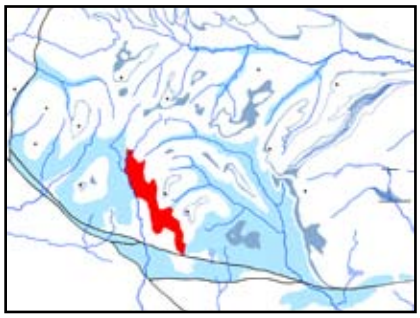
CHAPTER 24

Caves of Pen-y-ghent and Fountains Fell

Graham Proudlove and Tony Waltham



Dominating the eastern flank of Ribblesdale, Pen-y-ghent is one of the well-known Three Peaks of the Yorkshire Dales. Though rising to only 694m, and therefore the lowest of the three, its steep profile ensures that it is visible and recognisable from anywhere in the dale. The adjacent Fountains Fell rises to 668m and provides a complete contrast, in that it is a broad hulk of upland with rounded shoulders and no distinctive summit. Both hills are outliers of the shales and sandstones, along with thin limestones, all within the Yoredale Group, and both have caps of sandstone within the Millstone Grit Group. Streams that drain off both hills sink into the main underlying limestone close to the margins of the largely impermeable outliers, creating a long line of open caves and deep potholes. Some of these descend into major cave systems, with long streamways that extend towards resurgences close to the dale floor.

Geology of the limestone

Great Scar Limestone forms a wide outcrop along the length of eastern Ribblesdale (Fig. 24.5). A borehole at Silverdale, between Pen-y-ghent and Fountains Fell, recorded a thickness of 191m for the limestone (Fig. 24.4). Only 122m of this is recorded as the thickly bedded, pale grey or cream limestone of the Cove and Gordale members of the Malham Formation, though both limestone members appear to be atypically thin at the borehole site. These are the limestones well-known for containing most of the deeper potholes in the Dales. Both above and below them, darker and more thinly bedded limestones also contain extensive cave development.

The overlying Hawes and Hardraw Scar limestones of the Yoredale Group are virtually contiguous with the Great Scar Limestone Group in the southern part of Ribblesdale, and contain the long and low entrance passages that distinguish many of the deeper potholes. Farther north, these limestones are separated by intervening shale beds of increasing thickness, so that north of Sell Gill most of the major stream sinks lie at the top of the Lower Hawes Limestone, which remains contiguous with the underlying Great Scar Limestone. Higher within the Yoredale succession, the Simonstone, Middle and Main limestones are also cavernous, but in this area each has only minor cave development restricted to its own thickness.

***Figure 24.1**. The waterfall near the upper end of the streamway in Browgill Cave (photo: Paul Deakin).*

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***Figure 24.2**. The beautifully decorated keyhole passage of Fool's Paradise in Gingling Hole (photo: Clive Westlake).*

***Figure 24.3**. The hill of Pen-y-ghent, rising above the eastern slopes of Ribblesdale. The conspicuous lines of limestone scars, above the improved pasture that is divided by dry-stone walls and below the darker open fell, are formed in the strong, upper beds of the Gordale Limestone. They lie just below the main line of stream sinks. The single line of white scars higher on the hills is formed by the Main Limestone, which locally marks the top of the Yoredale Group (TW).*

Beneath the Cove Limestone, the darker lower beds of the Great Scar Limestone contain the low-level streamways behind Brants Gill Head. However, some of these beds are missing in areas where deposition was inhibited across higher parts of the basement rock lanscape that initially stood proud of the Carboniferous sea. Outcrops of the Chapel House Limestone (Fig. 24.4) have not been mapped in this part of Ribblesdale, so the bed is not shown in Figure 24.12.

Across most of the area, the limestones dip gently towards the north, as is typical across the Askrigg Block. This increases the overall relief within the limestone, so that sinkholes at the top of the limestone, around the southern end of Fountains Fell, are more than 260m above resurgence level at Brants Gill Head. Furthermore, known cave passages within the phreas, in the lowest limestone beds down-dip of the rising, are around 300m below elevations of the highest sinks.

Limestone thicknesses, and potential cave depths, are also influenced by the considerable relief on the basement, representing the topography that was submerged by the Carboniferous sea (see Fig. 9.18). Some of the lowest beds within the Great Scar Limestone are absent over the main basement ridges, but even the lowest levels of the trunk caves are developed largely in slightly higher beds. Consequently the regional dip is the main factor that directs the underground drainage from Fountains Fell so far towards the north instead of letting it drain out into the lower parts of Ribblesdale. The basement rocks are mainly siltstones and flagstones of Lower Palaeozoic age. Their outcrop in the floor of Ribblesdale reaches little farther north than Horton village, and they have been quarried extensively at various sites down the dale as far as the North Craven Fault, which marks the end of the inlier a short way upstream of Stainforth.

	mudstone / shale		
(10m)	dark grey limestone	Hardraw Scar Limestone	Yoredale Group
14.5m	dark grey limestone	Gayle Limestone and Upper Hawes Limestone	
8.5m	grey limestone	Lower Hawes Limestone	
73m	pale grey limestone	Gordale Limestone	Great Scar Limestone Group
5.4m	Porcellanous Beds		
44.5m	pale grey limestone	Cove Limestone	
33.5m	dark grey limestone	Kilnsey Formation	
11m	dark grey limestone	Chapel House Limestone	
	siltstone / mudstone	Lower Palaeozoic	

***Figure 24.4**. The limestone sequence in the Silverdale Borehole, drilled by the British Geological Survey to a depth of 200m from the limestone bench near Dale Head, between Pen-y-ghent and Fountains Fell (Murray, 1983). The borehole collar was at the top of the Gayle Limestone at an altitude of 427m. It is notable that the borehole found the Cove Limestone to be 50m thick, which is atypically thin; it is 74m thick at the type site of Malham Cove (Cordingley et al., 2015), and can be up to 90m thick. The text and maps in this chapter use the term Great Scar Limestone informally to include any of the Yoredale limestones that are locally contiguous with the Great Scar Limestone Group.*

Geomorphology of the karst

The main limestone bench down the eastern side of Ribblesdale is rather less conspicuous than is typical for many of the Craven Dales. For most of its length, the vagaries of Quaternary ice flow left only a narrow bench above gentle slopes down to the dale floor. The slopes of Pen-y-ghent and

*[opposite] **Figure 24.5**. The western slopes of Pen-y-ghent and Fountains Fell along the eastern flank of Ribblesdale. Cave passages are shown on the maps in Figures 24.11, 24.28 and 24.41.*

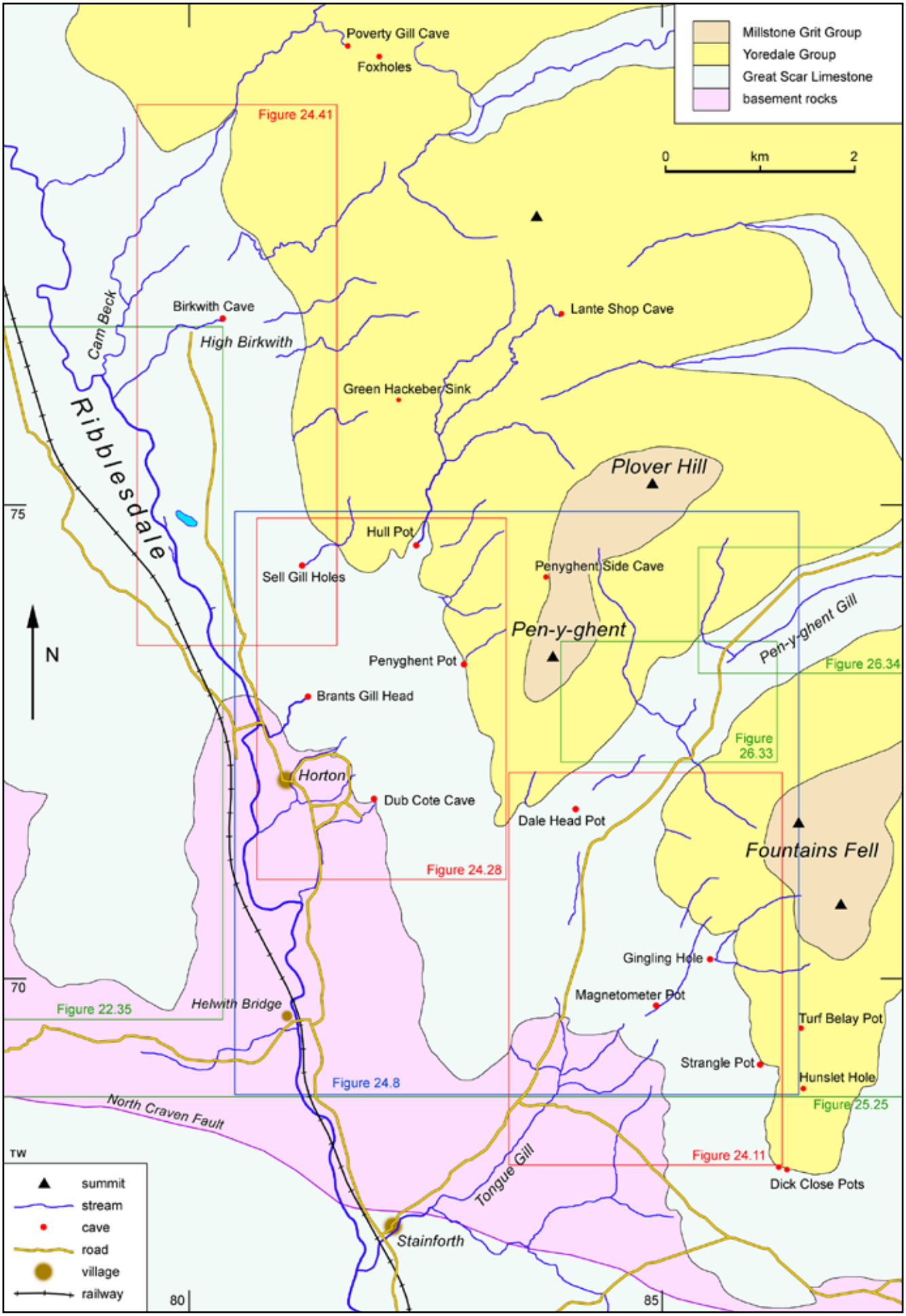

Millstone Grit Group
Yoredale Group
Great Scar Limestone
basement rocks
0 km 2
Poverty Gill Cave
Foxholes
Figure 24.41
Birkwith Cave
Cam Beck
High Birkwith
Lante Shop Cave
Green Hackeber Sink
Ribblesdale
Plover Hill
75
Hull Pot
Sell Gill Holes
Penyghent Side Cave
Pen-y-ghent
Peh-y-ghent Gill
N
Penyghent Pot
Figure 26.34
Brants Gill Head
Figure 26.33
Horton
Dub Cote Cave
Dale Head Pot
Figure 24.28
Fountains Fell
Gingling Hole
70
Figure 22.35
Helwith Bridge
Magnetometer Pot
Turf Belay Pot
Strangle Pot
Hunslet Hole
Figure 24.8
Figure 25.25
North Craven Fault
TW
Figure 24.11
Tongue Gill
Dick Close Pots
summit
stream
cave
road
village
railway
Stainforth
80
85

***Figure 24.6**. The dry valley of Sell Gill, below where it loses its beck into Sell Gill Holes (TW).*

the area around Birkwith were latterly covered by slowly moving ice that left a blanket of glacial till across most of the limestone outcrop. Farther south the slopes of Fountains Fell were almost in the lee of Pen-y-ghent's southern shoulder, so they also escaped much erosional impact from the ice moving down Ribblesdale. This area therefore has very little limestone pavement, but has an abundance of shakeholes developed within the glacial till, notably along the buried margin of the limestone adjacent to the effectively impermeable Yoredale cover.

