
Ease Gill Cave System

(GCR name: Leck Beck Head Catchment Area)

[SD 67 78]–[SD 66 81]

Highlights

The caves under and around Ease Gill form the longest and most complex system in Britain, which ranks among the ten longest caves in the world. They contain an exceptional range of cave geomorphological features, and the passages, sediments and speleothems provide an unparalleled record of karstic evolution and associated surface development through the Pleistocene.

Introduction

The Ease Gill Cave System extends beneath Casterton, Leck and Ireby Fells, around the western and southern flanks of Gragareth Hill (Figure 2.1); it is bisected by the county boundary of Cumbria and Lancashire. A limestone upland is drained by the most extensive and most complex series of caves in Britain. The Dinantian Great Scar Limestone is about 200 m thick and contains numerous shale bands up to 2 m thick; it has a very gentle dip to the north-west. The Dent Fault juxtaposes the limestone against impermeable Lower Palaeozoic greywackes to the west; adjacent to the fault the limestone is folded into steep dips, with several small folds and tear faults in a disturbance zone up to 200 m wide. The southwest margin of the limestone is a clean break along the North Craven Fault, where the limestone has been thrown down to the south by about 200 m; thick glacial till masks the outcrop of the fault and the Yoredale shales beyond it. Away from the marginal faults, the limestone is broken by many minor faults and major joint sets dominated by trends almost north-south and north-west-south-east. A shallow syncline plunging down-dip on Leck Fell is one of many minor flexures not yet mapped in detail.

Allogenic recharge of the limestone is derived from shale sequences of the overlying Yoredale facies forming the upper slopes of Gragareth and Crag Hill; all the streams sink close to the limestone margin. The surface topography and hydrology are complicated by thick deposits of glacial till over much of the limestone. This cover collects the runoff and directs it into the numerous subsidence dolines developed where the till is washed into the underlying limestone fissures.

The main surface feature of the area is the narrow valley of Ease Gill Beck (Figure 2.2). In normal weather conditions the beck carries no surface stream between the shale margin and the resurgence at Leck Beck Head, but flood flows reach various sinks down the limestone valley. Leck Beck Head lies just east of the Dent Fault, and is the rising for all the underground drainage between Aygill Caverns in the north and Ireby Fell Cavern in the south-east.

Despite the scientific importance of an integrated multi-level cave system with more than 80 km of passages, containing extensive clastic and speleothem deposits, published work on the underground geomorphology is limited. Accounts of the geomorphology of the caves beneath Casterton Fell have been given by Ashmead (1967, 1974b), and of those beneath Leck Fell by Waltham (1974d). Descriptions of all of the caves are given by Brook *et al.* (1994), and additional reports on particular caves include those by Foley (1930), Atkinson (1950), Simpson (1950), Eyre and Ashmead (1967), Waltham and Hatherley (1983), Yeadon (1985), Eyre (1989) and Monico (1995). A survey of all of the caves then known in the Three Counties System was published by Waltham and Brook (1980a). Aspects of the geology and its guidance of cave development in this area have been further discussed by Waltham (1970, 1971a, b, 1974a) and Lowe (1992b). Speleothem dates have been obtained from several caves (Waltham and Harmon, 1977; Atkinson *et al.*, 1978, 1986; Gascoyne *et al.*, 1983a, b; Gascoyne and Ford, 1984; Baker *et al.*, 1995b, 1996), and the relationship between the caves and landscape evolution has been discussed by Waltham (1986).

Description

The catchment of Leck Beck Head contains more than 80 km of known cave passages, most of which are integrated into the Ease Gill Cave System. The caves are sensibly divided into three sectors. Ease Gill Caverns contain about 58 km of passages, largely beneath Casterton Fell and linked beneath Ease Gill to Link Pot and Pippikin Pot (Figure 2.2). The caves of southern Leck Fell have about 12 km of connected passages (Figure 2.2); they also have a flooded connection with Pippikin Pot, making a single interconnected cave system 71 km long. The caves of Ireby Fell form another system nearly 12 km long which drains into the Leck Fell caves, though the connection has not yet been explored (see (Figure 2.6)).

Casterton Fell and Ease Gill Caverns

Ease Gill Caverns is a huge dendritic cave system containing more than 58 km of explored passages (Figure 2.2), which include virtually every type and feature of cave passage morphology encountered within the Yorkshire Dales karst. The caves are accessible through more than a dozen entrances, most of which lie in the Ease Gill valley, though four are located high on the fells to the north and south.

The main feature of the cave system is the massive, abandoned phreatic trunk passage which extends east to west under Casterton Fell. It originates beneath the upper reaches of Ease Gill and heads west to the complex of old passages in Lancaster Hole, where it is joined by similar large old passages from Bull Pot of the Witches and turns south to end at sediment chokes in multiple outlets. Parts of the trunk passage are 10 m in diameter; some sections retain their phreatic morphology of rounded tubes and enlarged cross-rifts, but other sections are greatly modified by roof breakdown. There are extensive clastic infills, completely choking some passages, and calcite speleothems of spectacular variety decorate some very beautiful chambers (Figure 2.3). This old, high-level passage lies almost directly above the present, active main streamway. This is a splendid vadose canyon, mostly 2–4 m wide and up to 25 m deep, with clean limestone walls rising above stretches of gently graded streamway interspersed with water chutes and deep moulin pools. Parts of the canyon are entrenched in the floor of the old high-level tunnel, but other sections have bedding plane roofs or turn into high rifts. There is extensive undercutting, particularly along shale bands, and some has led to massive collapse from the passages above. The canyon ends below Lancaster Hole in a high rift containing the terminal sump pool; this drains into a large phreatic conduit 30 m below water level and heading straight for the Leck Beck Head resurgence.

