Masson Hill caves

[SK 28 59]–[SK 29 58]

Highlights

The Masson Hill caves pre-date and post-date mineralization in a deep phreatic zone, subsequently drained by incision of the Derwent Valley. They are critical to an understanding of vein-guided karst drainage elsewhere in the Peak District. Sediment within the caves contains evidence for some of the earliest Pleistocene glacial episodes in Britain.

Introduction

The caves lie beneath the northern and eastern slopes of Masson Hill, immediately west of the anomalous limestone gorge at Matlock Bath where the River Derwent has entrenched updip of the limestone reefs (Figure 4.16). Most are sections of very ancient, partially choked, phreatic passages. These have been modified to some extent by lead and fluorspar mining, which has destroyed some natural features, but has allowed access to many more. The geology and mineralogy of the caves are uniquely complex within the Pennines. The hydrothermal mineralization is directly related to the cave development, as the mineralizing fluids both utilized and created solutional cavities within the Carboniferous limestone.

Descriptions of various parts of the cave system are given by Flindall *et al.* (1981), Gill and Beck (1991) and Warriner *et al.* (1981). The karst and cave development is discussed by T.D. Ford (1964a, 1984), Ford *et al*. (1977b) and Worley and Nash (1977), and the processes of mineralization are reviewed by meson and Ford (1982) and Quirk (1993).

Description

The Carboniferous limestone exposed at Masson Hill forms a gentle flexure over an anticline which plunges steeply with the regional dip to the east. The carbonate sequence is broken by two basalt lavas — the Matlock Lower Lava and the Matlock Upper Lava — and by several thin wayboards of volcanogenic clay. Between the lavas, about 40 m of limestones contain the major caves.

Most of the known cave passages interconnect to form the Masson Cavern system, where pre-and post-mineralization phreatic solution caverns are linked by old mine workings into a single underground complex with more than 2000 m of natural passage (Figure 4.16). The north-western part of the system has been destroyed by surface mining on the hilltop, leaving two elongate networks, just separated by the open pit. One descends south-east, obliquely downdip, through Great Masson Cavern (Figure 4.17), and on to the disconnected fragment of Rutland Cavern; the other descends almost straight downdip, northeast to the old Masson and Ringing Rake Soughs at river level. Individual cave chambers are up to 20 m high or wide, and the whole cave system has a vertical range approaching 200 m.

Pre-mineralization caves are filled or lined with hydrothermal fluorspar and other minerals. Further solutional enlargement of these old caves by meteoric groundwater occurred in the late Tertiary and early Pleistocene, at the same time as new caves were formed. Much of the phreatic network has been filled with complex sediment sequences, comprising both locally derived vein minerals and also inwashed glaciofluvial material. Interbedded stalagmite layers are sparse, and evidence for a major vadose episode of cave excavation is lacking. Magnetostratigraphic analysis of sediment sequences in three separate parts of the system has established that fluvioglacial material was deposited during an interval of reversed magnetic polarity, indicating an age in excess of 780 000 years (Noel, 1987; Noel *et al.,* 1984).

Temple Pipe (Figure 4.16) shows similar pre- and post-mineralization cavern development to that seen in Masson Cavern. Some excellent sediment sequences are preserved in its two fossil phreatic chambers; it is now a show cave. A number of other cave passages are intersected by the other mines in the area, of which the longest are in Devonshire Cavern.

Jug Holes (Figure 4.16) consists of an isolated series of phreatic cave chambers. These were formed by limestone solution both before and after the hydrothermal mineral infilling. Factors controlling cave development are clearly recognizable, and the site is typical of a Derbyshire pipe vein system. The cave was developed downdip in about 40 m of Asbian limestone sandwiched between the Upper and Lower Matlock Lavas; subsequently the cave has been partly filled with sediments, which were derived from the mineralized cave walls, from the lava flows, and from inwashed glaciofluvial material. There are extensive stalagmite deposits in parts of the cave; some of these rest directly on the altered top of the Matlock Lower Lava which forms the cave floor.

Interpretation

The three cave systems reveal a complex history, with the development of pre- and post-mineralization phreatic solution caverns separated by an episode of hydrothermal mineralization and a considerable timespan (T.D. Ford, 1964a, 1984; Ford *et al.,* 1977b; Worley and Nash, 1977). The earliest episode of cavern development was associated with the initial phase of hydrothermal mineralization in the late Carboniferous. Solution voids within the limestone were excavated by meteoric water which had travelled distances up to 100 km through Namurian clastic rocks at depth, where it was enriched in minerals before rising into the limestones on the Peak District block (Quirk, 1993). There is no definite evidence for limestone solution by locally derived meteoric water influence at this time. Many of these cavities were then filled partly or wholly with fluorspar and other hydrothermal minerals. Voids remaining within these veins, pipes and flats were• then utilized by meteoric karst water as the limestone was exposed by erosion in late Tertiary and Pleistocene times; this new phase of solutional activity both enlarged some of the old caves and also developed new ones.