Perhaps the most conspicuous feature of the surface geomorphology is the drumlin field that extends southwards from Ribblehead (Mitchell, 2008; Mitchell and Prescott, 2012). The Birkwith area has a long line of low scars formed in the upper beds of the Great Scar Limestone, and parts of these are masked by drumlins that are draped over them. The contrast between the rounded hills of glacial till and the bare outcrops of limestone between them is a distinctive feature of that part of Ribblesdale, and the stream that sinks into Calf Holes is just one of many that winds between the drumlins before it drops underground.

None of the streams draining into Ribblesdale from Pen-y-ghent and Fountains Fell maintains a surface course across the limestone outcrop. Downstream from the stream sinks, most dry valleys are no more than minor features of the landscape, entrenched into just parts of the limestone slopes (Fig. 24.6). These were formed largely by meltwater when underground drainage was still inhibited by frozen ground during the declining stages of the last glaciation. The single major dry valley in the area (Fig. 24.7), south of Hull Pot, is likely to have carried a surface stream down its entire length during the final retreat of the last ice sheet. Its large size suggests that it was also an active fluvial valley during earlier stages of periglacial conditions, and was protected from major glacial erosion by its position in the lee of Whitber Hill. Much of Silverdale is also dry, but this valley is largely a feature of glacial erosion; both Silverdale Gill and Fornah Gill maintain surface stream courses on the blanket of glacial till, but both streams sink before they have crossed all the limestone. Risings from the base of the limestone, where it is crossed by the dendritic valleys that drain Silverdale, are small because the limestone dips into the hill and carries cave waters away and towards Brants Gill Head. Farther north, and along the northern edge of the Birkwith karst, Ling Gill maintains a surface flow along much of its length even in dry conditions.

***Figure 24.7**. The dry valley below Hull Pot, with the long, upper line of scars formed in the strong beds near the top of the Gordale Limestone, and the flank of Pen-y-ghent rising beyond (TW).*

Hydrology of the caves

The largest hydrological system in eastern Ribblesdale is that behind Brants Gill Head. Its catchment extends to 26.3 km^2, if that of the associated Dub Cote Cave is included, making it the third largest within the Dales, after Nidd Heads and God's Bridge. It contains more than 30 km of known cave passages (Fig. 24.8). Its proven vertical range is 298m from Rough Close Sinks at 524m to the deepest point yet reached, 35m below water level in the downstream sump of Penyghent Pot. It is likely that the Dick Close Pots, along with small, nearby sinks along the shale boundary, also drain to Brants Gill Head, with a maximum underground descent of around 310m.

The northern part of the Brants Gill Head catchment includes numerous sinks on the western flank of Pen-y-ghent hill, most of which drain through the lower reaches of Penyghent Pot. In similar style, all or most of the multiple sinks around the southwestern flank of Fountains Fell probably drain through the lower reaches of Gingling Hole. A third group of caves includes the main resurgences within the catchment; these are isolated from the two groups of influent caves, each on its own hill, by considerable lengths of unexplored cave passage.

Up the dale from Brants Gill Head, the karst drainage is broken into five much smaller hydrological systems, each draining to its own resurgence (Fig. 24.41). Two of these resurgences are at dale-floor level, with water rising from conduits within the lower beds of the limestone sequence (Lowe and Waters, 2014), but the other three are perched well above the dale floor within the upper beds of the limestone.

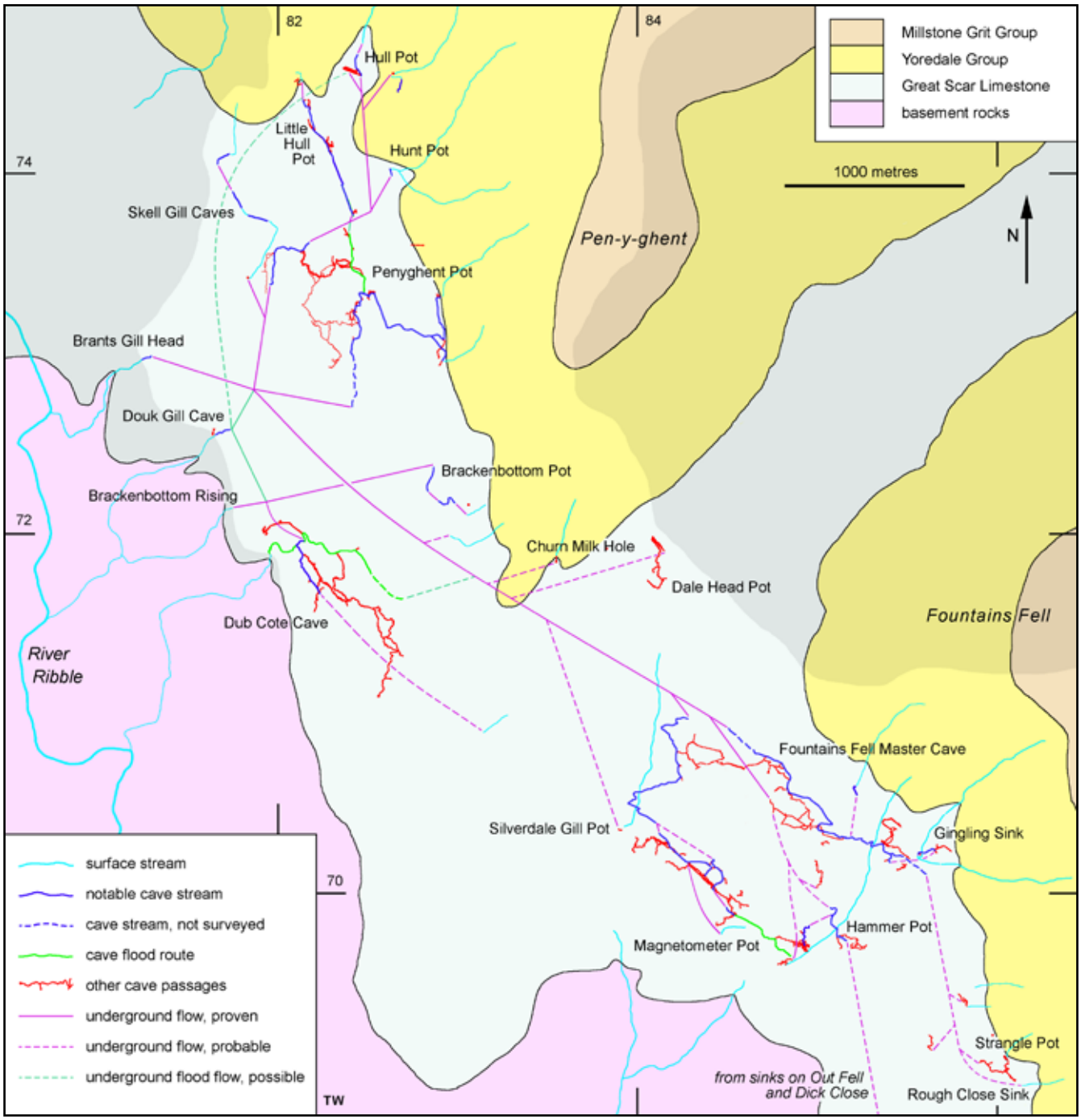


Figure 24.8. *The complex hydrology of the Brants Gill Head catchment, with its variable and evolving flood routes through known and unknown cave passages, and including Dub Cote Cave. Only the larger cave streams are marked, so some of the flow links emanate from cave passages with very small base flow streams. Flow lines are broken where they are unproven, and only those regarded as probable are marked. Details of the major flow convergence behind Brants Gill Head and the flood overflow to Douk Gill are completely unknown. The possible extra flood route from Hull Pot to Douk Gill is indicated by the maximum flood flows at the sink appearing to be more than can be transmitted through the lower reaches of Penyghent Pot, and the rapid response of Douk Gill during such conditions. Surface flood courses are not shown. The shaded areas are outside the Brants Gill Head catchment. (After surveys by ULSA, CDG, NPC and others.)*

Figure 24.9. *Brants Gill Head in wet weather with an emergent stream at close to its maximum flow when higher levels of flooding are diverted to Douk Gill Cave (photo: Duncan Jones).*

Brants Gill Head and the resurgence caves

The permanent resurgence of Brants Gill Head (Fig. 24.9) lies at an altitude of 261m, about 35m above the nearby River Ribble (Fig. 24.28). It is situated within the dark, impure Kilnsey Limestone, but is still about 8m above the base of the limestone (though there is considerable local relief on the basement, which could reach higher stratigraphical levels unseen within the hill). As the primary, year-round resurgence for most of the caves on Fountains Fell and Pen-y-ghent, it has a normal discharge of about 150 L/s, but a maximum that is little more than double that, as constrictions or obstructions in its feeder conduit divert flood flows to the resurgence at Douk Gill Scar. There is less than 50m of accessible passage at Brants Gill Head (Hill and Hall, 2015). This reaches a large, underwater boulder choke, which is almost certainly connected to the slumped till within the doline overhead, and probably accounts for the constriction that inhibits the flood flows.

At the foot of its small scar, Douk Gill Cave is the flood resurgence for Brants Gill, producing flows that probably exceed 2000 L/s in wet weather, but only a trickle of water in base conditions. It lies just 3m above the elevation of Brants Gill Head. Less than 200m of bedding-plane passage is accessible, all heavily modified by block collapses from the roof. These also prevent further progress, though a strong, cold draught (in summer) from the cave's western arm indicates passage with airspace beyond the zone of breakdown.

Nearly a kilometre south of Douk Gill Scar, Dub Cote Cave has more than 4 km of mapped passages accessible (only to divers) behind another flood rising that is 21m above the level of Brants Gill Head (Abbott, 1985; Hill and Hall, 2015). Nearly all the passages are largely guided by their respective bedding planes, which dip very gently towards the north, and all the sumps are shallow. A short way in from the entrance, a small passage leads through two normally static sumps to two sub-parallel systems of passages.

The northern passage, mostly 2–3m wide, carries water from its upstream constriction in Sump 7 to its constricted, submerged outlet in Sump 2. The source of this stream is unknown, but its size increases greatly during flood events, when the cave is not sensibly accessible because part of its flood flow emerges from the entrance. This conduit could be a flood overflow from the unknown route from the Fountains Fell Master Cave through to Brants Gill Head, but no link has yet been proven. The flood-route passage in Dub Cote Cave has a minimal gradient, and lies close to the altitude of the downstream end of Gingling Hole, but is around 20m above the levels of Douk Gill Cave and Brants Gill Head.

Dub Cote Cave's southern passages lie at a level about 15m above that of the northern streamway. Their upstream, southern, part carries a small stream from unknown sources, which eventually drains out through a crossover passage to the northern streamway. Their downstream end, towards the northwest, is the abandoned, phreatic tube of The Windtunnel, some 2m in diameter, parallel to and above the smaller Pacer Streamway, which carries yet another stream with an unknown source. This joins the other base-flow streams within the cave, and their combined waters drain to the small, capped Brackenbottom Rising, though any flood overflow goes to Douk Gill Cave.

