Castleton caves

[SK 099 813]–[SK 149 826]

Highlights

The Castleton area contains the most extensive and complex karst drainage system in the Peak District of Derbyshire. It exemplifies a style of drainage unique to this area; draining from both stream sinks and percolation sources, via deep phreatic conduits guided by mineral veins, to linked vauclusian risings. Within the confines of this site are contained a record of nearly one million years of landscape development.

Introduction

The limestone plateau around Eldon Hill is drained by the most extensive cave systems in the Peak District; the resurgences are in the Peak Cavern gorge behind Castleton. The Carboniferous limestone, of Asbian and Brigantian age, forms a reef complex along the northern boundary of the site, with lagoonal carbonates and thin interbedded basalt lava flows to the south. Large east–west mineral veins, or rakes, traverse the limestone and have, in the past, been worked for lead and zinc ores. Both the reef and lagoonal facies are penetrated by the caves, and the mineral veins are also utilized by the underground drainage. Streams flowing from the impermeable shale slopes of Rushup Edge feed a line of sinkholes along the north-western edge of the limestone outcrop. This allogenic water, joined by autogenic input, passes beneath the topographic divide and resurges from vauclusian risings in the Peak-Speedwell cave system in the floor of Hope Valley.

An extensive literature has been published on the caves and hydrology of this area (T.D. Ford, 1966b, 1969, 1977b, 1986a, b; Christopher, 1980, 1984; Christopher *et al.,* 1981; Christopher and Wilcock, 1991; Ford and Gunn, 1992), with other work by Pitty (1971) and Johnson (1967). A thematic issue on the Peak-Speedwell Cave System was published as Volume 18, Number 1 of *Cave Science* (Ford, 1991). Descriptions of all of the caves are given by Gill and Beck (1991), with more detailed accounts of specific parts of the system in Cordingley (1986, 1988, 1989), Ford (1956), Proudlove (1985), Salmon (1956, 1959), Salmon and Boldock (1951a, b), Shaw, R. P. (1983), Smith and Waltham (1973), Westlake (1967) and Wright (1987). Recent major discoveries have been described by Nixon (1991, 1992) and Beck (1991). Data on speleothems and sediments have been published by Ford *et al.* (1983), Thistlewood and Noel (1991) and Murphy (1993), and the underground hydrology is summarized by Gunn (1991) and Bottrell and Gunn (1991).

Description

The caves of the Castleton area represent parts of a single, though complex, hydrological unit (Figure 4.2). The accessible sections of cave passage fall into three distinct groups, which are linked by inaccessible passages, flooded or choked with sediment.

Sinkhole caves below Rusbup Edge

Twelve sinks lie along the limestone–shale boundary to the east of Perryfoot. Short sections of accessible cave passage are associated with some of these but only at two can access be gained to more extensive systems. The westerly of these is P8 (Jackpot), with more than 1500 m of passage, while to the east the Giant's–Oxlow system has more than 4700 m of known passage.

The P8 cave (Figure 4.2) is developed mainly in rocks of the Asbian lagoonal facies. It consists of a complex of tall vadose canyons cut into the floor of large, high-level, phreatic passages which are partly fault-controlled (Smith and Waltham, 1973). These lead to a perched phreatic zone where flooded passages are separated by short sections of drained, old phreatic tubes abandoned by the present main stream. Several sumps have been explored in this part of the cave but the main stream is lost beyond sump 6. The explored passage has been followed upstream and into a high-level flood route, where sumps 7, 8 and 9 have been passed by divers to enter a short dry passage with two shafts descending to sump 10. This is unexplored; it lies at a level about 18 m above Speedwell Main Rising. At least three separate streams now occupy the passages of P8. The entrance stream sinks into gravel in the upper part of the cave under normal conditions and is not seen again in the known cave. A second stream rises from a sump in the lower part of the cave and flows into the main sumps at the end of the lower streamway. This water is derived from sinks 2–7 (Figure 4.2) and is entirely independent of the entrance stream (Gunn, 1991). A third independent stream is met in the passage between sumps 5 and 6.