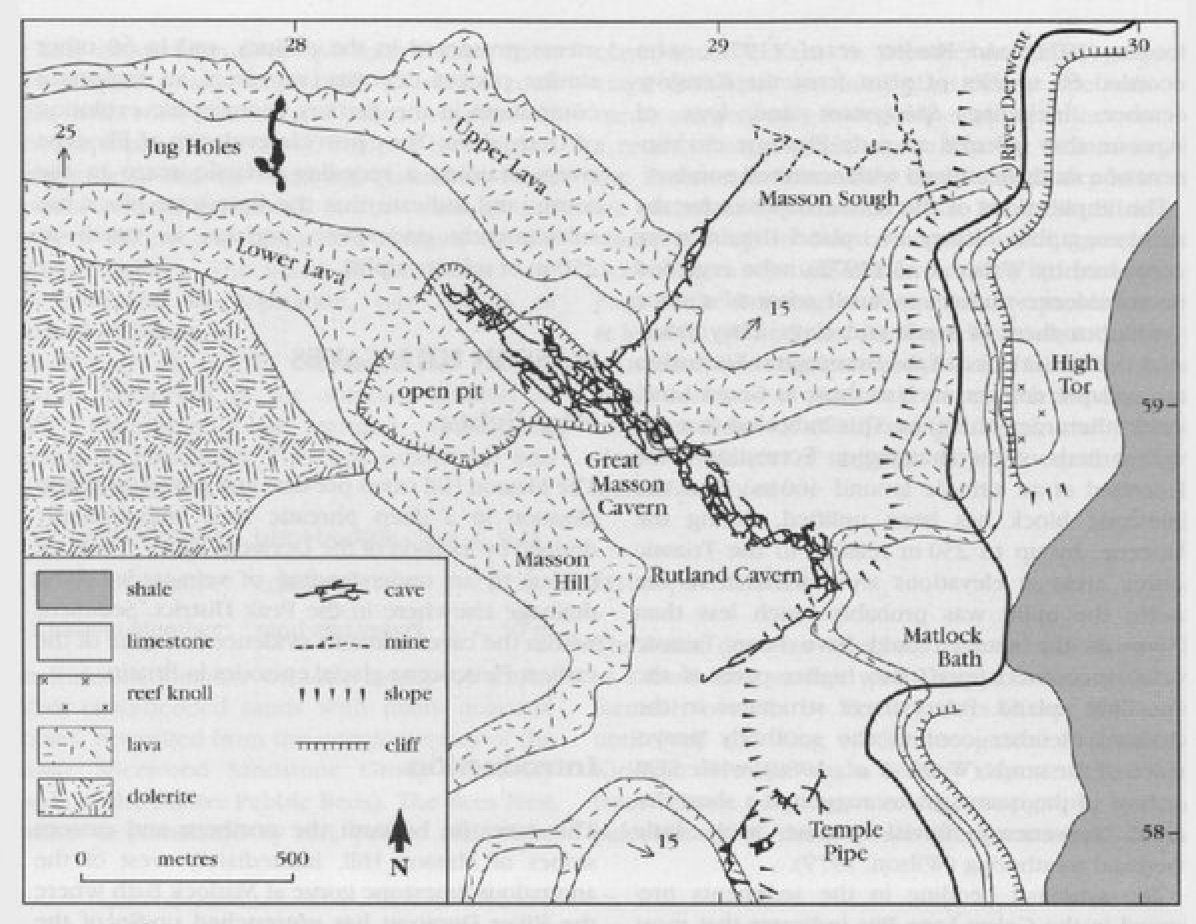
Cavern development was strongly influenced by the geology. The lavas acted as confining aquicludes, and the patterns of solutional opening were determined by the irregular dolomite/limestone interface, early diagenetic solution of the lower part of the limestone, the presence of several thin wayboard tuffs, and a NNE–SSW joint system. The presence of sulphide minerals may have contributed to cave development, by acting as a source for the generation of sulphuric acid, in the style now widely recognized as inception in karst limestones (Ball and Jones, 1990; Lowe, 1992).

