
Brants Gill catchment caves

[SD 81 72]–[SD 85 69]–[SD 82 74]

Highlights

The karst drainage of the Brants Gill catchment is uniquely complex, transmitting water both updip and downdip from widely separate sinks to a single perennial resurgence and two flood risings. Complex series of active and abandoned cave passages include flood overflow routes and a site where the underground drainage has been seen to be diverted in response to evolution of the cave.

Introduction

The caves of the Brants Gill catchment lie beneath the western slopes of Penyghent Hill and Fountains Fell, along the east side of Ribblesdale (Figure 2.1). The Great Scar Limestone forms an extensive outcrop along the middle and lower benches, below outliers which are dominantly shales of the Yoredale facies and form the higher slopes of both Penyghent and Fountains Fell. Lower Palaeozoic basement rocks are exposed in the floor of Ribblesdale (Figure 2.28). The unconformable base of the limestone, on these greywackes and slates, has considerable relief, reaching a maximum in the lower part of Silverdale where a basement ridge almost 100 m high is exposed. The general dip of the limestone is about 1° north, across many small faults but relatively undisturbed by minor folding. All the upland streams sink on reaching the top of the Great Scar Limestone, and there are more than a dozen, known, major cave systems, together with many smaller caves and choked sinkholes. More than 25 km of passages have been mapped in the catchment. The cave waters all emerge at three risings, of which only Brants Gill Head has a permanent flow. All three risings are located in the basal beds of the limestone sequence, and they lie over 270 m below the highest sinks.

Descriptions of most of the cave passages are given by Brook *et al.* (1991) and were briefly reviewed by Waltham (1974e). The more significant descriptions of the caves by their original explorers include those of Penyghent Pot (Monico, 1989c), Dub Cote Cave (Monico, 1995), Hammer Pot (Batty, 1957; Heys, 1957) and Gingling Hole (Batty, 1967; Monico, 1995).

Description

Although linked into a single integrated underground drainage system, only a comparatively small proportion of the total length of the cave passages that must exist within the Brants Gill catchment has yet been explored. The known caves form two main groups of sinks, on Penyghent Hill and Fountains Fell, and a group of resurgence caves (Figure 2.28).

Influent caves on Penyghent Hill

Hull Pot is the largest single sink feeding the Brants Gill system (Figure 2.28). Its entrance is a huge quarry-like pothole, 90 m long and 20 m wide and deep, aligned WNW–ESE along a minor fault. In flood, a river cascades into it from the north, but under normal flow conditions the water sinks in the riverbed at various points up to 100 m upstream. Beneath the eastern end of the open pot, a series of immature bedding plane passages and vadose shafts descend steeply to a depth of 60 m, where the main route on appears to be obscured by a massive collapse pile which may be continuous up to the floor of the surface pothole. High Hull Pot is a series of vadose rifts and shafts descending joints for 65 m to a choke of collapsed blocks (Figure 2.27).

Hunt Pot has a classic rift entrance 25 m long and 4 m wide, developed on a minor north-south fault (Figure 2.30). A stream from the east cascades down it, to enter a perched sump in a choked and very narrow rift 61 m below the surface and 75 m above the Brants Gill Head rising (Figure 2.28).

Little Hull Pot has a meandering vadose canyon which leads to two vadose shafts dropping 60 m to a rift passage developed along a minor fault (Figure 2.28). The stream flows south-east, obliquely against the dip, into a series of phreatic loops up to 12 m deep; these are perched 24 m above the Brants Gill Head rising, as they drain into the lower passages of Penyghent Pot. Probably all of the water from Hunt Pot, High Hull Pot and Little Hull Pot, and at least part of the flow from Hull Pot, passes through Penyghent Pot on its route to Brants Gill Head.

Penyghent Pot is the most extensive cave system yet known in the catchment, with more than 5500 m of mapped passages (Figure 2.29). From the small sink at the entrance, the stream follows a low, bedding-guided, vadose canyon southwards, before it turns to the west and is joined by a tributary inlet from the Spike Pot entrance. Rift Passage is 1–3 m wide, developed on a minor fault, with the stream descending 90 m in its series of cascades and vadose shafts. At the foot of the rift, the stream turns west into bedding plane caves, and drops into a major streamway draining from north to south. Upstream this forms the Hunt Pot Inlet, where a rejuvenated phreatic passage leads to a series of flooded rifts, which have been explored to a point very close to similar flooded rifts in Little Hull Pot. Downstream, the same phreatic tube is interrupted by two waterfall shafts in its descent to a sump at the level of Brants Gill Head; the flooded passage continues beyond a depth of 36 m. West of the Main Stream Passage, an extensive and complex series of caves are nearly all developed on a shale bed at an altitude of about 283 m, 22 m above the Brants Gill Head resurgence. Most of these passages are small, half-flooded, phreatic tubes with limited vadose modification, but they intersect some short sections of larger, and probably older, phreatic tubes whose continuations are blocked by sediment. Drainage from Hunt Pot, Little Hull Pot and High Hull Pot used to enter the Hunt Pot inlet and flow into the Main Stream Passage but, since 1986, it has taken a new route through the Living Dead Extensions to the west. A separate small stream flows through the Friday the Thirteenth Series and drops down shafts to a sump at the same level as the main downstream sump.

