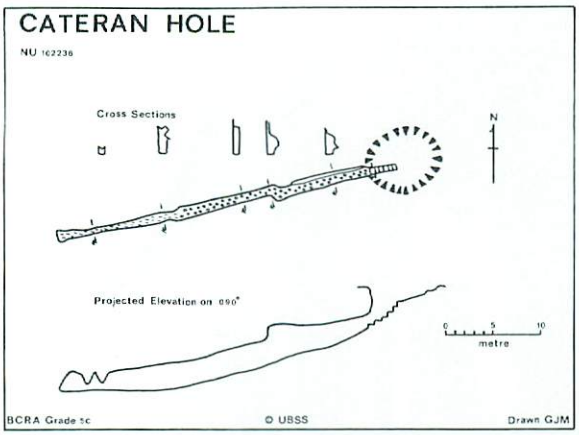

FIG. 2—CATERAN HOLE

CATERAN HOLE

N.G.R. NU 102236
length 37.8 m
depth 8.8 m

Description

The entrance is situated in a 7 m by 8 m depression on the north-west slope of Cateran Hill. Guidance for finding it is given in the appendix.

The depression is roughly oval in shape and from its lowest point a series of six worn stone steps leads down to the entrance, 3 m high, 0.75 m wide and overhung with long grass and bilberry bushes. A single passage 2.5 m high and 0.9 m wide, with a floor of angular coarse pebbles, slopes gently down from the base of the steps (FIG. 2). On the northern side is a rough ledge, 12 m long and between 1 m and 1.75 m from the floor, formed on a bedding plane. After 14 m the passage widens abruptly to just over 2 m before narrowing again between flat vertical walls, 3 m high to a bouldery roof (FIG. 3). After 25 m the floor levels and is covered in soft, wet mud. At this point, in September 1987, water 1 m deep was encountered and continued for 12 m to the end of the cave. The roof lowers, and 35 m from the entrance it is neccessary to crawl under two dog-tooth shaped jammed blocks 1 m apart. In September 1987 the water formed a short duck here, but in October 1988 this was no more than a muddy crawl. Mud deposits on the walls show that on some occasions this sumps completely. Beyond the crawl is the final chamber, 2 m high, 1 m wide with mud coated walls and ending in breakdown.

Cateran Hole is well-known in the area, it is mentioned in both a local history (Graham, 1982) and a guide book (Hopkins, 1983). Tradition relates that a subterranean passage extends from it to the Hen Hole, a gully on Cheviot some 17 km distant. On one occasion after a group of explorers ventured as far as the Hurl Stone, a pillar about 6 km away, near the hamlet of Newton, their journey was curtailed when suddenly all their lights went out and above them they heard the noise of horses' hooves and strange voices crying:

> Hup, hup and gee again!
> Round and round the Hurl Stone. (Graham, 1982)

Graham also states that the cave was once the resort of smugglers. The cave has undoubtedly been modified by man. This is seen particularly in the entrance steps and the shelf-like appearence of the ledge. It is not known whether there is any evidence for the association with smugglers, although the meaning of the word 'Cateran' in part supports this. The *Oxford English Dictionary* gives 'One of a Highland band; a Highland irregular fighting man, reiver, or marauder' and, more generally, 'Brigand, freebooter, marauder.'; implying that the hill, if not the cave, has associations with violent extra-legal activity.

