Upper Dentdale caves

[SD 732 861]–[SD 741 864]

Highlights

The caves of Upper Dentdale constitute an excellent example of a karstic drainage system which has been developed and partly intersected beneath a limestone valley floor. The passages show strong geological controls in their structure, including cavern modification by collapse.

Introduction

The glaciated trough of Dentdale is cut just deep enough to expose the Great Scar Limestone in a stretch of its floor east of the village of Dent (Figure 3.1). The River Dee traverses the limestone outcrop in a shallow rocky gorge which is dry in normal weather for 1500 m, when all the flow is underground. Sinks and open cave entrances swallow the water into a major sub-valley conduit, where the main flow is joined by tributary streams sinking along the southern side of the dale (Figure 3.8). As the main caves, below river level, are frequently flooded, many passages and entrances are choked by debris, and only a fraction of them have yet been entered. The limestone outcrop lies across a very gentle anticline, plunging with the regional dip to the north, and is locally disrupted by steep dips in shatter zones; the carbonate succession is broken by shale beds up to 2 m thick, and includes the Gayle and Hawes Limestones which are contiguous with the Great Scar.

The geomorphology of the main caves in Dentdale was first described by Long (1971) and Lyon (1974) before further significant discoveries were made (Monico, 1992, 1995; Allwright *et al.,* 1993; Brook *et al.,* 1994; Holmes, 1994) and a number of speleothem dates were obtained from the site (Gascoyne *et al.,* 1983a, b; Gascoyne and Ford 1984).

Description

There are numerous sinks into rifts and bedding planes along the course of the River Dee. The furthest upstream are 1 km after it crosses onto the limestone outcrop, and they are spread over the next 2 km of riverbed as far as the Ibbeth Peril plunge pool, below a small waterfall which is normally dry. Water from all these sinks enters a conduit which is only partially explored and appears to be largely flooded; the sinks are at altitudes of 220 down to 185 m, the caves at Ibbeth Peril reach water levels at 155 m, and the Poppies resurgence is at 148 m.

Most of the known caves in Dentdale are tributaries or flood distributaries of this main conduit, which has only been reached in the flooded section of Tub Hole (Figure 3.8). The Ibbeth Peril Caves have a main entrance beside the waterfall and plunge pool, from where a downstream passage heads north-east into the Main Chamber. This is one of the largest cave chambers in the Pennines, covering 30 m by 60 m with a height of up to 14 m; its floor is a chaos of massive limestone blocks which have fallen away from the roof. Several stream passages converge on the chamber, and the combined outlet drains northeast to a sump and a complex flooded zone. Flowstone overlying fluvial or fluvio-glacial sediments in an almost choked side passage is postglacial, giving dates of 6–29 ka (Gascoyne and Ford, 1984).

The pattern of cave streams draining downdip to the north-east, almost directly opposite to the surface valley flow, is repeated in the other active inlets. The aptly named Upstream Downstream Passage lies directly beneath the surface stream, yet the vadose cave stream flows in the opposite direction. A very old phreatic bedding passage, under the north side of the riverbed connects the inlets in the Ibbeth Peril and Broadfield Caves. Drainage from the upper sinks in Hacker Gill flows north through the Upper Hackergill Caves, which continue downstream as the Upstream Downstream Passage in Ibbeth Peril (Figure 3.8); a distributary takes some of the water under the river, into the small streamways in Broadfield Caves (Figure 3.9). Water from the lower sinks in Hacker Gill drains to risings in the south bank of the Dee riverbed and then sinks again into short caves on the north side, which are assumed to drain into the main conduit.

Just upstream of the impenetrable bedding planes of the Poppies resurgence, a flood channel joins the River Dee from the Tub Hole rising. Feeding this flood resurgence, a wide cave passage has a flat roof left by extensive collapse of bedding slabs. Where the dry cave passes under the surface riverbed, holes lead down into a complex zone of flooded passages. The main phreatic tunnel extends downdip to reach depths of 34 m at the exploration limit almost beneath Broadfield Caves (Figure 3.8). In low flow conditions the water in this passage drains to the west, but in normal conditions the flow is to the east (Monico, 1992); and in flood conditions a massive flow pours from Tub Hole. The explored cave all appears to be part of a series of loops which form only part of the main conduit system; the complex flow patterns suggest that there are more, parallel conduits further downdip to the north.