Caves of Fountains Fell

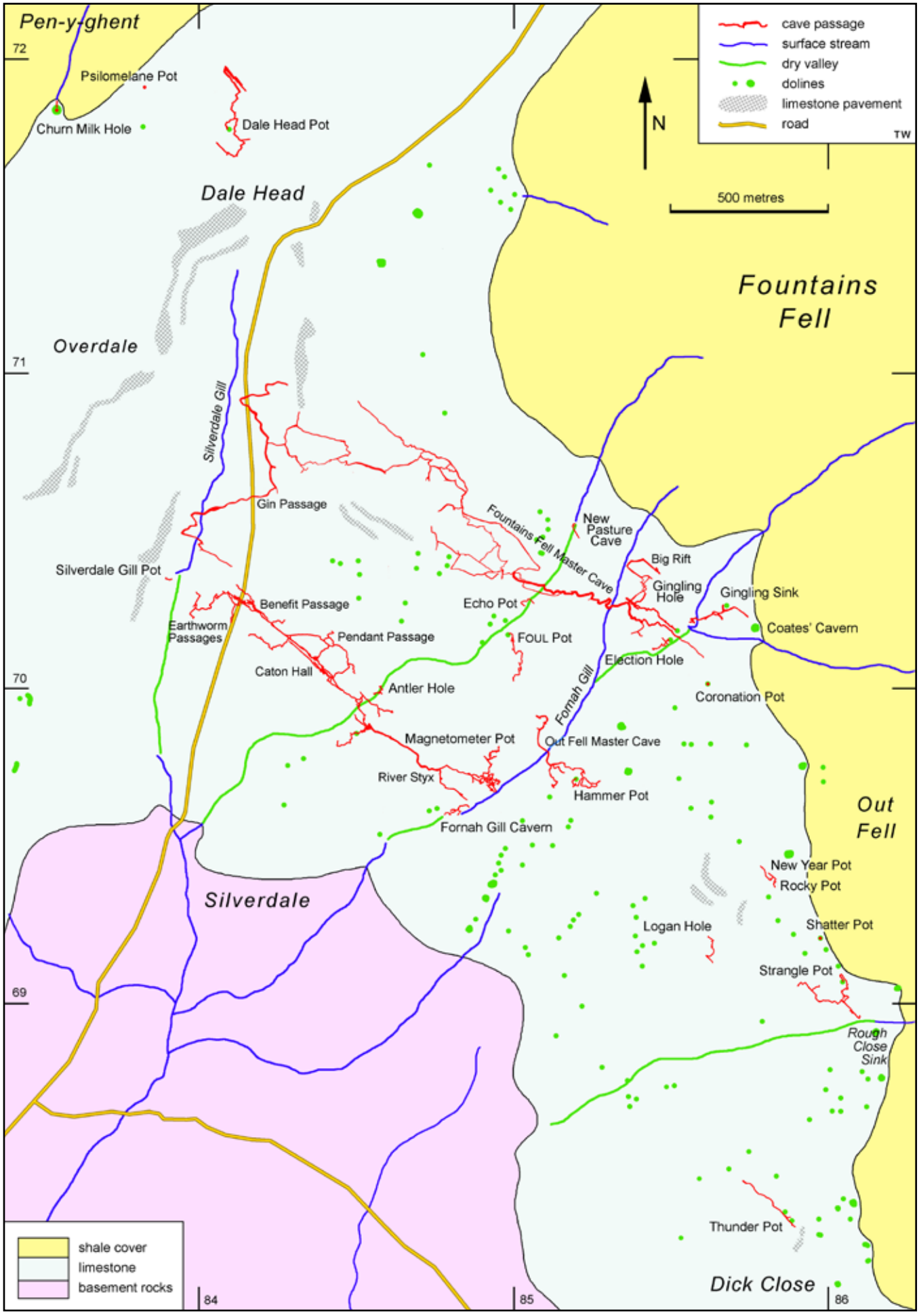
A group of long and deep caves beneath the western slopes of Fountains Fell contains more than 18 km of known passages (Fig. 24.11). The caves' drainage ignores the topographical slope down Silverdale towards the nearby Ribblesdale, as it is all guided by the gentle northerly dip of the limestone eventually to resurge at Brants Gill Head.

The largest sink on the fell is Gingling Sink, which takes streams via various routes into small flood-prone passages that constitute the cave of the same name (Heys, 1957). At a depth of only 52m, the water is lost into a cobble-choked, underwater, bedding-plane passage, and is almost certainly next seen in one of the upstream sumps in the Fountains Fell Master Cave, 100m below. Just above the last sighting of the water, a complex of rifts and boulder chokes around the large Masada chamber has yielded no way of following its draught.

Entered by an 8m-deep shaft in the floor of a doline beside the dry valley below the sinks, Gingling Hole has a vadose streamway along rifts and meanders, descending into Stalactite Chamber, 10m wide and festooned with calcite dripstone (Fig. 24.15). An excavated hole in the debris floor descends into Fool's Paradise, a beautiful, calcite-decorated, keyhole passage with a 2m-diameter tube above a 2m-deep vadose trench (Fig. 24.16). This continues to a series of rift passages and shafts that provide two descending routes, Big Pitch and Big Rift, to separate static sump pools that are 35m apart and 165m below entrance level, at an altitude of about 307m (Batty, 1967). Below the 60m-deep shaft of Big Pitch, a sump 85m long and a short canal passage lead into the Fountains Fell Master Cave.

Figure 24.10. *The abandoned phreatic passage that continues into the lower levels of Gingling Hole from below the boulder choke in Stalactite Chamber (photo: John Forder).*

[opposite] ***Figure 24.11***. *Outline geology and the main, known caves of the western slopes of Fountains Fell. The position of the Fountains Fell Master Cave must be regarded as approximate, as it is based on a very rough survey of its upstream section. There are few proven hydrological links within this area; all links, proven and probable, are shown on Figure 24.8. On this map, the Great Scar Limestone includes the Hawes and Hardraw Scar limestones that are contiguous with it. (After surveys by NPC, CDG, ULSA and others.)*


Pen-y-ghent
72
Psilomelane Pot
Churn Milk Hole
Dale Head Pot
Dale Head
Overdale
71
Silverdale Gill
Gin Passage
Silverdale Gill Pot
Benefit Passage
Earthworm Passages
Pendant Passage
Caton Hall
Antler Hole
70
Magnetometer Pot
River Styx
Fornah Gill Cavern
Silverdale
69
Fountains Fell Master Cave
New Pasture Cave
Big Rift
Gingling Hole
Gingling Sink
Echo Pot
FOUL Pot
Election Hole
Coates' Cavern
Coronation Pot
Fornah Gill
Out Fell Master Cave
Hammer Pot
Fountains Fell
Out Fell
New Year Pot
Rocky Pot
Logan Hole
Shatter Pot
Strangle Pot
Rough Close Sink
Thunder Pot
Dick Close
N
500 metres
cave passage
surface stream
dry valley
dolines
limestone pavement
road
TW
shale cover
limestone
basement rocks
84
85
86

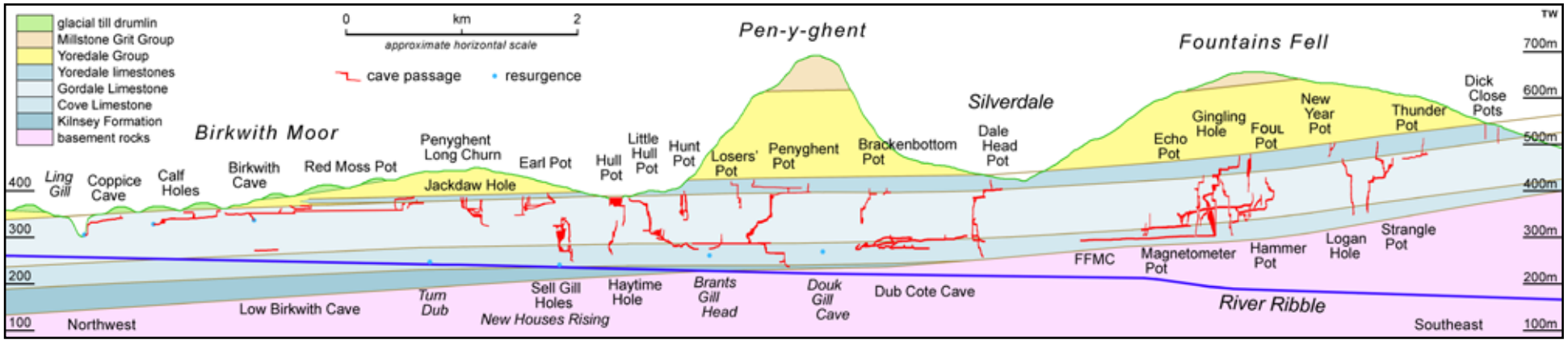


Figure 24.12. *Diagrammatic profile through the main caves of the Birkwith area, Pen-y-ghent and Fountains Fell. The scale is approximate and the vertical exaggeration is x4. Many cave passages are omitted for purposes of clarity. The limestone dip does become progressively steeper towards the North Craven Fault, but is still only about 4° where it contains the Dick Close Pots.*

The Yoredale limestones marked in a slightly darker blue are only those that are locally contiguous with the Gordale Limestone. So the Hardraw Scar Limestone is not shown north of Hull Pot, where it is separated from the main cavernous limestones by an increasing thickness of shale and is therefore isolated within the Yoredale Group. Similarly, the Upper Hawes Limestone separates from the main unit in the vicinity of Red Moss Pot. The Gayle Limestone is not readily distinguished in this area and is included with the Upper Hawes Limestone. The Lower Hawes Limestone is included with the Gordale Limestone, as it is also a thickly bedded rock typical of those containing most of the deep caves.

Dub Cote Cave is drawn at its correct altitude, but it lies only a few metres above the base of the limestone and on or close to the boundary of the Cove and Gordale limestones; this boundary is at higher elevations around the cave and considerably up-dip from the line of the drawn geology through the lower reaches of Penyghent Pot. Similarly, the main resurgences of Brants Gill Head and Douk Gill Cave (and also Brackenbottom Rising) all lie within the Kilnsey Limestone, therefore close to the impermeable base of the limestone succession. Low Birkwith Cave, Sell Gill Holes and Dale Head Pot also do not quite match their geology because they are off-set from the line of the profile. FFMC = Fountains Fell Master Cave.

Figure 24.13. *Stalactites in a bedding-plane opening near the Big Rift in Gingling Hole (photo: John Forder).*

Figure 24.14. *The upper reaches of Silverdale, with Neals Ing farm in the foreground. Left of centre, the eastern flank of Pen-y-ghent rises beyond the limestone scars of Overdale. Fountains Fell forms the right skyline, beyond the bleak, till-covered slopes of the Fornah Gill valley. The high-level passages in Magnetometer Pot lie beneath the green fields in the middle third of this view; farther away, the Fountains Fell Master Cave lies at a depth of about 150m beneath the brown fells along and beyond the skyline between the two higher hills (TW).*

***Figure 24.15**. A traverse high in the Stalactite Chamber within Gingling Hole (photo: Gary Douthwaite).*

Exploration history

The earliest systematic and organised attempts to explore the caves of the area began in the 1890s when the Yorkshire Ramblers' Club explored Pen-y-ghent Long Churn and Sell Gill Holes, shortly followed by Cross Pot and Hunt Pot, the latter being a serious undertaking for the time. A renewal of activity in the 1920s saw members of the same club explore Little Hull Pot and also Gingling Hole as far as Stalactite Chamber, while the Gritstone Club descended High Hull Pot. The many subsequent explorations evolved alongside changing techniques in caving (Gemmell and Myers, 1952; Heap, 1964; Cooper, 2006: Haigh and Cordingley, 2017).

The Northern Pennine Club explored Penyghent Pot down to its sump in 1949, and in 1957 began a long series of discoveries on Fountains Fell. They started with Magnetometer Pot after using the eponymous instrument to re-locate railway lines supporting stone slabs over the buried entrance shaft, and with Hammer Pot, which marked a step forward in the exploration of really narrow and difficult caves. They explored Gingling Hole to depth at the first sump in 1966, Dale Head Pot in 1975, and Strangle Pot and other shaft systems high on the fell in the 1990s.

Cavers from Leeds University explored many of the long low-level passages in the far reaches of both Penyghent Pot and Magnetometer Pot during the 1980s. Members of the Cave Diving Group explored many passages beyond known sumps, notable the Fountains Fell Master Cave in the 1990s and most of Dub Cote Cave during the previous decade. Notable among many further discoveries were that of Red Moss Pot by the Burnley Caving Club in 1971, most of Earl Pot by the Loughborough University Speleological Team in 1970, and Haytime Hole by the Kendal Caving Club in 1978.