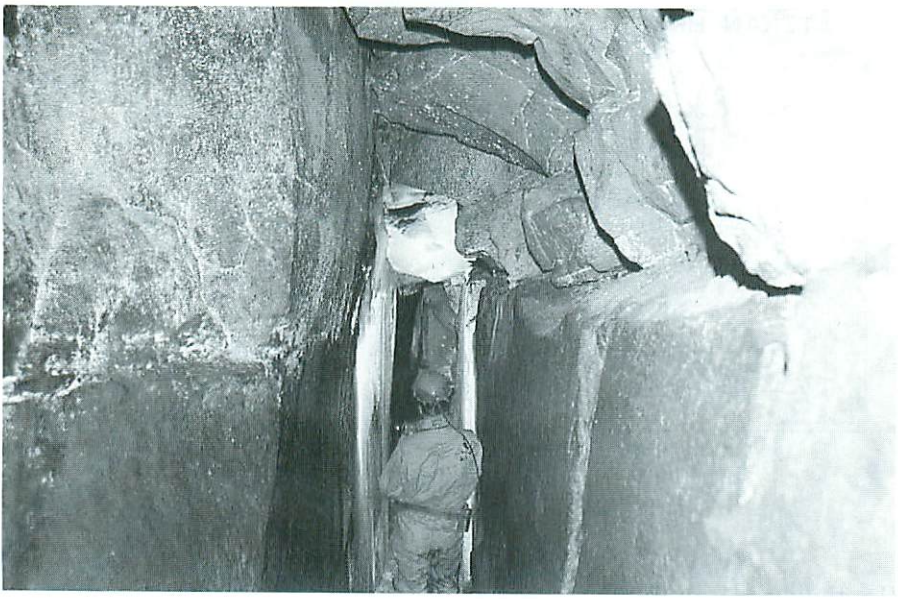

FIG. 3—CATERAN HOLE, THE LOWER PART OF THE CAVE

Formation

Cateran Hole is a mass-movement cave formed along fractures widened by the slipping of the northern wall towards the hillside, north and slightly east. This can be seen from the plan of the cave (FIG. 2) where the fit between the walls is plain. The correspondence between the walls is obvious within the cave, except in the first section, along the ledge. This is probably due to the removal of loose rock by man in making it fit for his use. It is a type C gull cave (Self, 1986).

In this area, the Fell Sandstone is highly fissured and prone to mass-movement. This is evidenced by other nearby sites: Hepburn Crag Caves (NU 074247) and Cateran Rift (NU 102232). The former site consists of a series of small rock shelters within massive foundered boulders; the latter is a gully formed by the widening of a fracture parallel to the crag face and is approximately 40 m long, 3 m wide and 4 m deep, with short talus caves among the fallen rock on its floor. Both sites are found on crags and show much more movement than is apparent at Cateran Hole.

Ryder (1987) expressed surprise that such a cave should form on such a gently sloping hillside. The evidence from Hepburn Crag and Cateran Rift, however, demonstrates that the conditions necessary for mass-movement to occur are amply fulfilled in the area of Cateran Hill. These conditions are vertical or near-vertical fractures along which the rock can part; an underlying layer of mechanically incompetent or well lubricated rock over which the sandstone can slide; and for the local dip to be close to the direction of the hill slope allowing the rock to move downhill under the actions of gravity. It is not known what underlying rock layer has allowed movement to occur, however it has been found elsewhere that shale or silt layers can perform this role (W. B. White, pers. comm.), so presumably one of the siltstone partings has done so in this case. Thus it is possible that were the hillside,

or the local dip, to be steeper then the result may have been an open gorge rather than a narrow cave.

ROUTIN LYNN CAVE

N.G.R. NT 982368
length 9.6 m

Description

Routin Lynn Cave was discovered by the author's dogs in 1985, and replaces St. Cuthbert's Cave, a sandstone rock shelter 1.5 km farther south, as the most northerly cave in England. Location details are in the appendix.

The cave entrance is 1.3 m wide and 1.5 m high. The passage (FIG. 4) rapidly narrows to an elliptical tube about 1 m wide and 0.6 m high (FIG. 5), with a squeeze after 5 m immediately followed by the final chamber where the cave closes down into impassably small tubes. The total length is 9.6 m. The cave is floored by decaying leaf mould. There is a second small cave some 3 m to the right and 1 m higher up the cliff face. It is a similar tube 3 m long and 0.6 m wide. It may be associated with an alcove 3 m into the main cave.

Formation

In general this cave resembles a normal phreatic tube, found in any limestone region. It is elliptical in cross-section, its walls show poorly formed scalloping, and it has the typical flared entrance of a resurgence cave. No caves of this type in non-carbonate rocks have previously been reported in Great Britain. However, cave formation in quartzitic sandstones is known, notably in South America (Urbani and Szczerban, 1974)

