Manifold Valley

[SK 09 51]–[SK 09 56]

Highlights

The Manifold and Hamps valleys are allogenic river gorges cut into the Carboniferous limestone. Both rivers are being progressively captured by underground drainage, and the length of active riverbed varies with the amount of run-off. The multiple sinks and risings demonstrate a complex underground hydrology. Abandoned caves in the valley sides have enabled the valley age and rate of incision to be estimated.

Introduction

The Manifold River has cut a deeply entrenched valley for 9 km, from Wetton Mill downstream to Ilam Hall. The tributary Hamps valley is similarly entrenched, downstream of the limestone-shale boundary at Waterhouses. The valleys lie across the south-western corner of the Carboniferous limestone outcrop, where it contains many reef knolls. The headwaters of both the Hamps and Manifold rivers lie on the Namurian shales and sandstones, and both flow onto the limestone where they progressively sink underground. At high stage, water may flow on the surface all the way to the main Ilam rising, though the Hamps rarely flows over its full course. In dry weather the water sinks further and further upstream. The Manifold Valley has truncated a number of caves, some of which contain important archaeological remains.

The area was studied by Warwick (1953, 1964), and Ford and Burek (1976) examined the role of the reef knolls in determining the form of the valley. The caves are discussed by Potts (1977), and are described by Gill and Beck (1991). Excavations at Elderbush Cave, among others, are described by Bramwell (1964, 1977). Sediments from the same cave and also Darfur Ridge Cave have been dated using uranium-series and paleo-magnetic techniques (Rowe *et al.,* 1989b; Atkinson and Rowe, 1992) which give estimates for the rate of incision and the age of the valley. Ford and Gunn (1992) provide a field guide to the Manifold Valley.

Description

The headwaters of the Manifold drain an area of Namurian shales below the Millstone Grit escarpments. The river flows onto the limestone, and in dry conditions sinks at Wetton Mill, shortly after it encounters the first reef knoll. Downstream, the river bed may be dry for 9 km, as far as the Ham risings (Figure 4.18). Under slightly wetter conditions the water continues to flow over the surface to sink by the Darfur bridge or at Redhurst Swallet, about 400 m below Wetton Mill. Under progressively higher stages, the flow continues downstream to a further series of sinks. Only under very wet conditions does the river flow above ground all the way to the main risings at Ham. Similarly, the Hamps sinks into its bed shortly after contact with the limestone at Waterhouses, but in wetter weather sinks progressively further downstream; it rarely flows on the surface to meet the Manifold. Within the shales, the valleys have gentle slopes and the tributaries are graded to the main valley floor. Where the valleys are cut through the limestone, the sides are much steeper, often forming impressive vertical crags such as those at Beeston Tor. Many of the short tributary valleys are permanently dry and hang above the main valley, forming knickpoints indicative of successive rejuvenations. The main flanks of both valleys are evenly graded and covered in vegetation, but cliffs and crags are common in the reef limestones.

Downcutting of the Manifold Valley has truncated a number of old, high-level caves, most of which were small phreatic systems. Elderbush Cave is a truncated phreatic tube located close to the valley rim at 275 m OD, while the lower Darfur Ridge Cave is a small phreatic passage extending 100 m. Both of these caves contain stalagmites which have proved suitable for dating (Rowe *et al.,* 1988; Atkinson and Rowe, 1992).

Thor's Cave has a massive entrance, but its phreatic rifts reach back less than 50 m. There are more remnant rift caves in Beeston Tor. A new cave system is presently developing under the valley floor, gradually capturing the surface flow. Fragments of this system can be entered at a number of locations. Darfur Pot, just downstream of the main sink at Wetton Mill has 360 m of very flood-prone passage, while further downstream, Redhurst Swallet extends for some 280 m in a series of tight joint and tube passages (Potts, 1977). Ladyside Pot is another fragment where 450 m of passage extends under the river bed. All the water resurges at a series of large springs at Ilam Hall; diving in the main rising has revealed only 250 m of submerged passage reaching a depth of 54 m.

Interpretation

Remnants of former valley floors can be identified from knickpoints in the dry tributary valleys, Warwick (1953, 1964) used these to deduce that the valley had been deepened in six successive stages. This was almost certainly in response to base-level lowering in the valleys on the Triassic mudstone to the south, aided by more vigorous phases of downcutting during the Pleistocene cold phases. The influence of the limestone lithology is important, as the river course has been dictated by the position of the reef knolls (Ford and Burek, 1976). The river has been diverted round each reef, as at Beeston Tor and Thor's Cave Crag; other bends on the river, around Ecton Hill, have been influenced by the strong folding of the limestones. The sinuous course of the river was not superimposed from a former shale cover, as suggested by Warwick (1953); it developed as a result of lithological contrasts as incision progressed, concomitant with falling base levels to the south.