South of Penyghent Pot there are several small caves at sinks just below the shale margin. Larch Tree Hole and Churn Milk Hole are large old sinks choked with boulders; Churn Milk swallows a small stream which resurges at Brants Gill Head (Figure 2.28). Dale Head Pot is the only cave on this section of fell yet explored to great depth (Figure 2.28). A small, meandering vadose canyon follows the dip to the north, to the head of a series of vadose shafts and narrow rifts, developed on a series of closely spaced joints; these enter a sump at the same level as Brants Gill Head.

Influent caves on Fountains Fell

The two largest streams on Fountains Fell converge on the Gingling Wet Sinks, where they drain through a series of constricted bedding planes and rifts to a perched sump at a depth of only 52 m (Figure 2.31). An adjacent sinkhole contains the entrance to Gingling Hole, which contains over 5200 m of known passages, reaching a depth of 192 m (Figure 2.31). Vadose canyons and small shafts descend to a series of large chambers and old phreatic tunnels at a depth of 50 m; these include Stalactite Chamber and Fool's Paradise, both exceptionally well decorated with calcite straws and dripstone (Figure 2.32). The main passage continues north down a series of narrow rifts and shafts to a junction, where two sets of rifts and shafts descend north-west-south-east joints in parallel for nearly 90 m to sumps at the same level. The sump in the southern rift is a perched phreatic loop which is an inlet to the complex of passages forming the Fountains Fell Main Drain. A large stream flows to the north-west, emerging from a flooded link from the Wet Sinks, and finally flowing into the remote Terminal Sump, about 20 m above the level of Brants Gill Head. The main passages are phreatic tubes 2–3 m in diameter and vadose canyons 2–5 m deep. Small cascades break the gentle overall gradient, and some sections of tube remain flooded through shallow loops. The largest inlet appears to carry the water from Hammer Pot; a series of abandoned passages, partly choked with collapse and clastic sediments, lies between the two streamways and provides dry by-passes to the flooded sections.

Hammer Pot has a small streamway in its entrance series, joining a much larger passage at depth (Figure 2.31). From the entrance, tightly meandering, vadose canyons, mostly less than 0.5 m wide but about 5 m high, link wider shafts in the descent to a low bedding plane cave which emerges in the Out Fell Master Cave. The large stream in this rises from a deep flooded shaft, and can be followed downstream for 200 m to a waterfall into a chamber just before a sump, which probably drains into the Fountains Fell Master Cave (Figure 2.31).

Magnetometer Pot has a complex entrance series of canyons and shafts, which probably drain east to Hammer Pot, but also intersect an abandoned phreatic cave heading north-west (Figure 2.31). The old trunk passage as far as Caton Hall

is up to 5 m in diameter, and there are numerous smaller side passages. Many of these are choked with sediment, but there are at least 20 sumps preventing progress along inlet and outlet passages. Although Magnetometer Pot is largely abandoned beyond its entrance series, the relict galleries transmit large flows in flood conditions.

The large stream in the lower passage of Hammer Pot appears to be the drainage from the many small sinks on Out Fell and Dick Close (Figure 2.28). Few of these can be followed beyond their short entrance shafts. Strangle Pot is the notable exception. It has two sections of phreatic passage, guided by joints along almost level shale beds, incised by small vadose trenches and broken by seven small shafts; these lead to the head of deep rifts which descend more than 70 m. The lower rift is a massive old feature with a vertical wall of boulders opposite the stream entry. Its impassably narrow outlet is about 15 m above the likely destination of the water, in Hammer Pot.

