Recent attempts to reveal a palaeokarst hollow in the station car park at Miller's Dale, Peak District

John Hunter

Abstract: Examples of contemporaneous palaeokarst surfaces within in the Peak Limestone Group of Derbyshire, as described in geological literature in previous decades, are becoming increasingly difficult to locate and examine. One palaeokarst channel exposed in a rock face at the back of Miller's Dale railway station was first reported by F. W. Cope in the 1930s, and recent works have seen a measure of conservation of the site.

On June 1, 1863, the Midland Railway Company opened a section of line from Rowsley to Buxton in the central Peak District, as part of the route that connected Derby with Manchester by 1867. Construction of this railway line along the Wye Valley between Buxton and Monsal Head required significant engineering works, including several tunnels and viaducts. John Ruskin, the outspoken Victorian artist, art critic and social commentator, famously condemned the desecration of the landscape by writing in one of the earliest of his monthly letters to working men: '… *The valley is gone, and the Gods with it; and now, every fool in Buxton can be in Bakewell in half an hour, and every fool in Bakewell at Buxton; which you think a lucrative process of exchange – you Fools everywhere*..' (Ruskin, 1871, p.64).

The railway closed in 1967, and in the mid-1970s several sections of the track-bed, excluding the tunnels, were converted into public footpaths within the Peak District National Park. In 2011, as part of an upgrade to what is now known as the Monsal Trail, several of the tunnels were repaired and reopened to create a single trail for 15 km from east of Topley Pike to north of Haddon Hall. In contrast to Ruskin's damning assessment of the railway line in 1871, the Monsal Trail, with its varied assortment of historic engineering, is now a well-used and much-appreciated public amenity.

The numerous railway cuttings excavated in the 1860s through rock in the steep sides of the incised, meandering Wye Valley exposed significant sections of the Peak Limestone Group stratigraphy. Consequently, the Wye Valley section of the Monsal Trail, together with its abandoned quarries and excavations for stations, was designated an SSSI and also a key national earth heritage site by the Geological Conservation Review.

One of the more extensive rock exposures along the railway line was at Miller's Dale, where a wide bench was cut out of the northern side of the valley to make space for a station [SK 138733]. The vertical rock face remaining in the hillside next to the sidings revealed the contact between the Asbian Miller's Dale Limestone and the overlying Station Quarry Beds, which constitute a locally-occurring basal unit of the Brigantian Monsal Dale Limestone.

Between 1903 and 1905, the Midland Railway Company expanded the number of tracks and platforms at Miller's Dale station. These works required the construction of a second viaduct across the river and the removal of a further slice of rock out of the hillside to enlarge the station footprint.

The changing position of the rock face at Miller's Dale station can be determined by comparing Ordnance Survey Six Inch maps (Derbyshire XV.SE) of 1899 and 1923. No images appear to exist of the rock face before it was cut back, but the altered rock face of 1905 is the same feature that exists today. The earliest image found so far of the expanded railway station at Miller's Dale and its new rock face is a postcard dated c1912 (Fig. 1). In this west-looking overview of the landscape with its limited tree growth (compared to today), the extent of the rock face along the north side of the station is evident. The Station Quarry, a separate excavation, is also visible in the distance, beyond the railway station.

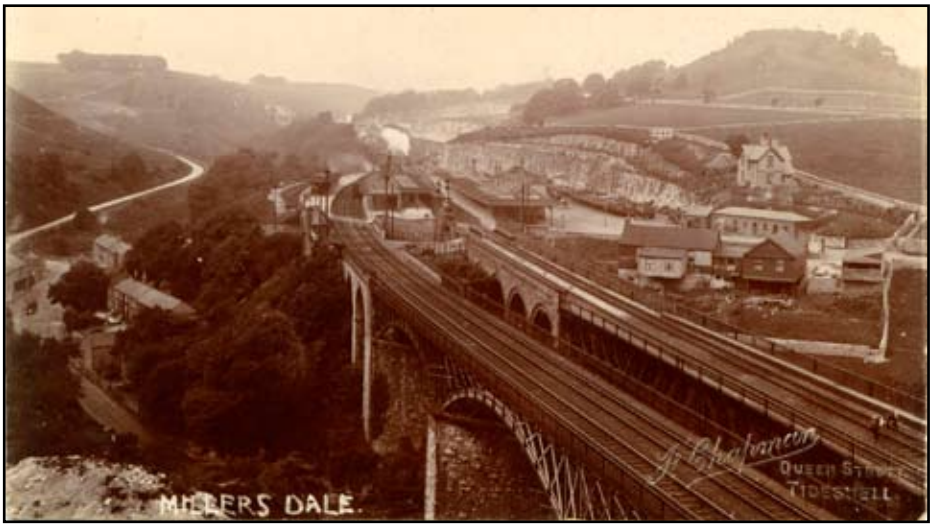

Figure 1. *Postcard from about 1912 showing a westward-looking view of Miller's Dale railway station (from the John Alsop Collection).*