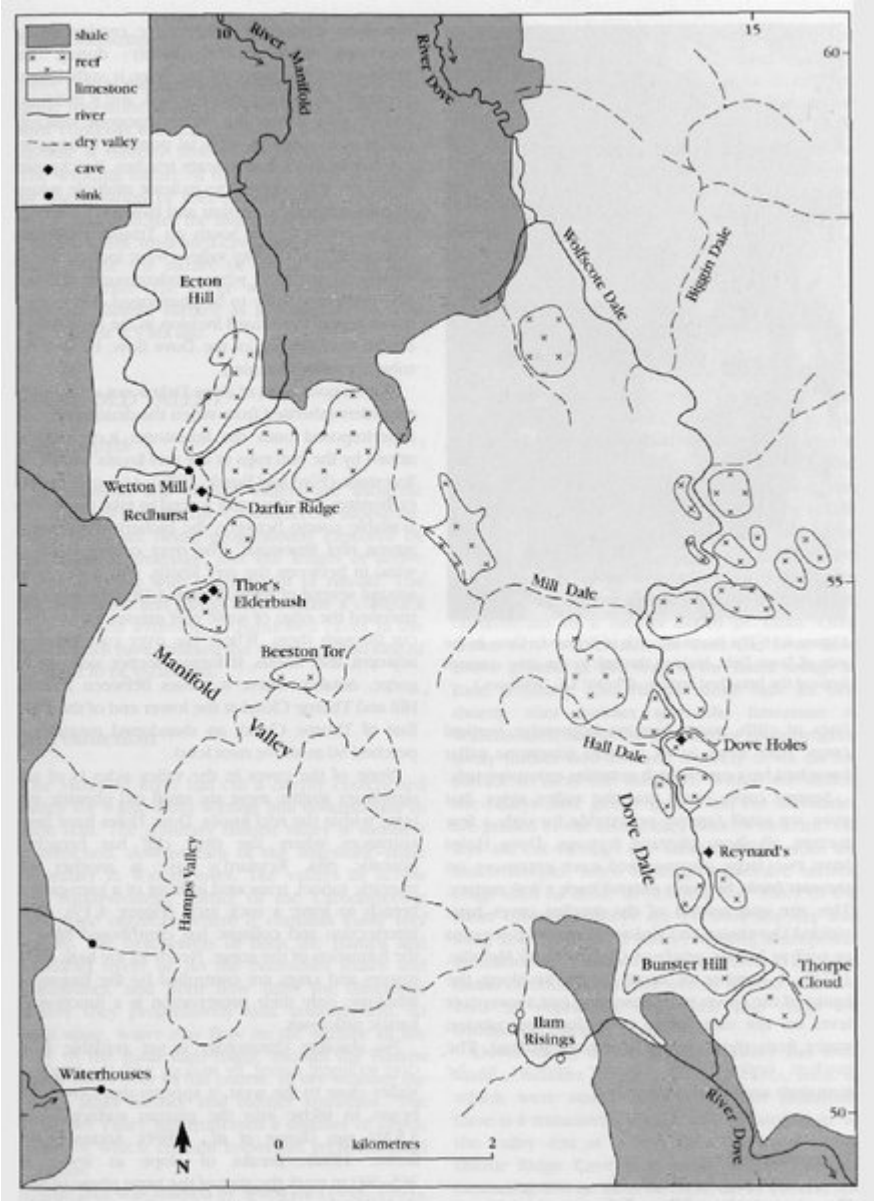
Nearly all the high-level caves are developed within the reef knolls, and they provide evidence of karst development which predates incision of the gorge. They represent earlier generations of caves developed at or below the contemporaneous valley floor, and are comparable to the phreatic system that is developing today beneath the river bed. To investigate the chronological development of the Manifold Valley, Rowe *et al.* (1988b) dated a suite of speleothems from Darfur Ridge and Elderbush caves using magnetostratigraphic and uranium-series methods. Uranium- series dating proved the stalagmite from Elderbush Cave to be older than 350 ka, while the presence of reversed-polarity stalagmite overlying normally magnetized stalagmite indicated a minimum age of 1.87 Ma. Elderbush Cave appears to have been drained by downcutting in the Manifold Valley, by or soon after 2.0 Ma. The cave lies 110 m above the present river bed, giving a maximum rate of valley incision of 5.5 cm ka^{-1}. Similarly, Darfur Ridge Cave was shown to be about 300 ka old, and gave an incision rate of 4.1 cm ka^{-1}. Extrapolation of these rates to the plateau surface at 265–300 m OD leads to the tentative estimate that valley incision began in the Pliocene about 3.5 Ma ago (Atkinson and Rowe, 1992).

The modern hydrology of the Hamps and Manifold valleys is complicated. The multiplicity of sinks and risings makes the underground flow patterns very complex. The resurgences at Ilam consist of 12 separate springs, which appear to have different catchment areas. The lowest two springs discharge only autogenic percolation water, while the next three are fed by the Manifold sinks. The Hamps water emerges from the Upper rising (taking about 3–6 days to flow from Waterhouses). Dye tracing has shown that the flow is transmitted via a complex conduit system, but with no mixing of the Hamps and Manifold waters (Ford and Gunn, 1990). The Hamps drainage system falls about 70 m over 4 km, which suggests there may be a significant vadose component, and is close to total underground capture. The underground Manifold drainage has a lower gradient, is more likely to be phreatic, and is less mature in that it is less able to transmit flood flows.

Conclusions

The two limestone valleys of the Manifold and Hamps provide fine examples of allogenic river gorges undergoing progressive capture by a developing underground drainage network. The river beds can be active or dry depending on stage, and the karst hydrology of the area is complex with a multiplicity of sinks and risings. Knolls of strong reef limestone defined the sinuous course of the Manifold Valley as it was entrenched into the karst plateau. The valley has truncated earlier cave development, recording a history of incision spanning about 3.5 Ma.

References



(Figure 4.18) Geological map of the active and dry valley systems of Dove Dale and the Manifold River in relation to the reef knolls in the Carboniferous limestone (partly after Ford and Burek, 1976).