Knock Fell Caverns

[NY 720 307]

Highlights

Knock Fell Caverns is the finest example in Britain of a joint-guided phreatic maze cave, with more than 4500 m of passages known within a single thin limestone in an area of less than 3 ha.

Introduction

Knock Fell Caverns lies at an altitude of 750 m directly beneath the surface watershed along the crest of the Pennine escarpment north of Knock Fell (Figure 3.1). The cave is developed in the Namurian Great Limestone, which is about 20 m thick and dips very gently to the north-east; mixed sequences of sandstones and shales lie both above and below the limestone. There are numerous shakeholes in the soil and drift over the limestone outcrop, and one contains the 7 m deep entrance shaft to the Caverns. Underground drainage within the limestone resurges at a strong spring near the head of Knock Ore Gill. The cave was mapped and described by Sutcliffe (1985).

Description

The shaft entrance to the cave lies on a joint intersection modified by collapse which has broken through to the surface. All the main passages are formed at one level within the Main Limestone. They are vertical phreatic rifts, all formed along joints, and they intersect in a maze of spectacular complexity (Figure 3.23). Most are less than a metre wide, and narrower joint fissures with fretted walls extend above and below the main solutional enlargement to give total passage heights of 5–10 m. Horizontal rock ribs and blades protrude from many of the passage walls, left by selective solution of closely spaced lithological contrasts within the limestone (Figure 3.24). Most of the known cave system, which has a total passage length of more than 4500 m in an area roughly 320 m by 120 m, lies beneath the cover of shales and sandstones. Passages to the west extend under the shakeholes on the limestone bench; these are largely choked by boulder falls and inwashed gravels, which now fill the floor rifts in adjacent passages. The eastern extremities of the cave reach towards the Teesdale flank of the ridge, and are also choked by sediment.

The entire cave is formed on joint fissures, and the tectonic fracture patterns therefore control the maze topography. Joints are more closely spaced in the southern half of the cave, while a more open maze has formed on more widely spaced fractures to the north. Some wider passages and chambers with rectangular profiles have formed by the breakdown of narrow blades of rock between solutional fissures on close, parallel joints. Part of the northern end of the main cave is underlain by a discrete lower level, the Inferiority Complex, with smaller phreatic passages forming a denser network than those in the main maze about 5 m above. Below this may lie younger, active caves draining towards Knock Ore Gill Head. The known cave is dry, apart from percolation water entering from roof fissures.

Some roof fissures reach to the top of the limestone, and the undermined shale has partially failed. Several wider avens on joint intersections reveal the sandstone roof which overlies the thin shale. The sandstone is fissured sufficiently to allow acidic water to percolate down from the blanket peat above. This water is mostly aggressive as it etches the cave walls, but small secondary calcite deposits have formed in a few places. The fossil corals of the Frosterley Band are conspicuous in the walls of many parts of the caves, and are locally spectacular where the limestone has been etched from around them by the aggressive percolation water.

Interpretation

Knock Fell Caverns represent the finest of the complex phreatic maze caves which are a feature of the thin Yoredale limestones in the northern Pennines. It is more extensive than the comparable mazes intersected by mine workings in

Swaledale (Ryder, 1975), and all of these have much denser passage networks than the rectilinear stream caves of Mossdale Caverns and other comparable sites. Knock Fell Caverns is typical of the dense mazes of cave passages formed by slowly moving water in confined aquifers (Palmer, 1975); solution takes place along all the fractures without selective enlargement on those fissures with hydraulic advantage in an environment of high flow rates. No flow patterns have been recognized in the cave.