Resurgence caves

There are three separate risings within the Brants Gill catchment (Figure 2.28). All lie close to the base of the limestone, but regional dip and the relief on the unconformity give them an altitude range of 21 m. Under normal flow conditions all water from the influent caves of Penyghent and Fountains Fell resurges at Brants Gill Head. The water emerges from narrow fissures between blocks in a large collapse zone, and it is significant that flood flows from Brants Gill Head never rise above about double the base flow. In flood conditions Douk Gill Head, 500 m to the south-east and 3 m higher in altitude, becomes active; normally dry, this produces flows of more than 0.5 m³/s in wet weather. Narrow beddings and large dropped blocks prevent access to the extensive cave system which lies behind Douk Gill Head. Dub Cote Cave is the third resurgence, lying further south and up-dip. Normally this cave carries only a tiny stream, but it acts as a major resurgence under extreme flood conditions. Over 4000 m of passages have been mapped behind the sumps which guard the entrance (Figure 2.28). The main stream route along the north side of the system is largely flooded through active phreatic tubes. A second small stream flows in small vadose canyons through the main series to the south; this consists largely of abandoned phreatic tubes and bedding plane caves, all partly choked by clastic sediment.

Interpretation

The Brants Gill Head catchment contains a major karst drainage system linking numerous sinks with one permanent rising and two flood overflow risings. The hydrology is complex, with convergent and divergent conduits, together with numerous perched phreatic loops influenced by a variety of geological factors.

On the western side of Penyghent Hill, all the drainage from Hunt Pot, High Hull Pot and Little Hull Pot enters the lower reaches of Penyghent Pot, where it flows into an extensive series of passages developed on a single shale horizon about 22 m above the Brants Gill Head resurgence. Perched sumps between these influent caves and Penyghent Pot have been created by the drainage against the northerly dip. The Main Stream Passage of Penyghent Pot is the only long section of cave which can be followed below this shale horizon, to enter a phreatic loop down a flooded shaft and then probably largely up the dip of bedding caves to the resurgence. Continuations of the known passages on the higher level are all choked with sediment, and it is likely that the main water flows diverge to the various flood resurgences due to obstructions within passages on this shale horizon. Some of the Hull Pot water may also flow through Penyghent Pot, but the remainder takes a separate, unknown, route to Brants Gill Head. The ephemeral nature of karstic drainage routes was seen in 1986 when the Hunt Pot Inlet in Penyghent Pot suddenly dried up; the water found a new route through the Living Dead passages further to the west. Such individual events are likely to be related to the creation or removal of sediment blockages, as solutional modification of the limestone is a much slower process.

The hydrological relationships of the three risings clearly show that their tributary drainage is active only in flood conditions, and also provide fine examples of intermittent flow in karstic conduits. Douk Gill is clearly the overflow passage for Brants Gill Head, and must diverge from the base flow conduit downstream of the confluence of the Penyghent and Fountains Fell drainage. The relatively constant flow rate at Brants Gill Head is due to constriction of its conduit downstream of the divergence. Dub Cote Cave floods rarely but rapidly, and appears to be a higher overflow route that probably only extends off the Fountains Fell conduit.

The sinking streams of Fountains Fell all drain to Brants Gill Head, taking an underground route of up to 6 km rather than the shorter westerly course to the base of the limestone in Ribblesdale. Past and present drainage routes descend to depth in the limestone, and then head obliquely and gently down dip in a direction about 20° from the strike, to pass behind the high basement ridge exposed in Silverdale. The plan positions and levels of each of these routes were then controlled by the locations of the contemporary sinks and their rising. The older route lay from sinks on a shale cover margin west of its present position, through Magnetometer Pot and out to Dub Cote Cave, where the modern cave exit has been slightly truncated by surface lowering (Figure 2.28). The later route developed from new sinks, on a shale margin retreating towards the east, to a lower resurgence at Brants Gill Head in a deepened Ribblesdale. This created the main passages of Gingling Hole on a course again at a low stratigraphical level in the limestone, parallel to, 40 m below, and nearly 1 km further down dip to the north-east from the Magnetometer route.

On both phases of development of the Fountains Fell drainage routes, a deep vadose zone appears to have been established rapidly in the cavernous limestone. There are no known traces of abandoned caves on a graded profile associated with a sloping water table commensurate with an immature karst aquifer. The route from the Gingling Wet Sinks descends 160 m in its first 100 m of plan length, and then falls only 40 m in the following 5 km to the resurgence. Though the lower passages are phreatic, and the palaeo-water tables have not yet been recognized from the cave morphology, the steep initial profile of the conduit indicates largely vadose drainage to a deep water table. The abandoned passages in both Gingling and Magnetometer are largely at levels only a few metres above the active drains, and represent minor adjustments and rejuvenations as the cave matured towards a graded profile established by its resurgence level.

