Kingsdale caves

[SD 69 76]–[SD 70 79]

Highlights

The long and deep, dendritic cave system under Kingsdale contains four drainage routes which have been followed and mapped for the whole way from their sinks to the single resurgence. These include influent caves on both sides of the deep glaciated valley, and one trunk route passes completely beneath the valley floor. The lowest level of the cave system include the longest series of submerged passages known in Britain.

Introduction

Kingsdale is one of the smaller of the Yorkshire Dales, cut into the limestone due north of Ingleton (Figure 2.1). It is notable for the very fine caves which lie under the limestone benches of both flanks and also beneath the valley floor, many of which are connected into a single underground drainage system feeding the resurgence of Keld Head. Kingsdale is a straight, glaciated trough descending gradually from the north towards the scarp of the Craven Faults. The valley is floored by clastic sediment up to 20 m thick, deposited as an alluvial sheet grading into the lake sediments which accumulated behind a late Devensian retreat moraine; this barrier lies at the southern end of the dale, and is breached by a postglacial ravine.

The Kingsdale trough is cut into the Great Scar Limestone, most of which dips north at about 3°, except where shallow synclines locally reverse the dip. Drainage from the shale slopes of Gragareth and Whernside sinks almost immediately on reaching the limestone bench. The flow in the Kingsdale Beck is maintained on thick glacial and alluvial cover over the limestone as far as sinks below Kingsdale Head, below which the beck is dry as far as Keld Head except under flood conditions. Keld Head is the sole resurgence for the main cave system; it lies on the western side of the alluviated valley floor, close to the base of the limestone.

Comprehensive descriptions of the Kingsdale caves include those of West Kingsdale by Brook and Crabtree (1969a) and Brook (1971b), of the flooded passages behind Keld Head in Monico (1995), of some of the East Kingsdale caves by Gascoyne (1973), of Rift Pot by Davies (1984) and of all the cave passages in Brook *et al.* (1994). The development of Kingsdale and its caves has been discussed by Brook (1969, 1971b, 1974a), and Waltham *et al.* (1981). The chronology of the cave and valley development was discussed in the light of dated cave sediments by Waltham and Harmon (1977), Atkinson *et al.* (1978) and Waltham (1986), and further dates were published by Gascoyne *et al.* (1983a, b) and Gascoyne and Ford (1984). Aspects of the geology and geomorphology of the caves have been discussed by Waltham (1970, 1971a, 1974c), Lowe (1992b) and Halliwell (1979b).

Description

More than 35 km of passages have been mapped in the cave systems beside and beneath Kingsdale. The cave passages fall into four groups: the largely integrated caves of West Kingsdale, the influent caves under the eastern bench of Kingsdale, the submerged conduits in the phreas behind Keld Head, and the more isolated caves to the west around Marble Steps Pot.

West Kingsdale Cave System

The dry weather flow of Kingsdale Beck is lost into choked sinks near the head of the glacial trough, and is next seen in an active phreatic conduit east of Rowten Pot (Figure 2.8). This follows the bedding updip, into a partially drained series of canals, and then into the head of the West Kingsdale Master Cave. This is a splendid vadose canyon up to 7 m deep and 2 m wide below a phreatic roof tube 5 m in diameter (Figure 2.9). The roof tube follows the bedding updip so that the

vadose canyon, descending over a series of small cascades, becomes more deeply entrenched downstream. Where the stream enters a sump pool at the start of the flooded conduits behind Keld Head, the roof tube continues south as an abandoned tunnel, to where it has been truncated by the glaciated flank of Kingsdale at Valley Entrance. Flowstone from the Roof Tunnel has been dated at 320 -168 ka, but not yet with enough detail and accuracy to ascribe it to a sequence of Pleistocene stages. Divergent, abandoned tubes extend west of Valley Entrance, and intercept one vadose inlet well decorated with calcite speleothems, before becoming choked.