Numerous smaller vadose streamways drain down the dip from the Ease Gill valley as inlets to the main streamway; several provide entrances, notably through Top Sink, Boundary Pot, Pool Sink and County Pot. Most of these are meandering canyon passages incised beneath shale beds and broken by small cascades and shafts mainly where joints and faults provided routes to lower shale beds. Repeated entrenchments, captures and re-routings into pre-existing passages have left complex intertings of active and abandoned passages on a scale unparalleled in Britain. Most inlets descend about 50 m to reach the main drain, and many lie below ancestral routes graded to the abandoned high-level trunk route. This further adds to the passage complexity, and some of the upper levels are cut by the Ease Gill valley where their choked upstream continuations are still visible in the south bank.

Cow Pot is the only significant sink on the shale margin high on Castellon Fell. Its stream descends an open vadose shaft to a washed-out shale bed along which it meanders before dropping 45 m through the roof of Fall Pot, a massive chamber formed where the old Ease Gill trunk passage has been enlarged by collapse into the streamway below. Close by, the entrance shaft of Lancaster Hole is a rift dropping 35 m into the high-level passages, and is now dry except in wet weather.

Immediately south of Ease Gill Beck, the northern end of Leck Fell is drained by the cave streams of Link Pot and Pippikin Pot (Figure 2.2). This part of the system is another complex of high-level and low-level passages connected by shafts and some descending inlets. Abandoned high-level routes of complex morphology originate under the Ease Gill valley and just south of the old trunk route through Ease Gill Caverns. They head south-west and converge on the trunk route through Pippikin Pot which is finally lost beneath the breakdown in the spacious Gour Hall (east of Witches Cave). Like its contemporary in Ease Gill Caverns, the trunk route has abandoned phreatic tubes over 5 m in diameter, collapse modified chambers, thick clastic fills and areas of spectacular calcite decorations; some parts are totally blocked by sediment and collapse. The western limb of the high levels has been breached by downcutting of the Ease Gill valley, but

a second abandoned passage provides an accessible route just beneath Ease Gill Beck where it is joined by the incidental entrance shaft of Link Pot. South of the Gill, four streams drain through young, low-level canyon passages, mostly less than 1 m wide, incised beneath the gently dipping shale horizons. The largest stream in Pippikin is the Cigalere inlet, with its long passage from sinks near the shale margin and an entrance high on the fell. This and the smaller streams find routes down joints to join the stream route from Link Pot which passes underneath on a lower shale bed. Where this water flows southeast against the dip, it is ponded into shallow phreatic loops, but it eventually descends a flooded rift to join the phreatic tunnel from Gavel Pot more than 20 m below resurgence level.

Immediately behind the Leck Beck Head resurgence, a complex area of flooded collapse and phreatic lifts obscures the confluence of the drainage from the Casterton and Leck Fell sides of the catchment (Figure 2.2). The main Leck Fell conduit appears to lie in Witches Cave, where a vertical shaft descends to a massive flooded passage which extends south at an average depth of 30 m. The nearby Pegleg Pot (Figure 2.2) contains sections of large old passage whose relationships to the other abandoned routes is unclear.

Bull Pot of the Witches contains a complex series of old high-level passages (Figure 2.2), which are abandoned phreatic tunnels extensively choked with clastic sediment. They largely follow shale beds along the axes of folds within the Dent Fault disturbance zone. Beneath them a younger vadose canyon drains into a phreatic loop through to the high-levels of Lancaster Hole; downstream of the loop, the stream cascades down a younger rift passage to reach the Ease Gill main drain just above the terminal sump. Aygill Caverns are an upstream continuation of the active and abandoned passages in Bull Pot of the Witches, but the connecting links are either choked or flooded.

Calcite speleothems from several parts of the Ease Gill caves have been dated by uranium-series analysis (Waltham and Harmon, 1977; Gascoyne *et al.*, 1983a, b; Gascoyne and Ford, 1984; Atkinson *et al.*, 1986; Baker, *et al.*, 1995a, b). Relatively few speleothems are older than 140 ka, and many post-date the main Devensian glaciation of the area, with ages less than 13 ka.

The caves of Leck Fell

A small group of deep caves are fed by streams draining off the shale slopes of Gragareth, and link into a single system of nearly 12 km of passages beneath the southern slopes of Leck Fell. The core of this system is the Leck Fell Master Cave, 1500 m long (Figure 2.2) and (Figure 2.6). Most of it is a large vadose canyon, with a phreatic roof half-tube in its downstream section, developed at a single stratigraphic horizon and draining downdip to the north and north-west. Its furthest upstream inlets are Lost Pot, with a sequence of vertical shafts, and the adjacent Box Head Pot, where a single shaft 110 m deep drops from a small shakehole directly to the streamway level. West of these, the complex Lyle Cavern High Level Series has large, old abandoned passages, choked with sediment and well decorated with secondary calcite, extending south-east and south-west towards passages in Notts Pot (Figure 2.6). The Lost Johns entrance series has a single stream canyon entrenched below a shale bed feeding a complex of rifts, canyons and deep shafts (Figure 2.5). These represent a sequence of stream routes invading a complex of tectonic fractures initially enlarged by phreatic solution. All routes rejoin at the fine waterfall shaft of Wet Pitch (Figure 2.4), from where bedding guided canyons lead to the Master Cave. Downstream, the main conduit collects further inlets, and drains through the Long Pool, a perched flooded section which retains the phreatic tube morphology; it then descends another vadose trench to the terminal sump pool, where an active phreatic tube continues to an underwater junction with the trunk conduit from Notts Pot.

