



Geological Site Report - **Update: April 2023**

Alan Richardson

Site Key: 395 **Site Type:** ED Disused Quarry
Site Name: Barnt Green Road Quarry
Grid Ref.: SP 001 753
Land Owner: Birmingham City Council
Site Surveyor: Alan Richardson
Location: Lickey Hills Country Park, Rednal B45 8ER

Rationale:

Since the last site report was submitted in 2020, previously unrecorded features have been identified, prompting a revision of previous interpretations. Despite the relatively short interval of time, it therefore seems appropriate to update the record of this important site.

Location:

Located within the Lickey Hills Country Park, the quarry lies on the eastern margin of the Lickey Hills Ridge, within the Type Area for the Lickey Quartzite (Lickey Hills between Kendal End [SP 001 746] and Holly Hill [SO 991 784]; Cofton Hill [SP 001 753] and Rednal Gorge [SO 998 759]). The locked gate to the site may be accessed from the Lickey Hills Visitors' Centre car park by a steeply descending footpath, or more directly, from a vehicle access point on the B4120 Barnt Green Road, opposite Reservoir Road. The key to the gate is available from the Lickey Hills Country Park Rangers. There is open access to a public viewing area that is provided with three interpretation panels to explain the geology.

Geological Context:

The Lickey inlier is a block of Lower Palaeozoic rocks bounded by faults that bring it up against younger Upper Palaeozoic and Mesozoic formations. The Lickey Quartzite varies in composition between a mature quartz arenite, and an immature lithic arenite; in places it is interbedded with soft clays and fine micaceous shaley siltstones. In thin section, the quartz grains are seen to have sutured contacts. The presence of clay horizons precludes a metamorphic origin for this mosaic texture: deep burial below 1km would be sufficient to account for its development. The composition of the clay minerals may offer more evidence of the burial history. At the southern end of the hills, in the Barnt Green area, older rocks of volcanic origin are poorly exposed.

Before the advent of radiometric dating techniques, the Lickey Quartzite formation was thought to be Cambrian in age. While an absolute age has not been determined for the Lickey Quartzite, the underlying Barnt Green Volcanic Formation has been dated to 510 Ma, suggesting an age of 510 – 439 Ma for the quartzite. [The BGS *Geology Viewer* now records the age of the Lickey Quartzite as “approximately 485 to 444 million years ago in the Ordovician Period”, and the age of the Barnt

Green volcanics as 485 to 478 Ma.] The formation is devoid of body fossils, but trace fossils have been identified near Eachway Lane (worm burrows) and in Warren Lane Quarry (feeding trail).

The rocks are described as having been deformed into a north-south trending anticline. Thrust faulting, associated with California-type strike-slip tectonics during the late Ordovician Shelveian tectonic event, may be responsible for the localised recumbent folding seen in this quarry. However, it is possible that the folds and thrust faults are the result of Variscan events. The rocks are well-jointed and cut by many faults.

Several high angle faults, relating to at least two episodes of fracturing, cut the rocks in the Warren Lane, Rose Hill and Barnt Green Road Quarries, and thrust faults have been identified in the Rose Hill and Barnt Green Road Quarries. At the Rubery Road Cutting, Silurian Rubery Sandstone lies unconformably on Lickey Quartzite, and 20th century excavations identified further unconformities where the LQF is overlain by Carboniferous and Triassic rocks. An unconformable breccia has recently been identified on the summit ridges of Bilberry Hill and Rednal Hill (and it is likely to continue onto Cofton Hill). Excavations in nearby Eachway Lane (Boulton 1933) and Tessel Lane (Wills & Shotton 1938) exposed sedimentary breccias of Lickey Quartzite that pass upwards into Triassic conglomerates, suggesting a probable connection with the summit ridge breccia. Deep tapering fissures in Warren Lane and Kendal End quarries are seen to be filled with a reddish pebbly sandstone incorporating fragments of Lickey Quartzite, and a matrix containing a significant proportion of aeolian sand: these are almost certainly associated with the Bilberry Hill unconformity, and are likely to be of Triassic age.

Site Summary:

The rocks here are believed to represent the lowest exposed sequence in the Lickey Quartzite Formation. They are less mature and have more interbedded sandy mudstones and micaceous horizons than rocks higher in the formation. The mudstones are predominantly soft clays – it is likely that many of them are bentonites of volcanic origin. When freshly exposed they are typically green in colour, but rapidly weather to red on exposure to oxygen and water. Some thin layers are purplish in colour and contain abundant muscovite.