The main conduit beneath West Kingsdale is joined by inlets from a line of sinks along the shale margin on the limestone bench which stands 60–130 m above the dale floor. The most northerly of these is Yordas Cave, where a stream cascades down a series of rifts into the Main Chamber, 55 m long and 15 m wide, containing remnants of calcite-cemented sediments high on its walls. Its water joins some flow from sinks in Kingsdale Beck and drains into a long active phreatic tube passing beneath Bull, Jingling and Rowten Pots, before emerging in canals at the head of the Master Cave (Figure 2.8). Bull Pot has a series of narrow rifts choked at their southern outlet. Jingling Pot is a large open vadose shaft, 67 m deep, choked close to a high aven in a roof window to the phreatic conduit beneath. The high-level vadose canyons of Jingling Cave and Rowten Cave converge in the trough of a shallow syncline, where they drain into Rowten Pot. Developed along major north-south fractures, this is an open shaft system 105 m deep; it joins the low-level conduit almost at the point where drainage by the knickpoint at the head of the Master Cave canyon has created an airspace in the phreatic tube. Simpson's Pot has shallow vadose canyons on high-level shale beds draining to a shaft system, which descends to a partially drained phreatic tube tributary to the Master Cave. Swinsto Hole also has a long passage on the high-level shales, before a staircase of waterfall shafts and a descending rift lead to the partly drained tube to the Master Cave shared with the Simpson's water (Figure 2.10).

Caves of East Kingsdale

Most drainage from the limestone bench on the east side of Kingsdale collects underground in the East Kingsdale Master Cave (Figure 2.8). This is very similar to its parallel west of the dale, as it has a long phreatic tube, following the bedding and draining updip from the north, into the head of a vadose canyon up to 5 m deep and wide beneath a roof tube. The canyon descends to a sump pool where the roof tube drops down joints into the phreatic zone behind Keld Head.

On the limestone bench above, Brown Hill Pot has descending rift passages draining to the south, against the dip, along a major fracture; a flooded tube then drains north from a sump pool level with its outlet in the Master Cave (Figure 2.8). The flooded conduit upstream from the Master Cave has a branch carrying water from choked sinks in the floor of Kingsdale. Spectacle, Vesper and Growling Pots all have short passages on high-level shale beds, and deep shafts on fractures which descend to chokes close to the Master Cave level. King Pot has a long sequence of small shale-guided, downdip canyons, shafts and narrow rifts descending 120 m to a drained phreatic tube which joins the roof tube of the Master Cave.

Crescent Pot is another immature system of small stream passages whose link to the submerged main drain is unknown.

Away from the central group of potholes, Heron Pot has stream canyons entrenched below shale beds and draining downdip, linked by joint rifts which drain back to the south as they cut down through the bedding (Figure 2.8). Dale Barn Cave has a series of partly drained phreatic tubes and small vadose canyons, draining east at low level beneath Scales Moor into Chapel-le-Dale (Figure 2.11); sediment chokes block the old passages beneath the eastern flanks of Kingsdale, and Illusion Pot provides an entrance through joint rifts.

Keld Head Cave System

The phreatic zone behind Keld Head has a system of 7.5 km of converging and looping passages all below water level (Figure 2.8). The trunk conduit from the West Kingsdale Master Cave follows the bedding updip, except at three points where it steps down joint-guided shafts (Figure 2.10); the final section before the resurgence has developed along a series of parallel calcite veins. Passage morphology varies from elliptical phreatic tubes, up to 8 m wide and 3 m high, to wide and low bedding plane passages. Fine silts cover the floor in many places; elsewhere the floor is bare rock or scattered with cobbles derived from choked inlets. Close behind the Keld Head resurgence, tributaries from the west

carry the drainage from Marble Steps Pot and its adjacent caves; these phreatic tubes form a series of loops not yet fully explored.

The flooded shaft below the East Kingsdale Master Cave drops 35 m to reach the bedding plane which the conduit then follows to the south-west, to connect with the main Keld Head phreas (Figure 2.8). This passes beneath Kingsdale in the 20–30 m of limestone that remains between the glaciated rockhead and the underlying basement rocks.

Caves of the Marble Steps area

The southern slopes of Gragareth, west of Kingsdale (Figure 2.1) are underlain by cave passages including those of Marble Steps Pot, whose streamways drain to Keld Head. Marble Steps Pot is a massive sinkhole which swallows a large moorland stream in times of flood (Figure 2.5). An upper series of chambers, rifts and shafts are developed on a series of hading fractures, and contain extensive fluvioglacial sediments which choke their outlet. A series of smaller, joint-guided rifts and shafts further to the south-west drop to a deep flooded rift at the same level as Keld Head.

