EXCURSION

Yorkshire Dales

Leader: Tony Waltham

Weekend July 31 - August 1, 2004

A return to the Yorkshire Dales seemed long overdue, and Ribblesdale was chosen as a venue to take in some of the classic sites and also a few places less well-known. Karst geomorphology on eastern Ingleborough and at Malham was interspersed with various localities at the limestone's basal unconformity and some fossiliferous sites at the top of the limestone. Members and guests numbered 24 for the occasion, and, after a cool start for the uphill walk on Saturday morning, the weather was delightfully warm and sunny. This allowed long rests on comfortable grassy fells, allegedly for geological discussion, during a long walk on the first day.

Limestone unconformity around Moughton

The party gathered on the Saturday at the Helwith Bridge Inn, and then took the cars to convenient parking below the Foredale Cottages (NGR 802701). Directly up from the cottages, the old Combs Quarry (800702) provides a spectacular exposure of the basal unconformity of the Carboniferous Limestone overlying steeply dipping, flaggy, laminated siltstones of the Silurian Horton Formation (Fig 1). The leader described the unconformity at the northern end of the exposure as having clean limestone in contact with the basement, with no basal conglomerate, and with about 1 m of relief on the unconformity suggesting marine invasion of a rocky foreshore (the close-up view is not worth the climb to it). It was the first of four localities that revealed environmental variations within the Carboniferous marine transgression.

Higher up, Foredale Quarry (800705) was worked in the limestone until about 1940. About 6 m of the thinly bedded, dark grey, muddy limestones of the Kilnsey Formation are only exposed at the quarry's southern end, while the upper 5-10 m of the quarry worked the Cove Limestone of the overlying Malham Formation. One face exposure was recognised as the wall of a meandering canyon cave that had been breached by the quarry working. It exposes stylolites in the limestone, developed in response to crystal orientations during pressure solution across a bedding plane or shale parting.

A break in the uphill walk onto the Moughton benches (790720) took in the view east. There was some discussion as to whether Pen-y-ghent Hill constituted a crag protecting a tail (in glacial style) extending south to and beyond Overdale (833708); the tail has a limestone core, but a till element on it was recognised by the softer drift topography. The leader suggested that a basement rise occupied almost the same position, as streams off Fountains Fell sink underground, where cave drainage is deflected away from the lower Ribble valley, as it all emerges at Brants Gill Head (812730) near Horton; whether this is due to folding of the limestone or to a buried basement ridge awaits detailed mapping.

A stroll across Moughton offered panoramic views from Ingleborough to Penyghent. The party looked down onto the Moughton Whetstone Spring, but did not descend to the poor outcrops of the Silurian whetstone siltstones where red and green banding may be due to weathering of Carboniferous age just beneath the limestone unconformity. On the plateau top, limestone pavements may be of poor quality due to by-gone, patchy removal of the top bed (with its better rundkarren forms) for rockery stone. The beds were viewed northwards into a shallow syncline that had been excavated into a stratimorphic depression (786726) by ice scouring weaker limestone cap-rocks as it overflowed from the Ribblesdale iceway into Crummack Dale. From Beggar's Stile, the party turned south, into the dale.

The basal unconformity was seen again at Austwick Beck Head (776718), a powerful rising of all the water sinking in the potholes of the Allotment, 2 km to the northwest. The flooded cave passage is on a bedding plane rising on the gentle dip about a metre above the unconformity. On its northern bank, the basal limestone has very few pebbles and lies over Ordovician mudstones that appear to exhibit Carboniferous weathering in the top few metres below the unconformity. In contrast, the southern bank exposes a basal bed more than a metre thick with well-rounded pebbles and cobbles of Ordovician mudstone within a limestone matrix. An almost-level bedding in the basement mudstones was observed to reveal a lozenge-pattern of jointing (Fig. 2); this was considered to resemble boudinage that could be ascribed to tension during strong Caledonian deformation of the region.

***Figure 1**. The basal unconformity in Combs Quarry.*

***Figure 2**. Basement jointing at Austwick Beck Head.*

Norber Scar

The party then followed the limestone scars that climbed an anticline southwest of Crummack Farm. At the crest (767710) this anticline was seen to be largely due to post-Carboniferous folding, as the counterpart could be seen in the eastern slope of Crummack Dale (783713), but there was unresolved debate on the scale of any pre-Carboniferous hill of basement that forms the core of the fold. On the west side of Crummack Dale, the core of the anticline was seen to be strong greywackes of the Silurian Austwick Formation, forming ice-plucked crags just below the unconformity (768709). The party then walked downhill to emerge on the limestone bench of Norber, famous for its splendid glacial erratics of the Austwick greywackes sitting on plinths of Carboniferous limestone. These erratics had been carried south by the Crummack Dale ice, and are now stratigraphically higher than their source. It was however clear that the popular concept of them being glacially transported uphill from the floor of Crummack Dale was inaccurate, as they appeared to derive from the crags that were largely at a higher level within the core of the basement rise.