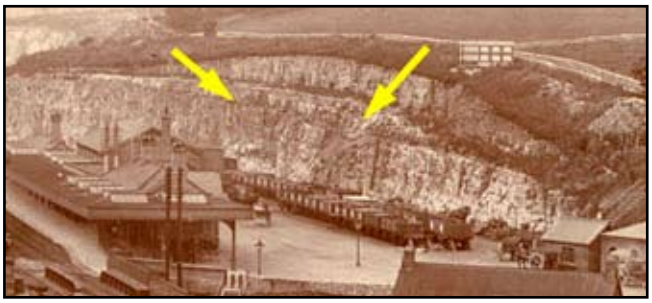

***Figure 2**. Enlargement of central part of Figure 1.*

Cope's observations

The contact between the two limestone formations that comprise the rock face can be seen on an enlarged portion of the postcard (Fig. 2, left arrow), as can a disturbance, or slump, in an isolated part of the strata beneath the contact (right arrow). The separate horizontal step near the top of the rock face is an upper bench, cut back to improve its stability. It is not known whether the slump feature was also present in the original rock face before it was modified in 1905. One of the earliest geological descriptions of the area around Miller's Dale railway station was published by F. W. Cope, in 1937. He explained the complications in local stratigraphical correlation caused by the intermittent presence of the Upper Miller's Dale Lava at or close to the contact between the Asbian and Brigantian strata and the limited areal distribution of the Station Quarry beds beneath it.

He also observed that in some nearby localities the upper surface of the Miller's Dale Limestone was 'scored with small pot holes', whereas in the railway station goods-yard a large 'cauldron-like erosion feature' existed, about 3 m deep and nearly 2 m at its greatest width. It was filled with soft grey shale and contained a large (1.5 m), water-worn limestone boulder at the bottom. He stated that the shale contained a fossil assemblage of obscure plant remains, fish scales and crushed molluscs. A few pebbles of dark, fine-grained, pyritized, limestone were also noted. Compaction of the shaly fill in the erosion hollow had resulted in the gentle sag of the lowermost beds of the overlying Station Quarry Beds into it. These features and other evidence were used to interpret a period of tectonic uplift and erosion between the Upper Asbian and Lower Brigantian strata, with the hollow representing a section through a washout channel.

In an excursion guide published in 1967, Professor Cope referred to the boundary between the Asbian and Brigantian limestones in the Miller's Dale station area as a conspicuous disconformity, with deep, pebble-filled pockets in places and a large boulder visible in a deep, shale-filled pot-hole or channel in the station yard. In 1972, he published an idealised sketch, which is possibly the only recorded image, of this prominent feature (Fig. 3). Additional details, such as a thin, saucer-shaped layer of dark grey micrite enclosed within the shale fill, were provided (Cope, 1972). The shale below this micrite layer contained the fragmentary fossil remains, while the shale above it contained segregations of pyrite cubes and small pieces of pyritized calcilutite. A thin shale parting can also be followed along the formation contact away from the erosional hollow. He noted that the exposure was, by that time, largely overgrown with willows, the roots of which had considerably disturbed the weathered shaly-fill material.

In the same article Cope also described a similar, wider, erosion channel at the equivalent stratigraphical position in a narrow cutting near the eastern portal of the Litton railway tunnel.

Subsequent interpretations

Further descriptions of the stratigraphy of the area around Miller's Dale station offered some alternative interpretations of the formation of these large erosive hollows, involving karstic dissolution (Butcher & Ford, 1973; Walkden, 1974, 1977). Walkden also commented on the overgrown state of the outcrop at the back of the station yard, and his description of the large boulder as being 'formerly observed' by Cope implies that it could no longer be seen.

