Nidderdale caves

[SE 100 764]–[SE 105 730]–[SE 088 739]

Highlights

The limestone inliers of the upper part of Nidderdale provide windows into a major cave system largely developed beneath the sandstone which forms the outcrop along the valley floor. The positions of shallow phreatic loops in the flooded zone of Goyden Pot are constrained within thin beds of limestone which cross a number of faults. Tributary caves exhibit further geological controls, and include some associated with the subaerial limestone gorge at How Stean.

Introduction

An important group of caves lies in the upper valley of Nidderdale, and its tributaries, upstream of Lofthouse (Figure 3.1). The easterly dip off the Pennine anticline carries the Great Scar Limestone well below the floor of Nidderdale, although it lies at the same altitude as Wharfedale, which is cut 150 m deep into the Great Scar. Nidderdale is cut largely into the Namurian Grassington Grit, which locally oversteps and cuts out much of the Brigantian succession of Yoredale beds. The valley floor reaches through the Grit to expose Yoredale limestone in a sequence of three inners (Figure 3.11). In the north, the Limley inlier is an anticline confined within a triangular fault block. Lesser faults cross the valley downstream and a southerly upthrow on the Dry Wath fault returns the limestone to outcrop in the Thrope inlier, until it again dips very gently to the south beneath the Grit. The Lofthouse inlier is the largest of the three, has a gentle dip to the east, and is faulted along its southern margin. The limestone in Nidderdale forms a unit 40 m thick; most of this is the Middle Limestone, which is locally contiguous with the overlying Five Yard and Three Yard Limestones (Wilson, 1983).

Allogenic water from the Grassington Grit catchment to the north and west flows along the River Nidd until it sinks into the fractured limestone of the Limley inlier. Mild flood flows reach on the surface to the sink into Goyden Pot, but the river bed downstream is normally dry as far as the resurgence inflows in the Lofthouse inlier. From Manchester Hole to Nidd Heads the underground drainage route is within the limestone, which is about 40 m thick. The caves of How Stean Beck and Blayshaw Gill lie in the same limestone in the Lofthouse inlier.

The geology and geomorphology of the Nidderdale caves have been described by T.D. Ford (1964b) and Davies (1974a), and passage development in New Goyden Pot was further discussed by Davies (1974b). Descriptions of the cave passages are given by Yates (1934), Brindle (1956) and Brook *et al.* (1988), and of the flooded caves between Goyden and Nidd Heads in Monico (1995).

Description

The caves of the River Nidd

Goyden Pot is the main cave on the River Nidd and has flooded connections to Manchester Hole and New Goyden Pot, creating a single system downstream from the sink (Figure 3.12). This has a mapped length of more than 6.3 km, descending 61 m, and another 1.2 km of flooded passage has been explored upstream from the Nidd Heads resurgence.

Under normal flow conditions the River Nidd sinks in fissures in the Middle Limestone on the northern side of the Limley anticline to enter the main river passage of Manchester Hole. This is a single large canyon, up to 12 m high and 6 m wide, extending south for 500 m to a sump. Over the crest of the Limley anticline, the cave river has breached the base of the Middle Limestone exposing the underlying shale and the Simonstone Limestone in the canyon walls. The main chamber of the cave is heavily modified by massive block collapse.

The downstream sump is a short phreatic loop which ends at multiple outlets into the open cave passages of Goyden Pot, which are joined by a large flood route from the gaping entrance in the surface river channel. Following the western edge of the Goyden Pot network, the River Passage is a splendid, wide canyon strewn with sandstone boulders. This descends 35 m by following the bedding obliquely down dip; fractures guide it around sweeping loops, with chert nodules projecting from the walls, beneath a sloping bedding roof, and then downdip into a sump. East of the River Passage, the Labyrinth is a sloping network of small phreatic tubes, chambers and tall rifts, lying updip in the same bedding planes (Figure 3.12). This area is now largely inactive, except where an underfit stream flows in the New Stream Passage before entering a flooded phreatic loop through to New Goyden Pot. Many of the Labyrinth passages are choked with clastic sediments, and there are some calcite speleothems which show evidence of erosion and re-solution. Upstream of the sump in the River Passage, high-level rifts provide a dry route into another short section of canyon passage, and then into a series of shallow phreatic loops.