The most dramatic feature of the quarry is the recumbent folding in the quartzite. The fold axis trends north-east to south-west. The structural alignment together with the localised nature of the deformation suggests that it may be associated with thrust faulting, evidence of which is seen in the Rose Hill Quarries. This level in the Lickey Quartzite may have been particularly prone to this type of flexural-slip folding owing to the abundance of clay layers interbedded with the quartzite. The nature of the deformation has prompted Nigel Woodcock to suggest that it may be a consequence of California-type strike-slip tectonics, related to the Shelvian event, but a Variscan origin cannot yet be dismissed.

In the south-east corner of the quarry, movement along multiple clay-rich layers in the overturned upper limb of the fold has resulted in fragmentation of the intervening quartzite strata. Where this limb has been thrust over the lower limb, the steeply inclined east-dipping upper limb meets the north-dipping lower limb along one of several movement planes corresponding to clay-rich layers in the lower limb. The hinge of the fold is exposed in this quarry face, but it has suffered considerable fragmentation. Stereographic analysis of the planes of movement suggests a movement vector of 179/22. While there is no single discrete plane of movement, the net effect is that of a low-angle thrust. The recumbent fold sits above the thrust zone, but the sense of folding is anomalous with respect to the attitude of the thrust. In the main face of the quarry, the thrust follows bedding, dipping from left to right. If the hanging wall block has been thrust from right to left, any associated flexural-slip folding would be expected to exhibit an 'S' pattern, rather than the 'Z' that is observed.

XRD Analysis

In 2021, samples of one of the clay-rich bands and the adjacent quartzite were subjected to XRD analysis by Jonathan Wilkins:

Results Summary

XRD of the clay rich bed show that the dominant clay mineral is illite. A separate smectite phase was not present. (This is to be expected of rocks of this age). There was a large mixed clay component of smectite illite, indicating full conversion to illite had not completed. A small percentage of kaolinite suggests a contribution from an acidic igneous source. Hematite suggests a volcanic origin. The reddish colouration suggests a terrestrial setting.

XRD of the Lithic Arenite (Lickey Quartzite) shows 77% of the sample to be quartz and 16% feldspar of which 7% was potassium feldspar indicating an acidic igneous origin. Illite was the dominant clay mineral present. Single phase smectite constituted a sizable portion of the clay fraction. This suggests that flow barriers within the rock existed to prevent ion exchange that should have led to the smectite conversion to illite as had occurred in the underlying clay rich layer.

The BGS *Geology of Britain Viewer* records the age of the Lickey Quartzite as “approximately 444 to 485 million years ago in the Ordovician Period”, but as it seems likely that the clay-rich layers are bentonites, this date may be further refined. Textural evidence suggests burial in excess of 1000m, followed by folding along a north-south axis, with thrust faulting generating localised recumbent folding. Subsequent uplift exposed the Lickey formation to erosion before deposition of the Upper Landoverly Rubery Sandstone. During the deposition of this formation, but after lithification of the earliest units, extension opened fissures, which filled with fragments of both formations and a matrix of unlithified sand, probably during the early Silurian transtension event. The Lickey Quartzite was subsequently exposed in both the Carboniferous and Triassic.

Condition status:

Site Type: ED. At present, the status is uncertain. The lower parts of the quarry faces are regularly maintained by the Lickey Hills Geo-Champions, and the effects of faulting in the SE face are clearly visible. This area of the site is ‘Good Improving’. However, since a major clearance in 2010, employing a long-arm excavator and high-pressure water hoses, the upper reaches, which most clearly reveal the recumbent folding, have become increasingly obscured by accumulating debris and plant growth (See Photographs 13 & 14). Major funding is required to restore these parts of the site; without this work, they must be regarded as ‘Poor Declining’.

Designation Criteria:

Scientific: The site is crucial to the understanding of the chronology of structural events affecting the Lickey Quartzite formation.

Educational: The site offers an opportunity to study structural features rarely exposed in the English Midlands, and provides a relatively safe environment in which to teach the basics of structural recording.

Connectivity with the Landscape: This site holds unique clues to explain the topographical prominence of the Lickey Hills inlier.

Historical Associations: The significance of this quarry has been noted by such geological luminaries as Lapworth, Boulton, Wills and Hardie. In the Second World War it was a barrage balloon site for the defence of the industrial centre at Longbridge.

Aesthetic: When clear of vegetation, the recumbent fold provides a dramatic visual record of the forces imposed on rocks at depth.

Evidence Base:

Appreciation of Nature: It is a place to stand and wonder upon the many and varied processes that have combined to create the natural sculpture that lies within, and the inconceivable extent of geological time.