Large Pot has a small streamway descending a series of immature vadose rifts and vertical shafts to a sump, which also drains to Keld Head. An abandoned distributary extends south to meet another streamway, which drains through a series of narrow rifts to a magnificent circular shaft 46 m deep into the large, old chamber of Necropolis. This is a section of abandoned, phreatic, trunk passage containing thick banks of clastic sediments. It continues north-west, beyond a series of boulder chokes, into another large chamber which can be reached by a 60 m deep shaft from the narrow entrance rifts of Rift Pot (Figure 2.5). Passages heavily choked with sediment and collapse extend westwards to intercept another old phreatic trunk route 3–4 m in diameter. This is choked in both directions, but a stream sinking in its floor has been dye tested to an inlet in Ireby Fell Cavern.

Low Douk Cave has a meandering vadose canyon draining to a sump pool level with Keld Head (Figure 2.5). It has intercepted several sections of large, abandoned vadose and phreatic passage, one of which terminates at a choke close to the old passages in Rift Pot.

Interpretation

The Kingsdale caves clearly show the geological control on their inception and development. The vadose canyons were initiated on bedding planes and shale beds, and therefore drain down the dip. This is roughly to the north except where local folding is stronger than the regional dip around Rowten and Simpson's Pots. Canyon streamways converge in the troughs of two shallow synclines, before finding fractures which allow them to drop to lower levels (Waltham, 1970). Most phreatic trunk passages are also developed along the bedding, except where they gain depth by dropping down joints to reach lower bedding planes. They then drain gently updip, following the hydraulic gradient to the south towards the lower ground and lower resurgence sites. Most of the bedding planes, which were the inception horizons for the caves, contain thin beds of shale; these are seldom seen in surface exposures, but their stratigraphical distribution underground adds an extra component to interpretations of cyclicity in the limestone deposition, and also accounts for levels of cave development unrelated to erosion levels (Waltham, 1971a, b).

Joints have determined the location of many cave passages, including the series of rifts in Marble Steps Pot and the zig-zag course of Heron Pot. The large vadose shafts and rifts in the potholes of East Kingsdale are developed on faults; many other shafts, including the sequence in Rowten Pot, are aligned on joints, which allow streams collected on the higher shale beds to drop down to the level of the main phreatic trunk passage. Joints have also influenced the phreatic flows, notably within the Keld Head phreas, where the passages drop down joint-guided shafts to lower bedding planes.

The section of the West Kingsdale Cave System between Swinsto Hole and Keld Head has been proposed as the type site for cave development in the Yorkshire Dales karst (Waltham *et al.,* 1981). The route from sink to rising is completely explored and mapped, and contains all the main types of cave passage: a vadose canyon drains downdip on shale beds, to shafts and a rift on joints, through old caves just below an ancient water table, down into a partially drained phreatic zone with canyons entrenched in tube floors, and into an active phreatic conduit largely updip on the bedding (Figure 2.10).

The sequences of abandoned high-level passages show that the Kingsdale caves have had a long history extending well back into the Pleistocene. Their development is linked to that of the adjacent Ease Gill caves, and to the fluvial and glacial excavation of the Kingsdale valley.

The oldest cave passage in Kingsdale appears to be the large abandoned phreatic conduit through the lower levels of Large and Rift Pots; it is likely that Marble Steps Pot was a major tributary sink into these passages. For much or all of their history, they drained to the north-west, through Ireby Fell Cavern, to an ancient resurgence in the lower Ease Gill valley. During subsequent glacial episodes, these passages and their resurgence have been largely or wholly choked with glaciofluvial clastic sediment. Parts of this trunk route were later invaded by smaller vadose streams, which now drain through lower outlets to both Keld Head and Leck Beck Head. This cave carried water sinking in an immature proto-Kingsdale whose floor was still well above the 300 m level of the passage in Large Pot. There were also inlet caves from sinks along the shale margin around Kingsdale, but only fragments of these abandoned passages are now seen at high levels intersected by the modern stream caves. It is conceivable that an even earlier stage had underground drainage from Gragareth feeding to a resurgence in Chapel-le-Dale, which is a much lower and older valley. If this route existed, the Rift–Large passage first carried a flow to the south-east, and the downstream conduits have either been eroded away by surface retreat on Twisleton Scar End, or remain undiscovered beneath Scales Moor.