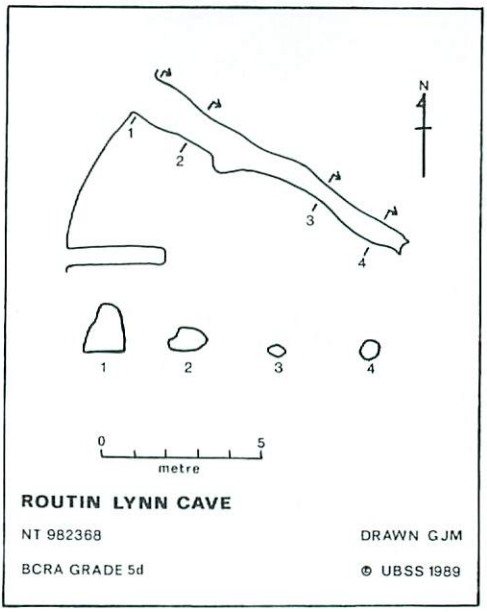

FIG. 4—ROUTIN LYNN CAVE

Sandstones of this type have two main characteristics that differ from normal karst rocks: they are much less soluble in water and are porous, therefore groundwater flow rarely becomes concentrated into conduits. Solution as a contributory factor in the formation of Routin Lynn Cave can be ruled out. The solubility of crystalline quartz is 14 ppm (White *et al.*, 1967) compared with figures of around 250 ppm of dissolved calcium carbonate frequently found in natural water systems. Although Sweeting (1972, p. 307) considers that solutional activity plays a part in the formation of pseudo-karren (see below) and Chalcraft and Pye (1984) show evidence that direct solution of quartz grains does occur in the South American sandstones, Bögli (1980, p. 2) states that quartzitic sandstone is only likely to be karstifiable under hydrothermal and also extremely humid tropical conditions which remain the same for millions of years. These conditions do not apply to northern England.

FIG. 5—INTERIOR OF ROUTIN LYNN CAVE, LOOKING INWARDS

Fell Sandstone is known to be a highly fissured rock (Hodgson and Gardiner, 1971). It is therefore possible that a degree of groundwater flow concentration will take place; however for this to lead to cave formation by mechanical erosion two further factors must apply. It would be necessary for the initial fracture to be wide enough for the flow to be turbulent, in order for it to support a suspended load. Thus a minimum width of about 5 to 10 mm (White and Longyear, 1962) would be required. Secondly it would be neccessary for the fracture to be open at its 'downstream' end so that the suspended load of particles can be washed out instead of blocking the outlet and preventing the continuation of the process. Routin Lynn Cave fulfills both these conditions. It is possible to see in the roof of the cave on its north-west side the fracture that the line of the cave has followed. In addition, its elliptical shape is due to preferential erosion along one, softer, bed. That the cave has not developed to any greater extent is not due to any deficiency in the mechanism but simply to the loss of its water supply. The cave is now quite dry.

There is one alternative condition to be considered. If the initial fracture had not been open, but had been subject to secondary infilling by deposition of calcite; then the initial process would have been the solution of this vein, until the fissure had become wide enough for turbulent flow to have begun. There is no evidence as to whether calcite was initially present in this case or not. It is unlikely; in the south-west of the outcrop there is a high degree of calcite cementation, but in the area in question the fractures appear not to have been affected by such secondary deposition (Hodgson and Gardiner, 1971).

A similar, though much smaller, feature, has also been noted in a small sandstone outcrop (NU 004310), high on the slope of Dod Law overlooking the river Till. At the base of the outcrop is a small cave, 2 m wide, 1.3 m high and 1.3 m deep, which has probably been artificially enlarged to form

a shelter. This commands a wide view of the surrounding area and may have been used by shepherds. At the back of the cave is a small elliptical tube, 0.5 m by 0.2 m. This can be seen to run through the outcrop along the line of a joint. This, too, is now dry; but was presumably formed by a similar process to Routin Lynn Cave.

SMALL SOLUTION FEATURES

The area contains two types of small scale feature formed by water action on the sandstone surface, which can both be seen on the outcrop on Dod Law.

Firstly, to the left of the shelter is a fine example of spongework (FIG. 6), divided by 2 m of blank wall into two distinct areas each about 3 m high and 1 m wide. This finely etched feature must have been formed by water action under conditions quite different from present ones, as it seems unlikely that the sort of coarse mechanical weathering processes, such as freeze/thaw, that would affect an exposed rock face could have brought about such a delicate result.