New Goyden Pot contains another section of the underground River Nidd flowing through large passages, which are reached by two shafts dropping down a fault from a small entrance in the surface river bed (Figure 3.12) and (Figure 3.13). The river emerges from shallow phreatic loops where the cave passage follows almost horizontal bedding horizons within each fault block (Figure 3.13), and steps in their profile lie where each fault is crossed (Davies, 1974b). The long crest of a loop between the Dry Wath and Thrope Edge Faults has the gently graded stream flowing along the floor of rejuvenated phreatic tunnels which take a large double bend towards the east, collecting the tributary flow from the Goyden Pot New Stream (Figure 3.12).

South of the Thrope Edge Fault the underground River Nidd enters further shallow phreatic loops, separated by very short lengths of vadose cave over some of the loop crests. Banks of gravel and cobbles are common in the downloops, and almost block the flooded passage at the present limit of exploration. It is likely that the continuing passage is mostly underwater, but sections of descending open streamway must occur as the water levels in downstream New Goyden are a few metres above the level in Nidd Heads. Upstream from the resurgence, a complex of passages to the twin risings are distributaries from a trunk conduit, which has been followed for over 700 m without meeting airspace. Most of this flooded cave is nearly level, but in at least two places the flow rises steeply up rifts from depths of more than 30 m.

The caves of How Stean Beck

How Stean Beck is a tributary of the River Nidd, which flows through a spectacular limestone gorge up to 15 m deep, currently operated as a commercial tourist attraction. On the north side of the gorge, a group of caves contains almost 2.5 km of mapped passages, traversed by underfit streams. Eglin's Hole lies upstream of Low Eglin's Hole (only the latter appears on (Figure 3.12)), to form a single, linear, vadose system draining down the limestone dip, partly guided by chert beds. Both caves have low bedding plane passages, locally up to 15 m wide where loops and inlets coalesce. Some of the bedding openings have shallow vadose floor trenches, and others are choked with boulders or blocked by roof collapse. The main water enters from choked sinks which are minor leaks from How Stean Beck. The vadose caves descend nearly 50 m to a sump where the bedding plane passage continues below the level of the resurgence, which is a rising through the Nidd alluvium.

The How Stean Gorge is a subaerial canyon which carries a larger stream flow than the parallel caves; its floor lies about 10 m below the caves. A single tributary on its south side flows for 50 m through How Stean Tunnel, and Tom Taylor's Cave is a rift on the north side carrying flood flows from the Eglin's caves (Waltham, 1984; Brook *et al.,* 1988).

The caves of Blayshaw Gill

Adjacent to the mineralized faults on the south side of the Lofthouse inlier, the two potholes in Blayshaw Gill enter fragments of an old phreatic cave intersected by the modem valley (Figure 3.12). Multiple levels add to a total of more than 950 m of mapped passage, much of it now choked with ochreous clay and boulder falls. Blayshaw Beck sinks into the Five Yard Limestone and a well developed cave passage crosses a fault directly into the Middle Limestone, where it continues following bedding planes downdip to the east. The modem stream has cut a vadose canyon in the floor of the older cave, as far as a sump at the level of the alluviated resurgence 30 m below the sinks.

Interpretation

The caves between Goyden Pot and Nidd Heads provide a classic example of karstic drainage beneath a major valley floor which only carries a surface flow in high flood conditions. Much of the cave system lies beneath the outcrop of the Grassington Grit, between limestone inliers at the sink and resurgence, but the geology of Nidderdale is unlike that of the other Yorkshire dales. Cave inception in the buried limestone was probably accelerated by seepage of aggressive water from the surface soils down though the permeable sandstone, as the unconformity at the base of the Grassington Grit has locally cut out the intervening Brigantian shales.

All the caves in the valley show strong control by bedding planes within the limestone unit which is only 40 m thick. The extensive phreatic Labyrinth in Goyden Pot is formed on dipping bedding planes, and the vadose caves beside How Stean Beck drain directly downdip. The major cave passage carrying the River Nidd drains obliquely down the dip in Goyden Pot, and takes a circuitous course through almost horizontal limestone in New Goyden Pot. In both cases, segments of the cave passages are aligned on joints which are enlarged into tall rift fissures and chambers.

