Cliff Force Cave and the Buttertubs

[SD 875 690]

Highlights

Cliff Force Cave is the finest known example of an inter-dales cave, in which geological structure has allowed the underground drainage to cross beneath a major surface watershed. The Buttertubs are a series of spectacular potholes developed by small sinking streams meeting a thin limestone, with open shafts descending directly to the underlying aquiclude.

Introduction

The well known Buttertubs potholes and the entrance to Cliff Force Cave lie within 150 m of each other on opposite sides of the Cliff Beck valley. This is cut into the steep fells of Muker Common, descending from the Buttertubs Pass on the south side of Swaledale (Figure 3.1). Cliff force Cave has a long stream passage with drainage from the Wensleydale slopes passing beneath the topographic divide. The Buttertubs swallow small streams from the valley sides into large entrance shafts which belie the very short distances to their resurgence. Both features are developed where the Namurian Main Limestone is exposed in the valley sides (Figure 3.15); this forms a bed about 25 m thick, with clastic sedimentary rocks both above and below. The sequence dips very gently to the north-west and is broken by mineralized faults orientated north-east.

Cliff Force Cave has been documented briefly by Langthorne (1976), Clough and Clough (1981), Ryder (1981) and Brook *et al.* (1988). The Buttertubs are widely cited as examples of limestone potholes, but further comment on their morphology is only brief (Waltham, 1984).

Description

Cliff Force Cave contains about 2000 m of passages reached through an abandoned exit just above the present resurgence (Figure 3.15). The Entrance Series consists of narrow, joint-guided, phreatic rifts and avens, partly blocked by collapse and fluvioglacial fill; they lie above a short inaccessible section of the stream route. Beyond them the Lower Streamway is a vadose canyon, initially more than 3 m high and wide, developing into a narrow rift with undercuts at stream level, oxbow loops and a few collapse chambers. Above the streamway, the Spar Shop Series is an abandoned gallery largely formed as a sequence of interconnected rifts and now partly filled with clastic sediment. The two levels join in Fault Hall, a chamber 15 m in diameter developed on a mineralized fault. The stream cascades into Fault Hall from the Drain Queen's Highway, a phreatic passage mostly 3 m high and wide with prominent rock flakes projecting from the walls. The Room of Dangling Doom is the start of a long zone of heavily collapsed phreatic passage developed just below a thin mudstone which is exposed in parts of the roof. Further passages are flooded, but the water has been traced from a group of sinks in the Main Limestone at Sargill, nearly 3 km south-east of their resurgence. These lie in valleys whose surface thalwegs descend into Wensleydale.

Where Lover Gill crosses the Main Limestone, north of Cliff Force Cave (Figure 3.15), an old phreatic maze cave has been intersected, and some drainage now passes through truncated fragments of the maze preserved in both banks of the gill (Brook *et al.,* 1988).

The Buttertubs are a series of open vadose shafts in a narrow bench formed on the top of the Main Limestone along the west side of the Cliff Beck valley (Figure 3.15). In wet weather they take small streams from the peat-covered shale slopes above, but their catchments are very small. There are five main shafts, with clean, fluted walls; these have been deeply crenulated by waterfall retreat, to form interconnected series of shafts and slots between remnant pinnacles of limestone (Figure 3.16). They are all 15–20 m deep, to floors of fallen limestone blocks and clas-tic sediment, and their streams drain either through the floor debris or into impenetrable wall fissures. All this water resurges from Cliff Beck Head Cave, which lies directly down the bank from the Buttertubs (Figure 3.15), about 25 m lower down. This has small converging stream passages formed on joint/bedding intersections close to the base of the Main Limestone, and sandstone is exposed in the beck just below the rising.

Interpretation

Cliff Force Cave is one of a number of underground drainage routes carrying flow beneath the major surface watershed between Swaledale and Wensleydale (Ryder, 1975). It demonstrates clearly the fundamental control by geological structure on karst drainage routes; the Sargill streams flow south-east on the surface towards Wensleydale, until they sink underground and flow north down the dip towards Swaledale. Geological controls have influenced the cave in many ways. A few bedding planes and shale bands were the inception horizons for the whole cave, but the extensive collapse in the upstream sections has occurred beneath a thin, incompetent mudstone band; this was clearly not an inception horizon as it lies above the solutional features within the roof. Joint fissures are a part of the cave morphology, but the stream route has not encountered any old phreatic networks comparable to the maze fragments breached by Lover Gill. Phreatic solution and collapse along the mineralized fault which crosses the drainage line has produced the large Fault Hall; however, the cave has continued to follow the bedding, perhaps because the fault has none of the older phreatic rifts on the scale of those on faults in the karst of north Wales and the Peak District.