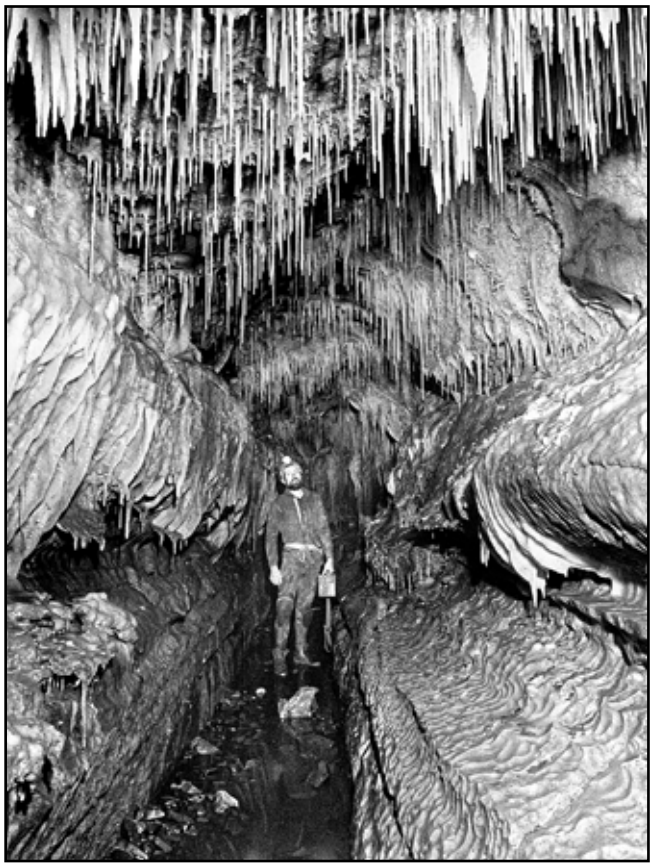


***Figure 24.16**. Fool's Paradise in Gingling Hole: the perfect example of a keyhole passage with a decorated phreatic tube above a scalloped vadose trench (photo: Jim Cunningham).*

Also known as the Main Drain, the Fountains Fell Master Cave carries a large stream towards the northwest and is at the core of a complex of loops and side passages that reach to further streamways (Stanton, 2015; Hudson and Mallinson, 2015). Mapped passages extend to nearly 7 km in length (Fig. 24.11). All are active or abandoned phreatic tubes, with many of the latter carrying large, underfit streams, and all the known cave is notable for its lack of secondary calcite deposits. The Main Drain can be followed for more than 2 km, to a downstream sump that remains shallow and is unexplored beyond 230m into its underwater passage. Rapids and low cascades in the streamway mark its descent to the downstream sump pool at an altitude around 290m (Fig. 24.12), so still about 30m above Brants Gill Head, which is 4 km away in a straight line. The upstream sumps are likely to include one that carries the water from Gingling Sink. Parts of this very impressive streamway are 12m high and 7m wide, passing beneath tall shafts that appear to be inlets from unknown potholes. Dimensions decrease downstream where the phreatic tunnel braids, with muddy, abandoned galleries lying to the southwest and slightly up-dip of the active streamway.

Near the downstream sump, a crossover passage to the west has a phreatic tunnel lowering to a static sump that leads to a small active inlet. This descends into Gin Passage, a splendid borehole 5m wide and 2m high carrying an underfit stream of gin-clear water. This can be followed for over a kilometre. Its downstream sump is in peat-stained water that probably marks its nearby link to the Main Drain beyond its current limit of exploration. Upstream, a series of short

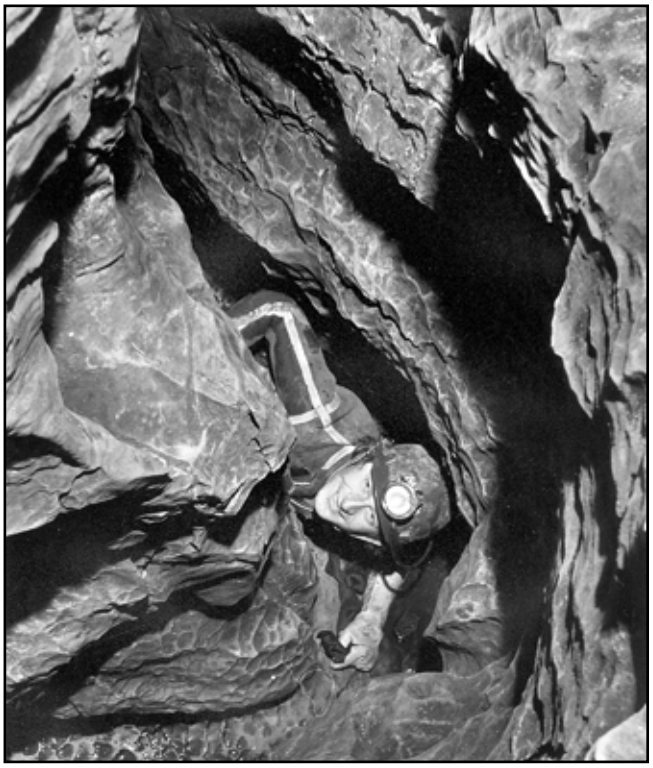


***Figure 24.17**. A very narrow, meandering, vadose canyon within the entrance series of Hammer Pot (photo: Clive Westlake).*

sumps and branching passages distinguished by silt and boulders lies very close to the probable source of its water in the small streams in the far reaches of Magnetometer Pot.

North of Gingling Hole and close to the shale boundary, New Pasture Cave has 90m of small joint-guided streamway that descends only 9m to a choked sump. Above Gingling Hole, Coates' Cavern had an unstable chamber until it collapsed to form a doline. The nearby Coronation Pot has only rifts choked with boulders that reach to about 100m deep. Election Hole has less than 100m of small passages to a choke beneath the large doline in the dry valley below Gingling Sink.

Well down the limestone slope, Hammer Pot is entered at a small stream sink. Its tall, extremely narrow, meandering stream canyon (Fig. 24.17) eventually enlarges and descends 60m with five waterfall shafts (Batty and Heys, 1957). The stream then enters the aptly named Sludge Crawl, guided by a bedding plane as far as the Out Fell Master Cave, which extends for 200m at the same level. This carries a large stream from unproven sources, but probably from some of the sinks further south along the western flank of Fountains Fell, including the area known as Out Fell. The upstream sump has water rising 28m in vertical shafts from a narrow rift (Madden, 2015). The streamway is not a master cave in the traditional sense of a base-level conduit; it descends gently as a clean-washed, potholed canyon (Fig. 24.18) to the head of a powerful, 15m-deep waterfall in a large shaft. Below the drop, a low, braided, boulder-strewn bedding passage leads to a sump that is impenetrable beyond 8m.

The Hammer Pot water flows to Brants Gill Head, but it has not been proven or recognised in any of the inlets in the intervening Fountains Fell Master Cave; it is quite possible that the continuing cave passage follows a separate bedding plane about 30m above that which guides the Master Cave.

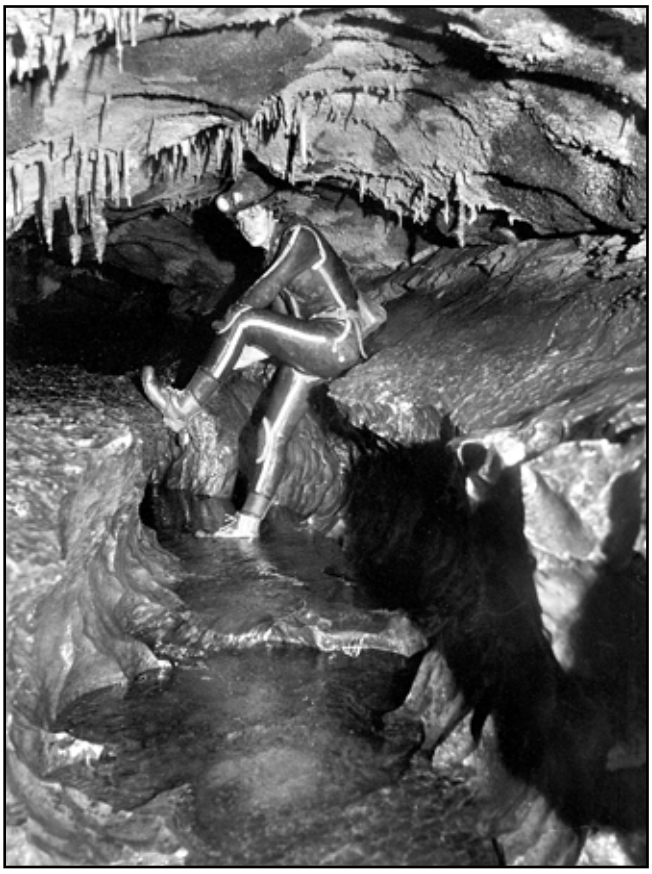


***Figure 24.18**. The clean-washed, main streamway known as the Out Fell Master Cave within Hammer Pot (photo: Clive Westlake).*

***Figure 24.19**. Calcite straws in the narrow canyon passage midway down FOUL Pot (photo: Mike Bottomley).*

***Figure 24.20**. A narrow joint-guided rift passage in Thunder Pot (photo: Harry Hesketh).*

Between the two "master caves", Echo Pot and FOUL Pot both descend to the level of the Fountains Fell Master Cave, thereby precluding any link to the Hammer Pot drainage, and each has only about 250m of known passage. FOUL Pot (the name is an acronym with irreverent reference to Univerity of Leeds cavers) is 120m deep, with rift passages and tall, narrow stream canyons that are broken by four larger shafts and reach to a constricted sump (Hesketh, 2001); some of the rifts are constricted, but the cave also has some fine stalactites (Fig. 24.19). In contrast, Echo Pot has a small streamway descending to the head of a rift that descends 100m in steps; this is choked with boulders at floor level 134m, below the entrance (White and Monico, 1989).

Strangle Pot is the longest and deepest cave yet known along the southwestern flank of Fountains Fell, with nearly 500m of passage and nine shafts reaching down to an excessively narrow rift at a depth of 157m (Hesketh, 2015). Its entrance shafts, a pair of chambers 60m down, and the 60m-deep final shaft are each on major fractures aligned northwest–southeast, but many of the intervening passages are small canyons beneath bedding-plane roofs. The abandoned passage entering through the chambers extends to a point close to, but about 40m beneath, Rough Close Sink. This sink has been proven to drain to Brants Gill Head, and it has been assumed that its water, and that from other sinks on Out Fell and Dick Close, flows via the Out Fell Master Cave in Hammer Pot. However, Strangle Pot and Logan Hole both reach to levels a little below that of Hammer Pot's streamway, so at least some of these caves probably drain via lower routes directly to the Fountains Fell Master Cave (Fig. 24.8).

***Figure 24.21**. One of the many shakeholes that trace the outcrops of the Yoredale limestones that are largely hidden beneath glacial till across the higher parts of Dick Close (TW).*

From its entrance lower down the fell, Logan Hole is only 120m deep, with a succession of short shafts and minimal horizontal development, down to a terminal sump in a rift only a few centimetres wide (Hesketh, 2015). Further to the south and just inside Dick Close's northern wall, Thunder Pot has two shafts that drop into 240m of small streamway (Fig. 24.20); this can be followed downstream to a choked bedding-plane passage 46m below entrance level (Hesketh, 2015). Dick Close Pots include more than 20 potholes, some of which are noted for their strong draughts; four sites can be followed to depths of around 30m, but all are choked before reaching any significant lengths of horizontal passage.

Among the shorter caves high on Fountains Fell, Rocky Pot and New Year Pot are interconnected with known passages totalling little over 100m in length. These include a segment of phreatic tube that is 3m in diameter, with a deep vadose trench in its floor (Mills and Grey, 1970). Shatter Pot, on Out Fell, and Split Pot, which is one of the Dick Close Pots, also have abandoned fragments of mature, phreatic cave. All these phreatic remnants are at altitudes greater than 500m, and represent cave development that is either ancient or was within perched aquifers when active.