The party then perused the plinths on which the erratic blocks stood, and considered these as bits of limestone protected from postglacial rainfall dissolution by the blocks acting as umbrellas. Should this be the case, the heights of the plinths (up to 400 mm) indicate Holocene surface lowering of about 0.04 mm/year. The leader pointed out that this is comparable to surface dissolution rates calculated from solute loads in waters of the karst springs in the area, and is slightly lower than the rates of stream cave entrenchment in the limestone (0.08 mm/y) calculated from the ages of wall stalagmites. It is however lower than surface denudation rates in the warmer climates of Slovenia (0.065 mm/y), and substantially lower than the rate of valley-floor lowering in the glaciated troughs of the Yorkshire Dales (0.12 mm/y), calculated from stalagmite ages since caves were drained by glacial rejuvenations. Though protection of the plinths makes an attractive story, only a few of the many erratics do stand on plinths, and these may be largely ascribed to bench edges where erratics happened to be dropped on them. Also, the relationship of plinth height to the umbrella effect is weakened if dripwater runs round underneath some of the boulder faces; or this may explain why so few boulders stand on substantial plinths.

On leaving Norber, the base of the limestones was regained at Nappa Scar (769698). At first sight, the footpath appeared to lie along the unconformity; a metre of very coarse, poorly-sorted, debris with a carbonate cement forms the base of the scar above and on its north side, while slate is exposed along parts of the footpath. However, a scramble below the footpath reached scars that expose over 2 m of a mature, carbonate-cemented conglomerate with well rounded pebbles 5-10 mm across, that rests directly on the true basement unconformity over steeply dipping Ordovician slate. The slate exposed in the footpath is in loose blocks up to 2 m across, with structural orientation not as in the basement exposed below the scars (Fig. 3). The coarse deposits at footpath level were considered as a submarine landslide, or debris flow, formed shortly after marine invasion of the basement platform; concepts were mooted of it deriving from a weathered soil on a newly submerged hill (now cut by Crummack Dale), and of landslides triggered by activity on the Craven Faults. The origin of the conglomerate was unresolved, though it clearly derives from a quieter environment that was either fluvial or shallow marine.

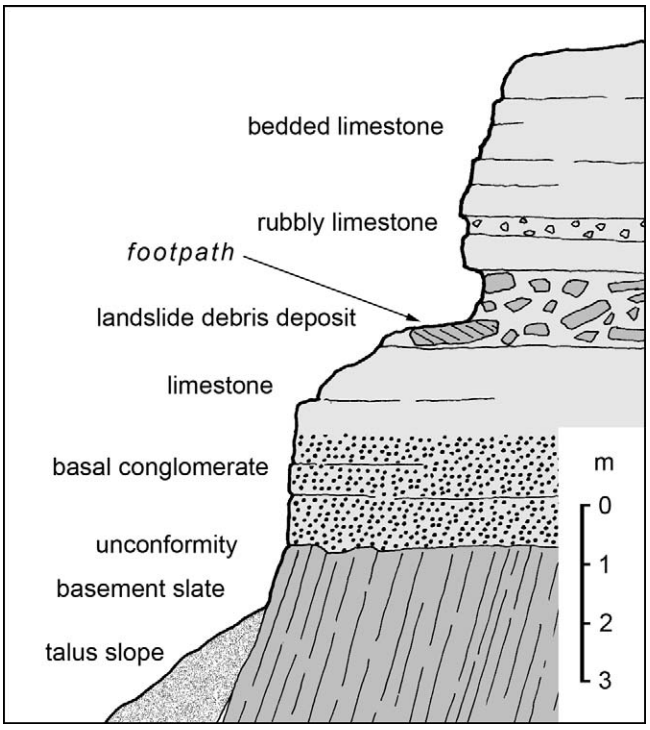

***Figure 3**. Sketch section through Nappa Scar.*

Figure 4. *Flute casts exposed above Newfield House.*

An eastward walk along the valley floor, and a footpath above Newfield House then took the party to a viewpoint (798695) overlooking Dry Rigg Quarry. This works an annual 350,000 tonnes of the Horton Formation, valued as roadstone because of its resistance to polishing (PSV = 70-72). However, the quarry will close in 2009, after backfilling with all the waste fines so that the adjacent wetland can spread back over it, except for a part left as a deep lake beneath the high western quarry face. A descent to the southeast then took the party to some midfield crags (800693). These expose spectacular flute casts on the undersides of greywacke beds, the result of erosion and deposition by turbidity flows (Fig. 4). Units 400-1200 mm thick represent individual flows, and each is graded upwards from greywacke to slate with the flutes scoured into the top of each slate. Now dipping at over 70°, this turbidite exposure is a classic. It was then only a short walk to liquid refreshment at the Helwith Bridge Inn, except for the drivers who were despatched to recover the cars.

