Leader: Noel Pearson 8 September 2019

Within the geological structure that is the Stainmore Trough is a topographic feature, a trough some 6km from north to south. It is floored by mid-Carboniferous sediments that abut, with increasing dip, against older more competent lower Carboniferous limestones. This is the Stainmore Monocline. Its eastern boundary is defined, from south to north, by the Argill Fault (or Dent Line) and the Augill and Barnarm Faults. The Monocline, a result of Variscan NW-SE compression is cut by these later faults. It is east facing in the south and trends anticlockwise as the Dent and Pennine Lines intersect. The excursion visited three locations north of the A66 where these structural patterns can be seen, as shown in Figure 1.

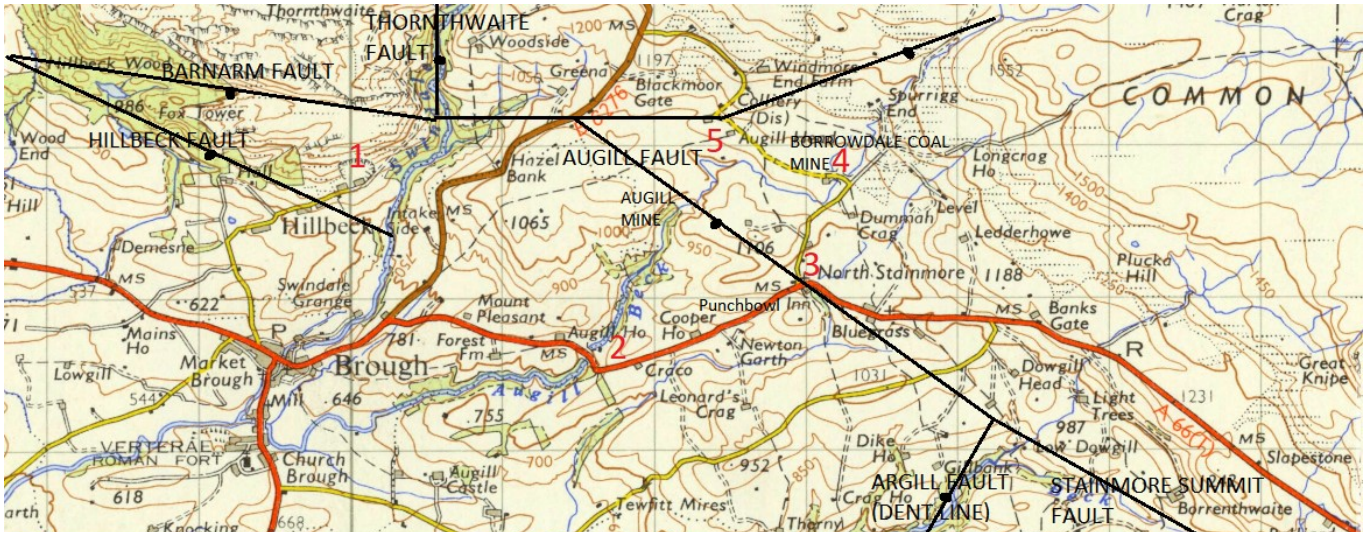


Figure 1 Main faults with downthrow. The main A66 is shown c. 1950. East of Brough the current dual carriageway runs south of the old road to Augill House, cuts the corner at the Punchbowl Inn and runs north of Bluegrass to rejoin at Bank Gate.

Location 1. Barnarm Fault above Helbeck Quarry.

Starting from the parking area (NY 800 158), below the entrance to Helbeck Quarry (sometimes known as Hillbeck), the route follows the track NE, for 600m, up to the Carry Band area to enter Open Access ground. Turning SW, a track carries on to the vantage point of Spoonymire Hill (NY 801 162). Figure 2 shows the panorama with centre left, the Melmerby Scar Limestone (MsL) at the core of an anticline and the overlying Robinson Limestone (RsL) to the right, dipping into the Barnarm Fault. The reservoir at the left is situated on an impermeable clastic bed in between the two limestones. Right, or north of the fault, the Carry Band dips gently to the north, but in E-W cross-section exhibits, as yet unmapped, faults and folds. The steeper NE downfolding at the eastern end of the escarpment has clearly been affected by the Thornthwaite Fault.

The route continues below Horseshoe Scar and to the left of Barnarm Scar. Figure 3 gives a better view of the dextral slip between the two. Eventually a viewpoint is reached (NY 791 163). To the north, the previously observed structures in the escarpment continue with,



Figure 2 View from above the Helbeck Quarry. The Barnham Fault west to east runs below the escarpment and into North Stainmore



Figure 3 View SW from Carry Band of the Barnham Fault, with dextral movement of Barnham Scar with respect to Horse Shoe Scar, both Melmerby Scar Limestone.

lower down, some tight folding (again unmapped). The view to the south looks over the Outer Pennine (Hillbeck) Fault and the downthrown Alston Formation in Yosgill Sike which underlies the Permian sandstones in the middle distance. Here the A66 essentially follows the Eden Valley Syncline to the north west.

