Chapter 5 The Mendip Hills karst

Introduction

The Mendip Hills rise east of the Bristol Channel as an elongate plateau roughly 30 km long and 8 km wide, composed largely, but not entirely, of cavernous limestone (Figure 5.1). At their western end they stand 200 m above the Somerset Levels, but their eastern end declines gently and is buried beneath the Jurassic scarplands.

The carbonate succession includes almost the entire Dinantian sequence of the Lower Carboniferous, and reaches over 800 m in thickness. The main karstic rocks are the strong, fine-grained shelf limestones; they include beds of very fine-grained calcite mudstone, known as chinastone, and also beds which are conspicuously bioclastic or oolitic. Some of the carbonates are dolomitized and there are many thin clastic horizons within the main sequence. The lowest unit in the succession is the Black Rock Limestone, a dark well bedded series in which most of the swallet caves are formed. Above this, the Burrington Oolite, Clifton Down Limestone and Hotwells Limestone are all pale grey but weather to the white patina seen at outcrop, notably in the white cliffs of Cheddar Gorge.

The limestone is underlain by Dinantian calcareous shales with thin interbedded limestones; these are known as the Lower Limestone Shales and are transitional from the Devonian Old Red Sandstone. The sandstones crop out in four anticlinal cores to form hills rising 30–60 m above the limestone plateau (Figure 5.1). On the flanks of the Mendip plateau, the limestones are overlain unconformably by Triassic screes and fan deposits, formed largely of limestone blocks and known locally as the Dolomitic Conglomerate: these are also cavernous at some locations, notably at Wookey Hole, where they constitute an integral component of the single karst aquifer. On the lower, eastern part of the plateau, outliers of Mercia Mudstone, silicified limestones of the Harptree Beds and Liassic limestone lie unconformably on the Carboniferous limestone. Triassic palaeokarst was restricted by the contemporary desert environment, and most of the cave infills appear to be in tectonic fissures and associated with Jurassic neptunian dykes (Ford, 1984; Stanton, 1991).

Structurally the Mendip Hills are the most complex of Britain's four major regions of cavernous karst. They are essentially formed of four *en-échelon,* periclinal anticlines. Marginal dips are mostly between 20° and 70°; they are steepest and at some locations overturned on the northern limbs. Extensive faulting, overthrusting and overfolding complicates the geology (Smith, 1975a). In some areas, the limestone contains hydrothermal mineralization, but this has not influenced the karst processes in the way that it has in the Peak District.

The karst

The Mendip Hills form an upland exhumed from beneath a Mesozoic cover, and traces of Triassic features survive, mainly in the marginal slopes. Though the limestone hills may have been stratimorphic early in the Trias, the summit surface is now eroded and planed to reveal the anticlinal cores of sandstone; the main plateau surface is regarded as a result of subaerial planation largely during the Pliocene (Ford and Stanton, 1968). This was followed by exhumation of the plateau sides from beneath a Triassic cover; this was a gradual process stripping the cover progressively towards the east, during the course of about a million years. This has left the highest parts of the plateau and the most mature karst at the western end of the Mendips, around Cheddar Gorge, while the younger, eastern end of the limestone plateau is only partially exhumed and barely rises above the level of the Triassic plain in the Mells Valley (Figure 5.1). There is no evidence that the Mendips were glaciated at any time during the Pleistocene, though ice did occupy parts of the surrounding lowland (Hawkins and Kellaway, 1971; Smith, 1975a).

The dominant surface landforms on the Mendip limestones are fluviokarstic. Some of these may be superimposed from an earlier impermeable cover, and were modified by subsequent subaerial evolution, before karstification reached a stage at which drainage was entirely underground. Surface erosion was then temporarily re-established under periglacial conditions during the Pleistocene, when karstic drainage was hindered by the ground ice (Smith, 1977). Dry valleys are entrenched into much of the upland limestone surface, and these steepen into gorges in their descents of the plateau margins (Ford and Stanton, 1968); the best known is Cheddar Gorge, which has the largest feeder system of dry valleys.

On the interfluves and the plateau margins, the topography is more disorganized and less fluvial; large, shallow, closed depressions create some limited areas of polygonal karst. Solutional dolines of various morphologies and origins are scattered across the karst plateau, but many have been modified by past mining activities. Subsidence dolines are numerous in some outcrops of the Harptree Beds, but the absence of till precludes the development of extensive fields of subsidence dolines such as are found in Britain's glaciated karstlands. There are no limestone pavements. Rock scars are not a feature of the karst, except along the steeper flanks of the deeper sections of the gorges. Thick soils on the plateau have a significant loessic component, but are replaced by thin stoney soils on steeper slopes; except for the steeper valley and marginal slopes, the whole area is now farmland.

The caves

The erosional resistance of the sandstone in the anticlinal cores has created low hills which supply allogenic drainage onto the limestone in the heart of the Mendip karst. Nearly all these streams sink where they reach the limestone. Further allogenic stream sinks are provided by drainage from the Mesozoic outliers. The sinking streams are joined underground by percolating autogenic recharge, and flow through numerous stream caves which feed to resurgences around the foot of the plateau marginal slopes. This situation is best seen at the western end of the Mendip plateau, which is the oldest section with the highest local relief; stripping of the Mesozoic cover has progressed towards the east, where relief is lower and the karst is less mature.

The typical Mendip cave has a stream sinking at the stratigraphic base of the Black Rock Limestone (Smith, 1975a). A vadose passage descends rapidly with the steep dip, until the local base level (or notional water table) is reached on a profile gently, and roughly, graded to the contemporary resurgence level. From there, a phreatic cave continues with a looping profile following down the bedding planes and up the joints, with sections of shallow, sub-horizontal loops along the strike. Continued erosion within the looping phreatic passages cuts trenches through the loop crests and raises the loop troughs by sedimentation and paragenetic roof solution; together these processes lead to a more uniformly graded passage profile. The Mendip Hills have long been cited as the type area of cave development in steeply dipping limestones (Ford 1968; Ford and Ewers, 1978).