The Giant's Hole–Oxlow Caverns system (Figure 4.3) is the deepest in Derbyshire, at 214 m, and the second deepest in Britain (Westlake, 1967). The main stream in Giant's Hole flows eastwards through the reef limestones and into rocks of the bedded lagoonal facies. Here it has cut a meandering vadose canyon, the Crabwalk, more than 1 km long and up to 20 m high, though rarely more than 0.5 m wide; development of the meanders has been influenced by many small mineral veins. Beyond the Crabwalk a complex of phreatic rifts and incised canyons, formed along faults and veins, are now partly flooded and extend below present water level. Abandoned passages in the entrance series contain thick sediment sequences. Other passages, developed along bedding planes in the nearly horizontal lagoonal limestones, extend southwards from the roof of the Crabwalk and from the downstream complex to link with Oxlow Caverns, accessible via a mined shaft from the surface. Oxlow Caverns are a stacked series of phreatically enlarged vein cavities, linked by low or narrow passages. They extend over a vertical range of 150 m on Faucet Rake, and cut through the bedding plane on which lies the abandoned phreatic outlet from Giant's Hole.

Less than 100 m separates the southern end of Oxlow Caverns from the northern end of Nettle Pot (Figure 4.3), a 180 m deep, old phreatic fissure system developed largely along a post-mineralization fault. The deepest point is in parallel rifts in the Red River Series. An extensive series of low, wide chambers is formed by phreatic solution adjacent to thin toadstone lavas, at two levels about 50 m and 60 m from the surface; these extend along the fault, to Gour Passage, reaching towards New Rake, the probable route for water from P8 to the Speedwell stream cave.

Relict caves of Treak Cliff and Eldon Hill

Several almost completely abandoned caves lie in the northern tip of the reef limestone where it forms Treak Cliff, a steep bank at the head of the Hope Valley (Figure 4.2).

Winnats Head Cave, contains high level, phreatic chambers up to 50 m long and 20 m high and wide, from where stalagmite has been dated to 176–191 ka BP (Ford *et al.,* 1983). Small passages and rifts connect with a series of collapse chambers and vadose shafts containing a small stream. These have been descended to a silt choked sump, at a depth of 136 m.

Blue John Cavern, now a show cave, contains a network of abandoned phreatic passages and a wide vadose canyon 25 m high. The cave intersects several much older, pre-Mesozoic, phreatic tubes filled with hydrothermal fluorspar and since partly re-excavated (Ford, 1984).

In Treak Cliff Cavern, also a show cave, phreatic chambers cut through the reef limestones and also through the reef front Boulder Bed. The latter shows mid-Carboniferous karst features in the form of solution fissures and small phreatic tubes, and contains spectacular 'Blue John' fluorspar mineralization within them. The inner chambers contain excellent speleothems, some of which have been dated at 125 ka BP, overlying ochreous clay perhaps derived from early Pleistocene periglacial loess.

Windy Knoll Cave is truncated and choked fragment of a very old sinkhole, and a fissure at its entrance has yielded a suite of Pleistocene mammal bones (Dawkins, 1875; Bramwell, 1977).

A series of sediment-choked swallet caves have been exposed in the faces of Eldon Hill Quarry (Figure 4.2). They contain a variety of facies which can be broadly grouped into four types: (1) very coarse, poorly sorted gravels dominated by clasts of arkosic sandstone derived from the Millstone Grit; (2) finer gravels dominated by well-sorted, well-rounded, decalcified chert pebbles; (3) quartzose sand; and (4) laminated cap muds. The quarry face has also broken into a decorated phreatic tube, roughly parallel to New Rake.

Further to the south, Eldon Hole is an open shaft 30 m long, 5 m wide and 60 m deep enlarged by wall-collapse of a solution chamber bounded by two subparallel joints. A large parallel chamber, decorated with speleothems in the roof, can be entered via a short passage. A downward continuation with a stream at the base, reported by Lloyd and King (1780), is now blocked by debris.

The Peak-Speedwell Cave System

More than 15 km of passages have been mapped in the connected caves of Peak Cavern and Speedwell Cavern (Figure 4.4). All the collected underground drainage of the area flows through the two main streamways towards the resurgences of Russett Well and Peak Cavern gorge. Most of the water from the Rushup Edge sinks reappears at the Main Rising in Speedwell Cavern, while the stream in Peak Cavern is derived largely from percolation water and from flood overflows from Speedwell.