Just 100 m directly above the Leck Fell Master Cave, the main streamway of Short Drop Cave is a meandering vadose canyon fed by inlets from sinks along the edge of the limestone (Figure 2.2).

It contains sections of large, old canyon partly choked by sediment and collapse, but since reinvaded and undercut by the much smaller and younger vadose stream. The old vadose passage descends into a contemporary phreatic tube at the Gavel Pot entrance. It is almost choked by sediment and collapse where it passes beneath the large dolines of Gavel Pot and Ashtree Hole. The stream flows through the chokes and continues as an underfit in the drained phreatic tunnels beyond; it then descends a series of vadose shafts to a sump which is a window into the phreatic conduit from Notts Pot.

North of the Leck Fell Master Cave, the deep shafts of Big Meanie, Death's Head Hole and Rumbling Hole are developed on a single vertical fault. In Rumbling Hole the stream descends a series of cascades towards the east, to reach a long, narrow canyon tributary to, and cut below the same inception horizon as, the Master Cave. The shafts of Death's Head Hole and Big Meanie intercept an abandoned phreatic tube aligned on the fault. Extensive clastic fills block its old inlet from Rumbling Hole and its old outlet to the abandoned high levels of Gavel Pot. A small stream flows through it, from Long Drop Cave to a choked link to its inlet in the Master Cave below.

Absolute ages have been determined for calcite stalagmites and flowstone from Gavel Pot and Lost Johns Cave (Waltham and Harmon, 1977; Atkinson *et al.*, 1978, 1986; Gascoyne *et al.*, 1983a, b; Gascoyne and Ford, 1984). All sampled material proved to be either postglacial, <13 ka, or from a period of 140–85 ka spanning the Ipswichian interglacial and the early part of the Devensian.

Ireby Fell Cavern and Notts Pot

A major cave system with nearly 12 km of passages lies beneath Ireby Fell (Figure 2.6). It swallows two small streams at the entrances of Ireby Fell Cavern and Notts Pot, collects a large flow of percolation water, and drains out under Leck Fell. Ireby Fell Cavern has a fine meandering vadose canyon which descends a series of small shafts for more than 100 m to enter a large abandoned phreatic trunk passage more than 6 m in diameter. This is choked by sediment at both ends. Its stream is an underfit, which is ponded in the shallow sump into Ireby 2, before leaving the large old tunnel in a younger passage to the north. This follows a single bedding downdip, down a vadose canyon and then down a submerged tube to a phreatic lift up a fault into the lower galleries of Notts Pot. Higher levels of abandoned phreatic passages are known in both Ireby 1 and Ireby 2, connected to the lower levels by invading inlets, including the entrance passage. One small inlet has been dye tested from the abandoned high-levels in Rift Pot (Figure 2.6).

Notts Pot contains the most complex vertical maze of closely spaced, parallel shafts in any British cave. A small stream descends 120 m through this maze, cascading down routes which change when the flow is diverted by accumulations of clastic debris. Some high-level chambers and abandoned outlets are at similar levels to the Lyle Cavern high levels above the Leck Fell Master Cave. The shafts form the entrance series, known as Notts 1, which is merely an inlet to the drainage route beneath from Ireby Fell Cavern into Notts 2 (Figure 2.6). From the terminal sump of Notts 1, a phreatic loop drains into the long stream passage of Notts 2. The upstream end of this is a fine phreatic tube which can be followed for 700 m to a knickpoint, beyond which the stream descends in a narrow vadose canyon; the whole passage follows a single inception horizon downdip to the north-west. There are many tributaries, both active and abandoned, and the cave continues through further shallow phreatic loops into Notts 3 and Notts 4.

Underwater sediment chokes prevent progress downstream from Notts 4, into the continuation reached in the bottom of Gavel Pot. At least some of the flow appears to descend to depth, guided by unknown structural features, and then rise up a vertical flooded shaft in the Gavel Pot sump, forming a spectacular phreatic lift from a depth of 64 m. The top of the lift is on a bedding horizon just below water level, and a phreatic tube continues downdip to the north (Figure 2.2). The Gavel Pot stream joins it through a shaft in its roof, and the Leck Fell Master Cave joins it in a tube on the same horizon. It continues to a depth of 25 m where it is joined by the inlet from Pippikin Pot, and the continuation to Witches Cave remains unexplored.

Interpretation

Inception and development of the caves of Leck and Casterton Fells have proceeded within a framework of close controls imposed by geological structure and lithology. The role of bedding planes in directing underground flow is seen in the predominance of vadose passages draining down the dip to the north-west; these include the numerous inlet passages draining from sinks in the Ease Gill valley into the trunk drain of Ease Gill Caverns. The Leck Fell Master Cave, the main streamway in Notts 2–4, and the flooded conduit which takes both their flows to the submerged link with the Pippikin drain, all appear to be on the same bedding horizon. This is a spectacular example of a major inception horizon; the cave only leaves it in the deep, fracture-guided, phreatic loop which has its rising segment in the Gavel Pot sump (Figure 2.7).