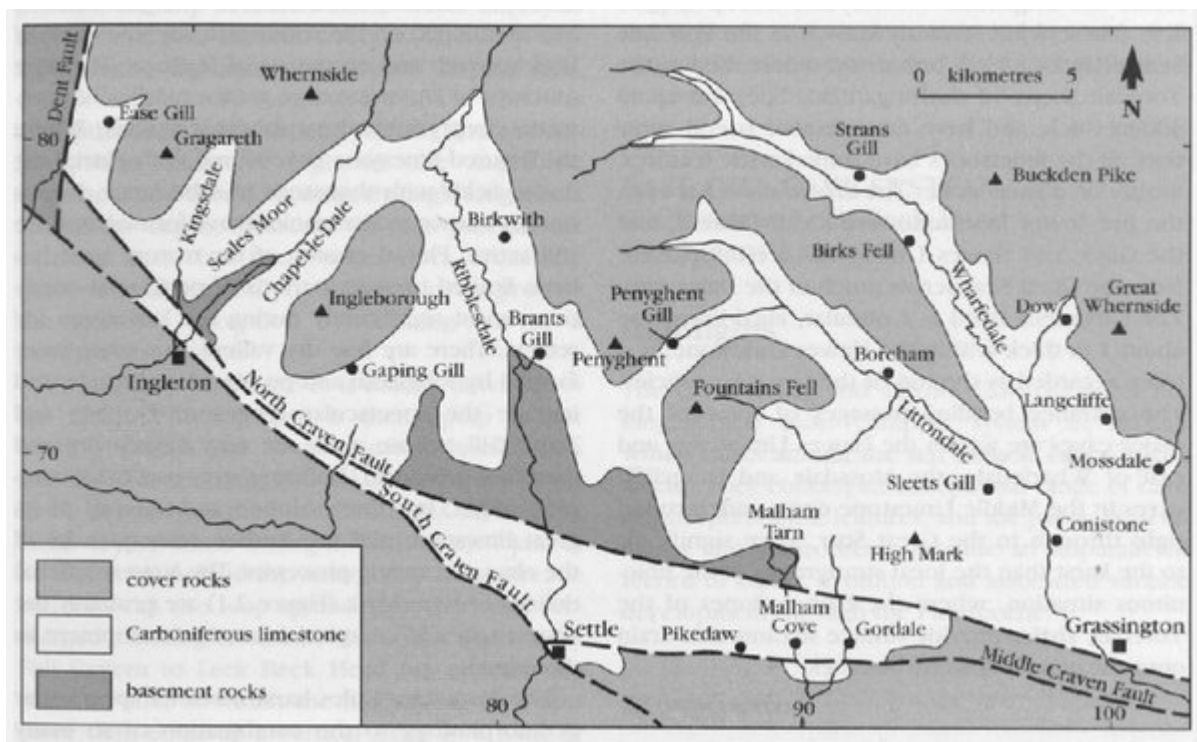
Though stratigraphical features have provided the greatest guides to cave inception, the joint patterns have exerted influence on the details of the cave morphology. The deep shafts of Gingling Hole and Dale Head Pot are all aligned on tectonic fractures, and rift passages have developed along the faults in Little Hull and Penyghent Pots, both with and against the dip. The entrances of Hull and Hunt Pots are classic examples of fault control, and the former has enlarged by the progressive solution and collapse of narrow limestone blocks between closely spaced fractures.

The sequence of development of the caves draining the northern sector of Penyghent Hill is not clear. Douk Gill Cave appears to be an older resurgence, now truncated by valley deepening and relegated to an overflow role. The extensive passage development at around the 283 m level in Penyghent Pot suggests that there may be an abandoned rising hidden beneath the soil profile at a level higher than Douk Gill; an old link to the Dub Cote Cave outlet could exist, but no evidence of it has been found. The influent caves contain various calcite and clastic sediments which indicate that the passages are old, and the caves appear to have developed through the interglacial stages of the Pleistocene. No sediments, from either the Penyghent or Fountains Fell caves have yet been dated, and further comment on the evolution of both the caves and the surface topography is therefore speculative.