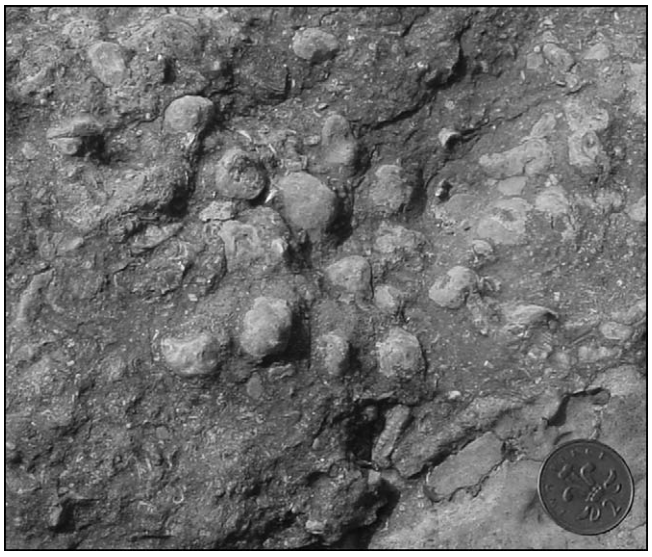

Figure 5. *Girvanella (or Osagia) at Lockey Gill.*

Sunday in the limestone

The party re-assembled at the head of Pen-y-ghent Gill (856733). A short walk down a footpath passed the fine karstic collapse known as Giant's Grave (857734). The downstream end of a cave up to 8 m wide along bedding planes has collapsed where its roof was only a bed about a metre thick and weakened by cross jointing. This is a rare case of a collapsed cave, albeit on a scale much smaller than Gordale or Cheddar (whose gorges are often mistakenly ascribed to such events). The party then turned into Lockey Gill, where an excellent exposure of the Girvanella Band was found just a few metres downstream of the road bridge (856735). This bed of black foetid limestone, just 300 mm thick and rich in the algal nodules the size and shape of almonds (Fig. 5), has long been used as a marker at the top of the Great Scar Limestone throughout northern England, though it is now mapped within the Hawes Limestone (the lowest of the Yoredale facies limestones of the Wensleydale Group) and locally forms more than one band. Though the algal nodules are distinctive, they are often only recognisable in weathered exposures. The bed may also be referred to as the Osagia nodule band, this being the correct generic name (from American localities) of the algae that creates the outer casing of the nodules (Johnson, G.A.L., 1958, discussion in Proc. Yorks. Geol. Soc., 114, 428-9).

A short walk onto the slopes of Fountains Fell then took the party to an unpublicised fossil locality in the Hardraw Scar Limestone. A stream section that exposes very fine shell beds of *Productus latissimus* almost directly overlain by coral beds of *Siphonodendron junceum* (perhaps more widely known by its old name, *Lithostrotion junceum*), offers insight into the fauna-rich environment of the Carboniferous shelf seas. The dry streambed below the exposure yielded blocks of *Siphonodendron*, but only fragments of the more spectacular coral, *Actinocyathus* (formerly *Lonsdalia*) *floriformis*, which was once common at the site (though not seen *in situ*).

Malham glaciokarst

The well-known Malham Cove was the next destination, approached the easy way with a walk down the Watlowes dry valley from Langscar Gate (888649). A high viewpoint on the east side of the Cove (see back cover) was the venue for discussion on its origins. The Cove is accepted as a feature that has retreated from a by-gone scarp on the Middle Craven Fault, which crosses the valley 600 m further downstream, but simple headward retreat of the karstic resurgence is not now regarded as viable. The flooded cave passage behind the Cove is about 6 m wide, and though it once took a flow larger than now, the stream's erosional power was small. It has only helped clear debris from the foot of the 70 m high Cove.