Most of the caves were filled with both autochthonous and allochthonous sediment, prior to the downcutting of the River Derwent which caused the change from phreatic to vadose conditions. Chatter marks on the sand grains indicate a glacial meltwater origin for some of the allochthonous material, and the age of 780 ka indicates that they date from one of the pre-Cromerian cold stages (Noel *et al.,* 1984). There is little evidence for significant vadose modification following draining of the phreas. This suggests that the vadose stream phase was brief and overloaded with fluvioglacial sediment, quickly choking the system, perhaps indicating that it was directly associated with an episode of glacial incision. Since then the surface catchment has been insufficient to allow significant drainage into the cave system. The scarcity of speleothems probably reflects the position of the system beneath the Upper Lava aquiclude.

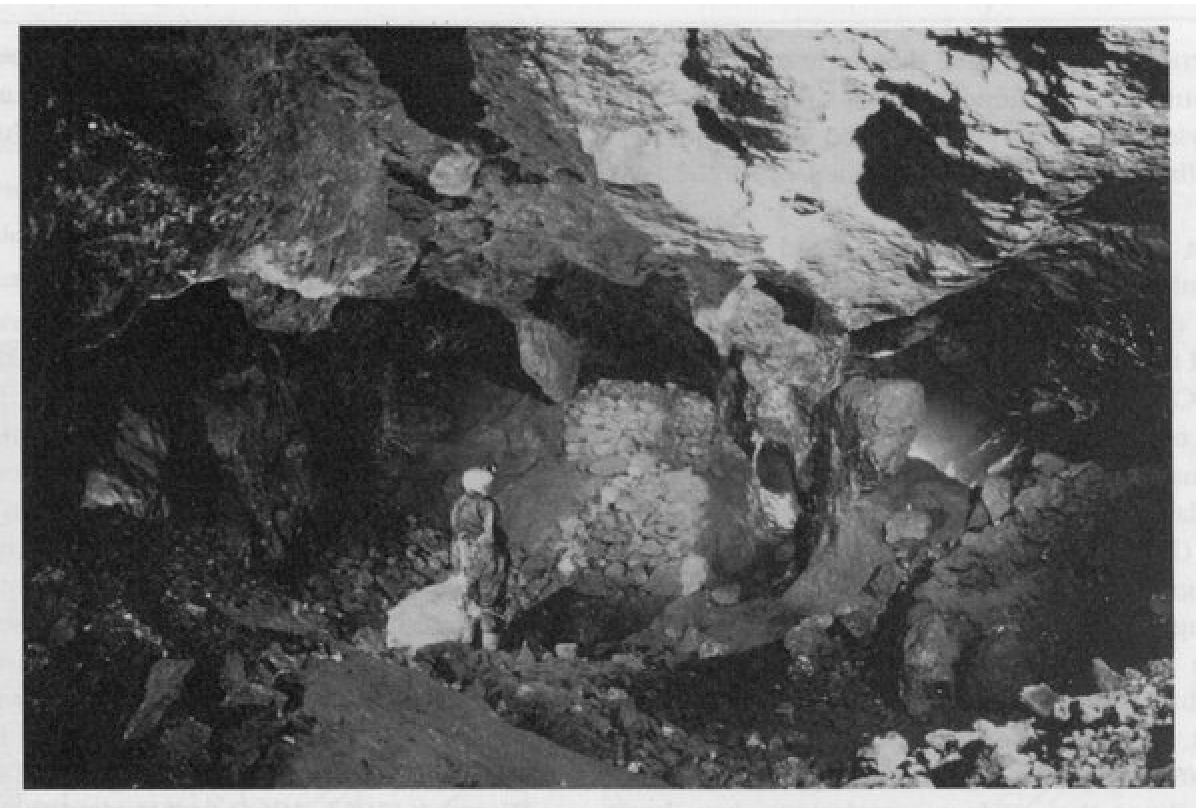
Conclusion

The Masson Hill site is the best example in Britain for demonstrating the relationships between mineralization of the limestone and cave development. It is important for understanding aspects of the hydrology of other cave systems associated with mineral veins, where the phreas remains largely inaccessible. Sediments in Masson Cavern include fluvioglacial material deposited during an episode of reversed magnetic polarity, more than 780 000 years ago. They are of comparable age to the material in the fissure caves of the Eldon Hill quarry, and are considerably older than most Pleistocene glacial deposits proven on the surface in Britain; these caves therefore provide incomparable evidence for the Pleistocene history of the area extending back beyond the Anglian glaciation.

References



(Figure 4.16) Geological map of Masson Hill and its cave passages, in relation to the Matlock Bath gorge. The mine workings in solid rock and the re-excavated natural caves are complexly interwoven; the symbols for cave and mine are generalized. The caves within the open pit have all been destroyed.



(Figure 4.17) Ribs of limestone left around solution cavities which were filled and then re-excavated by miners in the Black Ox Mine workings in Great Masson Cavern. (Photo: T.D. Ford.)