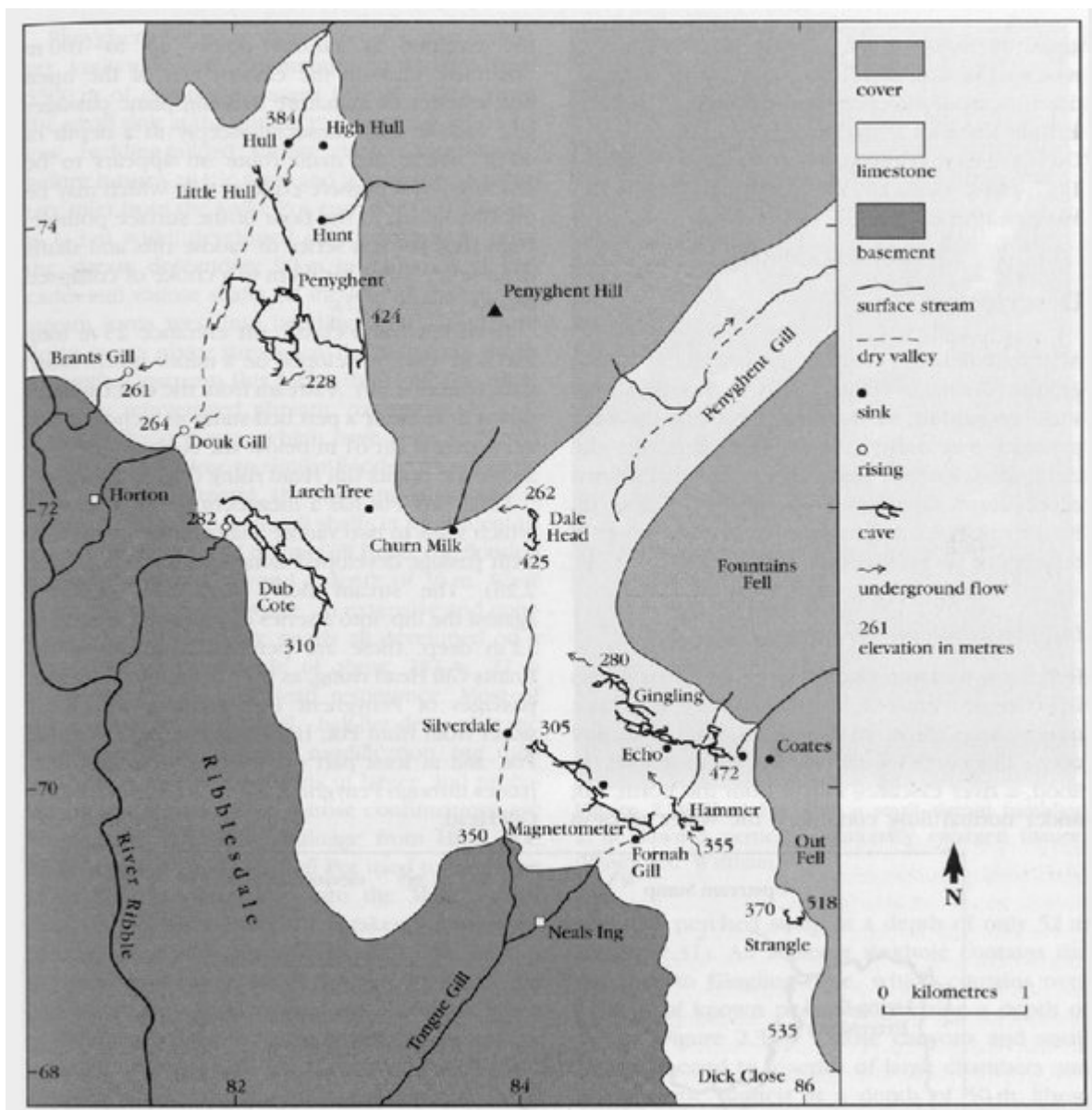
Conclusion

The caves of the Brants Gill Head catchment form a large dendritic system of karstic conduits which gather water from widely scattered sinks, and drain to one or more resurgences depending on flow conditions. The known caves reveal the rerouting of floodwaters in a karst better than any other site in Britain. Many of the cave passages which must exist within this catchment are yet to be discovered, but it is clear that their morphology has been influenced by the stratigraphy and fracturing of the limestone and also by a ridge in the impermeable basement.