***Figure 24.22**. The entrance to Magnetometer Pot, stabilised by a concrete pipe, within the Fornah Gill valley. Normally, the surface stream has only a tiny flow, but during flood events it rises to swirl around the upstanding pipe (photo: Duncan Jones).*

***Figure 24.23**. Banks of active flowstone in Easy Passage, which forms the trunk route through the old, high-level system of galleries in Magnetometer Pot (photo: Duncan Jones).*

***Figure 24.24**. The elliptical phreatic tunnel that extends beyond the far end of the River Styx in the high levels of Magnetometer Pot (photo: Gary Douthwaite).*

Between Fornah Gill and Silverdale Gill, the lower limestone slopes of Fountains Fell are underlain by the 5 km of known passages in Magnetometer Pot (Fig. 24.22). Most of these passages fall into two rambling, abandoned, phreatic systems that are each largely confined to a single bedding plane. The cave now contains no large stream, but is invaded by numerous small flows of percolation water, has more than 20 sumps (Hill and Hall, 2015), and carries a major torrent during flood events. The entrance passage descends steeply for 30m into a complex entrance series with various shafts down to standing water, besides a low passage that extends into the higher of the two old phreatic systems, forming the southeastern half of the cave (Myers, 1957). The main phreatic tunnel in this upper system (Fig. 24.23) continues beyond the lakes known as the River Styx, descends gently to the roof of Caton Hall, and continues as a high-level towards the northwest as far as a small chamber and a boulder choke.

From the floor of Caton Hall, Magnetometer Pot's lower system extends towards the northwest, largely on an inception horizon about 30m beneath that guiding the upper system, and probably on or near the Porcellanous Bed close to the base of the Gordale Limestone. Most of these far passages are low and constricted, with isolated rifts and avens on major joints. Small, clear, percolation-fed streams flow along Rough Crawl and Pendant Passage, with the former continuing into Benefit Passage before descending to the Kamikaze Sump, where a low bedding-plane passage is too constricted to follow underwater. This is only about 100m from, and probably at the same level as, the upstream sump in Gin Passage in Gingling Hole. The small, abandoned Earthworm Passages continue westwards on the main bedding plane, but cannot be followed beyond constrictions about 100m short of, and 40m below, the partially excavated boulder choke in Silverdale Gill Pot.

Down the valley from Magnetometer Pot, Fornah Gill Cavern fails to live up to its name, having less than 200m of small streamway descending to a downstream sump at a depth of 23m (Green and Hudson, 1957). Water level in this sump is about 10m above that of the sumps at the near end of the River Styx in Magnetometer Pot.

***Figure 24.25**. A low bedding-plane passage in the entrance series of Dale Head Pot (photo: Jack Pickup).*

Caves of Pen-y-ghent

The deepest cave at the southern end of Pen-y-ghent is Dale Head Pot, on the eastern bench at the head of Silverdale and close to the surface divide from the Littondale catchment (Batty and Eyre, 1979). Its 800m of passages reach a surveyed depth of 165m (though this appears to include some error, as it would place the sump below the level of its outlet at Brants Gill Head). An entrance descent of 20m and a short, low passage (Fig. 24.25) join more than 400m of streamway midway along its length. This follows a single inception horizon at or close to the top of the Great Scar Limestone, upstream of cascades that mark a descent of 15m to an underlying shale bed. The passage then meets a minor fault and follows the shale/fault intersection towards the northwest, to the head of a shaft system that descends 130m with three routes all formed within the fault. With the fault inclined a few degrees from vertical, the lower passages are displaced towards the northeast. The main shaft descends straight through a thin band of white limestone, which might be the Porcellanous Bed, and the downstream sump is in a narrow fissure on the fault.

***Figure 24.26**. Hull Pot in flood, with a lake across the entire floor of the open pothole, slowly filling up as the influent flood exceeds the flow through the underlying boulder pile. The waterfall into the pot appears only under flood conditions, because the influent stream normally sinks into its bed and flows through rift passages that by-pass the far end of the open pothole (photo: Dewi Lloyd).*

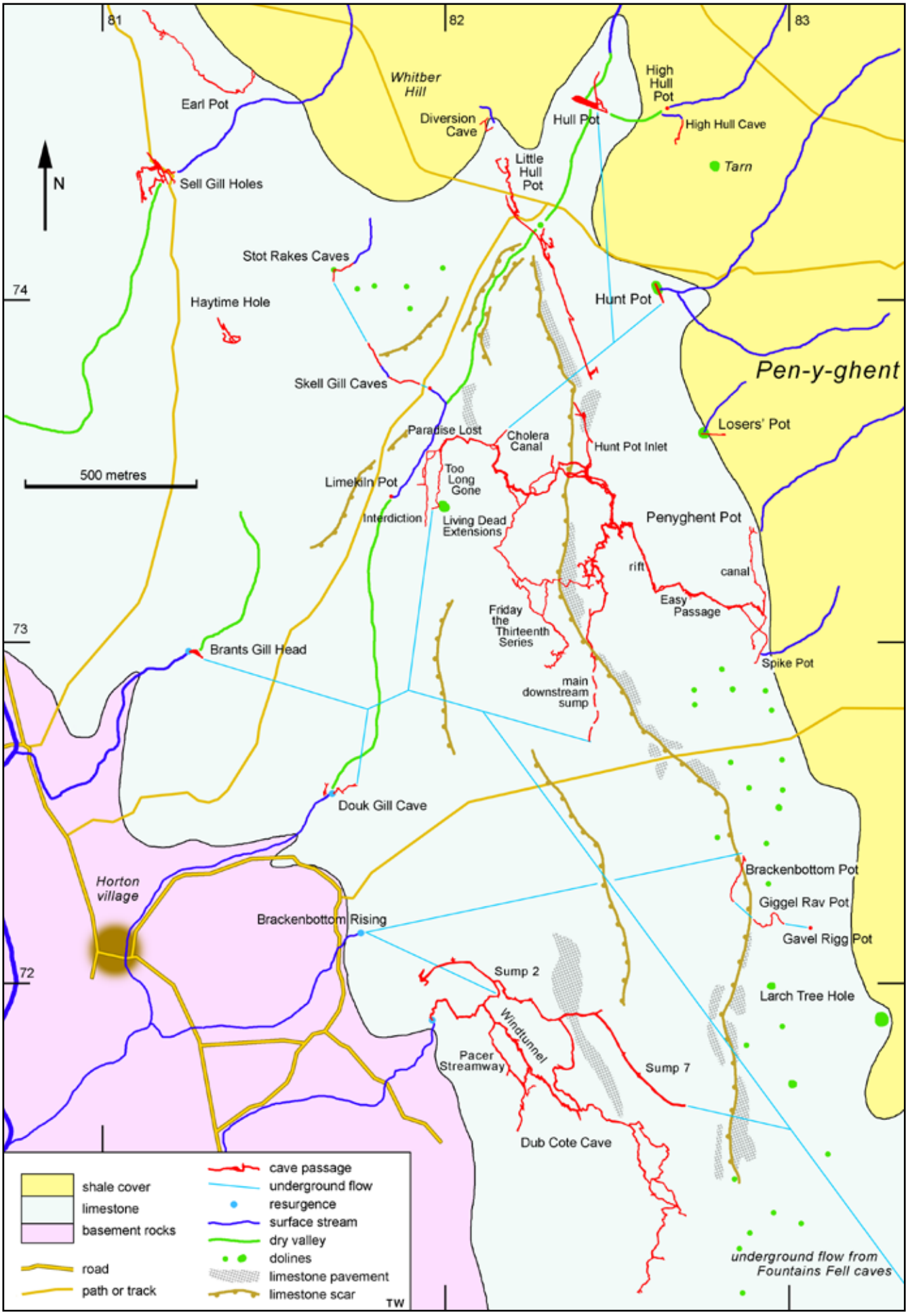
***Figure 24.27**. Hull Pot on a rare occasion when it filled completely with water and overflowed down the normally dry valley. Torrential rain and melting snow caused this flood in the winter of early 1993 (photo: John McKay).*

Across the southern shoulder of Pen-y-ghent, three large dolines are all formed on a single fault. Churn Milk Hole lies in the Hardraw Scar Limestone and has an excavated descent between large boulders to a depth of 27m. Larch Tree Hole is in the Hawes Limestone and is accessible only for a few metres of depth. Lying just north of the fault, Psilomelane Pot has rifts that descend 30m to Pool Chamber, where a bedding plane has guided two downstream passages that are both too low for major progress; the longer is floored with the black hydrous manganese oxide that gives the cave its name.

The small streamway in Gavel Rigg Pot is too narrow to follow some 50m from the entrance. Its water is next seen in Giggel Rav Pot, where a 10m entrance descent joins 200m of small streamway midway along its length; downstream this becomes too low to follow (Benn and Perry, 1991). Where next seen, the stream occupies the 70m-long inlet in Brackenbottom Pot (Fig. 24.28); below the 10m-deep entrance shaft, the passage descends along a fissure to the head of a shaft 35m deep on a cross-fissure. Debris chokes the foot of this, 100m below the level of the Gavel Rigg sink, and the water finally resurges from Brackenbottom Rising.

North of Penyghent Pot, a number of caves and potholes are entered in and around the Hull Pot valley (Fig. 24.28). Hull Pot swallows the largest stream of any sink in the Great Scar Limestone, with a mean flow of around 100 L/s from a catchment of 4.75 km^2. The open pot is 80m long and 15m wide and deep, elongated on a mineralized fault (Fig. 24.26). It can fill with water, with overflow reaching a doline almost above passages in Little Hull Pot during major floods (Fig. 24.27). A short cave at its eastern end includes a 40m-deep shaft, also on the fault and a low passage to a massive boulder choke (Fig. 4.31), which is probably linked to the boulder pile in the floor of the open pot (Pappard, 1977). The water flows to Brants Gill Head, but details of its underground route remain unknown (see page 429) and may include separate ways, as most of the water previously sank at the western end of the open pot (Wilkinson, 1967).

High Hull Pot consists of a single broken shaft 64m deep to a choke in the same rift, and the adjacent High Hull Cave has only 120m of small streamway behind its resurgence in the Hawes Limestone. At Hunt Pot a stream cascades down a vertical fissure 50m deep (Fig. 24.29). Rifts that include the


81
82
83
74
73
72
N
500 metres
Whitber Hill
Earl Pot
Sell Gill Holes
Diversion Cave
Hull Pot
High Hull Pot
High Hull Cave
Tarn
Little Hull Pot
Stot Rakes Caves
Haytime Hole
Hunt Pot
Pen-y-ghent
Losers' Pot
Skell Gill Caves
Paradise Lost
Cholera Canal
Hunt Pot Inlet
Too Long Gone
Limekiln Pot
Interdiction
Living Dead Extensions
Penyghent Pot
rift
canal
Easy Passage
Friday the Thirteenth Series
Brants Gill Head
Spike Pot
main downstream sump
Douk Gill Cave
Horton village
Brackenbottom Rising
Brackenbottom Pot
Giggel Rav Pot
Gavel Rigg Pot
Sump 2
Windtunnel
Larch Tree Hole
Pacer Streamway
Sump 7
Dub Cote Cave
underground flow from Fountains Fell caves
shale cover
limestone
basement rocks
road
path or track
cave passage
underground flow
resurgence
surface stream
dry valley
dolines
limestone pavement
limestone scar
TW

[opposite] ***Figure 24.28****. The main, known caves and outline geology of the area between Pen-y-ghent and Brants Gill Head. The extents of the main downstream sump and Interdiction, both in Penyghent Pot, are based largely on sketch surveys. Only the main hydrological links are shown, as the complexity of detail is recorded on Figure 24.8. On this map, the Great Scar Limestone includes the Hawes and Hardraw Scar limestones that are contiguous with it. (After surveys by ULSA, NPC, CDG, BUSS and others.)*

Figure 24.29*. Hunt Pot's impressive entrance rift (photo: John Dale).*

Figure 24.30*. In Shrapnel Pot the main shaft formed on the same minor fault that guides the rifts in Hunt Pot (photo: Daniel Jackson).*

adjacent entrance from Shrapnel Pot reach a total depth of 64m (Fig. 24.30), all on a minor fault, and the water is lost into a narrow slot and is next seen in Penyghent Pot (see page 429). Farther south, Losers' Pot has only a short bedding-plane passage heading eastwards beneath the shale cap to shafts that descend 50m to choked sumps (Benn and Haigh, 2002).