Interpretation

The modern drainage of the floor of Dentdale feeds sinking streams which drain downdip through vadose caves, until they meet flooded conduits which carry the flow along the strike to a single resurgence. In this respect, the valley provides a perfect example of karstic drainage influenced by geological structure. Bedding planes, mostly marked by thin shale beds, have provided the main horizons of cave inception. Most of the tributary stream caves follow the limestone dip to the north-east, whereas the surface drainage is to the west. The main sub-valley conduit is unexplored, but it probably takes the line of a series of shallow phreatic loops following bedding planes under the northern, downdip side of the valley. Thick shale beds, and local zones of contorted and fractured limestone, in the Ibbeth Peril Caves created areas of weakness which were exploited by solutional undermining and collapse to create the large chambers.

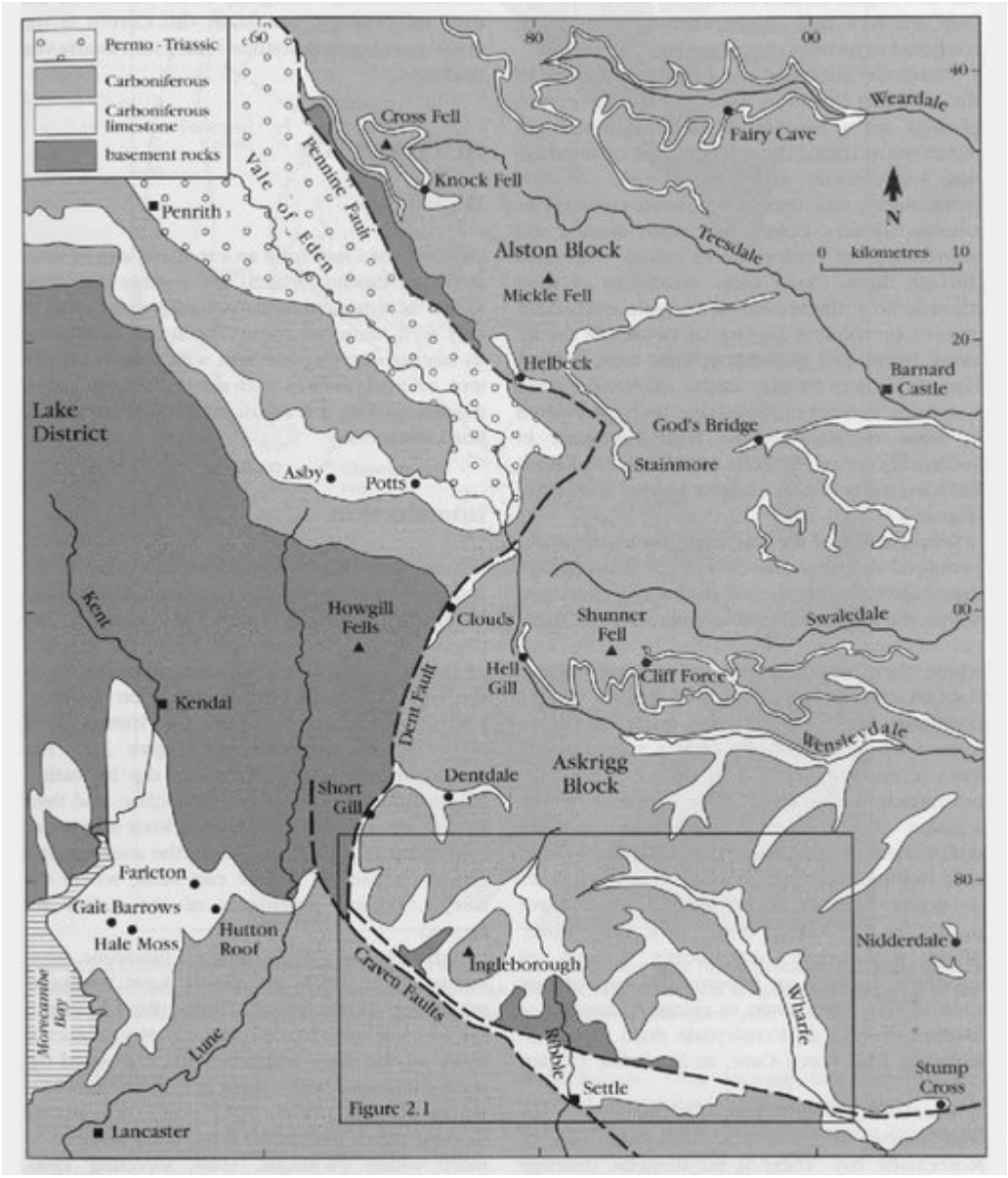
In detail, the situation is more complex as many of the drained, vadose passages have features of phreatic morphology, suggesting that they developed before the riverbed cut down to its present level. Speleothem dates of up to 29 ka (Gascoyne and Ford, 1984) indicate that the shallower parts of the system had largely attained their present size, and had been drained, before the Devensian glaciation. The wide phreatic bedding passage connecting the two main inlets of the Broadfield Caves probably represents an earlier sub-valley drainage route towards the resurgence.