Peak Cavern, now in part a show cave, has the largest natural entrance of any cave in Britain, more than 30 m wide and 10 m high. In the passage beyond, several avens have formed by upward solution along joints (Pitty, 1971). The Main Stream Passage, developed entirely in a single bedding plane without significant influence from joints, is a magnificent phreatic tube up to 7 m in diameter (Figure 4.5); it has several sections of vadose canyon, each entrenched where the gradient of bedding and tube is locally steeper. Within the same bedding plane, a series of smaller clay-filled tubes and joints are slowly being re-excavated. From one of these tubes, a series of avens rises 70 m into the White River Series, with more than a kilometre of old phreatic passages (Nixon 1991, 1992). These passages cut through the mineral vein of New Rake, and contain the most extensive and beautiful development of speleothems in the Peak District. At several points the old phreatic passages are breached by vadose shafts which descend 70 m to chokes on the main bedding plane. Lake Passage is a major inlet fed mainly by percolation water derived from the limestone outcrop around Dirtlow Rake (Figure 4.2). At the western end of Main Passage, the Far Sump Extension has several rifts rising more than 130 m above stream level (Cordingley, 1988). Much of the system lies beneath the Lower Lava, an aquiclude which has kept most percolation water and calcite deposition away from the lower levels.

Speedwell Cavern connects to Peak Cavern via several flooded or abandoned routes, but is more readily accessible through a mined shaft and an underground canal, which are now developed as a show cave. The tourist section ends at the Bottomless Pit, a solution cavern developed on Faucet Rake, but the canal tunnel continues south to intercept the main streamway. Most of the water from the sinks to the west usually reappears at the Main Rising, but at times the principal flow may come from Whirlpool Rising; only in flood conditions does it rise from both (Christopher, 1984; Bottrell and Gunn, 1991). Main Rising is the top of a 35 m deep phreatic loop developed along solution vein cavities in New Rake; upstream of the phreatic loop, there are two vertical phreatic lifts, and the flow emerges from a flooded rift 70 m below water level. The outlet water flows eastwards and is joined by water from Whirlpool Rising and two other inlets, before entering the long, immature passage to the Downstream Sump. It finally resurges at Russett Well, having passed beneath the Peak Cavern gorge and stream. Several older passages also enter the main upstream passage; some are partly filled with clay while others, originally entered by miners, were once steeply descending vadose inlets (Shaw, 1983). Under flood conditions some of the water from Speedwell Cavern overflows into Peak Cavern through Overspill Passage and Treasury Sump. The main passages of Speedwell are developed on a single bedding plane about 14 m below that which contains most of the Peak Cavern passages. At the western end of the system, Cliffhanger is a high-level phreatic tube, and the Leviathan is a massive and complex vein cavity above the streamway level, with a mined access to its top from James Hall's Over Engine Shaft.

Interpretation

The caves of the Castleton area constitute a complex integrated karst drainage system; this has been traced from multiple sinks to two adjacent resurgences with parallel feeders at different stratigraphic horizons. The underground drainage penetrates both reef and lagoonal limestones and has utilized mineral veins throughout its evolution.

Dye-testing has established that water travelling between the various sinks and the two resurgences follows convergent, divergent, crossing and flood-related drainage routes (Christopher, 1980, 1984; Christopher *et al.,* 1981) and passes beneath the surface interfluve. There is a very long history of karstic development in the area, commencing in the mid-Carboniferous with the solution fissures carved in Treak Cliff beneath the Boulder Bed (Ford, 1984). Deep phreatic caves, probably also of considerable antiquity, developed along mineral veins; they subsequently guided the through drainage from new sinkholes. The caves have been influenced by the distribution of reef and lagoonal facies within the limestone, notably by the extensive development on the bedding planes of the lagoonal facies. The presently accessible swallet and resurgence caves show a history of development, at least as far back as the Hoxnian (Ford *et al.,* 1983). This history must be related to the episodic water table lowering and rejuvenations in response to the incision of Hope Valley through the Pleistocene.