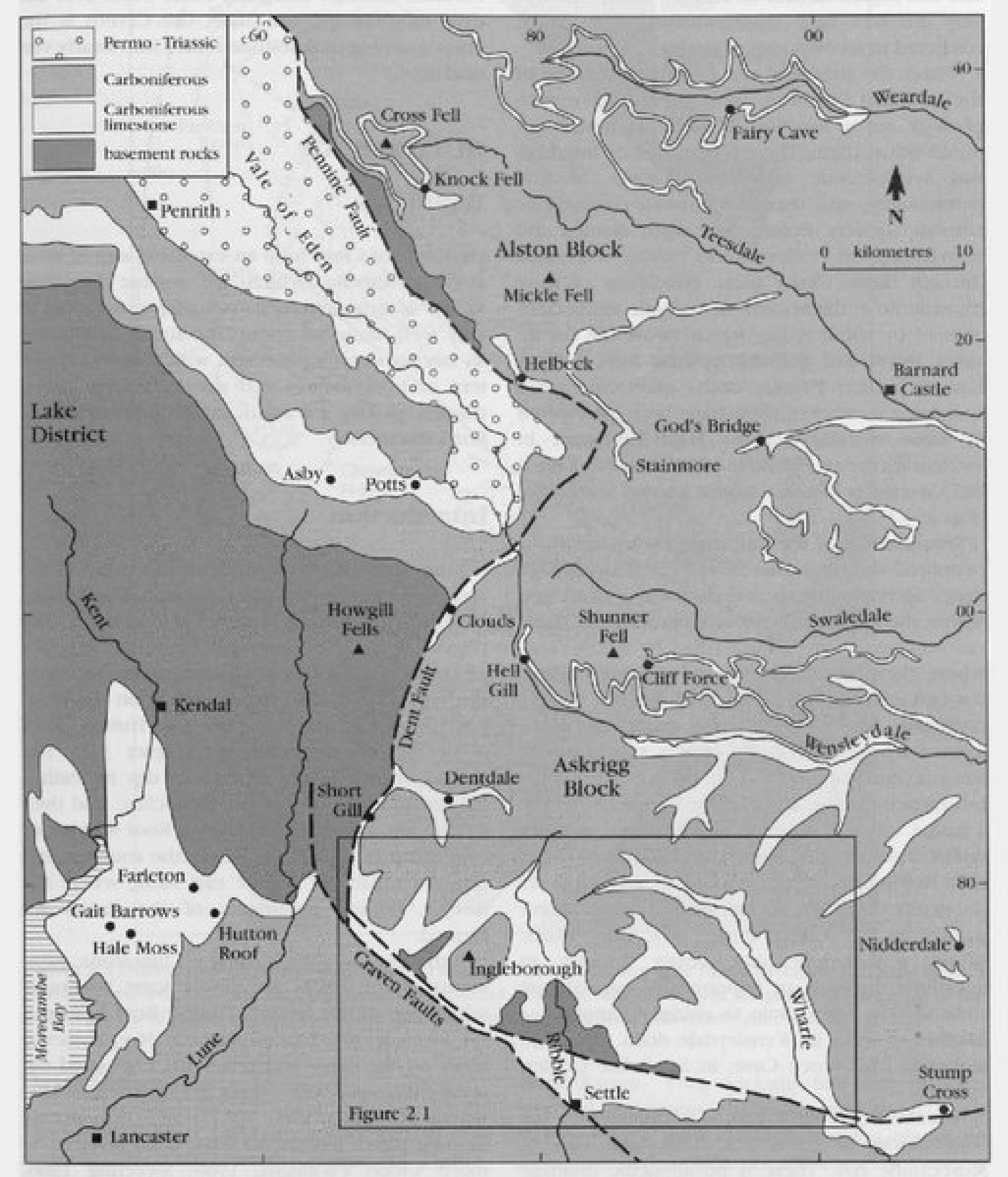
The many faults across the line of the underground drainage have been utilized to link sections of nearly horizontal cave conduit formed on just a few inception horizons within the limestone. This has created a stepped profile in the shallow, phreatic loops across downfaulted blocks (Figure 3.13), in a pattern rarely seen because of the intrinsic inaccessibility of these caves within the phreas: it is in marked contrast to the deep loops in the steeply dipping limestone off the Mendip Hills. Along the underground River Nidd some of the fault planes have proved to be sites of cave inception, linking the bedding horizons. In contrast, the caves of Blayshaw Gill cut cleanly across a fault plane, whose only role has been to bring two limestone beds into hydrological continuity.

The history of development of the Nidderdale caves is clearly long, as there are many series of abandoned and rejuvenated phreatic passages, but cannot be tied to a chronology of absolute dates. Surface modification during the climatic fluctuations of the Pleistocene included the rejuvenation of How Stean Beck. This appears to represent an unusual case where an underground drainage route, through the Eglin's caves, was abandoned in favour of a surface course. How Stean Gorge is a splendid limestone trench, which is effectively a vadose canyon passage without a roof. It may have origins from periglacial regimes when high flows of meltwater were constrained from sinking by permafrost sealing of the limestone fissures. Its continued subaerial entrenchment in postglacial conditions was probably aided by a gorge thalweg mostly steeper than the limestone dip, so that bedding planes could not offer hydrologically favourable routes for underground capture.