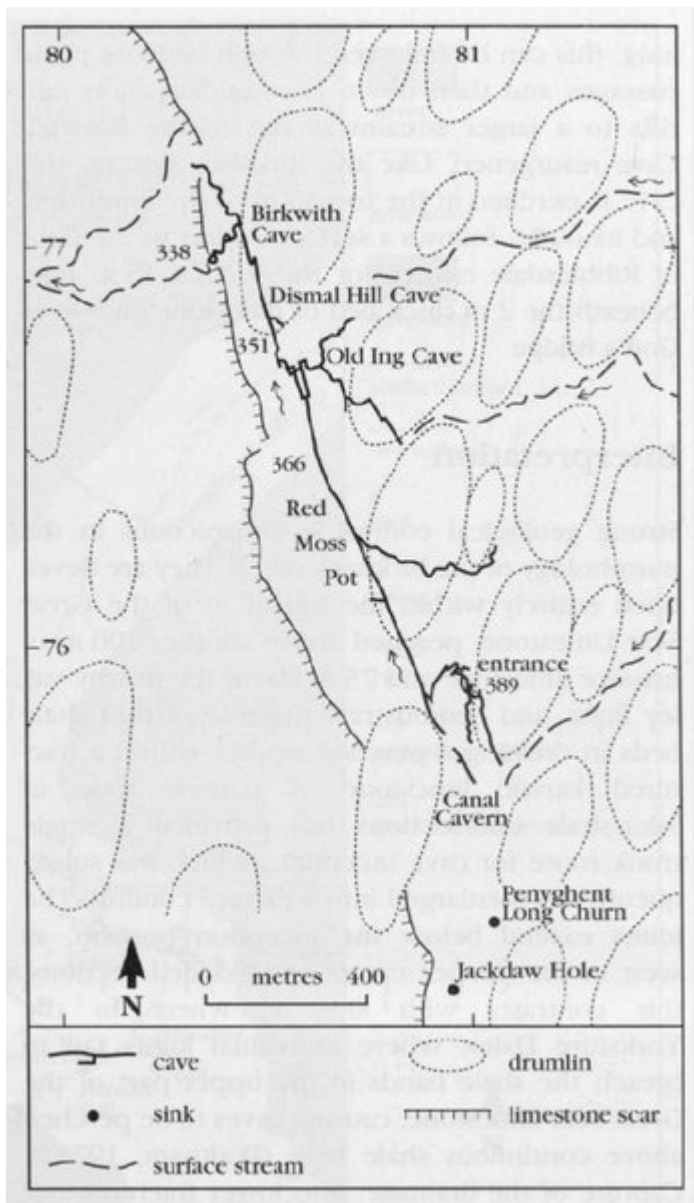
References



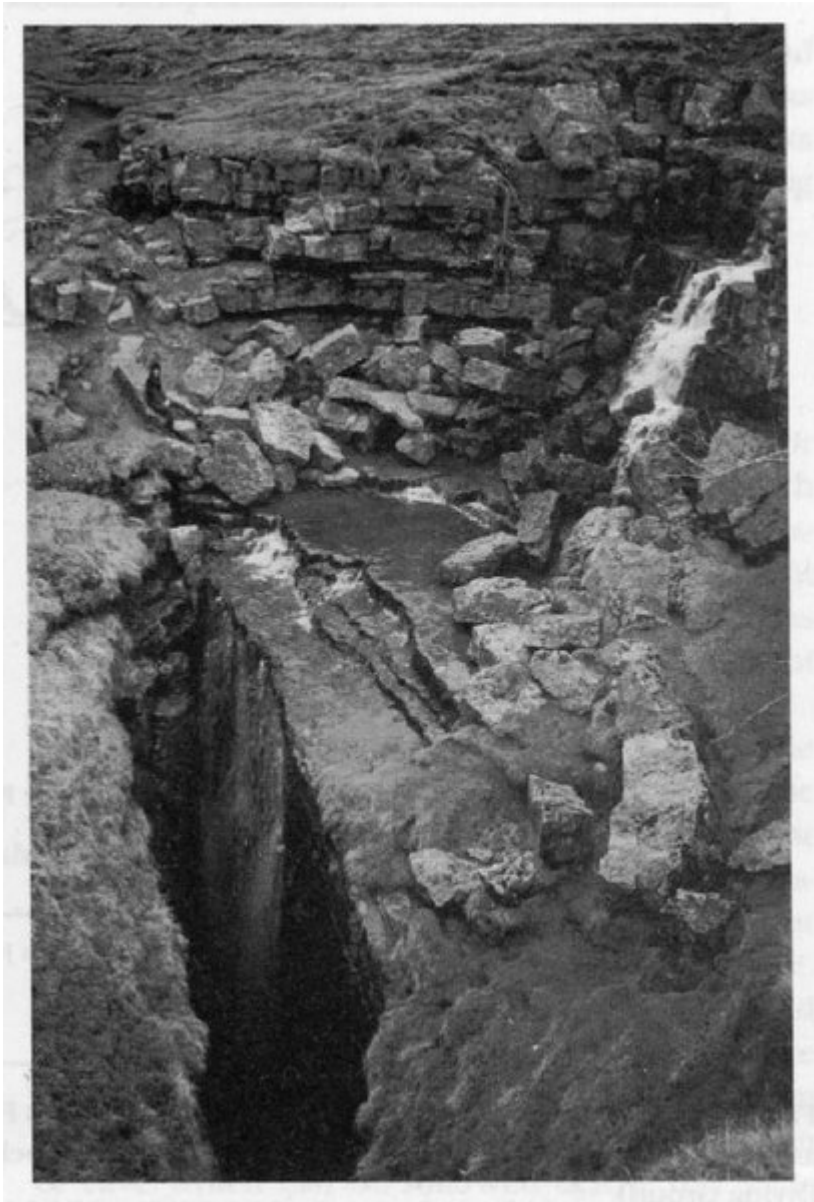
(Figure 2.1) Outline map of the Yorkshire Dales karst, with locations referred to in the text. The Carboniferous limestone shown includes all the Great Scar Limestone (Kilnsey, Cove and Gordale Formations) and also the lower Yoredale limestones (of the Wensleydale Group) where they are hydrologically linked to the Great Scar and are therefore part of the same karst unit. Higher limestones within the Yoredale Series are not marked. Basement rocks are Palaeozoic slates and greywackes. Cover rocks are the Yoredale facies of the middle and late Brigantian Wensleydale Formation and various Upper Carboniferous and Permian clastic formations.