Beneath Leck Fell many of the vadose stream caves follow constant stratigraphical horizons, and are guided in plan where they converge on trunk routes down the axial zone of a shallow, gently plunging syncline. The control which this fold has exerted on cave development is clearly seen where the Short Drop cave system lies directly above the Leck Fell Master Cave; both drain along the fold axis, aligned just north of west, and the drainage only converges after the high-level Short Drop stream has descended deep shafts on the joints in Gavel Pot. Where the Leck Fell Master Cave originally entered its contemporary phreatic, it turned north, obliquely updip out of the synclinal trough. This created a shallow phreatic loop, only partially drained by subsequent rejuvenation and vadose entrenchment through the crest of the loop, creating the low airspace which exists today through the lake (Waltham, 1974d).

In similar style, a second shallow syncline appears to have collected the cave streams into its trough, along the line of both the Ease Gill Master Cave and the abandoned trunk passage directly above it. This is adjacent to an anticline down the line of the surface gill, south-east of which another syncline collects the drainage in Pippikin. Deeper synclinal troughs exert comparable controls over some passage locations in Bull Pot of the Witches and Aygill Cavern, adjacent to the Dent Fault. Elsewhere, the shale bands within the almost horizontal limestone influenced the development of the caves on distinct levels (Waltham, 1970), which were considered by Sweeting (1950) and Ashmead (1974b) to correlate with earlier base levels.

Fracture control of the passages and shafts is seen clearly in many parts of the cave system. Joint control is particularly well developed in the entrance series of Lost Johns Cave; the upper and lower streamways are developed along shale horizons, and a complex of active and abandoned rifts descend over 100 m between them, developed almost entirely on two intersecting systems of joints (Figure 2.6). The rifts were first partially opened by phreatic solution on the joints, far below the initial stream route which followed the upper streamway and then headed north, still following the shale beds in a continuation now totally blocked by sediment and flowstone. Rejuvenation prompted vadose drainage down through these rifts into a new streamway on the lower shale bed, and this captured the stream from above. The multitude of joints allowed frequent re-routing to form the parallel shafts and rifts seen today. The complex vertical maze of Notts Pot has also developed at the intersection of a number of joints and small faults. The influence of larger faults is clearly seen in the shafts and linear phreatic rifts and tubes along the fault through Rumbling. Hole, Death's Head Hole and Big Meanie (Figure 2.2). The deep phreatic lift between Notts and Gavel Pots is on a major fracture which is probably a minor fault.

The complexity of the cave system behind Leck Beck Head, and the presence of numerous high-level phreatic passages up to 100 m above the present resurgence, reflects a long and complex history extending well back into the Pleistocene. The Ease Gill valley appears to have been protected from deep glacial excavation by high ground to the north which prevented any major iceway developing towards the south, comparable to those in most of the Dales through the Yorkshire karst. This has restricted the proportion of old cave passages lost to glacial erosion. In the Leck Fell caves, three phases of erosion have been identified, separated by two episodes of sediment infilling (Waltham, 1974d). Each phase was characterized by vadose erosion to a greater depth in response to successively lower resurgence levels. Within each major phase, successive events can be recognized as underground captures evolved within the karst. The first erosive phase had a contemporary water table at an altitude of 290 m, identified by the vadose to phreatic transition down the Short Drop conduit into Gavel Pot (Figure 2.7). The second erosive phase correlated with a resurgence level at 225 m, only 12 m above that of the modern phase. A similar sequence could be anticipated in the caves of Casterton Fell, but Ashmead (1974b) identified only two main cycles of cave development, related to water levels found in the first and third phases recorded in Leck Fell. The intermediate level close to the present resurgence level may not easily be seen in the deep canyons at the lower end of the vadose main drain under Lancaster Hole. Evidence for the middle phase almost certainly lies in the complex of the Ease Gill inlets, but may be masked by the numerous captures and diversions controlled purely by the local geology.

The older passages include the large, abandoned, high-level, trunk route through Ease Gill Caverns, the ancient phreatic tubes forming the core of Pippikin Pot (Figure 2.2), the trunk route along the Death's Head fault, and the ancient stream canyon in Short Drop Cave which drained to the abandoned phreatic tubes of Gavel Pot (Figure 2.7). Another ancient conduit now forms the large, partially drained tunnel through Ireby Fell Cavern; this appears to have carried the main drainage from an old, high-level, ancestral Kingsdale through the large tunnels of Large Pot, and also from the old Marble Steps sink (Figure 2.5). The outlet of this route, north-west of its choke in Notts 2, was probably to a rising close to the Dent Fault, now obscured beneath the glacial till south of Leck Beck Head. It appears to have been abandoned when the

more rapid Pleistocene deepening of Kingsdale, where it crosses the Craven Faults, diverted the flow to Keld Head.