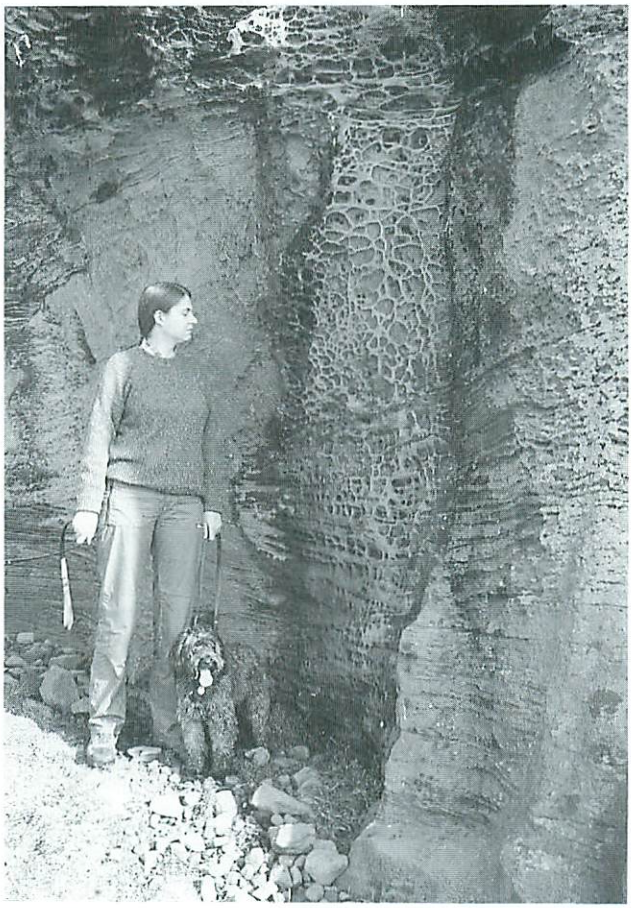

FIG. 6—SPONGEWORK ON SANDSTONE CRAG, DOD LAW

Secondly, smoothly rounded grooves, or rundkarren, can be found on many exposed rock surfaces including the top and front edge of the Dod Law outcrop. It is possible that these have been formed by the solutional activity of very slowly moving water, under a soil cover, on the quartz matrix of the rock. On rock surfaces that have been carved with Bronze Age cup and ring markings, for example the display at Routin Lynn, the natural markings and the man-made ones do not overlap. This implies that the karren either form very slowly or not at all on the exposed rock surface, as otherwise they would have cut into the artificial carvings during the several millenia since they were made. The effect of soil cover is to keep water in contact with the rock for much longer. Morey *et al.* (1962) note that it is possible to form supersaturated solutions of quartz with concentrations as high as 395 ppm at 25°C by agitating quartz/water mixtures for 370 days. Their paper is not conclusive as to the mechanism of this process, although they do suggest their results may be due to the dissolved quartz diffusing away from the surface more rapidly than new crystal growth can occur if impurities and structural irregularities in the quartz exist which inhibit such growth. Thus the equilibrium state between solution and re-crystallization is not being reached.

Sweeting (1972, p. 307) comments that similar features on exposed gritstone surfaces are assumed to be the result of solutional activity. Similarly, such features in the Roraima quartzite of Venezuela have been shown to be solutional in origin (White *et al*, 1967). Whilst doubts were expressed above as to the role of solution in the formation of Routin Lynn Cave, it should be noted that one constraint has been removed when considering surface features; that is the need for the water to act as the agent of removal of the insoluble residues as well as acting on the quartz matrix; this, again, allows much slower moving water to be acting.

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APPENDIX—CAVE LOCATIONS

Cateran Hole

Cateran Hole is difficult to find, but can be located by taking the road which leads from Heburn to North Charlton. Park by the bend in the road 300 m west of Quarry House (NU 104248) and follow the obvious track south-south-east from the road. After approximately 800 m a somewhat indistinct junction is reached; the main track continues across the moor and leads eventually to the ruined farmhouse of Blawaerie; to the left a less obvious path leads up the long slope of Cateran Hill. Follow this, and after about 600 m turn off the track downhill in the direction of Quarry House. A useful reference point at this stage is the tall radio aerial to the north; when this appears to be just inside the wood near the house, leave the path. The depression is about 200 m from the track. The cave is marked on the 1986 edition of the OS 1:25000 map, Pathfinder sheet 476 (NU 02/12).

Routin Lynn Cave

To find the cave, park at the cross-roads at NT 983367. Take the road towards Routin Lynn Farm and then turn left on the second path into the woods, follow this down valley to the stream confluence, turn right and walk up the bank of the major stream. The cave is on the right of the path about 20 m downstream of a 10 m high waterfall.