The evolution of the Castleton cave systems is long and complex; it has been discussed in detail by Ford (1986b), and the evolution of individual cave systems has also been reviewed by Smith and Waltham (1973) and by Westlake (1967). The limestone of the Castleton area was first exposed during the mid-Carboniferous, when solution fissures in the bedrock and the Treak Cliff Boulder Bed were formed. Faulting and mineralization in the late Carboniferous and Permian produced a series of east-west mineral veins across the area. A deep, slow phreatic circulation along mineral vein cavities may have been initiated shortly after this, enhanced by the stripping of the late Palaeozoic and Mesozoic cover during Plio-Pleistocene times. With increased runoff, associated with changes of climate in the Pleistocene, a shallower system of swallet and resurgence caves developed along prominent bedding planes, though still draining via the deep mineral vein conduits. Their subsequent evolution was influenced by the incision of the major surface drainage of the area, which controlled local base levels within the limestone. Treak Cliff Cavern, Blue John Cavern and Winnats Head Cave represent former swallet caves draining off a more extensive Millstone Grit cover. The large size of the vadose canyon in Blue John Cavern indicates that it was a major sink at this time. Uranium-series dates from these sites indicate ages in excess of 190 000 BP (Ford *et al.,* 1983).

The modern swallet caves lie along the shale-limestone boundary below Rushup Edge. Their stalagmites give generally younger uranium-series dates, though the complex morphology and abandoned passages, in both Giant's Hole and P8 Cavern, indicate that they are of considerable age and have undergone extensive modification since their initial formation.

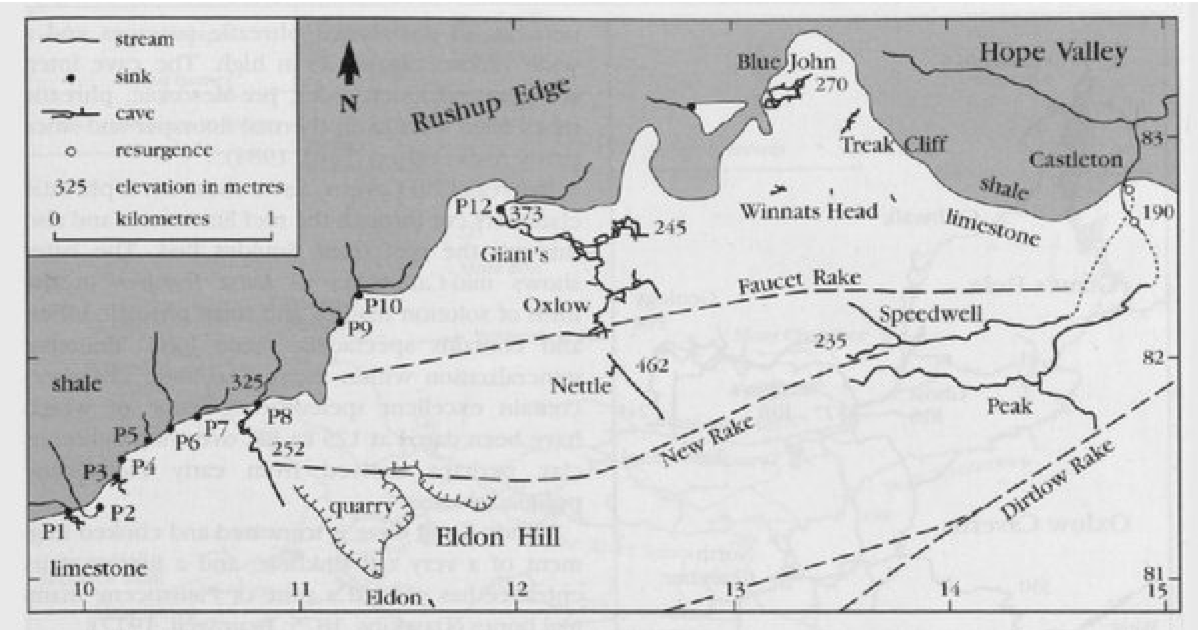
The sand infills preserved in the filled caves of the Eldon Hill quarry indicate episodes of aeolian reworking of glaciogenic sediment (Farrant, 1995). By analogy with the currently active swal-let caves, the coarse and fine gravel facies may reflect sites of deposition which lie respectively proximally and distally to these ancient swallets. Uranium-series and palaeomagnetic dating of these sediments and the intercalated speleothems indicates a history of development extending back at least 780 000 years; the earliest sediments may date back to more than 910 000 BP, as an episode of normal magnetic polarity precedes the last period of reversed polarity. The caves evidently predate the valley below Rushup Edge, and are probably of early Pleistocene age.