Connectivity with Landscape: The Lickey Hills constitute a prominent north-south ridge of resistant rock that stands above the surrounding younger rocks. The Barnt Green Road Quarry is cut into the base of the eastern flank of the ridge, immediately adjacent to the break in slope that reflects the boundary with the less resistant adjoining formation.

Diversity: As the best Lickey Quartzite quarry with public access, it provides a peerless window into the internal makeup of the Lickey Hills inlier.

Education: Provides opportunities for field sketching of the recumbent folds and the 'step-over fault'. Can be used to demonstrate the way the eye can be deceived by apparent dips in adjacent quarry faces – the anticline that seems to be apparent in the SE corner of the quarry does not exist. Three interpretation panels are provided. The quarry is one of the sites included in the Lickey Hills excursion on the Deep Time Voyager phone app: <https://deeptime.voyage/voyager-app/>

Historical Associations: In World War 2 Barnt Green Road Quarry was used to accommodate a barrage balloon mounting, as part of a barrage around the Austin Aero Works at nearby Longbridge.

Naturalness: The sediments provide evidence of fluctuating conditions in the environment of deposition, and variations in sediment supply. The deformation structures illustrate the ductile nature of rocks under high confining pressures when subjected to stress over long periods of time.

Rarity: The only site in the area where this intensity of folding can be observed. It is unusual in being localised recumbent folding. The deformation appears to be related to the thrust faulting seen here and in the Rose Hill Quarries, and may have considerable significance in terms of Palaeozoic tectonics. The site appears to be the only exposure of the lowest part of the Lickey Quartzite formation. The fault at the SE corner provides an unusually clear example of a thrust turning into a high-angle fault.

Typicalness: It constitutes part of the Type Area for the Lickey Quartzite (Lickey Hills between Kendal End [SP 001 746] and Holly Hill [SO 991 784]; Cofton Hill [SP 001 753] and Rednal Gorge [SO 998 759]).

Cultural Associations: BGRQ is one of the Lickey quartzite quarries which were once prominent features of the local industrial landscape. They provided roadstone in the early 20th century, but most had been abandoned by the 1930s.

Fragility: The dominant feature of the quarry is the recumbent folding that has now become heavily obscured by rock debris and plant growth. Without costly remediation it will disappear from sight.

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Maps:



Photographs:



Photo 1. A general view of the quarry. The recumbent fold is seen at the upper right. At bottom left the SE face is visible.

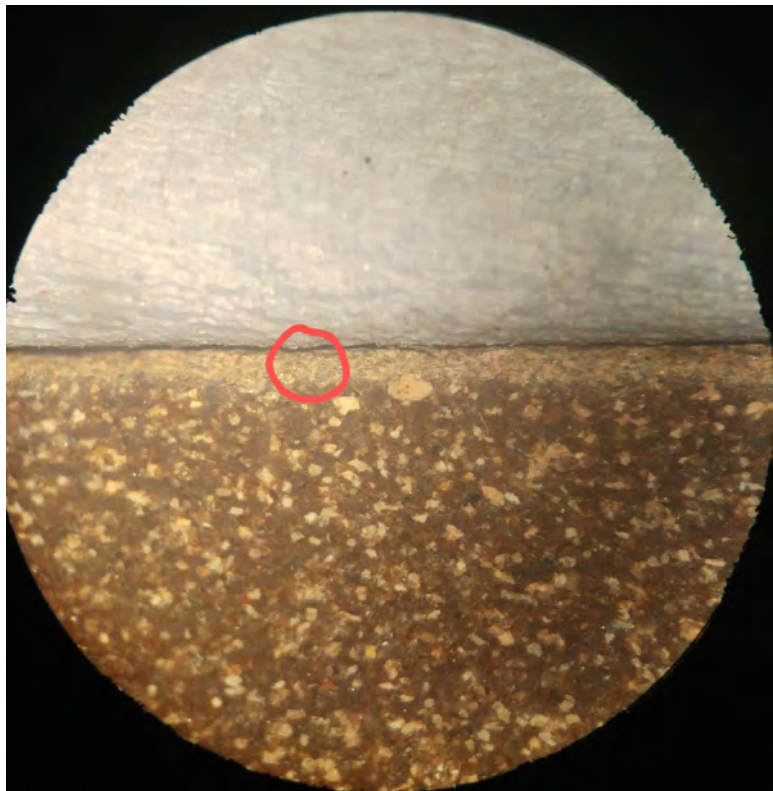


Photo 2. A polished surface of the 'quartzite' exhibiting an abundance of feldspar and red haematite staining. The red circle identifies the fine-grained uppermost part of the bed, which is capped by a thin, dark, muscovite-rich layer, overlain in turn by the clay-rich layer of Photo 3. Diameter of red circle approx. 4mm.