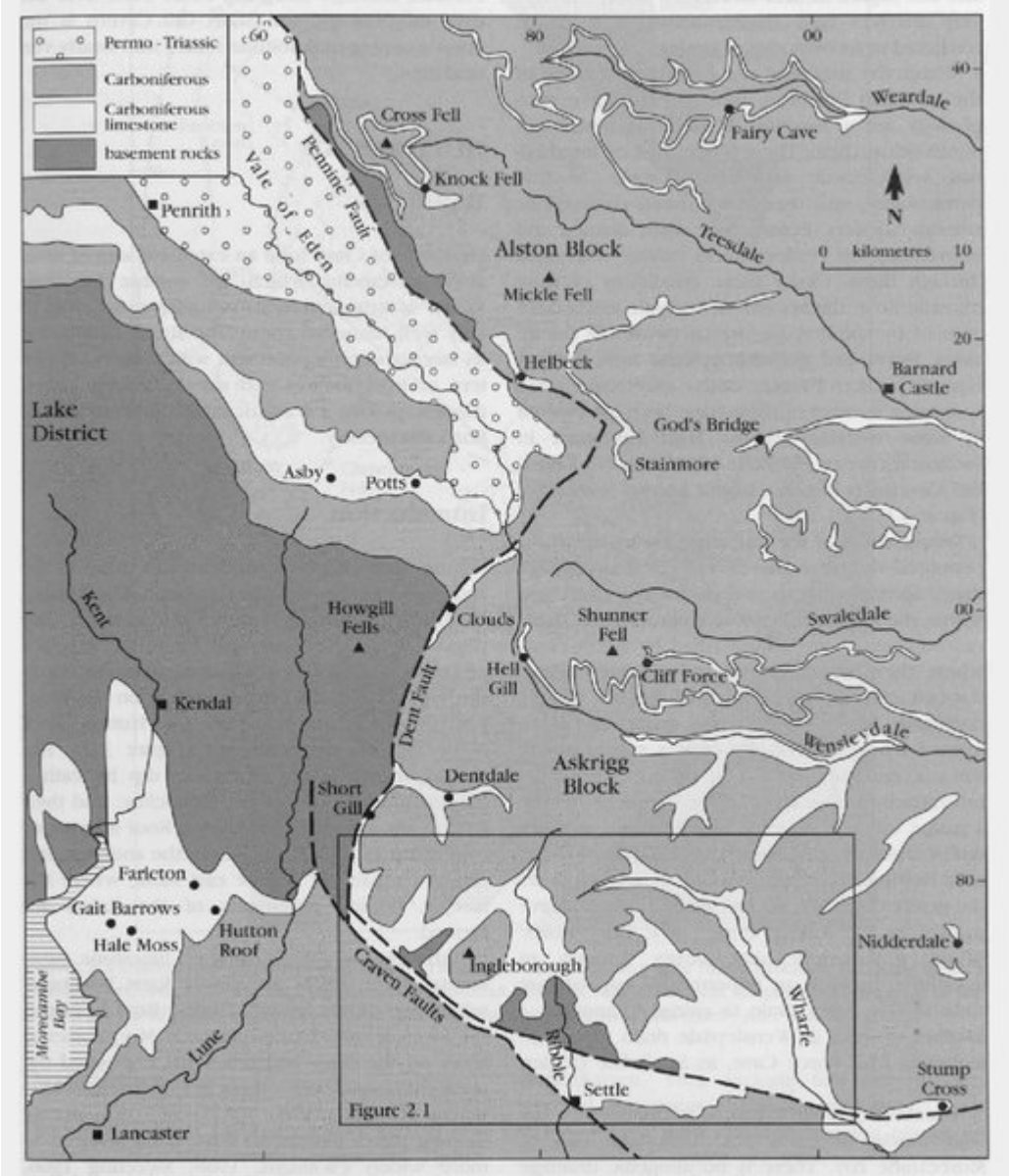
Permeable, jointed sandstones lie both above and below the cavernous limestone, in each case separated by only thin shale beds which are seen to be breached in some of the roof shafts. These sandstone aquifers could have provided, via the fractures, a diffuse input of aggressive water into the limestone, in the style recognized in many other maze caves (Palmer, 1975). This could have taken place with either upward or downward flow when the limestone was deeply buried in an artesian phreas. Alternatively, it may be much later, with downward flow through an exposed sandstone cap into a limestone phreas perched on shale, and unable to drain across the low dip into distant surface valleys. In either case, the phreatic development was terminated when surface lowering left the cave perched just beneath the watershed cap. Vadose modification has been minor.

The cave lies at very high altitude, close to both the Pennine fault scarp and a long dipslope down to the Milburn Forest. Hence much of the phreatic passage development may be very old, substantially predating the surface landforms. Clastic and calcite deposits within the cave represent the only material suitable for absolute dating in this part of the Pennines, and hence may provide a valuable record of the valley incision and geomorphological history of the area.