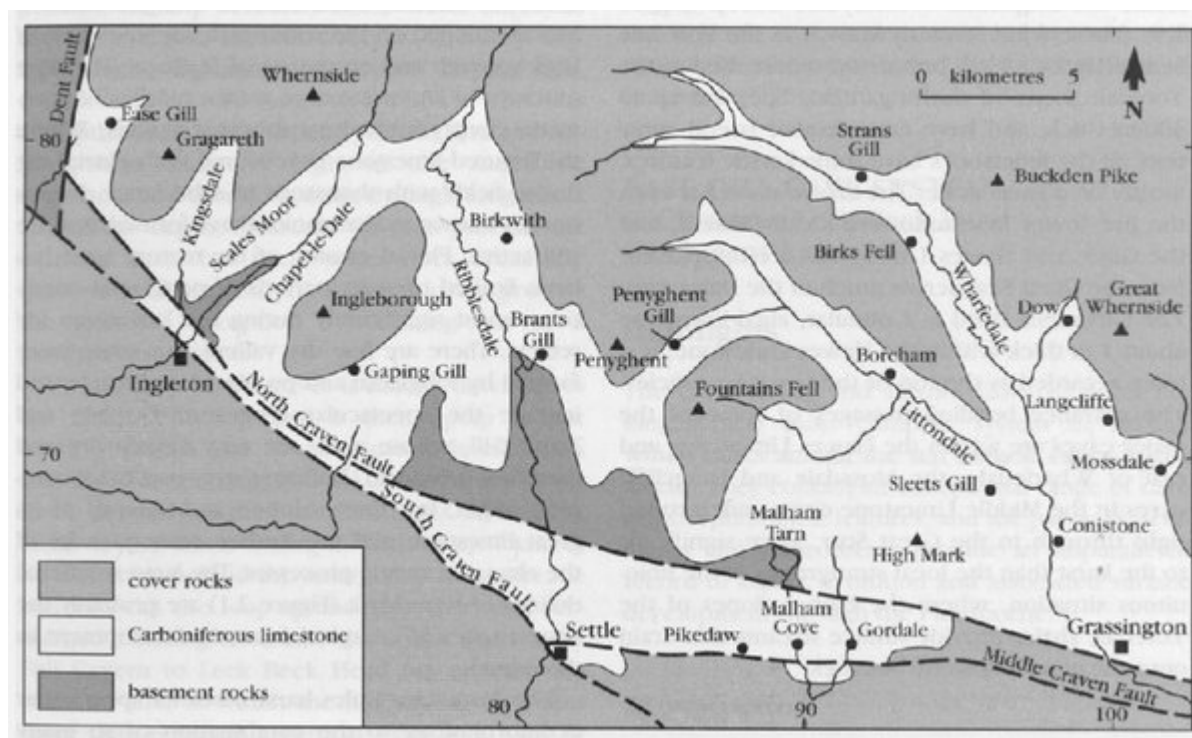
By analogy with other sites, the abandoned, high-level, trunk caves under both Leck and Casterton Fells are likely to be at least half a million years old. Most of the dated stalagmites are much younger, from a major phase of deposition spanning 60–140 ka, though this included several long interruptions. Two flowstones from the high level in Ease Gill Caverns show only that this route was abandoned by 290–350 ka, and it was probably drained long before this. More significant are the flowstones in the Leck Fell Master Cave, which show that the resurgence was no more than 12 m above its present level at an age of about 115 ka. Since about 300 ka, the maximum rate of mean surface lowering in the Ease Gill Valley appears to have been only 0.2 m/ka (Waltham, 1986).

There are clear gaps in the recorded periods of calcite deposition within the caves, and there are also interruptions to the growth patterns in many sectioned samples. Calcite deposition was widespread during the Ipswichian interglacial, between 140 and 85 ka, but speleothem hiatuses show that the high-level main passage of Ease Gill Caverns was filled or flooded at least once between 200 and 140 ka. Detrital layers also show that deposition was interrupted, probably by flooding, in the Lyle Cavern high-levels between 128 and 123 ka. Baker *et al.* (1995b) have found a remarkably good correlation between the timing of speleothem growth in Lancaster Hole and periods of maximum solar insolation during the last 130 ka; the main periods of deposition were at about 130, 85 and 60 ka. Erosion of speleothems indicates that the lower part of the caves was again in the phreatic zone between 85 and 38 ka, and there was major flooding and reworking of the cave sediments during the latter part of the Devensian, at 35–12 ka. These details of the cave geomorphology are evidence of the climatic fluctuations of the late Pleistocene; in this case, these appear to have influenced the stalagmite deposition largely by variations in recharge rates through the vadose aquifer (Baker *et al.*, 1995b).