Little Hull Pot has 100m of small, meandering, stream passage to the head of the first of two shafts (Fig. 24.31) that together descend 60m. The streamway below continues towards the southeast within the same zone of fractures, which probably include a small fault (Gemmel and Myers, 1952). Beyond a roof by-pass over the first sump, the main

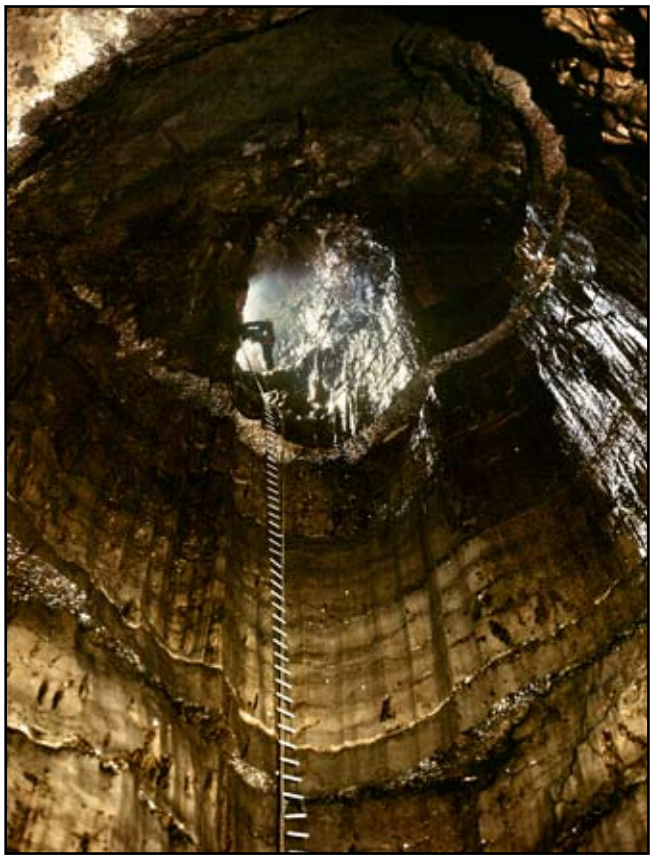


Figure 24.31*. The 30m-deep second waterfall shaft inside Little Hull Pot (photo: Paul Deakin).*

downstream sump lies 98m below entrance level. The underwater passage has been followed for nearly 400m, via a series of air-bells and phreatic loops to depths of 15m, nearly all along the same fault line (Hill and Hall, 2015). Farthest point reached is about 100m from the exploration limit in the Hunt Pot Inlet sump in Penyghent Pot, though this follows joints and bedding planes west of the main fault.

A small stream sinks into Stot Rakes Caves and then flows through the two Skell Gill Caves with their intervening surface course; nearly 250m of small streamway is known in the three caves. Downstream, the water resurges in the rocky valley below Hull Pot to form Skell Gill, which then sinks into the collapsed Limekiln Pot (Wilkinson, 1967) at a level 50m above that of the resurgence at Brants Gill Head.

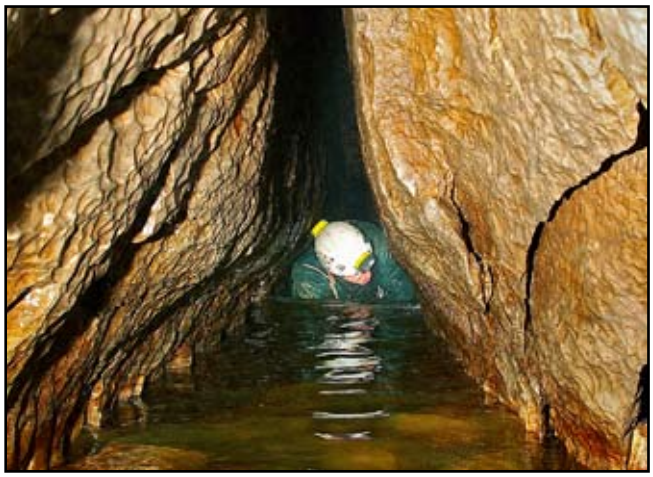


Figure 24.32*. A short canal in the lower streamway that follows a minor fault in Little Hull Pot (photo: John Forder).*

***Figure 24.33**. Penyghent Pot is notorious for the long, dark and gloomy canal within its low entrance passage (photo: Paul Deakin).*

Penyghent Pot

The descending streamway in Penyghent Pot is frequently described as the finest pothole in the country, but also leads to an extensive series of mainly small passages that form the far reaches and are among the most remote in any British cave. Its known passages now extend to nearly 6 km (Fig. 24.28), reaching depths of 160m at the downstream sump, at the level of Brants Gill Head; the underwater passages descend to 196m below the entrance (Fig. 24.12).

The entrance drops into the long, low passage partially filled by the infamous canal (Fig. 24.33), which lies along a single bedding plane in the dark grey Hawes Limestone, and is also notable as a site where cave trout can often be seen (see Chapter 13). The first waterfall shaft has an inlet passage from a sink near Spike Pot entering above it, and the actual Spike Pot Inlet enters a short way along Easy

***Figure 24.34**. A conspicuous half-tube follows the bedding in the Lower Main Stream Passage below the Niagara waterfalls in the lower reaches of Penyghent Pot (photo: Paul Deakin).*

***Figure 24.35**. The foot of the main shaft at the head of the long, fault-guided rift passage within Penyghent Pot (photo: Paul Deakin).*

Passage, which is formed in the highest beds of the Gordale Limestone. It reaches to the head of the shafts and cascades that descend for nearly 100m along a splendid, vertical rift formed on a minor fault (Fig. 24.35). The streamway then leaves the fault, descends the Myers Leap cascade and joins the Hunt Pot Inlet in an extensive series of passages developed on the inception horizon at the boundary between the Gordale Limestone and the underlying Cove Limestone. The combined lower streamway, a few metres high and wide, turns towards the south in the almost horizontal bedding (Fig. 24.34). Its stream then descends the Niagara waterfalls to follow another bedding plane 22m lower down, as far as the downstream sump nearly 2 km from the entrance.

***Figure 24.36**. In the lower streamway of Penyghent Pot; the name of the Niagara cascade is barely appropriate since its normal flow was reduced by the Hunt Pot Inlet water switching to drain through the Living Dead streamway (photo: Paul Deakin).*

***Figure 24.37**. Paradise in the Living Dead Extensions of Penyghent Pot is a phreatic tunnel developed along a single bedding plane; it continues into the Paradise Lost streamway (photo: Pete Bolt).*

The underwater passage descends a vertical rift and then follows bedding planes and joint rifts towards the south, reaching a maximum depth of 36m; it has been followed to a wide bedding passage with oxbows and inlets, 450m from and 28m below the sump pool (Hill and Hall, 2015).

Above the Niagara waterfalls, the long and nearly horizontal passages of the Friday the Thirteenth Series and the Living Dead Extensions are all developed on a single bedding horizon (Monico, 1989, 2015). These are phreatic tunnels that are now largely abandoned, with only short sections having minor vadose modification by invasive inlets. Most are no more than a metre high and little wider. Isolated shafts descend to clear sump pools, and scattered avens reach no great heights. The low passages eventually break out into Paradise (Fig. 24.37). This walking-size tunnel enters from the Hunt Pot Inlet, though any route through is blocked by impassable chokes on the line of a small fault. The Inlet is only accessible from the main streamway in Penyghent Pot; its upstream sump has 200m of underwater bedding-plane passages reaching close to the exploration limit in Little Hull Pot.

Historically, water from the Hunt Pot area (see box below) entered through its Inlet sump and joined the main stream passage. Then around 1986 the Hunt Pot Inlet ceased to flow, and its water now appears to enter Cholera Canal and Paradise Lost within the Living Dead Extensions. The streamway of Too Long Gone (Fig. 24.38) cannot be followed beyond a boulder choke about 20m above and 800m from Brants Gill Head. This choke could be the base of collapse debris in the floor of a large doline about 40m above the level of the cave, on the eastern side of the Hull Pot valley. West of Too Long Gone, the immature, distributary Interdiction streamway extends for about 250m to another impassable boulder choke at the same level.

***Figure 24.38**. The canal into the downstream sump in the Too Long Gone streamway in Penyghent Pot (photo: Pete Bolt).*

Flow changes in and around Penyghent Pot

Hunt Pot Inlet was the name given to the major tributary stream in the lower reaches of Penyghent Pot, following a positive dye-trace soon after the cave was explored. The sumps in the Inlet and in Little Hull Pot reach close enough to each other to suggest that the Little Hull water took this route through Penyghent Pot. However, some time around 1984, the large stream in the Hunt Pot Inlet ceased to flow except during major flood events. Its water appears to have taken a new route farther west, flowing into Cholera Canal and possibly other inlets into Paradise Lost, and then into Too Long Gone in the Living Dead Extensions in the far western reaches of Penyghent Pot (though this has yet to be confirmed by a positive dye-trace). The flow diversion was probably caused by a collapse or sediment blockage in the unknown, intervening passages that extend so far with minimal gradient on this single inception horizon.

The underground flow switch could have related to a temporary emptying of the Tarn, the lake 25m across in a doline southeast of Hull Pot. This lies on the outcrop of the Hardraw Scar Limestone, but is also on the line of a fault through Hull Pot, and a collapse within its floor could have been the source of debris that blocked conduits far beneath.

Flow rates at various flood stages clearly indicate that Hull Pot's water flows to Brants Gill Head, with flood overflow to Douk Gill Cave. However, it has not yet been proven whether or not these flows pass through the lower reaches of Penyghent Pot. When a flood pulse starts to form a lake in Hull Pot, the large flow of turbid water that emerges from Douk Gill with minimal delay appears to be more than could pass through the small Living Dead passages in Penyghent Pot. The base flow could take a separate route, passing beneath the perched conduits in Little Hull Pot and the Living Dead, and it is likely that some flood flow completely misses the passages in the known parts of Penyghent Pot, though another flood distributary could pass along the Hunt Pot Inlet.

The flooded doline known as the Tarn (photo: John Cordingley).

Figure 24.39. *The deep rift that opens into the Main Chamber in Sell Gill Holes (photo: Steve Sharp).*

Caves draining to New Houses Risings

Lying a few metres east of the River Ribble, the main New Houses Risings are fed by Sell Gill Holes, Haytime Hole and a few minor sinks (Fig. 24.41). There also appears to be a considerable input of autogenic flow from a large catchment on the limestone (Halliwell, 1980). New Houses Rising West yields water from a large pool on the west bank of the Ribble, but the source of its water is unknown.

Sell Gill Holes have more than 600m of known passages, formed largely along a fault and parallel fractures aligned northwest–southeast, which descend steeply for 101m to an impassably narrow fissure. This is virtually at resurgence level, but a natural flood pulse seen in the Main Chamber in 1980 took two hours to emerge, suggesting that vadose passages are present for some of the 850m between sump and rising.

