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## 7 The Millstone Grit of Almscliff Crag and Harlow Car, near Harrogate

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### Purpose

At Almscliff Crag a typical Millstone Grit (Carboniferous, Namurian) is well exposed, and shows the effect of a gravitational slump that developed during deposition. At Harlow Car, finer-grained sediments can be examined in sequence below the Almscliff Grit. The two localities lie on opposite sides of the Harrogate Anticline.

### Logistics

This one-day excursion can be split into two half days if required. Almscliff Crag (Localities 1–7) involves scrambling over rocks, and walking boots are needed. The geological meaning of the scenery is best appreciated in low winter sunlight.

Harlow Car (Localities 8–10) includes a stream section and needs wellington boots. This section is best on a bright day in February or March; the summer months are unsuitable because the trees cut out the light, and in autumn the stream may be too full. Access to both is by car, but parking space is limited and neither is suitable for large parties. The walking distance in each case is about 2 km.

*Note:* The Almscliff Grit has been renamed the Warley Wise Grit on the most recent B.G.S map [Sheet 70].

### Maps

O.S. 1:50 000 Sheet 104, Leeds, Bradford & Harrogate; B.G.S. 1:50 000 Sheet 62 Harrogate, Solid or Drift edition; 1:50 000 Sheet 70 Leeds, Solid or Drift edition.

B.G.S. Memoir, Harrogate (Cooper & Burgess, 1993).

### Geological background

In early Carboniferous times the area was situated in a subsiding trough known as the Craven Basin, with an area of slower subsidence, the Askrigg Block, not far away to the north. The distinction between block and basin was maintained by periodic movements on the Craven Fault-Belt. The top part of a thick sequence of marine mudstones and turbiditic sandstones laid down in the basin is exposed in the core of the Harrogate Anticline.

Sedimentation continued into late Carboniferous times without a break, but the area of marine deposition was soon invaded from the northeast by a large river carrying coarse-grained sand, and the sequence rapidly became dominated by its deposits, the Millstone Grits. The section at Harlow Car exposes interbedded siltstones and sandstones, including some turbidites, which are thought to have accumulated rapidly on a delta slope in front of the river mouth. The overlying Almscliff Grit is coarser-grained, and is believed to represent the deposits of the river channel itself. The advance of the river may have been accelerated by a drop in sea level.

The advance of the river was brought to an end by a rise in sea level, which caused the delta to retreat for an unknown distance back towards the source area. A thin bed of fossils, deposited in the shallow sea that occupied the area as the sea level rose, has been seen in a temporary section near Harlow Car, but is no longer visible. The fossils collected identify it as the Cravenoceras cowlingense Marine Band, and serve to correlate the Almscliff Grit with the Warley Wise Grit of areas farther west.

The Almscliff Grit is visible in the Harlow Car area but is more easily examined at its type locality, Almscliff Crag. Here it is possible to work out the flow direction of the river, and to see how the overall shape of the river deposit has been affected locally by a gravity-induced slump, or growth fault (Chisholm, 1981)

Repeated advances and retreats of the Millstone Grit river produced a sequence of alternating sandstones ('grits') and mudstones overlying the Almscliff Grit, and some of these beds can be identified in the features of the surrounding scenery.

The deposits of till that were spread across the landscape by the Quaternary ice sheets tend to obscure the detail of topographical features related to bedrock outcrops, but the broader outlines are not affected: the harder gritstone beds normally form upstanding ridges and the interbedded mudstones form lower ground.

## **Excursion details**

### **Almscliff Crag**

From the A658 Harrogate–Otley road, take the signposted road uphill to North Rigton. At the west end of the village, turn into Crag Lane and continue past Almscliff Crag to Locality 1. Park by the road [SE 265 491].

#### **Locality 1 [SE 265 491] is at the roadside**

Seen from here, the Crag is clearly made up of two cliffs, each about 15 m high, separated by a flattish slack. Big blocks have fallen off the cliffs. Walk up the footpath to the lower crag.

*Locality 2* is the lower crag.