During the Pleistocene Ice Ages, Kingsdale carried a major ice flow from the north and was deepened much more rapidly than the sheltered Ease Gill valley. The outlet to the Ease Gill resurgence was therefore abandoned in favour of new resurgences where the entrenched Kingsdale approached the Craven Fault scarp (Figure 2.1). The enlarged limestone catchment around the deeper Kingsdale supplied drainage to the developing low-level trunk routes, which are still at the core of the cave system. The sequence and levels of the resurgences in Kingsdale are largely unknown, but one old outlet was subsequently truncated at the Valley Entrance by deepening of the glacial trough. A later, lower route was out through Keld Head. Either or both of these truncated conduits could have continued beneath Scales Moor, perhaps through parts of Dale Barn Cave (Figure 2.11). Truncation by the side of the dale at Keld Head rejuvenated the first fractures upstream to rise above the new lower outlet level — and the West and East Master Caves were entrenched by knick-point retreat in the two main conduits.

Calcite flowstone from the Roof Tunnel, inside the West Kingsdale Valley Entrance, has been dated to 168, 230 and 239 ka (Gascoyne and Ford, 1984; Waltham, 1986). These indicate that this passage was abandoned and the outlet to Keld Head was active by late Hoxnian times, if not before. This then implies that there was very little glacial deepening of Kingsdale in the post-Hoxnian and Devensian stages. The glacial trough is fresh and uneroded, but its large lateral and retreat moraines may indicate that there was more deposition than erosion during the Devensian. The caves would have been flooded or inactive while ice occupied Kingsdale, and the low levels were temporarily flooded when the lake was impounded behind the retreat moraine. A more detailed chronology of the successive deepening of Kingsdale and the evolution of its caves cannot yet be established.

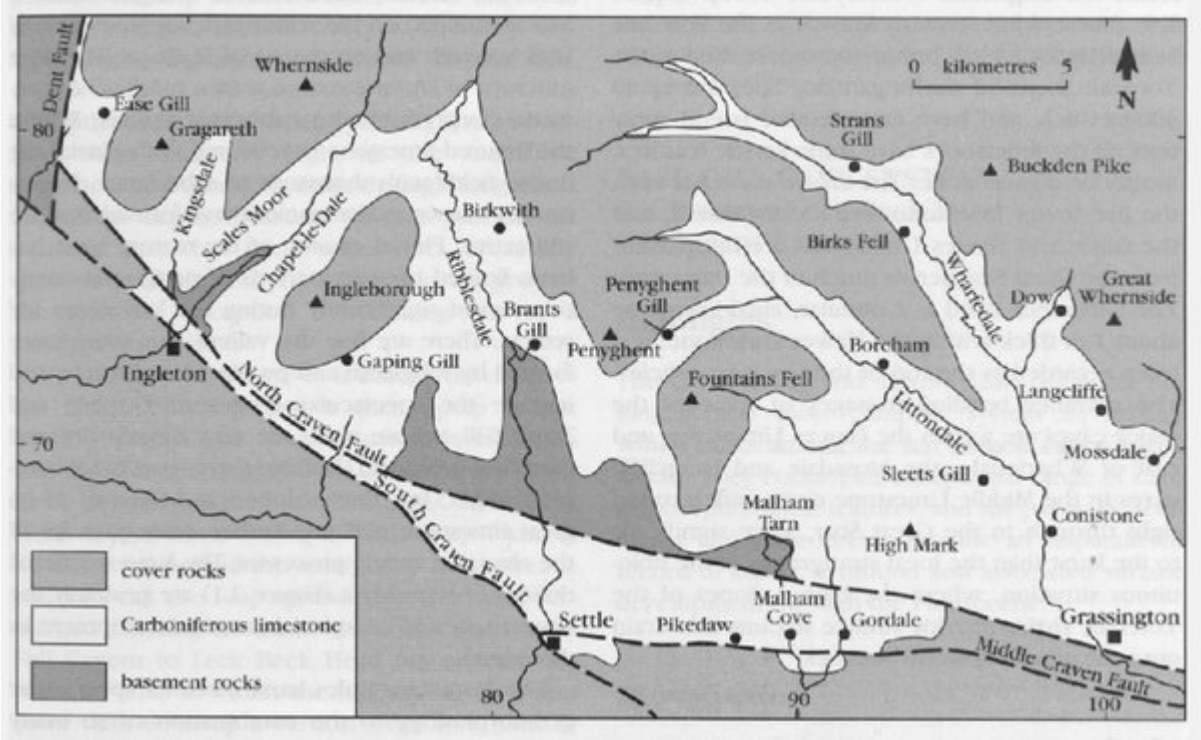
The history of Dale Barn Cave is unclear, and there are old abandoned passages at both ends of the system which relate to early phases of the drainage of both dales. The main passage is at low level, and appears to represent recent drainage from Kingsdale towards a lower resurgence in Chapel-le-Dale, when the latter was deepened more rapidly by larger ice flows in the Devensian and perhaps earlier glaciations.