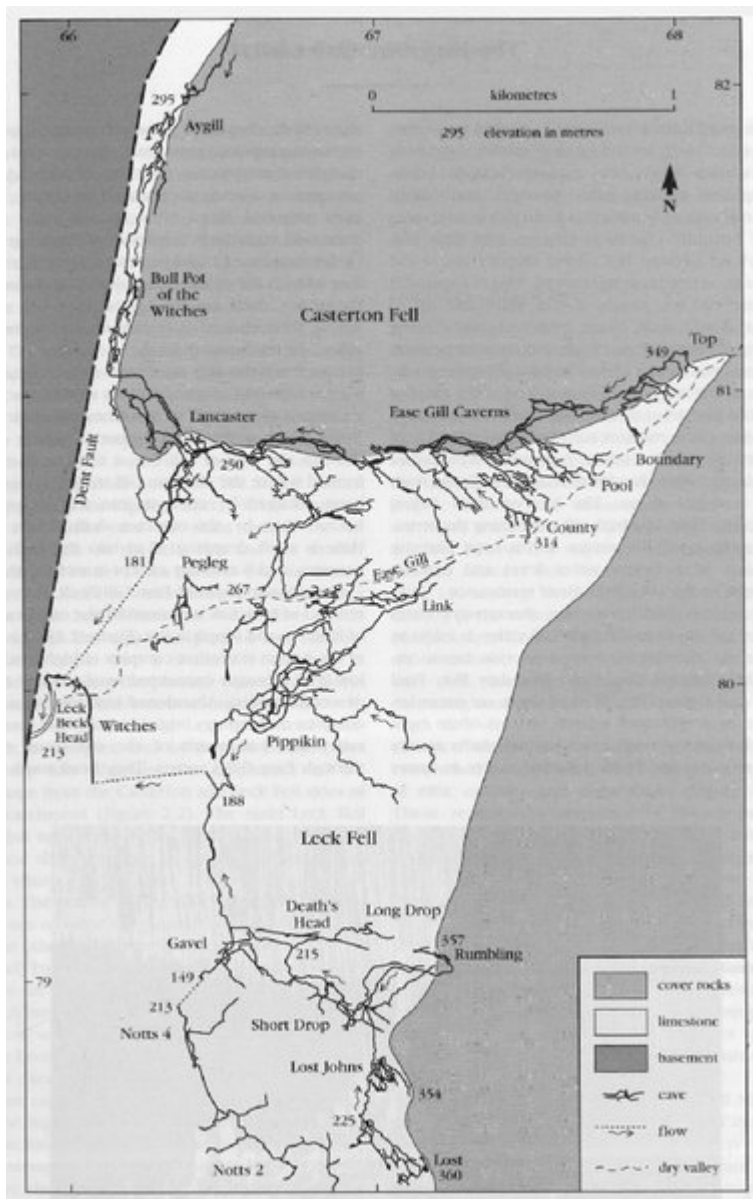
Conclusion

This site contains the largest and most complex dendritic cave system in Britain, containing splendid examples of almost every type of cave morphology. The caves exhibit a clear influence by a variety of geological factors. The evidence from cave morphology, configuration, sediment and speleothem content is extremely important in studies of the Pleistocene history of the northern Pennines.