Climb up and proceed anticlockwise round the top of it. The Almscliff Grit is a coarse to very coarse-grained sandstone with scattered pebbles of quartz. The major bedding planes dip northeast at about 22°. Approximately 1 m wide trough cross-bedding sets clearly indicate sand transport by currents flowing from the northeast. The cross-bedding can be seen below overhangs and on the top (dip slope) surface of the lower crag.

#### **Locality 3 is just across the flattish slack area at the foot of the upper crag**

The bedding on this face looks flat, but continue anticlockwise round the base of the cliff until the relationship between cross-bedding and tectonic dip again becomes clear. Both are much the same as in the lower crag. Good cross-bedding troughs, again pointing southwest, can be seen on the dip slope of this crag also.

Climb to the top of the crag and look at the view. To the south, a prominent escarpment forms the south side of Wharfedale, from Rombalds Moor behind Ilkley, in the west, through Otley Chevin and Arthington Bank to beyond Harewood, in the east. The escarpment is made up of a series of interbedded sandstones and mudstones in the upper half of the Millstone Grit sequence. They are dipping south beneath the Yorkshire coalfield, most of which is out of sight behind the escarpment. However the television mast at Emley Moor, visible in the distance through a low place in the escarpment above Arthington Viaduct, stands on a sandstone in the Lower Coal Measures. In the far distance, behind the Emley mast and to the right of it, the Millstone Grit appears again, forming the skyline. This is the central Pennine moorland between Huddersfield and Manchester.

In the middle distance, a broad vale occupied partly by the River Wharfe is underlain by softer mudstones and siltstones dipping gently southwards beneath the beds in the main escarpment. Lenticular sandstones form low ridges at Dunkeswick and Huby. Round to the west, the north side of Wharfedale is underlain by a series of gentle southerly-shelving dip slopes in the lowest of the Millstone Grits. These beds crop out also in the rising ground to the north. An intervening slack is underlain by softer beds (these can be seen later at Harlow Car).

Near at hand, to the east and south, the Almscliff Grit forms a continuous grassy ridge with a well-marked 7.–10° dip slope slanting down under the mudstones of the middle distance. This dip slope is the one that runs down from the crag

to Cliff House; North Rigton is also built on it. The crag is clearly an anomalous feature, a local rocky projection from what elsewhere is a smooth grassy ridge. It is also clear that there is a  $90^\circ$  difference in dip direction between the sandstones in the crag (dip to northeast) and the main dip slope (dip to southeast). The disparity is attributed to syndepositional slump-faulting, caused by instability in the underlying pile of rapidly deposited sediment. The mass of slumped sandstone (the crag itself) is dipping back towards the slump scar, and the fault runs round the north and northeast sides of the crag. The geometry of the feature is the same as that in a rotational landslide. The Almscliff slump moved while sand was being transported across the area, so although the landslide topography was evened out, more sediment was preserved in the slump scar than elsewhere. The general southeastward dip was imposed much later, at the end of Carboniferous times, when Variscan earth movements caused widespread folding.

Walk down the path to the road at Crag Farm and turn left.

#### **Locality 4 is on the road by Cliff House**

Locality 4 is on the road by Cliff House. Look up the dip slope towards the crag.

The difference in dip direction, and the fact that the crag sandstone underlies the sandstone of the dip slope, can both be appreciated from here. Proceed along the road as far as the first houses in North Rigton and take the footpath on the left, leading back towards Almscliff Crag.

#### **Locality 5 [SE 276 491] is at the start of the footpath**

At first this runs along the top of the dip slope but eventually it slants across the crest on to the scarp side. Like many of the features formed by sandstones in this area, the ridge is low and rounded, with no clear indication of where the base of the sandstone might lie. This is due to glacial action, which has smoothed off the finer topographical details and smeared a layer of till over all but the highest parts of the ridges. The position of the base of the grit on the map is therefore approximate.