The unusual size of the entrance chambers in Peak Cavern is due to solution and collapse in a lenticular development of back-reef shoal limestones, influenced by major joints. This was further aided by vadose entrenchment through a phreatic lift, which originally fed a vauclusian rising at the site of the modern entrance gorge (Ford, 1986b). The development of the phreatic drainage system in Peak Cavern, feeding to this vauclusian rising, probably predates an episode of incision of surface drainage in the Hoxnian, or in the Anglian glacial, which led to vadose entrenchment of the passages. The main passages in Peak Cavern are too large to have been formed solely by the percolation water which now drains through them; at some time in the past, the main drainage from the Rushup Edge sinkholes flowed through Peak Cavern, before underground capture took the water to the Speedwell Cavern route. A further similar capture appears to be developing now, as seen in the switching of flows between Main Rising and Whirlpool Rising, within Speedwell Cavern (Bottrell and Gunn, 1991). Further incision, probably in the Ipswichian, was responsible for the final draining of many of the phreatic tubes in the Peak-Speedwell system. Subsequent modification has been restricted to the infilling of some passages, by clay derived perhaps from periglacial loess, and by minor phreatic solutional enlargement of some parts of the system as a result of water dammed up by debris.

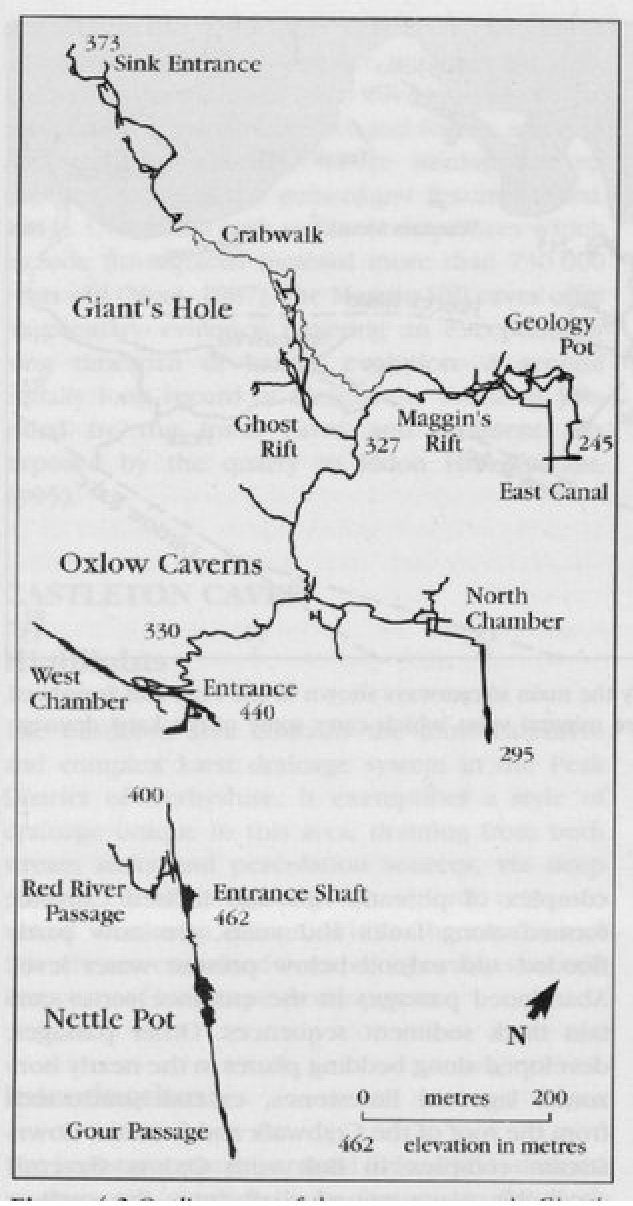
Conclusion

The Castleton limestone houses a large and important integrated cave system which shows evidence for a history of development longer than at most British karst sites. Caves have formed in different limestone facies and are closely linked with mineralized faults. The scarcity of calcite speleothems in the parts of the Peak–Speedwell cave system underneath an interbedded lava demonstrates the influence on autogenic drainage of minor aquicludes within the limestone aquifer. Speleothems and sediments within the caves have already provided evidence for a history extending back nearly a million years. The great depth range of passages within the system further increases the value of the evolutionary record of the cave and its surrounding landscape through the Pleistocene.

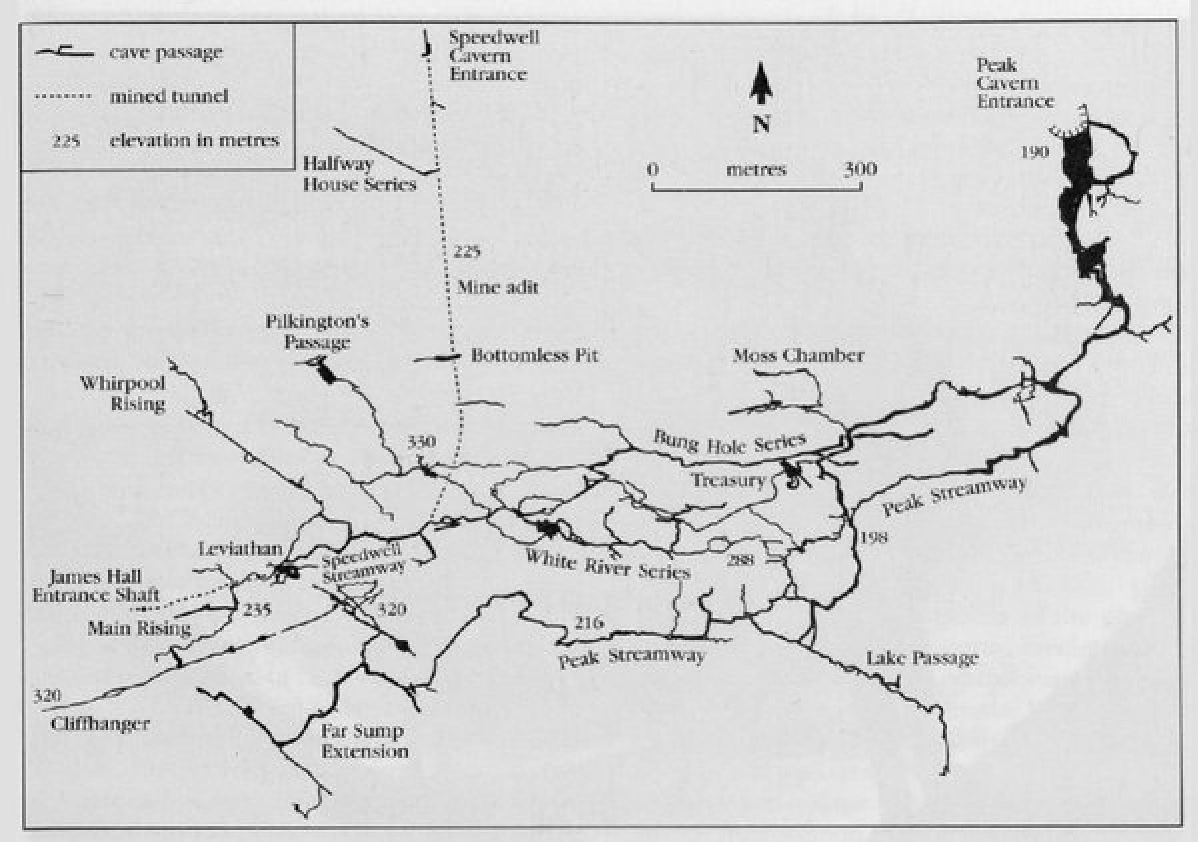
[References](#)