The large flooded passage in the Tub Hole sump appears to be the present main conduit, but it is a rising phreatic loop which is now being undercut by development of a lower route direct to the permanent resurgence. Base-level lowering progresses up the valley by successive erosion through the rising phreatic loops and complete or partial draining of the downloops. The gentle gradient of Dentdale ensures that this process is slow. Perched sump levels in and upstream of Broadfield Caves may correspond to ponding behind rising phreatic loops which have not yet been eliminated by vadose entrenchment.

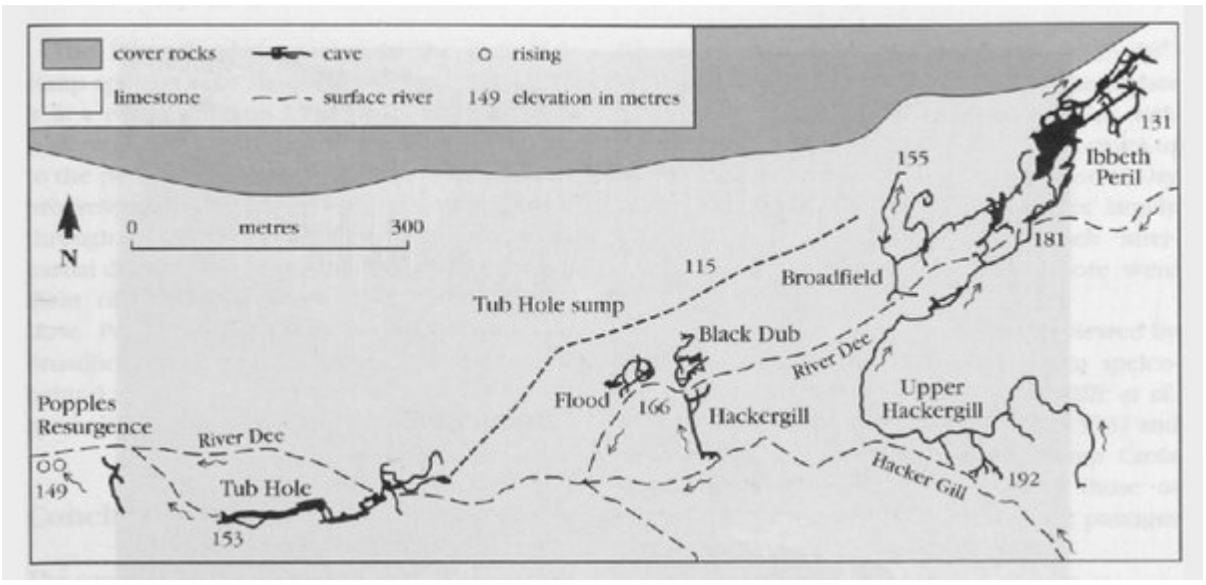
Conclusion

The caves of Upper Dentdale provide clear examples of all stages of development of karstic drainage beneath a major valley floor. Both vadose and phreatic parts of the cave system show clearly the influence of geological controls on drainage routes, and earlier phases of phreatic cave have been drained, incised and partially filled by calcite, clastic sediment and collapse in the vadose environment.

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 3.8) Outline map of the caves of Upper Dentdale. The line of the flooded section in the upstream sump of Tub Hole is only approximate (from surveys by Kendal Caving Club, British Speleological Association, Cave Diving Group and others).

(Figure 3.9) Tributary passage in Broadfield Cave with calcite deposits in a shallow vadose canyon cut beneath a bedding plane. (Photo: M.H. Long.)