Figure 24.40. *A canal along a constricted fissure passage in the lower part of Sell Gill Holes (photo: Gary Douthwaite).*

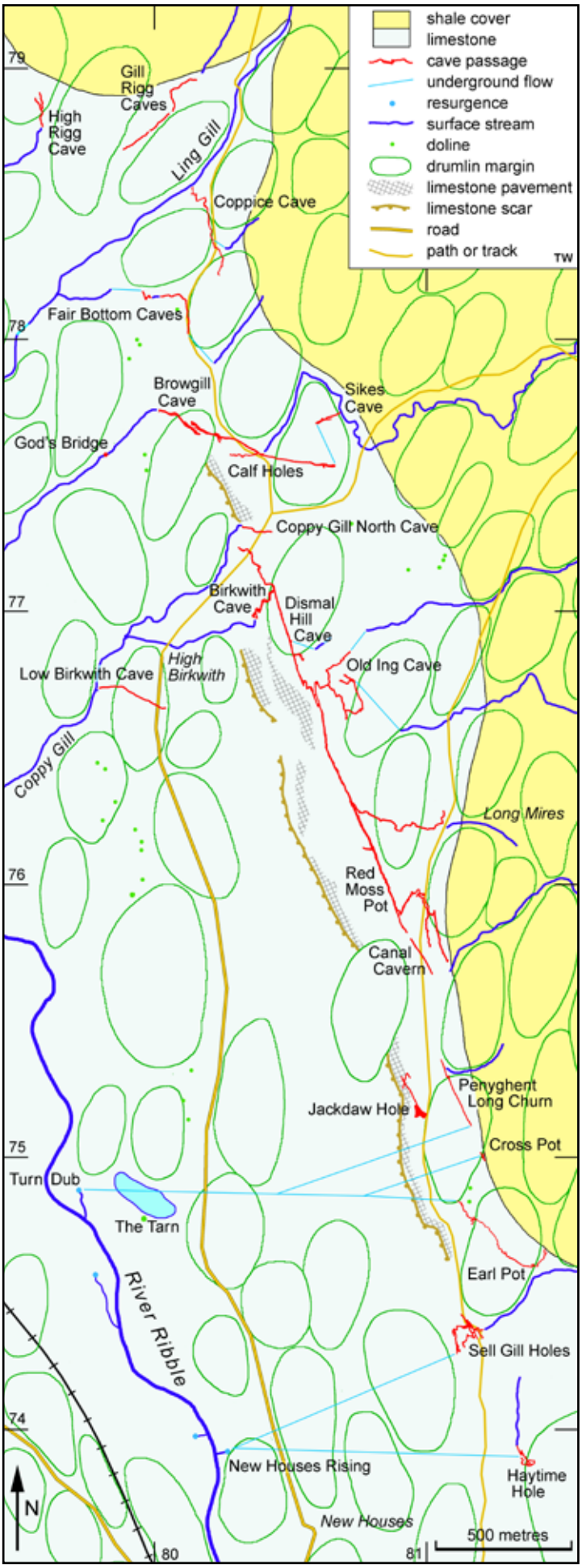


Figure 24.41. *The main, known caves and outline geology of the Birkwith area. The line of Low Birkwith Cave is only approximate. On this map, the Great Scar Limestone includes the parts of the Hawes Limestone that are contiguous with it. (After surveys by BCC, CPC, WRPC, LUST and others.)*

The Dry Entrance to Sell Gill Holes descends a succession of three shafts into the Main Chamber (Fig. 24.39), which is more than 20m high and wide. The stream at the main sink follows a short vadose trench to the top of a 40m cascade within a complex of shafts that also descend into the Main Chamber. The chamber's stream outlet reaches a boulder-strewn rift along a minor fault (Fig. 24.40). Beyond a transient sump that can develop in a pool behind silt banks, and below a 15m shaft, the water is lost into narrow fissures (Halliwell, 1996; Goodwin, 2003). At the base of the first drop within the Dry Entrance, the Calcite Way is an old stream route extending for 80m to calcite blockages, and its trickle of water re-appears in avens at the bottom of the cave. The even older passage known as the Guano Mine is a vadose trench initially 12m by 3m, but almost filled with breakdown and sediment. It passes directly over the Main Chamber, heading towards the northwest from the Dry Entrance rift, though its original drainage direction is uncertain.

In Haytime Hole a rift passage descends steeply towards the northwest into a chamber 12m across, heavily modified by breakdown. A meandering, canyon streamway continues to a second chamber and a sump that is choked underwater, 73m below and 300m from the entrance (Whitelock and Yeadon, 1978). Its water has been dye-traced to New Houses Rising.

Caves draining to Turn Dub

The large resurgence pool of Turn Dub, close beside the River Ribble, is best known as the resurgence for water from Alum Pot (see Chapter 22), but it also carries drainage from Penyghent Long Churn, Earl Pot and Cross Pot (Cordingley, 2016).

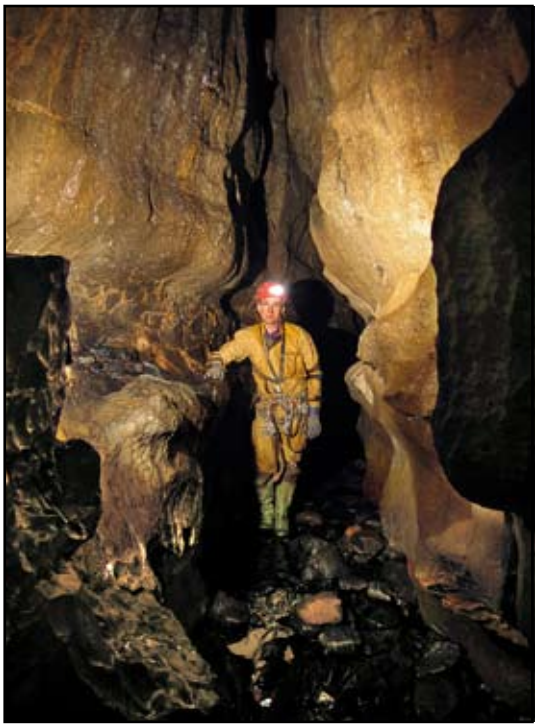
Earl Pot has 600m of known passages that reach a depth of 50m at a sump that is too narrow to pass at an altitude some 110m above that of the resurgence. The sink and entrance passages are in the Hawes Limestone, and downstream in the Gordale Limestone a single, meandering, canyon passage drains towards the northwest into a fracture-guided chamber known as the Scullery (Robshaw, 1972). Until it collapsed, Corkscrew Pot (also known as Backtrack Pot) offered a descent between large, unstable boulders into the Scullery chamber. Inspiration Hole (also known as Dead Rabbit Rift) provides another route into the same chamber, but is also unstable. Water sinks between boulders in the Scullery chamber's floor, into a short, constricted, lower streamway that can also be reached through the Sting Pot entrance (Halliwell, 1999; Cordingley 2015).

Jackdaw Hole is an open pothole 12m across and 10m deep to a floor of boulders. It appears to lie at the intersection of the faults that guide Hull Pot and the main chamber of Sell Gill Holes. An abandoned phreatic tube, 3m in diameter, extends towards the northwest for 75m to a solid choke of debris; this is probably one of the oldest passage remnants in the area, perhaps contemporary with the Guano Mine passage in Sell Gill Holes. It is invaded by small flows of percolation water that enter a sump too small for access; it is likely to drain to Turn Dub, but has not yet been dye-tested.

Penyghent Long Churn has its entire 300m of known length developed on a single fracture, which is probably a minor strike-slip fault, aligned on 155°. Most of the water carried by the cave is from the stream that falls 23m down the entrance shaft (Fig. 24.42), but additional inputs are from a long line of shakeholes that extends northwards round the drumlin margin towards the Red Moss Sink. Descending obliquely along the fracture (Fig. 24.43), the cave has a profile that steps down on four thin shale beds. The downstream sump is too narrow for exploration, and floodwater backs up well above its constriction.

The aptly named Cross Pot is formed at the intersection of two vertical fractures. That aligned on 160° is a minor fault with 100 mm of downthrow towards the west, but the other, on 130°, appears to be a joint with no recognisable displacement. Below a 23m shaft, short passages reach boulder chokes in both directions along the fault. A number of other shafts are known on the limestone bench, but none can be followed beyond a depth of about 20m.

[left] ***Figure 24.42****. A long rift, with a stream sinking into its southern end is the entrance of Penyghent Long Churn (TW).*



[right] ***Figure 24.43****. The stream route along the floor of the deep fissure that constitutes most of the accessible cave passage within Penyghent Long Churn (photo: Duncan Jones).*

The Birkwith Cave System

The remarkably linear Birkwith Cave System is made up from seven separately named caves that are nearly all interconnected (though some only by underwater passages) and all drain northwards to the Birkwith Cave resurgence. Some 4400m of passages are known (Fig. 24.41), but have a total depth range of only 50m (Fig. 24.12).

The greatest length of passage is within Red Moss Pot (Wilson and Hartley, 1972; Hartley, 1975). Its southernmost entrance passages from Red Moss Sink are low canals in the Hawes Limestone, as far as a series of waterfalls descending into the Gordale Limestone about 15m below. Beneath a short inlet from a second entrance, these pass through Fault Chamber, with its wall scored by horizontal slickensides. The streamway continues as a meandering vadose canyon until it joins the Canal Cavern inlet (containing a sump that has not been passed) at the head of the main fissure passage. This extends for more than 800m along a bedding/fracture intersection, with the roof descending very gently over a succession of long and deep canals (Fig. 24.44). The Long Mire Inlet is a meandering, stream canyon, tributary from the east. The main stream then passes through a complex zone of fractures, which induce two sumped sections and a 6m descent in the lower reaches of Old Ing Cave, where a meandering canyon tributary passage descends gently from the entrance.

Figure 24.44. *One of the deep canals within tall rift passages that distinguish the far reaches of Red Moss Pot (photo: Peter Wilson).*

Figure 24.45. *Deep water in the canal formed along the main fissure towards the upstream sump in Birkwith Cave (photo: John Forder).*

Figure 24.46. *The main streamway in Red Moss Pot, close to its junction with the Long Mire Inlet (photo: Peter Wilson).*

Downstream of the Old Ing junction, the passage descends 6m to enter a canal and the second sump, which are back on the line of the main fissure. This continues through Dismal Hill Cave into the rift canal in Birkwith Cave (Fig. 24.45), where the stream turns away to the southwest and steps down joints and bedding planes to descend 12m to the resurgence. The 250m of smaller passage heading north along a bedding plane is a flood overflow to the Coppy Gill Exit.

The most conspicuous feature of the cave system is its tight geological guidance. The main conduit extends in an almost straight line from Canal Cavern, through the length of Red Moss Pot and onwards to the canal in Birkwith Cave, where the stream turns away to reach the resurgence. Except for the short offset through the lower reaches of Old Ing Cave, this follows a single fracture, which appears to be a strike-slip fault. Furthermore, as far as Old Ing Cave, the passage is developed along this fracture at its intersection with a shale bed that is nearly horizontal and lies about 20m below the top of the Gordale Limestone.

Behind the rising at the head of Coppy Gill, the small streamway of Coppy Gill North Cave extends for nearly 200m to a sump, and appears to drain from small sinks in the valley east of Old Ing Farm. Lower down Coppy Gill, Low Birkwith Cave has 400m of low stream passages

The perching of the Birkwith Cave System

The main cave stream from Red Moss Pot through to Birkwith Cave is perched about 100m above the level of the River Ribble, which lies almost parallel and less than 1300m to the west. Both the cave and the river have tiny gradients, though they drain in opposite directions. The Birkwith resurgence is perched 90m above its surface stream's confluence with the Ribble. It could be that this perching is entirely due to a strong inception horizon. A single shale bed defines the roof of a vadose canyon in the upstream part of the main drain in Red Moss Pot, but descends with the dip so that it is in floor-level undercuts in a phreatic rift passage further downstream, and marks the roof again downstream of the cascade in Old Ing Cave and through Dismal Hill Cave (Hartley, 1975). This inception horizon within the Gordale Limestone may have prevented water escaping to lower levels within the fractures that also guide the cave; perversely, vertical fractures within the more thinly bedded Hawes Limestone do permit vadose flows to descend to lower levels within the entrance series.