Conclusion

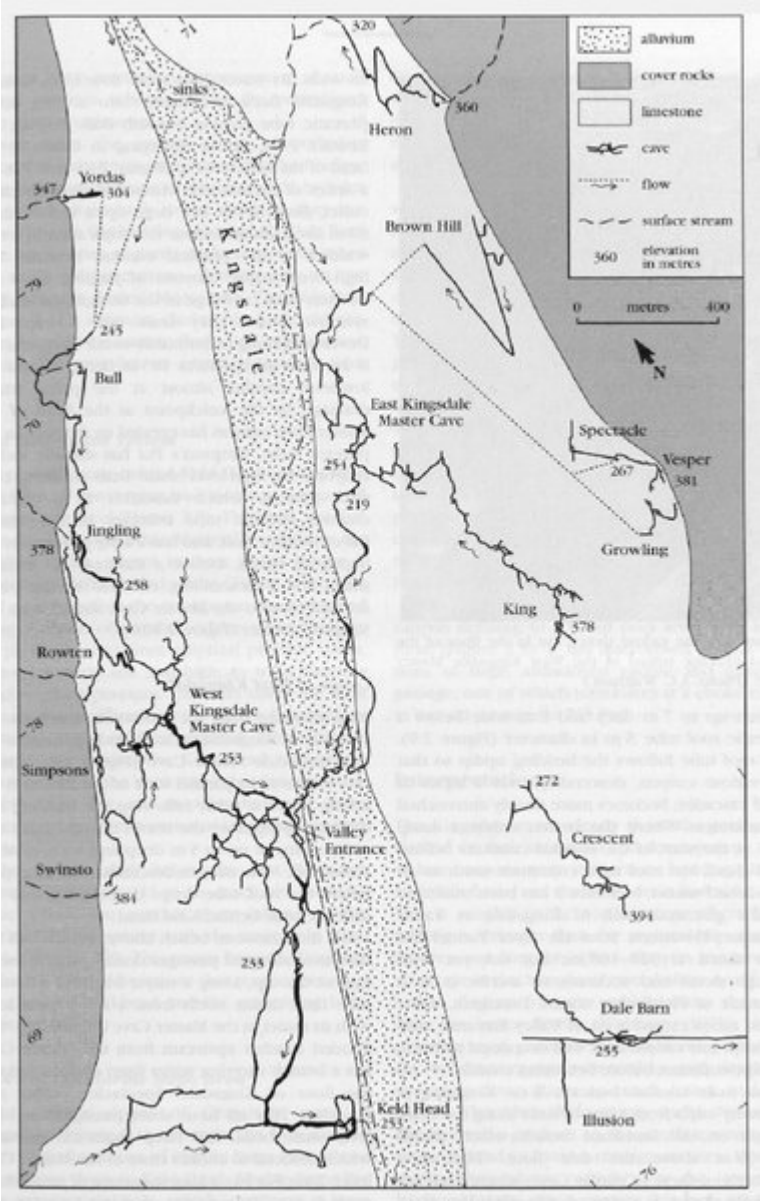
The caves of Kingsdale include the drainage route from Swinsto Hole through to Keld Head; this contains elements of vadose, phreatic and rejuvenated passages, and is completely mapped from sink to rising; it is the type example of cave development in the Yorkshire Dales. The 24 km of cave passages include a conduit which passes beneath a major valley, and the 7.5 km within the active phreas constitute the longest flooded cave system known in Britain.

The caves also represent past and present drainage links between Kingsdale and its neigh bours, Chapel-le-Dale and the Ease Gill valley, and these provide evidence of the contrasting glacial histories of the three valleys.