Long-term base-level lowering and episodic rejuvenation fossilize the phreatic systems, commonly before they have achieved graded profiles above their contemporary risings. Major rejuvenations are generally followed by utilization of completely new phreatic routes at lower level, but inception and initiation of the lower routes had already been started deep within the earlier phreas. Though the geological controls on cave development are strong, the inclined networks of intersecting fractures in the limestone permit rapid responses to rejuvenation, and there is a minimum of widespread water table perching within the modern aquifer.

Due to passage constrictions within the phreas, the depth of the active phreatic loops, and sediment accumulation in both active and abandoned phreatic loops, no cave system in the Mendip Hills has yet been found to be accessible over its entire path from sink to rising. Most Mendip caves are therefore either swallet systems with influent vadose streamways descending to active and abandoned phreatic levels, or resurgence caves with active and abandoned deep phreatic passages.

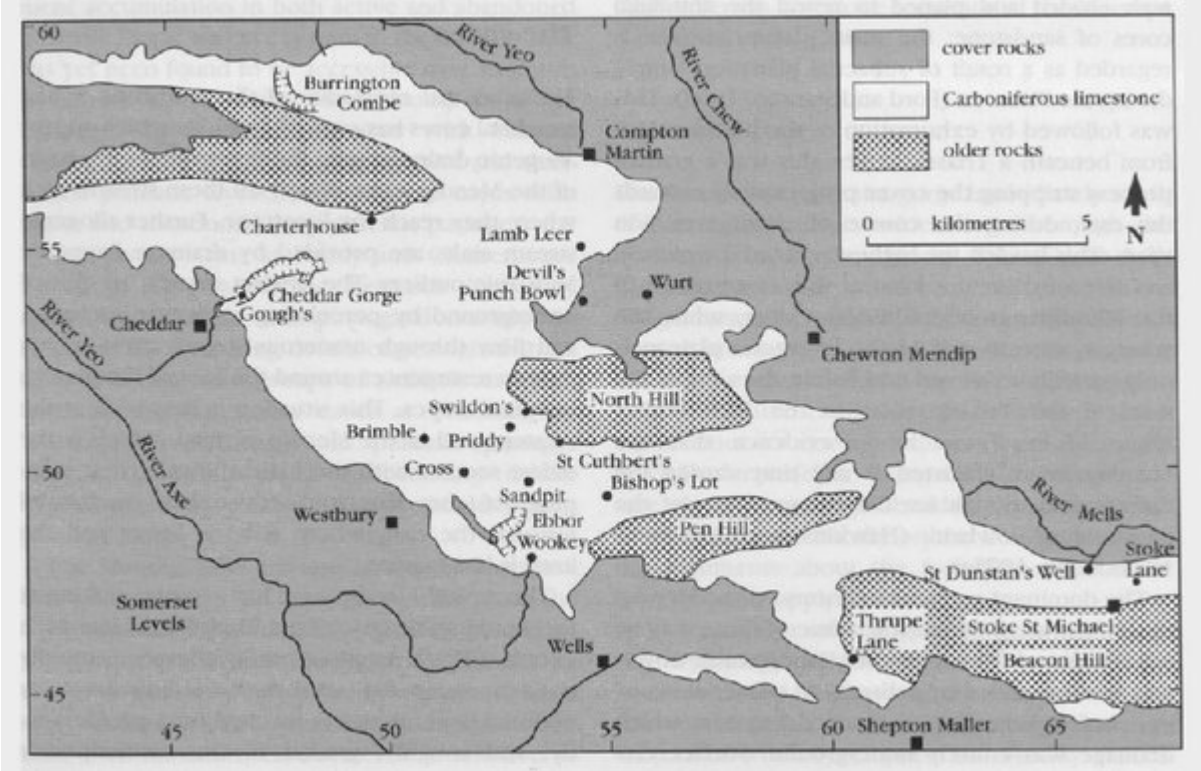
The cave systems at Priddy and Charterhouse are all of the swallet type. Between them they show considerable morphological variety in response to contrasting details of geological structure. The two main groups of sinkhole caves all drain to the resurgence caves at Cheddar and Wookey; these contain old phreatic passages notable for some of their secondary calcite deposits, and active caves with spectacularly deep phreatic loops.

The Mendip Hills are also noted for karst and cave development in lithologies other than the Carboniferous limestone. Of the caves formed by solution in the Triassic Dolomitic Conglomerate, the outer parts of Wookey Hole are the largest and most extensive. The Mesozoic limestones have their own miniature cave systems, in addition to the piping failures and collapse stoping induced by drainage into the underlying Carboniferous.

The absence of glacial cover enjoyed by the Mendip karst throughout the Pleistocene permitted a very complete record of sediments to accumulate in the caves. These sequences of both clastic detritus and calcite flowstone are exceptionally

valuable to Pleistocene stratigraphy (Atkinson *et al.,* 1978, 1986); correlations with surface evolution are facilitated by their survival in the successions of rejuvenated phreatic cave passages which evolved in close accord with falling resurgence levels.

References



(Figure 5.1) Outline map of the Mendip Hills karst, with locations referred to in the text. Cover rocks are mostly the Triassic and Jurassic mudstones and limestones; Upper Carboniferous rocks form the thrusted outlier on the east side of Ebbor Gorge. The Triassic Dolomitic Conglomerate is included with the Carboniferous limestone where it is composed of blocks of the limestone and is an integral part of the karst. Older rocks are the Devonian Old Red Sandstone and the Dinantian Lower Limestone Shale.