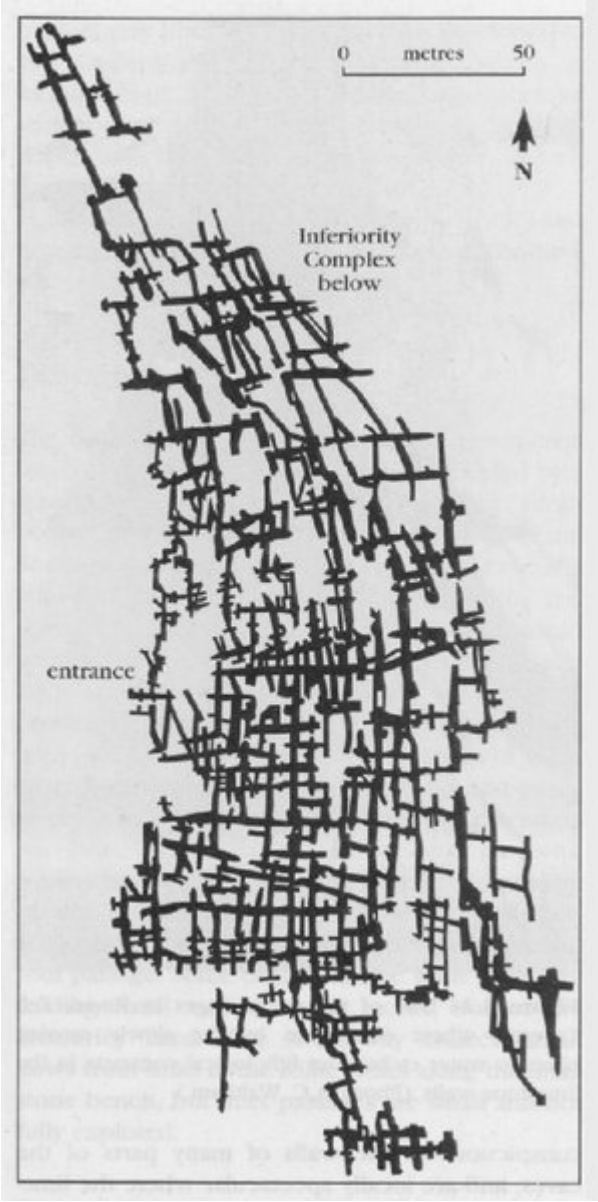
Conclusion

The scale and complexity of the phreatic maze of Knock Fell Caverns are unparalleled in Britain. Its configuration and position, with a joint network enlarged by solution in limestone beneath a permeable sandstone, suggest that it was probably formed by diffuse recharge to a confined aquifer with very slow drainage.

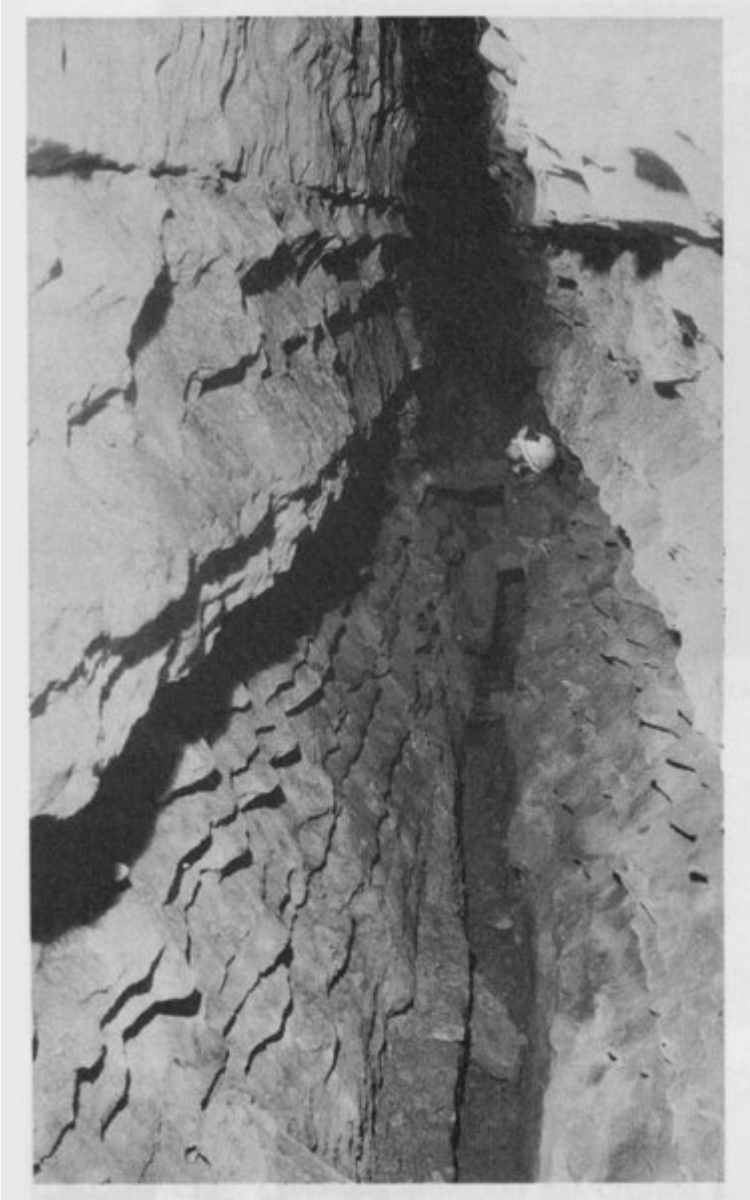
References



(Figure 3.1) Outline map of the karst regions in the northern Pennines, with locations referred to in the text. The other Carboniferous rocks are the non-carbonates of the Orton Group and Yoredale facies of the Dinantian, and the Namurian, but they include thin bands of limestone with lesser karst features not shown on this map. The Carboniferous limestone includes the Dinantian Great Scar Limestone, the Yoredale limestones with significant karst, and the Main or Great Limestone of Namurian age. The basement rocks are Lower Palaeozoic non-carbonates. Details and locations in the southern Dales are shown in (Figure 2.1).



(Figure 3.23) Outline map of Knock Fell Caverns, without the much shorter lower series which are omitted for clarity (from survey by Gritstone Club).



(Figure 3.24) One of the rift passages in Knock Fell Caverns, where dissolution by the slowly moving phreatic water etched out lithological contrasts in the limestone walls. (Photo: A.C. Waltham.)