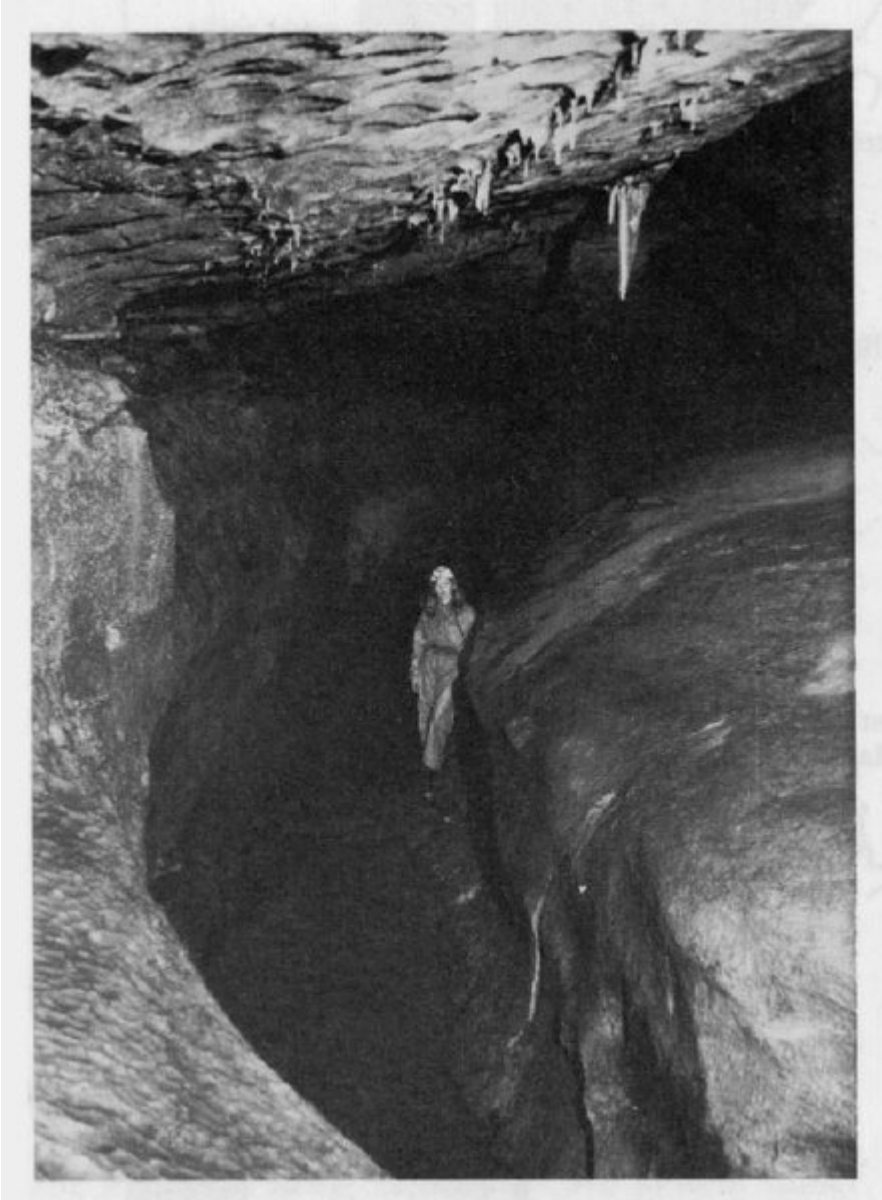
References



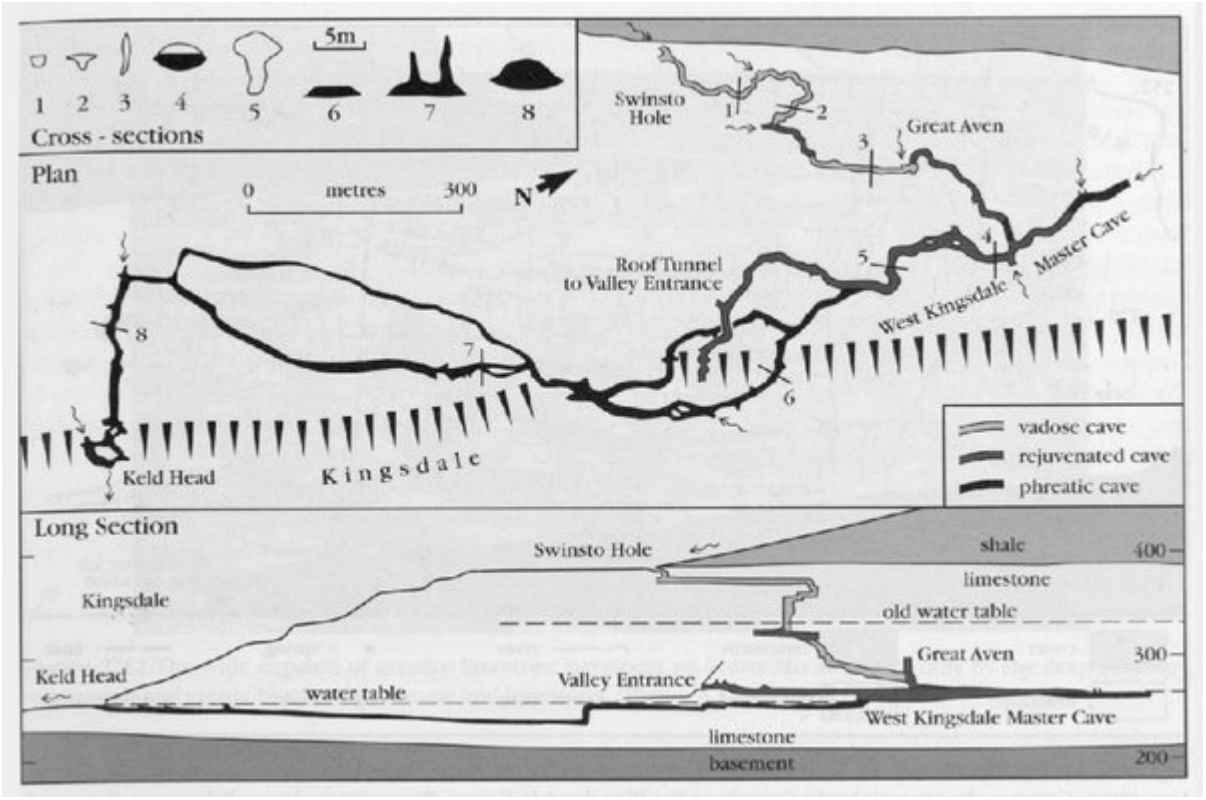
(Figure 2.1) Outline map of the Yorkshire Dales karst, with locations referred to in the text. The Carboniferous limestone shown includes all the Great Scar Limestone (Kilnsey, Cove and Gordale Formations) and also the lower Yoredale limestones (of the Wensleydale Group) where they are