About 200 m short of the crag, the ridge sticks up out of the till, and small quarries reveal sandstone dipping at  $15\text{--}20^\circ$  southeast. It is clear that the angle of the dip slope is somewhat less than the dip of the strata. Bevelled dip slopes of this sort are very common in Millstone Grit scenery. Proceed along the ridge to where it joins the crag.

#### **Locality 6**

Locality 6 is a small quarry with a pond in it. Poorly bedded sandstone dips to the southeast, whilst immediately to the north, the northeasterly dipping sandstones of the crag appear. There is no obvious dividing line between the two sets of strata, suggesting that the slumped sandstone was still soft when the overlying sandstone was laid down on it, so that the two have blurred into each other. Continue anticlockwise round the north side of the crag. A noticeable break of slope at the foot of the crag here marks the likely position of the slump fault.

#### **Locality 7**

Locality 7 is at the foot of the overhanging cliff, where a mud-flake conglomerate can be seen. Irregularly shaped holes, up to to cm across, show where mudstone pebbles have weathered out. The pebbles are scattered through a 1 to 2 m thickness of sandstone.

Return to Locality 1 via the tumbled blocks. Some are upside down, as shown by the geometry of the cross-bedding. The vertical fluting on some of them must have been eroded by the trickling action of rainwater over 10 000 years, the period since the last ice sheets melted.

#### **Harlow Car**

From the centre of Harrogate take the B6162 towards Beckwithshaw. On the outskirts of town, follow the signs for Harlow Car Gardens and turn off down Crag Lane. Park opposite the entrance to the Gardens [SE 281 542], and walk down

Crag Lane. Take the first side road on the left, past the Harrogate Arms. At the gates to Harlow Car Study Centre, follow the marked footpath leading off right, along the bank of Harlow Car Beck. The stream gradually cuts deeper until it forms a small ravine, exposing the beds that lie immediately under the Almscliff Grit. The dip is steep, so that about 270 m of these beds crop out over a distance of 400 m. Exposure is not continuous, and the location of the clearest sections varies from year to year, depending on accidents of stream erosion.

**Locality 8 [SE 2773 5425] is a chalybeate (iron-rich) spring, covered by a rounded stone canopy**

The water emerging is clear, but it gives rise to a rusty deposit as it flows away. This is one of numerous mineral springs that rise in the axial area of the Harrogate Anticline; the Harrogate spa waters are the sulphurous ones. Sandstones and siltstones crop out in the stream bed below, and are exposed at intervals to Locality 9, where access is better.

**Locality 9 [SE 2757 5437] is at a wooden footbridge below a fork in the path**

The bridge gives easy access to the stream bed. The base of the Almscliff Grit crosses the stream about 100 m below the bridge, but is not well exposed. The beds below the grit can be seen in the sections on both sides of the bridge. They are dark grey argillaceous siltstones with a great variety of paler-coloured sandstone interbeds, ranging from a few millimetres to over a metre in thickness. Some of the sandstone beds are graded, with sole structures, and are probably turbidites. All suggest rapid deposition on a delta slope fed from the mouth of a large river. Instability of these deposits, giving a tendency to collapse under their own weight, is likely to have caused the slump-faulting observed at Almscliff Crag.

Follow the path, which climbs up the east bank of the stream to the lip of Oakdale and along a ridge marking the outcrop of the Almscliff Grit.

**Locality 10 [SE 2774 5463] is just before the path meets Crag Lane, by Birk Crag House, where there are some crags of Almscliff Grit with small quarries**

The rock is very coarse-grained (coarser than most of the sandstones in the underlying beds), with small quartz pebbles. The bedding dips steeply (at 45–70°) into the valley, and this side of Oakdale is essentially a bevelled dip slope on the top of the main part of the grit. Trough cross-bedding can be seen on top of some of the steeply dipping beds indicating southwestwards flow, as at Almscliff Crag. The path continues along strike, past more gritstone outcrops at Birk Crag [SE 2795 5480], to Cornwall Road, an alternative point of access [SE 2842 5516].

Walk back to Harlow Car by the direct route, along Crag Lane.

[Bibliography](#)