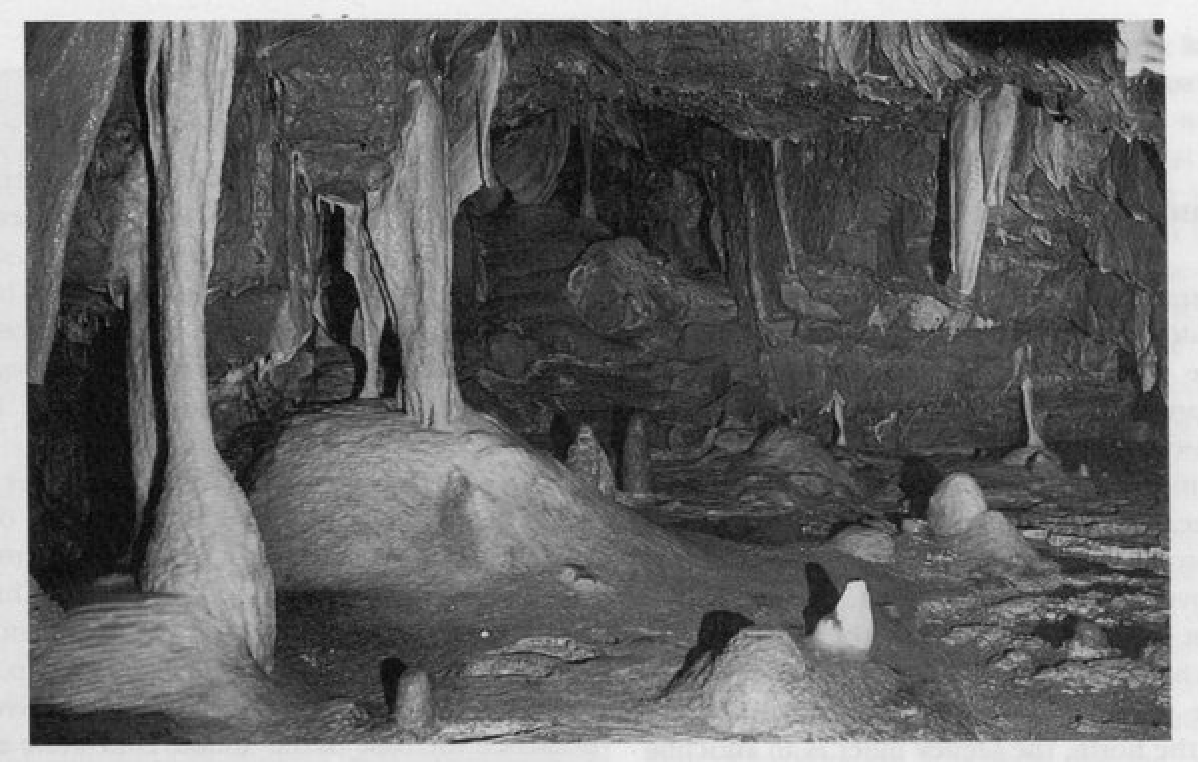
Conclusion

Nidderdale contains a major cave system carrying the entire valley drainage. Large vadose canyons descend from the main sinks to the head of a long phreatic series, where a staircase of flooded down-loops is interrupted by short sections of vadose cave over loop crests dictated by geological structure. The influence of faults on the pattern of conduit development through the karstic aquifer is seen more clearly than anywhere else in Britain. The tributary of How Stean Beck has a series of vadose caves which have lost their drainage to a subaerial gorge, in a reversal of the usual role of underground capture in a youthful karst landscape.