Subsequently, the BGS described the base of the Monsal Dale Limestone as generally sharp and conformable with the underlying Miller's Dale Limestone, with local exceptions, such as the Litton Tunnel entrance and the Miller's Dale station area, where there is evidence for erosion at the contact (Aitkenhead *et al.*, 1985). It was emphasised that disconformable bedding contacts, which represent interruptions in limestone deposition associated with temporary periods of sub-aerial exposure and karst-surface development, were probably the result of a complex interplay between eustatic and tectonic controls on sedimentation. The lithostratigraphical

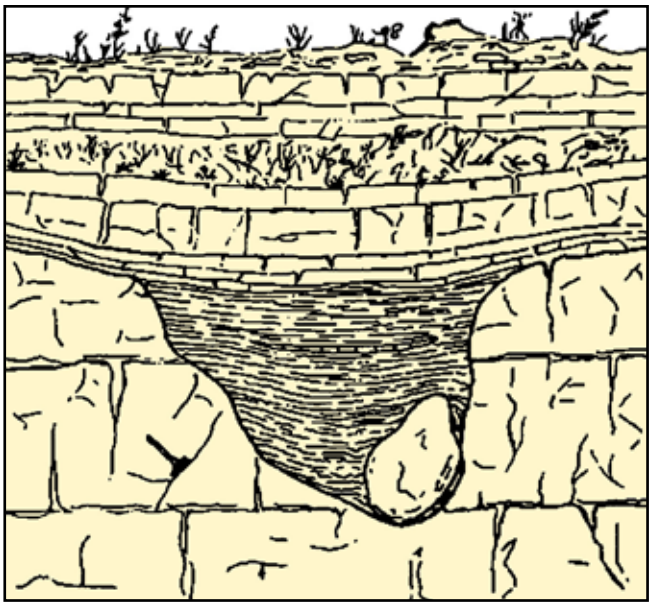

***Figure 3**. F. W. Cope's sketch of the erosion hollow in Miller's Dale station yard (from Mercian Geologist, 1972).*

framework for the Lower Carboniferous (Waters *et al*., 2009) mentions the palaeokarstic solution hollows on top of the Miller's Dale Limestone, but does not identify the Station Quarry Beds as a distinct unit within the Monsal Dale Limestone.

In 1990, Gutteridge proposed that the localised sub-Brigantian disconformity had developed near the margin of a structurally-controlled embayment or sub-basin within the shallow-water limestone shelf that formed the western extension of the East Midlands Platform in the Carboniferous Pennine Basin. However, the precise origin and the 3-dimensional form of the erosion hollows exposed in the Miller's Dale station yard (now a car park for users of the Monsal Trail) and in the eastern entrance cutting of the nearby Litton Tunnel remain elusive. It is unfortunate that the lack of rock exposure across large areas between the major outcrops in the central Wye Valley continues to frustrate attempts to derive an unequivocal understanding of the local stratigraphical detail at the Asbian-Brigantian boundary.

In the southern Lake District, a 26m-deep palaeo-valley incised into the Asbian Urswick Limestone and exposed in a quarry at Leaper's Wood, near Carnforth (Horbury, 1989: Horbury & Adams, 1996) is very similar to the example seen in Miller's Dale station yard. These authors suggested that isolated deep channels incised into a more extensive, hummocky palaeokarst surface of generally low-relief could have developed on more steeply-sloping pre-emergence surfaces, such as might occur in the vicinity of a platform margin. This explanation is consistent with Gutteridge's embayment-margin model for the Miller's Dale area. They considered that the Leaper's Wood Quarry palaeo-valley and its sediment fill represented a record of karstification with low-stand and transgressive deposition that differs in character from the typical high-stand facies accumulated on the platform interior. The low-stand sediments may have been of freshwater or brackish origin, and the transgressive sediments were probably shallow marine in a coastal on-lap setting. However, the shaly nature of the fill in the erosion hollow in the Miller's Dale station yard differs from the oolitic limestone fill of the Leaper's Wood Quarry palaeo-valley. It may represent an in-washed palaeosol accumulation, although that could be difficult to reconcile with the fish scales and mollusc shell fragments reported by Cope in 1937. The thin layer of micrite enclosed within the shale fill (Cope, 1972) may or may not be the product of a brief interlude of elevated sea level before the high-stand system developed again at the start of the Brigantian Stage.