hydrologically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



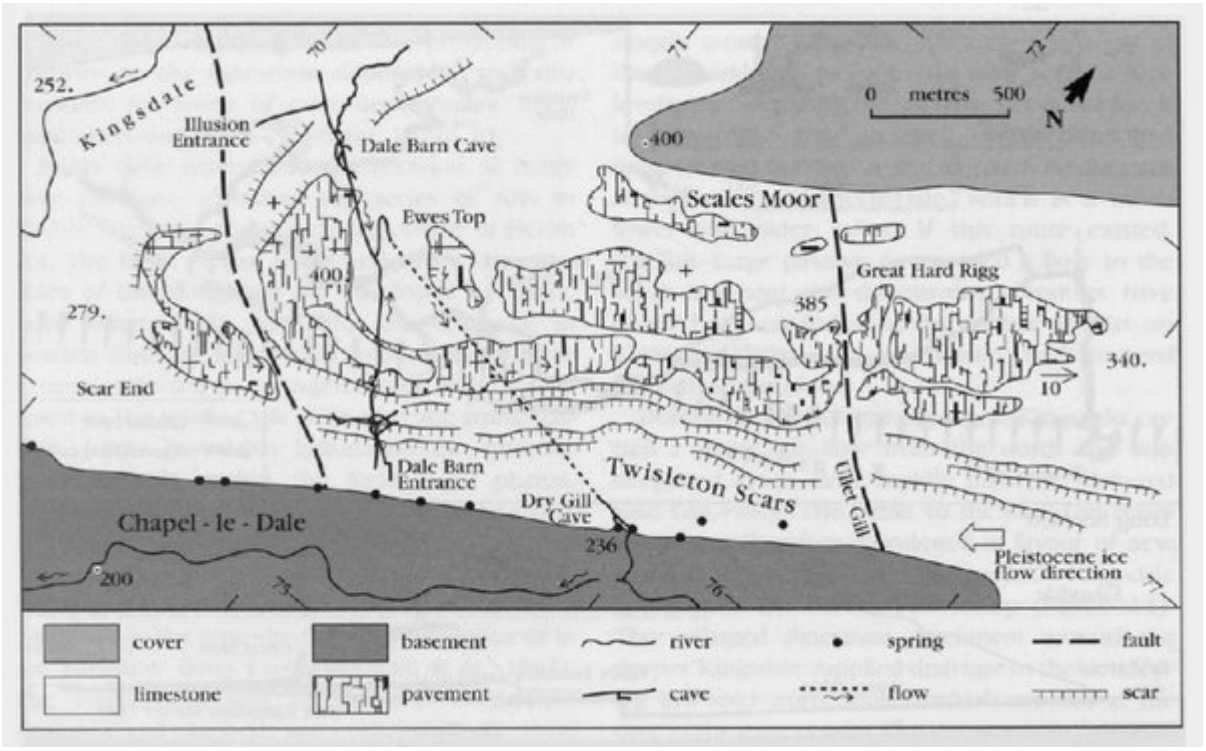
(Figure 2.8) Outline map of the caves of Kingsdale. These include 7.5 km of caves behind Keld Head, at the southern end of the system and beneath the valley floor, which are totally flooded (from surveys by University of Leeds Speleological Association, Cave Diving Group and others).