Unlike many caves in the thin limestones of the northern Pennines, Cliff Force Cave has evolved through several levels of passage development. Upstream of Fault Hall there is only a single phreatic passage, barely modified since it was partially drained. Downstream of Fault Hall there are three levels, of which only the active streamway is lower than the upstream passage. For much of the cave's history, water in the upstream passage was ponded behind a small phreatic lift on the fault. The highest level is only represented by passages close to the resurgence entrance; these may have been reached by a second phreatic lift, perhaps part of an old vauclusian resurgence system now obscured by glacial debris on the valley side. The second level is represented by the Spar Shop Series feeding to the dry passages and the present entrance; this was also active via the Fault Hall phreatic lift. The active streamway has a third level of initial phreatic development, followed by rejuvenation and vadose entrenchment.

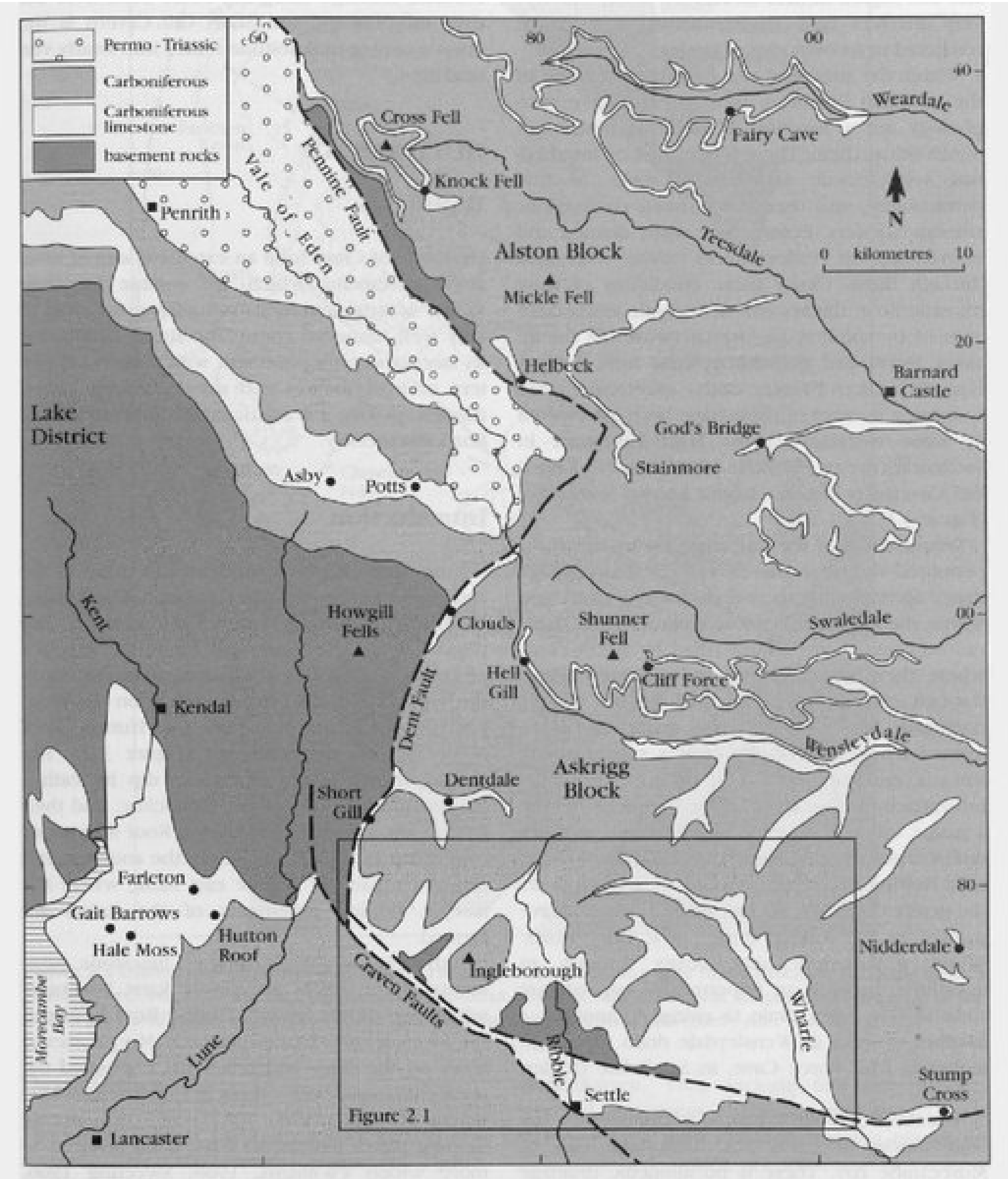
The three cave levels are all primarily phreatic, and appear to reflect successive stages of phreatic flow on lower inception horizons within a maturing aquifer. Only the last stage of vadose incision can be directly related to lowering of the resurgence. A scarcity of calcite speleothems in the cave is a consequence of the location beneath an impermeable shale cover, and no evidence of absolute ages is yet available. Though the stages may relate to the glacial excavation of Swaledale, it would be premature to relate rejuvenations to valley floor positions, when the resurgence position may have been so easily influenced by details of geological structure in such a narrow limestone outcrop. The inception stage for the development of this cave may have been exceptionally long, as it lies in a thin limestone with non-carbonate rocks both above and below; these would have excluded infiltration flows of soil water, though the underlying sandstone may have carried some primary groundwater flow. The lithology of the Main Limestone may include features very pertinent to cave inception and karstic evolution in carbonates not directly exposed to the surface.