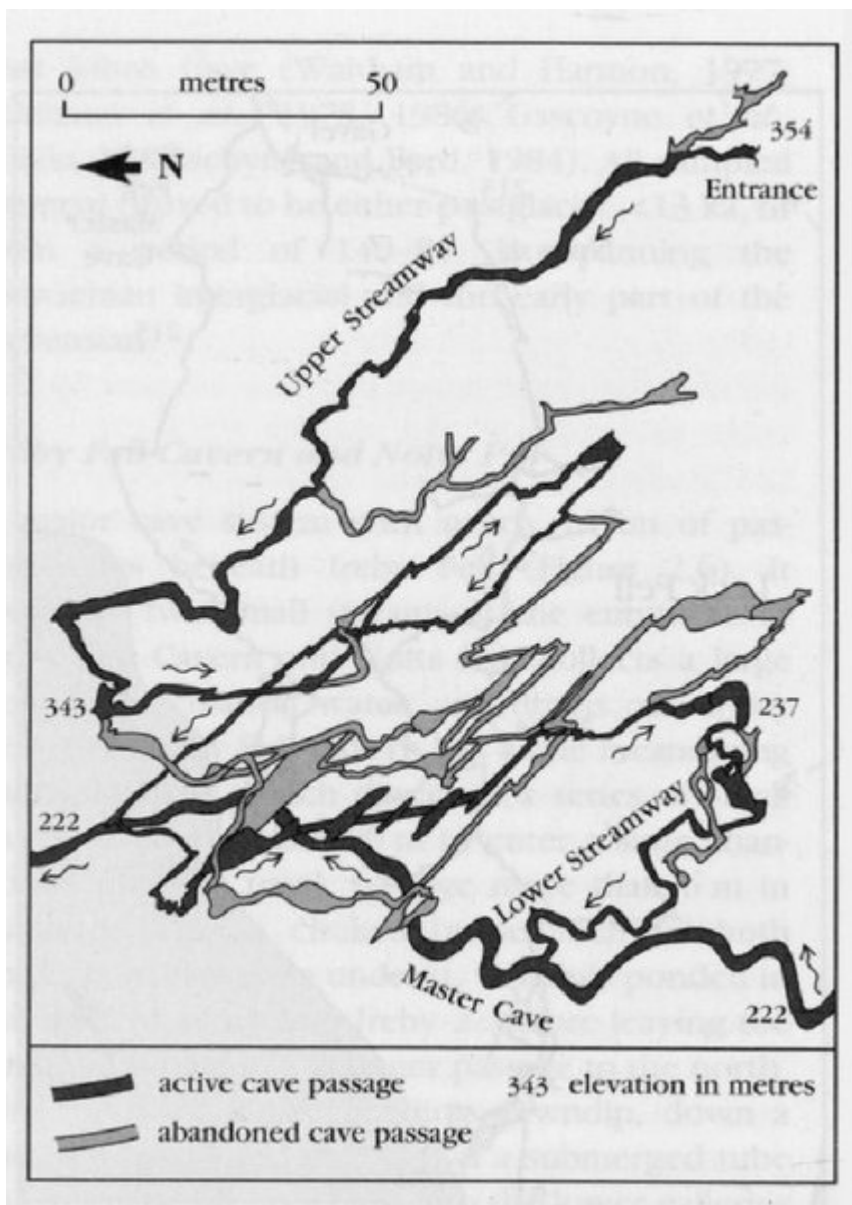
References



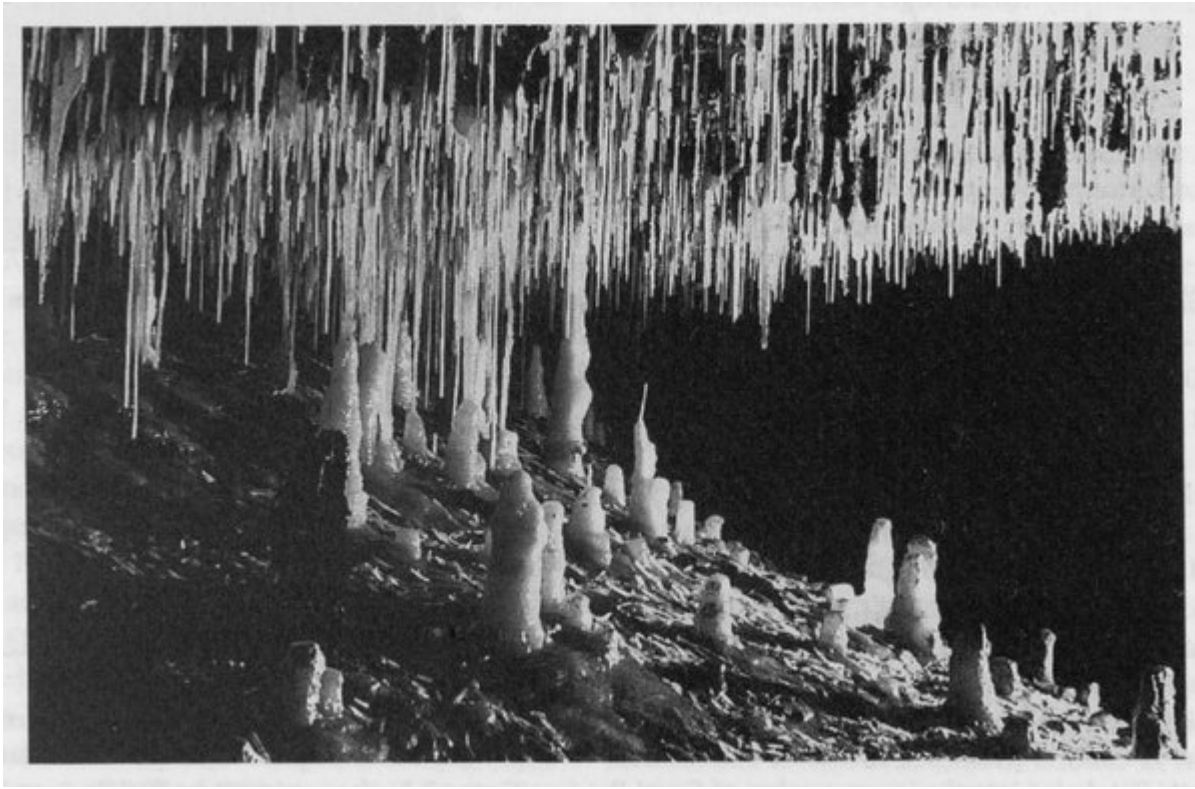
(Figure 2.1) Outline map of the Yorkshire Dales karst, with locations referred to in the text. The Carboniferous limestone shown includes all the Great Scar Limestone (Kilnsey, Cove and Gordale Formations) and also the lower Yoredale limestones (of the Wensleydale Group) where they are hydrologically 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.



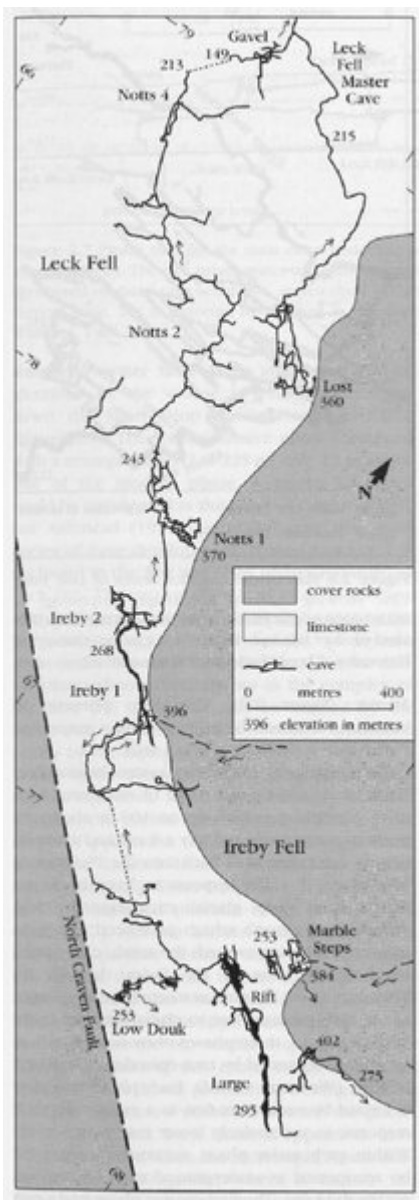
(Figure 2.2) Outline map of the Ease Gill Cave System. Limestone is the Great Scar Limestone. Basement rocks are Silurian clastics only exposed west of the Dent Fault. Cover rocks are Yoredale and Namurian shales and sandstones. Notts Pot drains into the lower reaches of Gavel Pot (see Figure 2.5) (from surveys by Red Rose and Happy Wanderers Caving and Potholing Clubs, Northern Pennine Club, Cave Diving Group and many others.)