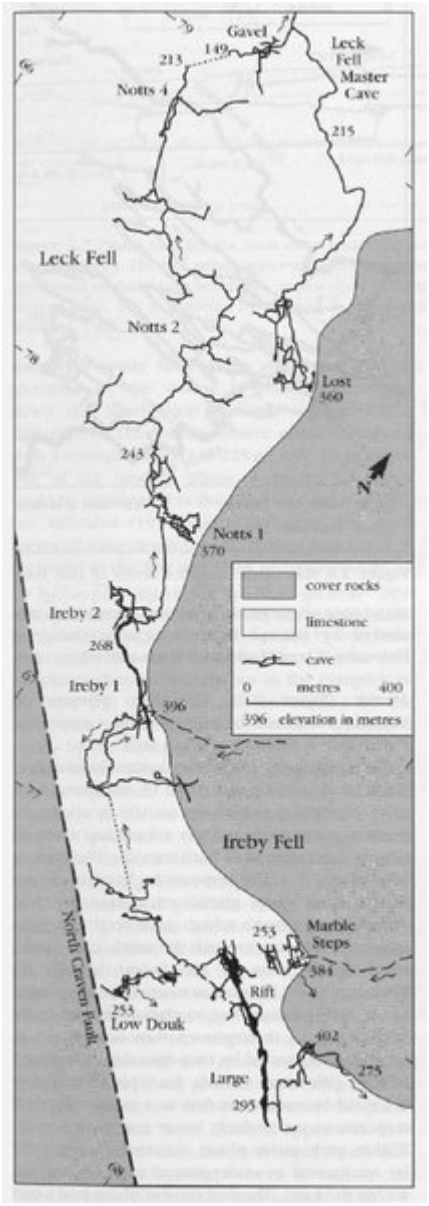
(Figure 2.9) The vadose trench cut in the floor of the broad phreatic tunnel in the West Kingsdale Master Cave. (Photo: A.C. Waltham.)



(Figure 2.10) Swinsto Hole to Keld Head, the type example of a Yorkshire Dales cave, and part of the Kingsdale cave system. Only the main passages along the underground drainage route are shown; there are additional vadose inlets, abandoned passages and phreatic loops. The vertical scale of the long section is exaggerated by a factor of 1.5. (Mainly after Waltham et al., 1981.)



(Figure 2.11) Geological map of Scales Moor. The limestone is the Great Scar Limestone, including the Hawes Limestone. Cover rocks are mainly clastic units in the Wensleydale Group. Basement rocks are Palaeozoic slates and greywackes. Only the larger areas of pavement are marked, and there are thin strips of pavement along the crest of nearly all the scars. Dale Barn Cave lies close to the base of the limestone, about 150 m below the main limestone pavements (cave survey from Northern Cave Club).



(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).