Any implied importance of phreatic development would suggest that the main cave was largely formed when the valley floor was at a higher altitude. Based on a rough estimate of denudation rates, this would date the cave to around 600,000 years ago (see Chapter 4). There is still much to understand about the origins of this cave system.

Amid the drumlin field of upper Ribblesdale, the long white scar is formed in the top beds of the Gordale Limestone. The long stream passages of the Birkwith Cave System lie less than 20m beneath the crest of the scar, perched far above the River Ribble and the floor of the dale (TW).

***Figure 24.47**. Flood conditions on the stepped waterfall that descends 15m into the fracture-guided entrance shaft of Calf Holes (photo: Brendan Marris).*

draining from the east towards its adjacent resurgence, but these are only accessible through sumps that are constricted by banks of silt. Its water is probably derived from small inputs between the drumlins on the limestone bench above, though the catchment could have considerable extent up-dip towards the south. The Low Birkwith resurgence is the only one at lower altitude than the Birkwith caves, but is still 20m above local base level. It appears to lie on the Porcellanous Bed inception horizon, and is probably about 100m above the base of the limestone.

Caves of Browgill and Ling Gill

Calf Holes and Browgill Cave form a single independent system with nearly a kilometre of known passages (Fig. 24.41). From a catchment of about 2.2 km^2, the main sink at Calf Holes can swallow a waterfall of some hundreds of litres per second during flood events (Fig. 24.47). The entrance shaft has an abandoned outlet to Cramp Cave at high level, and is joined at its foot by water from the 200m-long inlet passage that probably drains from Sikes Cave. A stream route through to the Browgill resurgence consists of spacious vadose canyons (Fig. 24.48), except where phreatic enlargements on bedding planes provide the link between the floor of the upstream passage and the roof of the downstream canyon. The entire cave system is perched above the dale floor on inception horizons that are close to those followed by the Birkwith caves.

North of Calf Holes, North Fair Bottom Cave is a similar but smaller sink between the rounded drumlin hills. Its water cannot be followed, but is next seen as a tributary midway along the 450m of small, vadose streamway draining northwards from Coppice Cave. Downstream, this descends 18m in a waterfall shaft just short of its resurgence in the

***Figure 24.48**. A bedding-plane roof on the main stream passage in Calf Holes (photo: Paul Deakin).*

floor of Ling Gill, the miniature limestone ravine that carries Cam Beck across the outcrop of upper beds of the Great Scar Limestone (Fig. 24.50). A dozen short fragments of mainly small cave passage open in the walls of Ling Gill, some providing underground loops to the stream that normally maintains a surface course along its entire length. Its flow, roughly in an up-dip direction, precludes any extensive development of vadose caves along the bedding planes where it is entrenched into the limestone.

Down the limestone slope from Coppice Cave, the three components of the Fair Bottom Caves have nearly 400m of known passages along a single stream course. This probably drains from another sink between the drumlins, through the caves and onwards to the head of a short tributary of Ling Gill Beck (Whitehead and Richardson, 1961). North of the Ling Gill ravine, the Gill Rigg Caves have nearly 400m of known stream passage (Whitehead and Wear, 1961); the destination of its water, either into Ling Gill or down-dip to the 250m-long streamway in High Rigg Cave, remains unknown.

***Figure 24.49**. Resurgence of the Calf Hole water at the exit from Browgill Cave (photo: Paul Deakin).*

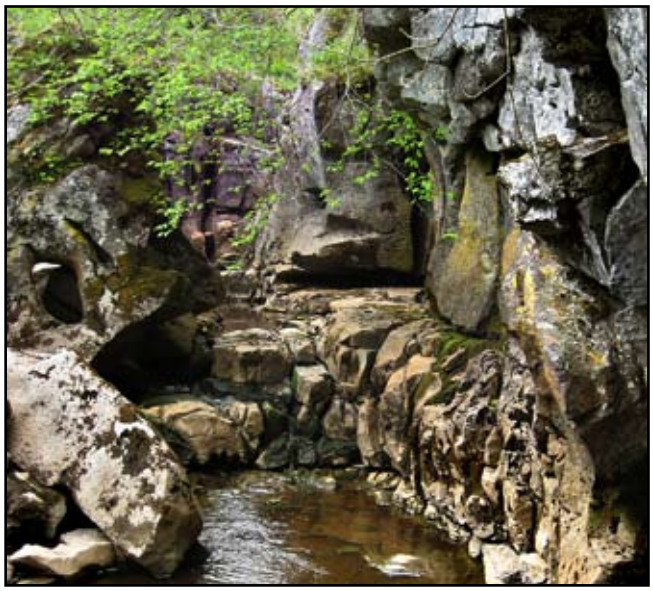


***Figure 24.50**. The limestone ravine of Ling Gill, where most of the stream flows along the floor, though parts of its flow loop underground along joints and bedding planes (photo: Stephen Oldfield).*

Minor caves in the Yoredale limestones

At altitudes well above the main cave systems within the Great Scar Limestone, the thin Yoredale limestones contain a scatter of small caves (Fig. 24.5), though none is known to have any great length of passage. High on Fountains Fell, Turf Belay Pot and Hunslet Hole are both in the Middle Limestone, but each is only a rift descending about 7m. At even higher altitude, Penyghent Side Cave is the only one known on the Main Limestone, but is probably more of a landslip fissure than a dissolutional feature.

One of the farthest headwaters of Hull Pot Beck emerges from the resurgence of Lante Shop Cave in the Middle Limestone (Gemmel and Myers, 1952). Nearly 400m of low, wet stream passages are now known, with at least four entrances scattered across the bleak moorland. Also in the headwaters of Hull Pot Beck, Green Hackeber Sink lies in the Simonstone Limestone, but no passage is accessible from the sink down towards the rising at the base of the limestone.

At the head of a tributary of Cam Beck, Poverty Gill Cave is another small resurgence in the Simonstone Limestone. Its 200m of small, joint-guided stream passages head towards a doline field on the bench above, among which five shafts and fissures reach depths of no more than 15m and are collectively known as the Foxholes.

Evolution of the caves

With a complete lack of dated stalagmites from the area, any chronology of even the main cave passages can be little more than conjecture. Clearly, the extensive phreatic passages now partially drained in the lower reaches of Penyghent Pot, Gingling Hole and Magnetometer Pot were rejuvenated by lowering of the floor of Ribblesdale during the Devensian glaciation; however, their altitudes, 50–100m above the dale floor, suggest that they also pre-date the Wolstonian and probably the Anglian glaciations. It would be reasonable to expect that Douk Gill Cave was the main resurgence before losing its base flow to Brants Gill Head as the dale was eroded to a lower floor-level. It is also likely that Dub Cote

***Figure 24.51**. Helictites cover the walls of an old phreatic pocket in the roof of Gingling Hole (photo: John Forder).*

Cave served as the main resurgence for the Fountains Fell caves, before deepening of Ribblesdale provided a steeper hydraulic gradient, first to Douk Gill Cave and finally to Brants Gill Head. These historical resurgences now become active in reverse order during increasing flood stage.

The main, high-level, phreatic passage in Magnetometer Pot is one of the few, abandoned, trunk passages known beneath eastern Ribblesdale. It appears to be one of the older caves under these hills, pre-dating the eastwards retreat of the shale cover when its inlet passages were removed by surface lowering; and the Fountains Fell drainage has since slipped away down-dip and to lower levels as the karst evolved and deepened. Other sections of passage, distinguished by fills of clastic sediments and calcite deposits, may be as old or even older. Choked, high-level passages in Jackdaw Hole and Sell Gill Holes, Stalactite Chamber in Gingling Hole, and old, phreatic fragments at high altitude in New Year Pot and nearby caves all appear to be isolated remnants of such older caves.

The sheer size of the open hole at Hull Pot suggests that it might be of considerable antiquity, along with the phreatic passages from the Hunt Pot Inlet through the lower reaches of Penyghent Pot, pre-dating their invasion by the stream from the present entrance. The site of Hull Pot was buried beneath ice sheets during each of the Quaternary glaciations, but its location kept it away from the zones of greatest erosion beneath the main ice streams aligned down Ribblesdale and across into Littondale.

Geological influences on cave development

As with most of the caves in the Yorkshire Dales, those of Fountains Fell and Pen-y-ghent exhibit a close relationship with the structure and stratigraphy of the host limestone. Perhaps more than in most areas, the limestone dip of a few degrees has a major influence, particularly in directing the Fountains Fell drainage on its long course to the Brants Gill resurgence some kilometres farther up Ribblesdale. Though the dip is the main factor, the Fountains Fell caves are also prevented from draining by up-dip phreatic flow along shorter routes to lower Ribblesdale, by the buried basement ridge that creates an impermeable barrier reaching elevations some 50m higher than the level of the conduit through the Fountains Fell Master Cave (Fig. 9.18). North of this buried ridge, the limestone dip decreases to almost horizontal in the area due west of Pen-y-ghent. This accounts for the network of passages in the low levels of Penyghent Pot, where the stream from Hunt Pot and other sinks has switched course among braided routes within a single inception horizon (Fig. 24.52).

Of the four major inception horizons within the Great Scar Limestone (Table 8.2), the second, at the boundary between the Cove and Gordale limestones, is the most conspicuous in the caves of Ribblesdale, especially where extensive passages are developed on a single horizon in the far reaches of both Penyghent Pot and Magnetometer Pot (Lowe and Waters, 2014). The Silverdale borehole records 5.4m of porcellanous limestones (Fig. 24.4), and it is not clear whether the major cave development is on just one, or more than one, horizon. No single inception horizon is recognisable at the top of the Great Scar Limestone, where multiple shale beds within the Lower Hawes Limestone guide the entrance streamways of many caves as they step gently downwards before reaching shafts in the Gordale Limestone. Similarly it is not possible to recognise a single inception horizon at or near the base of the Cove Limestone, where two bedding planes about 15m apart guide the passages in Dub Cote Cave. The Fountains Fell Master Cave and the Lower Main Stream Passage in Penyghent Pot appear to lie along another horizon that is within the Cove Limestone.

Many sections of passages in the caves of Pen-y-ghent and Fountains Fell, along with isolated chambers, tall rifts and many of the deep shafts, are developed along or down

***Figure 24.52**. The Highway to Hell, an aptly-named, long and low passage that follows a single bedding plane in the far low-levels of Penyghent Pot (photo: Pete Bolt).*

***Figure 24.53**. The classic stream sink of Hunt Pot, with its water cascading down a vertical rift formed on a strike-slip fault (TW).*

bedrock fractures aligned close to northwest–southeast. Their directions vary slightly, but they form one half of the conjugate sets of joints that are dominant across the Askrigg Block (Moseley, 1973). They are probably more important to the caves than the northeast–southwest joints because they lie more nearly parallel to the adjacent valley sides and have, therefore, been more prone to opening by stress relief.

A number of the major vertical fractures, aligned in various directions, are minor faults, mostly with small horizontal movements. Some can be traced over considerable distances and are conspicuous by their impact within the caves. The long rift passages in Penyghent Pot and the Birkwith Cave System, along with the open crater of Hull Pot, are notable examples of such fault-guided development.

Even though the passages along the Birkwith fault are so extensive laterally, their vertical development is almost completely restricted to a single, sub-horizontal inception horizon. The nearly total lack of cave development in the limestone below this level is an anomaly among the long and deep caves of the Three Peaks area. There are some splendid potholes and long cave passages already known beneath the slopes of Pen-y-ghent and Fountains Fell, but there are still some significant shortfalls in understanding the area.

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[*NPC J. = Northern Pennine Club Journal*]

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