The route now returns to the north of the steeply dipping Barnarm Scar, where the colour contrast between the pale MsL and darker RsL can be seen in hand specimens and there is also a closer view of the folding. Then go back to the turn on to the main path, where the continuation of the Barnarm Fault can be inferred to the east. On return to the parking area around 3.5k will have been covered.

Location 2. Augill Smelting Mill.

Taking the Middleton-in-Teesdale road from Brough, then right towards the A66 and left to Augill Bridge (NY 815 146), there is a convenient stopping point to car-share for the next location. Not without interest, this is a Cumbria Wildlife site with information about a smelt mill that served the Augill lead mine, further upstream, in the 19th Century. It was later converted to an iron roasting plant in 1859/60 which was presumably more profitable. (More detail can be found on the Historic England web-site).

Location 3. Punchbowl Inn.

About 2km east of Augill Bridge there is a turn to the north off the A66 to Borrowdale. This is the old road which passes the former Punchbowl Inn. Continuing up the road for 100m there is parking by the Parish Hall opposite a field (NY 829 151) at Location 3. The site is off the footpath which crosses the field so access was checked with the farmer first.

Location 3 is a Local Geological Site, noteworthy for the NW-SE limestone scarp face, shown in Figure 4 and the succession of sandstones and limestones all dipping SW at around 60°. Because the sequence, essentially the Alston Formation, becomes younger to the NE, the interpretation is that these beds have been overturned during compressional movements, with even younger

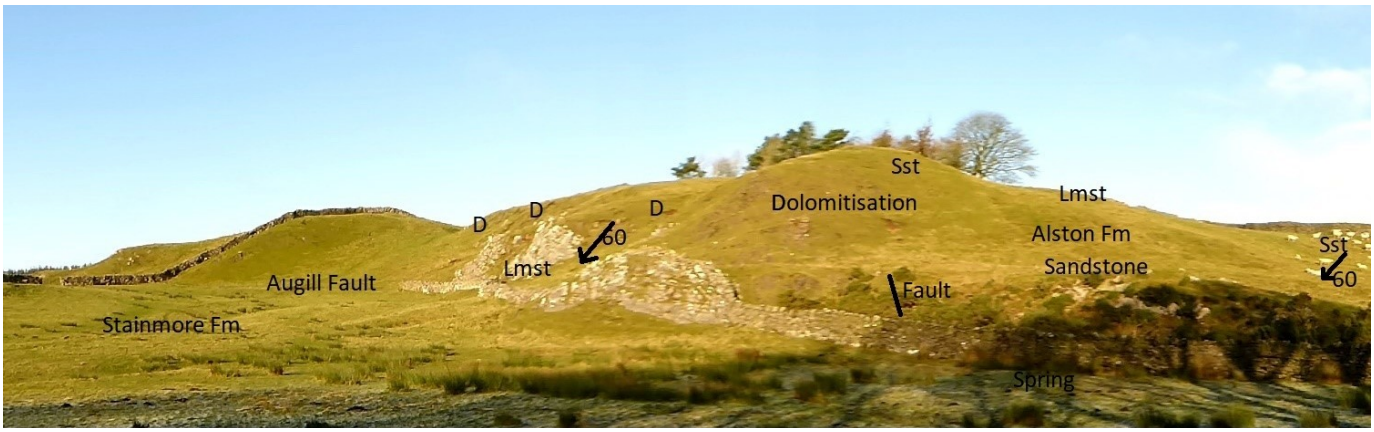


Figure 4 View NW of the Augill Fault Zone with overturned limestones younging NE into Alston Formation.