Subglacial and/or proglacial meltwater offers a better tool for fluvial excavation of the Cove and the Watlowes valley. Accelerated excavation by periodic jokulhlaups from an ice-dammed or sub-glacial lake within or beneath the Devensian ice sheet on the Malham Tarn plateau (as originally proposed by Alistair Pitty; pp 281-291 in *New directions in karst*, eds K.Paterson & M.M. Sweeting, 1986, Geo Books: Norwich) could account for the anomalously large sizes of both the Cove and Watlowes. In favour of fluvial excavation, the width of the Cove (so much greater than that of Watlowes) was compared to the proportions of the dry waterfalls among the coulees and scablands of Washington, USA, which were scoured by massive proglacial floods. Glacial action could involve ice plucking of the Cove wall where an iceway fed over the fluvially-notched fault scarp; this idea is supported by the reverse gradient over a hump (now cut by a post-glacial trench) on the thalweg rockhead immediately downstream of the Middle Craven Fault, and by the lack of any alluvial fan.

A lively discussion on the Cove could not be resolved, and the notion of polygenesis was regarded as attractive, with elements of fluvial, glacial and karstic erosion all contributing to evolution of the landform. Analogies were also made with the nearby Gordale Scar, where the wide lower section may share a genesis with the Cove, while the narrower gorge and waterfalls are meltwater features comparable to Watlowes, though the Gordale landforms are narrower due to headward retreat on minor faults that lie 70° clockwise from the line of the Craven faults.

After lunch in the warm sunshine, the party headed north, parked the cars above Selside village, and walked up the fell to Alum Pot (775756). Views down the 60 m deep shaft are almost obscured by trees, so the cave stream was pursued further up the fell. At the lower entrance to Upper Long Churn Cave, water could be heard in the cave beneath fissures that opened to daylight, and two cave entrances are provided by a breach in a dry ox-bow passage. Armed with a torch for each person, a careful venture into the upper entrance reached the stream after about 20 m of stooping. Upstream was then a delightful walk in a clean-washed canyon passage with flow-scalloped walls in pale limestone beneath a bedding plane roof that was the locus of cave inception (Fig. 6). How far members went up the streamway depended on their willingness to get wet feet or to climb over a few pools. About 300 m upstream, the chamber containing Dr Bannister's Handbasin was reached; some members climbed the inlet waterfall to emerge from the top entrance, while others returned downstream to enjoy the cave with eyes accustomed to torchlight.

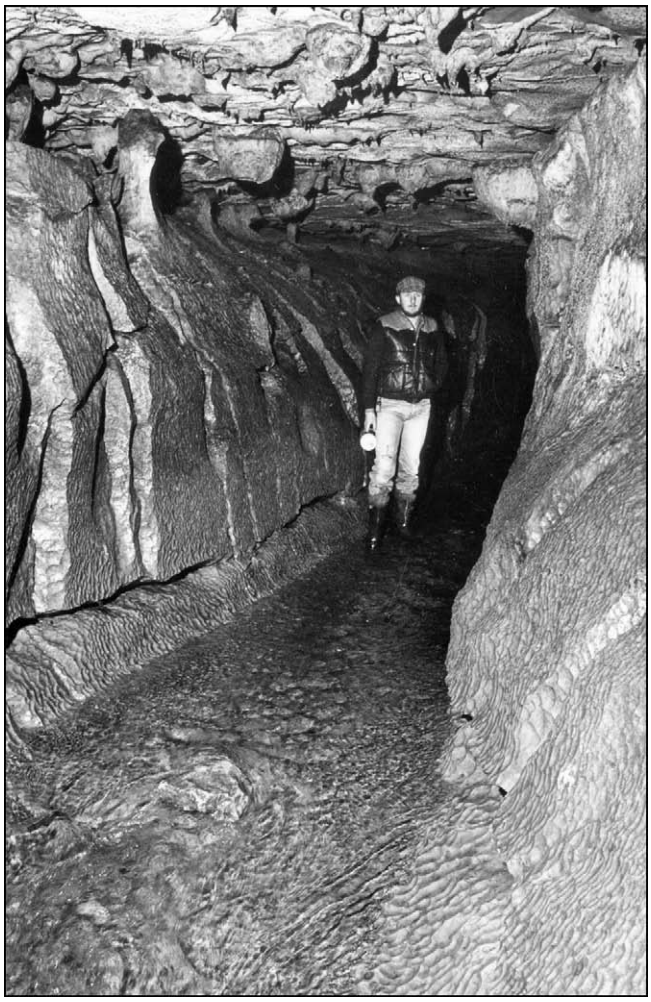

***Figure 6**. The streamway in Upper Long Churn Cave.*

After a final look at the excellent limestone pavement (773756) between the two cave entrances, and a distant view across Ribblesdale to the splendid drumlins around Birkwith, members headed for the cars and journeys home. A vote of thanks was proposed by Tony Morris, before the leader thanked the Society members, and especially the contingent from the BGS, for providing erudite discussion, and thereby contributing greatly to an enjoyable weekend.