Figure 4. *The palaeokarst erosion hollow in Miller's Dale station yard, in March 2013, before the trees and shrubs had developed their summer foliage.*

Recent conservation measures

In 2013, the Peak District National Park Authority invited members of the Sheffield Area Geology Trust to undertake a reconnaissance survey of the Monsal, Tissington and High Peak Trails to assess the current condition of the geodiversity interest and to recommend appropriate management and conservation work. During this survey it was found that the paleokarst erosion hollow in the Miller's Dale station yard was difficult to locate and could barely be distinguished behind and beneath a dense wall of mature trees, slumped soil and ground vegetation (Fig. 4). The survey found that unmanaged vegetation growth was also impacting upon

Figure 5. *The same site in April 2014, after initial clearance of the plant cover.*

other geodiversity features along the three trails. At sites where statutorily protected flora and fauna become established in unmanaged woodland environments, the competing biodiversity interest usually outweighs any geodiversity conservation interest.

In April 2014, maintenance work by a small team of National Park staff began at some of the identified, high-priority geodiversity sites. At the Miller's Dale station yard site this work consisted of an initial phase of tree felling, stump poisoning and shrub clearance to enable better assessment of the condition of the feature and to decide what further conservation work might be appropriate. After the tree removal, the general shape of the erosion hollow (as sketched by F. W. Cope) was readily apparent, including the sag of the overlying limestone beds. It was impossible to say whether the large, angular pieces of broken limestone in the lower right part of the hollow are the remains of the rounded boulder or simply a limestone block that has become detached from the overlying beds and slumped down the slope (Fig. 5). The shaly fill material is entirely covered by a dense mat of turf and is penetrated by tree roots. The turf mat protects the soft shale fill from weathering, but the root systems are probably destroying its sedimentary fabric.

At in informal site meeting in April 2014 it was decided that careful trimming of the creeping turf layer around the edges of the erosion hollow would help to define its shape better, and would also allow inspection of the condition of the sediment fill at the edges. Owing to the steepness and height of the slope, this, and removal of loose blocks from the upper limestone beds, requires rope protection beyond the abilities of the teams involved; and in the subsequent two years the National Park budget has been reduced. Consequently no further action has been taken at the site, and the vegetation has quickly become re-established (Fig. 6).

***Figure 6**. The site in July 2016, with an extensive plant cover already re-established on the previously cleared site.*

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References

Aitkenhead, N., Chisholm, J. I. & Stevenson, I. P., 1985. Geology of the country around Buxton, Leek and Bakewell. *Mem. Geol. Surv. G. B.*, Sheet 111.

Butcher, N. J. D. & Ford, T. D., 1973. The Carboniferous limestone of Monsal Dale, Derbyshire. *Merc. Geol*., **4**, 179-195.

Cope, F. W., 1937. Some features in the D1-D2 limestones of the Miller's Dale region, Derbyshire. *Proc. Yorks. Geol. Soc*., **23**, 178-195.

Cope, F. W., 1967. The Wye valley. 1-8 in Neves, R. and Downie, C. (eds). *Geological excursions in the Sheffield Region*. Northend: Sheffield.

Cope, F. W., 1972. Some stratigraphical breaks in the Dinantian massif facies in North Derbyshire. *Merc. Geol*., **4**, 143-148.

Gutteridge, P., 1990. Depositional environments and palaeogeography of the Station Quarry Beds (Brigantian), Derbyshire, England. *Proc. Yorks. Geol. Soc*., **48**, 189-196.

Horbury, A. D., 1989. The relative roles of tectonism and eustacy in the deposition of the Urswick Limestone in south Cumbria and north Lancashire. *Yorks. Geol. Soc. Occ. Publ*., 6, 153-169.

Horbury, A. D. & Adams, A. E., 1996. Microfacies associations in Asbian carbonates: an example from the Urswick Limestone Formation of the southern Lake District, northern England. *Geol. Soc. Spec. Publ*., 107, 221-237.

Ruskin, J., 1871. Fors Clavigera – letters to the workmen and labourers of Great Britain. Volume 1.

Walkden, G. M., 1974. Palaeokarstic surfaces in Upper Visean (Carboniferous) limestones of the Derbyshire Black, England. *J. Sed. Pet*. **44**, 1232-1247.

Walkden, G. M., 1977. Volcanic and erosive events on an upper Visean carbonate platform, North Derbyshire. *Proc. Yorks. Geol. Soc*., **41**, 347-366.

Waters, C. N., Waters, R. A., Barclay, W. J. & Davies J. R., 2009. A lithostratigraphical framework for the Carboniferous successions of southern Great Britain (onshore). *Brit. Geol. Surv. Res. Rept*, RR/09/01.

John Hunter,
Quintessa Ltd, Birchwood Park, Warrington WA3 6AE
miner@aditlevel.co.uk