The Buttertubs present a striking contrast to Cliff Force Cave. They are classic examples of invasion vadose shafts developed close to a steep valley side, with horizontal cave development only at the base of the limestone where the underlying aquiclude has perched the groundwater flow. Relaxation opening of the limestone fractures, towards the destressed hillside, may have accelerated early development of the shafts, whose position and lack of fill are essentially post-Devensian. The deeply fluted shafts demonstrate the role of small flows of corrosive water rich in carbon dioxide and organic acids from soil and peat. In both these respects, the Buttertubs are not typical of the many Pennine potholes which are at large stream sinks feeding cave drainage routes to distant resurgences. They are, however, spectacular and very accessible karstic shafts.

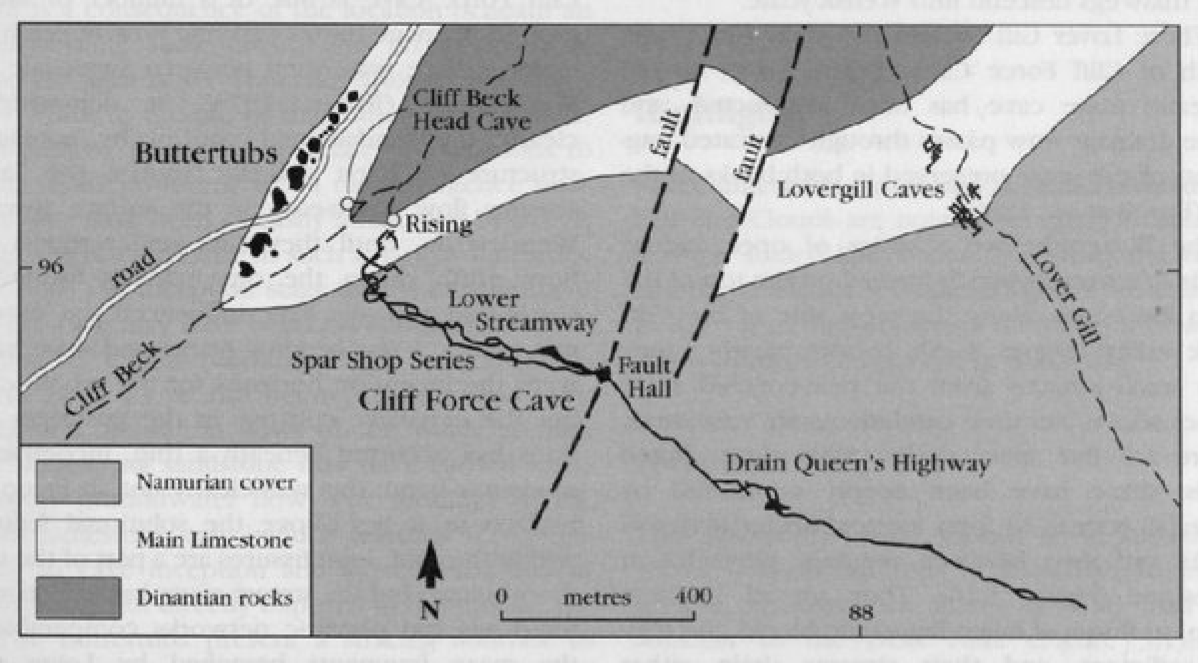
Conclusion

Cliff Force Cave is the prime example of a cave developed in a thin limestone by drainage passing beneath a major surface watershed. Geological controls, both structural and lithological, have influenced the configuration and morphology of the cave, producing a cave system on multiple phreatic levels, which is unusual in the thinner limestones of the northern Pennines. The Buttertubs are the product of entirely vadose development in the same limestone, with simple vertical shafts descending to the underlying aquiclude and draining rapidly into the adjacent valley.

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 3.15) Geological map of Cliff Force Cave and the Buttertubs. Both the Namurian cover and the underlying Dinantian rocks include thin limestones not shown and not connected to the Main Limestone (cave survey from Moldywarps Speleological Group).

(Figure 3.16) The fluted potholes and limestone pinnacles at the Buttertubs. (Photo: A.C. Waltham.)