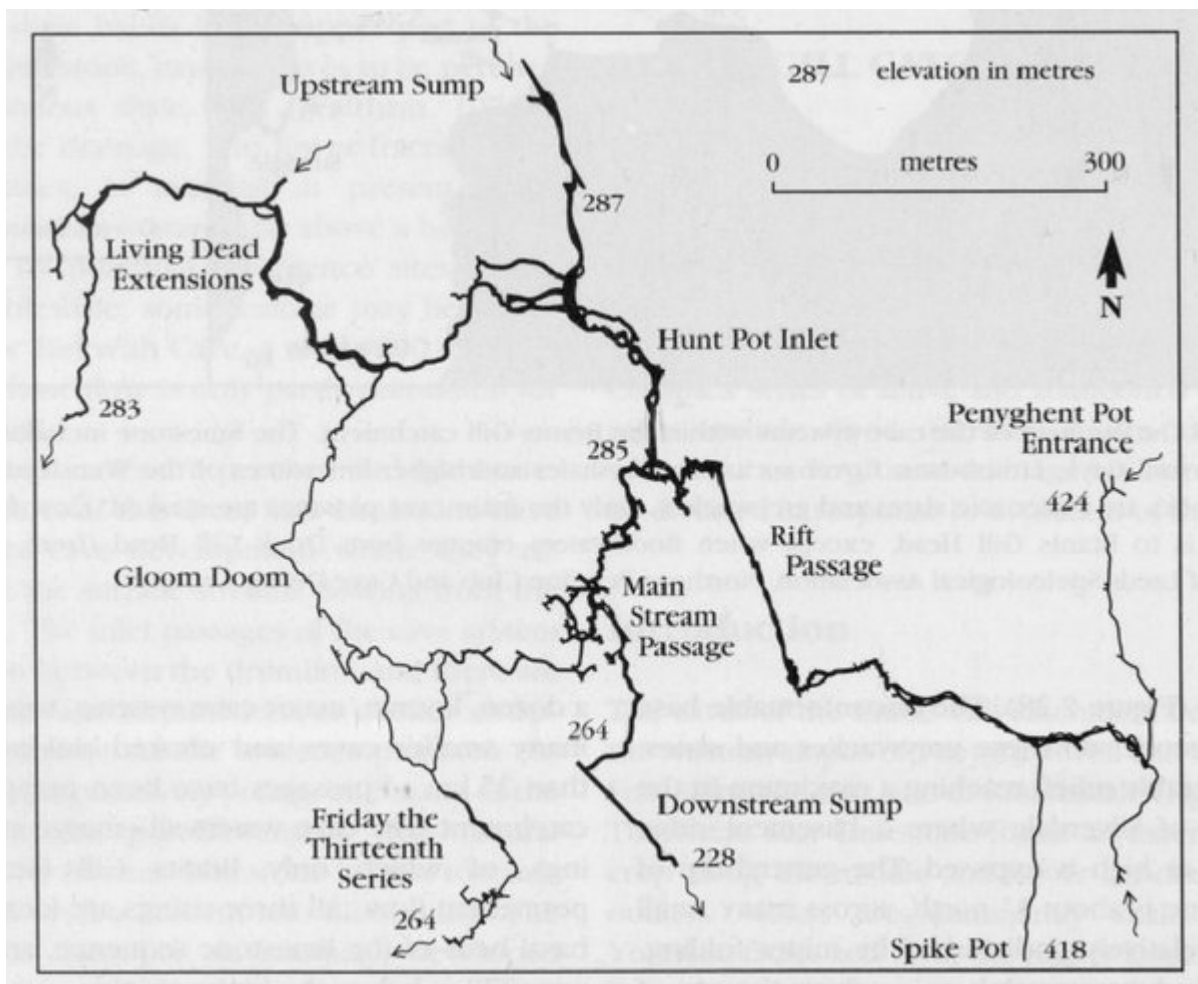
(Figure 2.28) Outline map of the cave systems within the Brants Gill catchment. The limestone includes the Great Scar, Hawes and Gayle Limestones. Cover rocks are the shales and higher limestones of the Wensleydale Group. Basement rocks are Palaeozoic slates and greywackes. Only the main cave passages are marked. Flow from all the main sinks is to Brants Gill Head, except when floodwaters emerge from Douk Gill Head (from surveys by University of Leeds Speleological Association, Northern Pennine Club and Cave Diving Group).