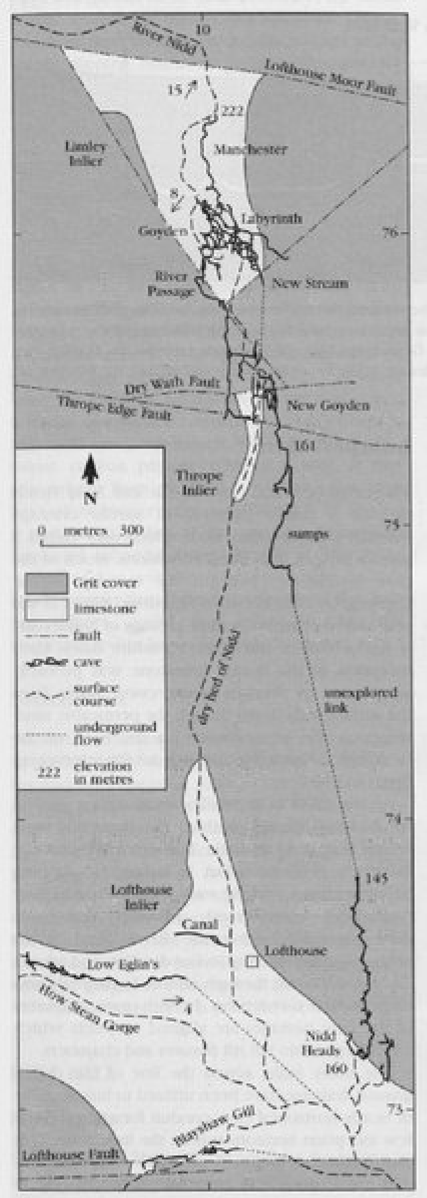
References



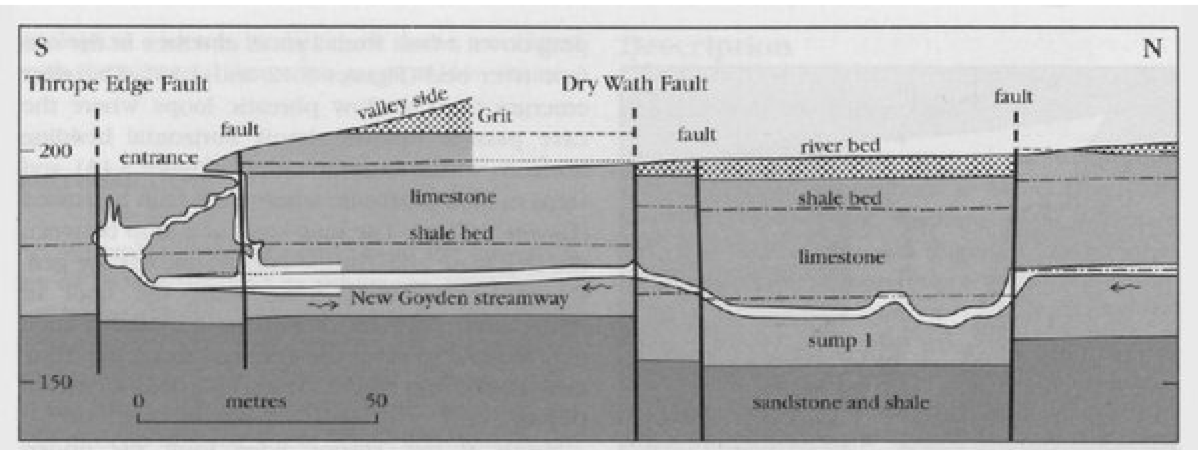
(Figure 3.1) Outline map of the karst regions in the northern Pennines, with locations referred to in the text. The other Carboniferous rocks are the non-carbonates of the Orton Group and Yoredale facies of the Dinantian, and the Namurian, but they include thin bands of limestone with lesser karst features not shown on this map. The Carboniferous limestone includes the Dinantian Great Scar Limestone, the Yoredale limestones with significant karst, and the Main or Great Limestone of Namurian age. The basement rocks are Lower Palaeozoic non-carbonates. Details and locations in the southern Dales are shown in (Figure 2.1).



(Figure 3.11) Thick flowstone deposits in a suite dated to 83 000 ka in the Wolverine Cave in Stump Cross Caverns. (Photo: A.C. Waltham.)



(Figure 3.12) Geological map of the caves in the upper part of Nidderdale. Limestone includes the Middle, Five Yard and Three Yard Limestones. Grit cover is the Grassington Grit and some overlying Namurian beds on the higher slopes. Eglin's Cave extends off the map to the west. (Outcrop geology after Wilson, 1983; cave surveys from Yorkshire Underground Research Team, Cave Diving Group and others.)



(Figure 3.13) Profile of the geology and cave passages in the western part of New Goyden Pot. The main streamway flows south towards the Thrope Edge Fault, and then turns into a loop back to the north which is not shown in this profile downstream of the entrance shaft. The grit is the Grassington Grit; the limestone includes the Middle, Five Yard and Three Yard Limestones; the sandstones and shales are of the lower Brigantian and include the Simonstone Limestone at *an unknown depth. (After Davies, 1974b.)*