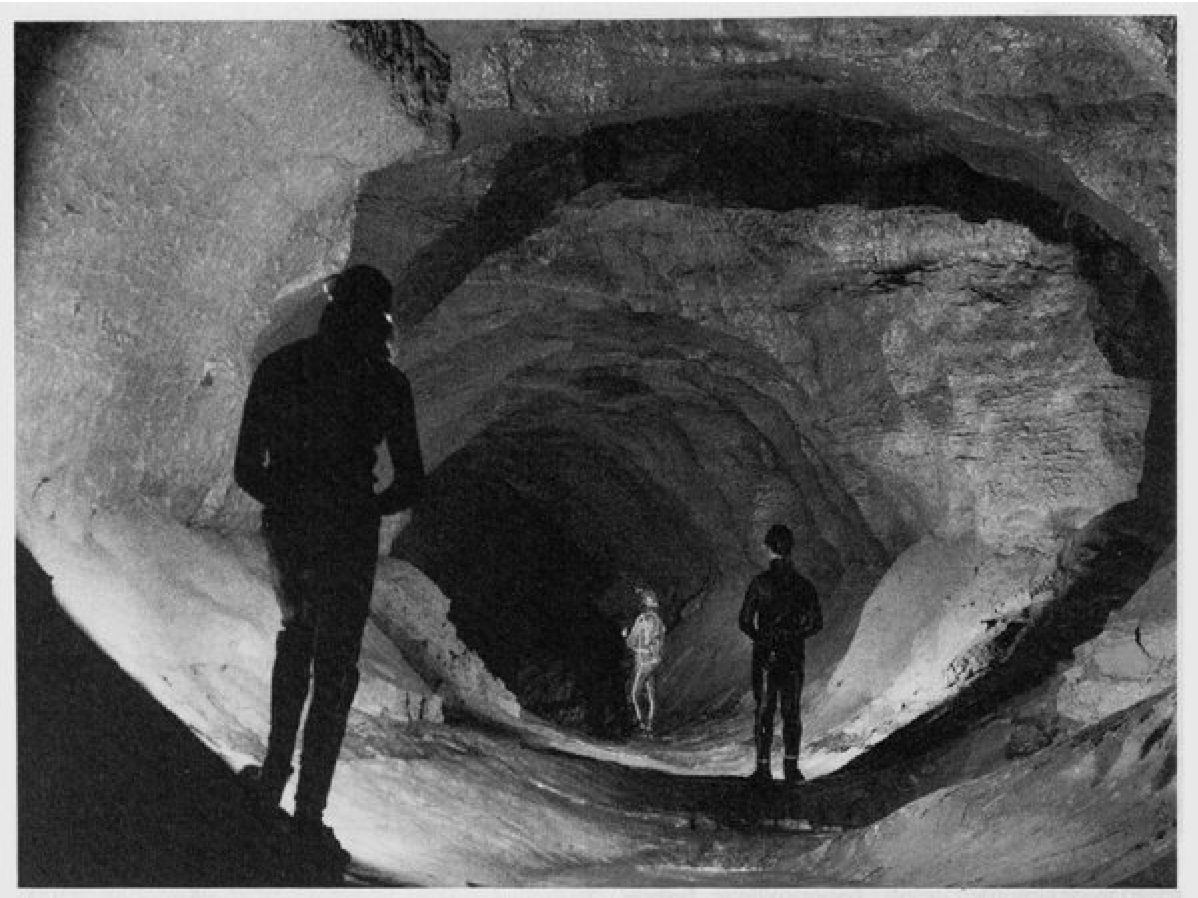
(Figure 4.2) Outline map of the Castleton caves, with only the main streamways shown in the Peak and Speedwell caves at the resurgence end of the system. The rakes are mineral veins which carry some of the karst drainage though their fissure systems.



(Figure 4.3) Outline map of the cave passages in Giant's Hole, Oxlow Caverns and Nettle Pot (from surveys by Eldon Pothole Club).



(Figure 4.4) Outline map of the Peak-Speedwell Cave System (from surveys by Technical Speleological Group and Cave Diving Group).



(Figure 4.5) The phreatic tube which forms the main part of the stream cave in Peak Cavern. The inception bedding plane is marked by the wall niches, and this section has no vadose trench yet cut in its floor. (Photo: J.R. Wooldridge.)