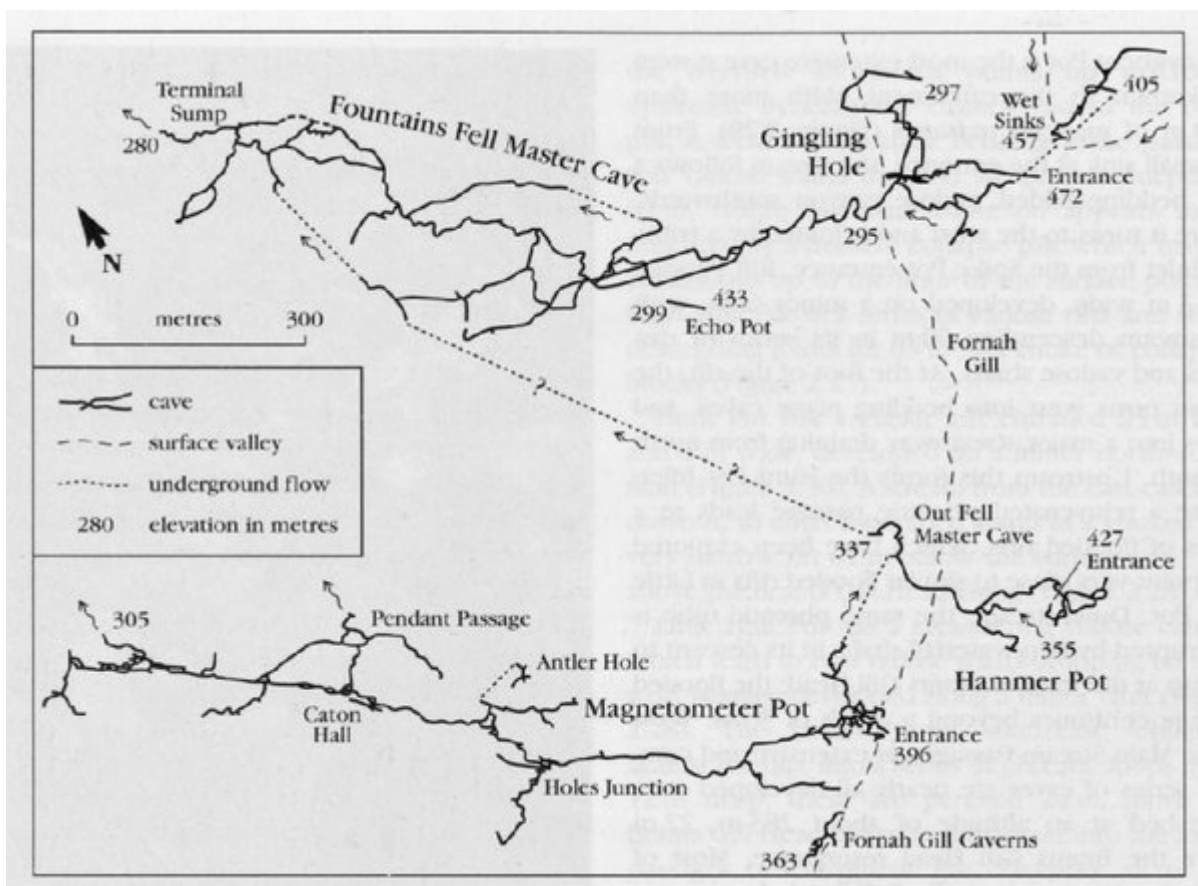
(Figure 2.27) Outline map of the caves of Red Moss and Birkwith, draining the limestone bench beneath part of the Ribblesdale drumlin field. Figures given represent elevation in metres (from surveys by Burnley Caving Club and others).



(Figure 2.30) Hunt Pot with a small stream tumbling 27 m down a vertical, solutionally enlarged fissure. (Photo: A.C. Waltham.)



(Figure 2.29) Outline map of the cave passages in Penyghent Pot; the Spike Pot entrance passage is only sketched in (from survey by University of Leeds Speleological Association).



(Figure 2.31) Outline map of the main caves of Fountains Fell; the drainage links into the Fountains Fell Master Cave are not proven (from surveys by University of Leeds Speleological Association, Northern Pennine Club and Cave Diving Group).



(Figure 2.32) Fool's Paradise in Gingle Hole — a beautifully decorated phreatic tube and entrenched vadose canyon. (Photo: J.C. Cunningham.)