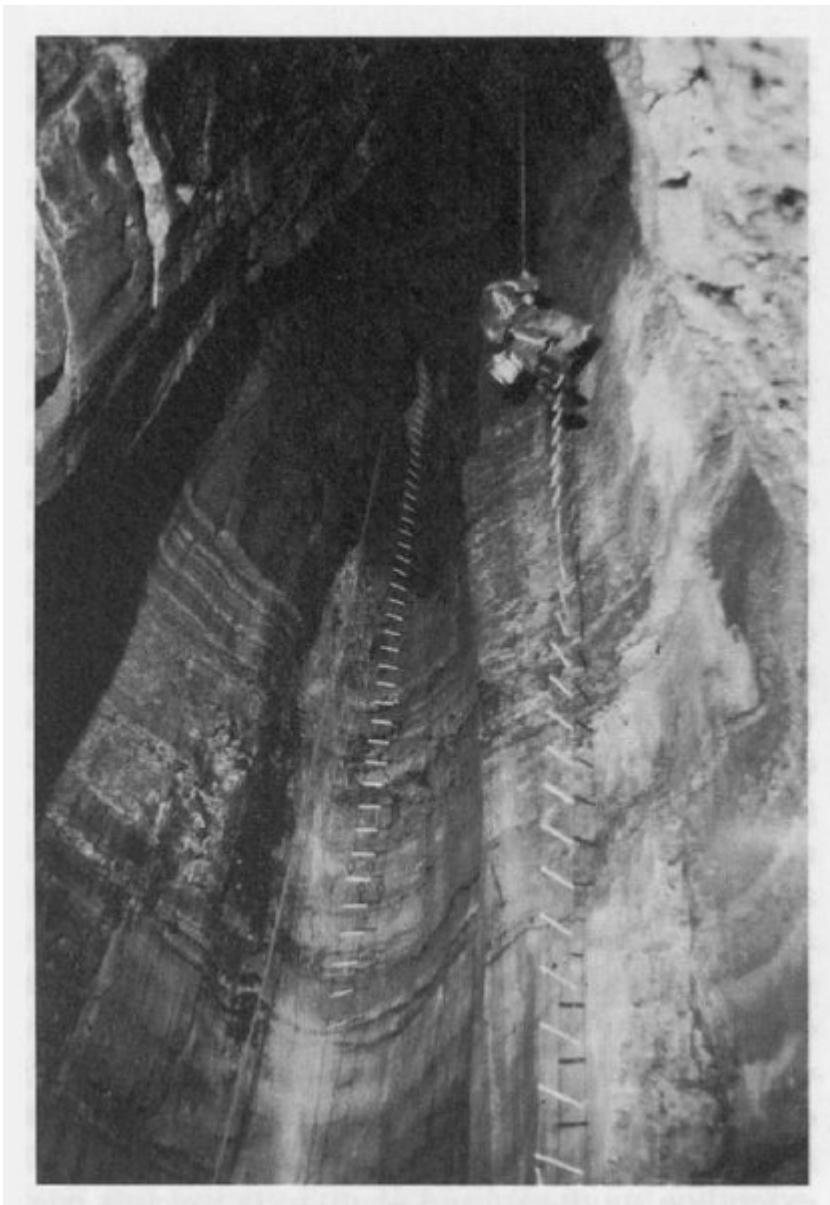
(Figure 2.6) Map of the Entrance Series of Lost Johns Cave showing contrasts in passage morphology on shale horizons and joints, as described in the text (from surveys by London University Caving Clubs and University of Leeds Speleological Association).



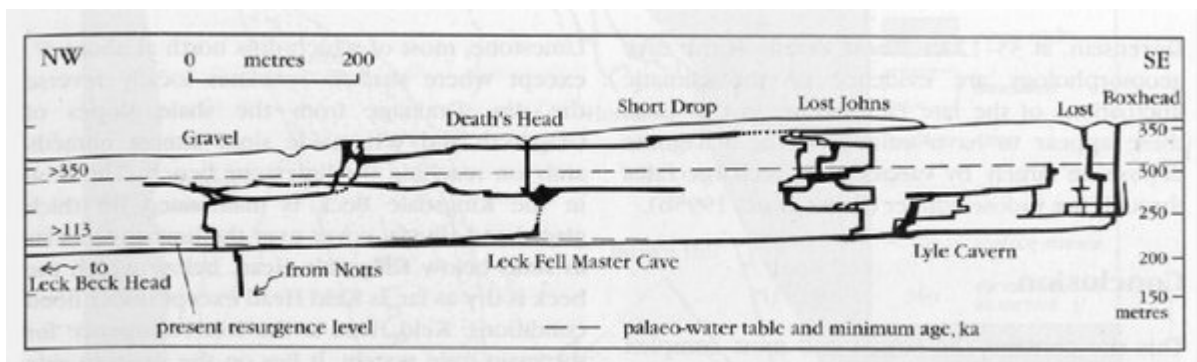
(Figure 2.3) Straw stalactites and short stalagmites form a spectacular display in Easter Grotto, part of the high-level passages in Ease Gill Caverns. (Photo: A.C. Waltham.)



(Figure 2.5) Outline map of the cave systems under the southern flank of Gragareth. Ireby Cavern and Notts Pot drain north into the Ease Gill Cave System, joining the water from the Leck Fell Master Cave, where the high-level passages in Lost Johns and Short Drop Caves have been omitted for clarity (see Figure 2.2); Marble Steps and Large Pot drain east to Keld Head (see Figure 2.8) (from surveys by Northern Pennine Club, Northern Cave Club and others).



(Figure 2.4) A few horizontal bedding planes score the cleanly washed walls of the waterfall shaft at Wet Pitch in Lost Johns Cave. (Photo: A.C. Waltham.)



(Figure 2.7) Profile through the main caves under the southern part of Leek Fell, with many passages omitted to improve clarity. The two palaeowater tables are recognized from the cave morphology, and are ascribed minimum ages based on dated cave sediments, as described in the text. The horizontal scale is approximately the same as the vertical scale, but is distorted by changes in the direction of projection. (After Waltham and Hatherley, 1983; Waltham, 1986.)