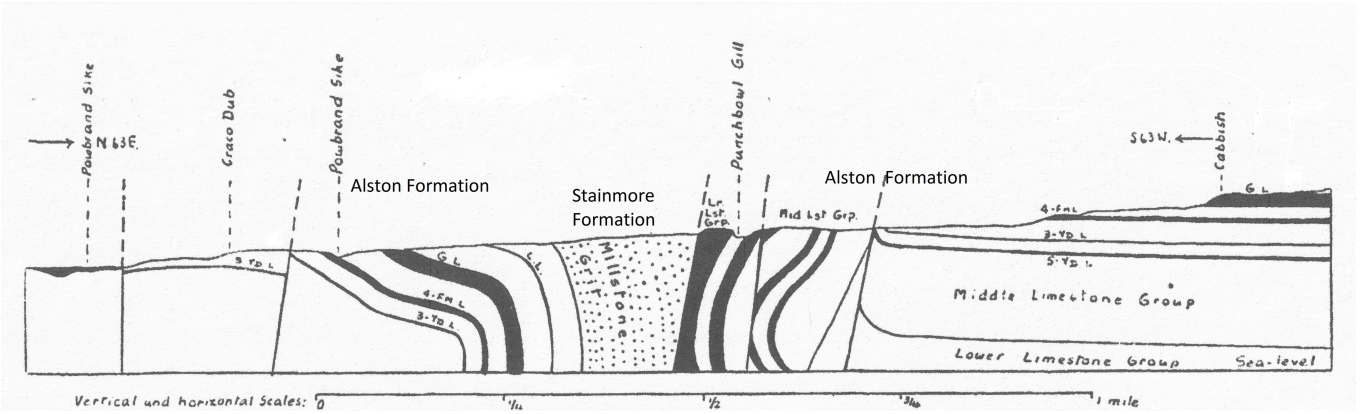


Figure 5 Turner's 1935 cross-section of the Augill Fault Zone just east of the Punchbowl Inn.

beds later down-faulted to the SW as Turner (1935) makes clear in his cross-section, shown in Figure 5. This is the Augill Fault Zone. It continues under the A66 to the SE where a similar SW facing scarp can be seen east of Punchbowl Sike. (The whole of the fault zone can best be appreciated from a vantage point south of the A66 on the Roman Road at NY 834 144).

Closer examination of the pale limestone scar shows several zones of dark brown, iron-stained, dolomitised rock interspersed seamlessly with the limestone. Presumably this is evidence for fluid movement along minor faults and fractures. The presence of a spring and a displaced sandstone bed, on the right of Figure 4, are also features of this fault zone. Without being specific, it is generally thought that these limestones and sandstones belong to the upper part of the Great Scar Limestone Group and the base of the Alston Formation. Colour differences from pale to dark differentiate bedding. Fossils are not conspicuous probably due to brecciation and alteration along the fault zone.

Location 4. Borrowdale Mining Area.

Continuing north on the Borrowdale road and turning left through a gate, a brief stop can be made by Borrowdale House (NY 832 158). Old maps show 'Shafts' nearby which continue north of the road for the next kilometre. These have been excavated through the Four Fathom Limestone to gain access to the Borrowdale Coal Seam which is only 30 to 50cms thick but was worked from the mid 19th century until 1934. The limestone seen by the bridge over



Figure 6 Borrowdale Beck view east upstream, cutting beds below the Borrowdale Coal above 3 Yard Limestone

Borrowdale Beck is dipping gently north-east and undisturbed by the influence of the fault zone not far to the south at Location 3.

Location 5. Augill Head to Augill Beck.

By following the road west through a gate, Augill Head is reached (NY 825 161). The route to the waterfall where Borrowdale Beck becomes Augill Beck is south across the field (checked with the farmer as off the main footpath) and to the left of a barn (NY 825 159). Here Borrowdale Beck can be seen, Figure 6, cutting its way through the clastics below the Four Fathom Limestone and then through the Three Yard Limestone. The dip to the NE of around 8° at Borrowdale Bridge has increased and is here around 60° NE. By following the beck downstream, where its circuitous course follows the softer clastic beds of increasingly older cyclothems, the route is essentially traversing the Alston Formation. On reaching the waterfall at the top of the Augill Gorge the beck cuts the Tynebottom Limestone, (Figure 7). So in the space of 400m the dip has changed from sub-horizontal to vertical as the Augill Fault Zone is approached. As the owners of Dunmah Farm would prefer to protect the wildlife and woodland surrounding Augill Beck, the top of the gorge, their northern boundary, is as far as can be accessed currently.



Figure 7 Borrowdale Beck breaches the vertical Tynebottom Limestone beds at the head of Augill Gorge.

Augill Beck continues south of the A66 and provides a continuous section that has been key to interpreting the Fault Zone. Photos in the BGS archive of the Augill Fault, the Augill Lead Mine and the distinctive 'White Post' (also p35 of the Brough Memoir) illustrate the structures. The interpretation by Turner (1935) has stood the test of time and has informed the Memoir (1979) and even been used by Underhill et al. (1988) to describe these structures at the northern end of the Dent Fault System. So here at North Stainmore, the northern extension of the Dent Line, is a glimpse of a structure that is one of the characteristics of the Dent Fault Zone that underpins the landscape and extends 40k to the south-west.

Acknowledgements

Location 3. A. Balmer, Forest Farm, Brough. (Tel No in Phone Book).

Location 5. P. Bousfield, Augill Beck Head. (Tel No via Fieldham Ho. Brough).

BGS Archive Photos. Augill Fault P007463, Augill Lead Mine P 222178, White Post P206868.

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