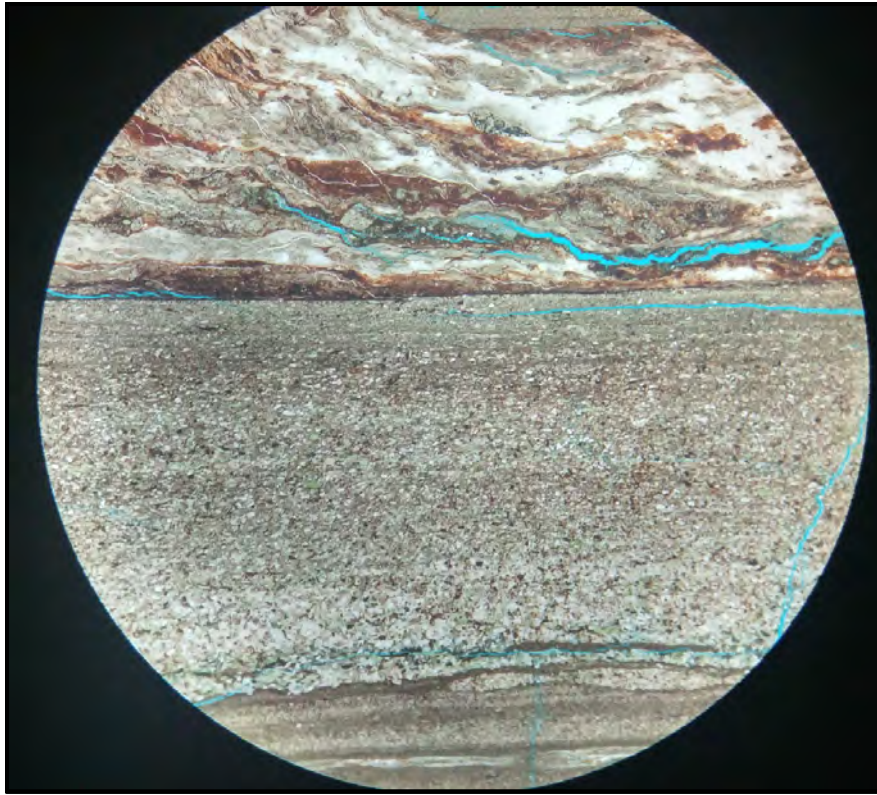


Photo 3. A thin section view of one of the clay-rich layers that facilitated flexural-slip folding. Field of view 4mm.

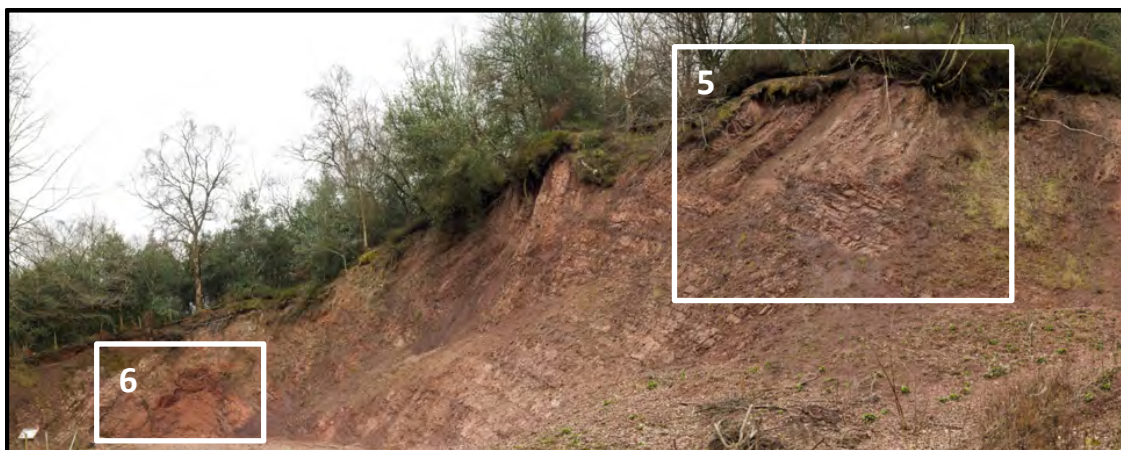
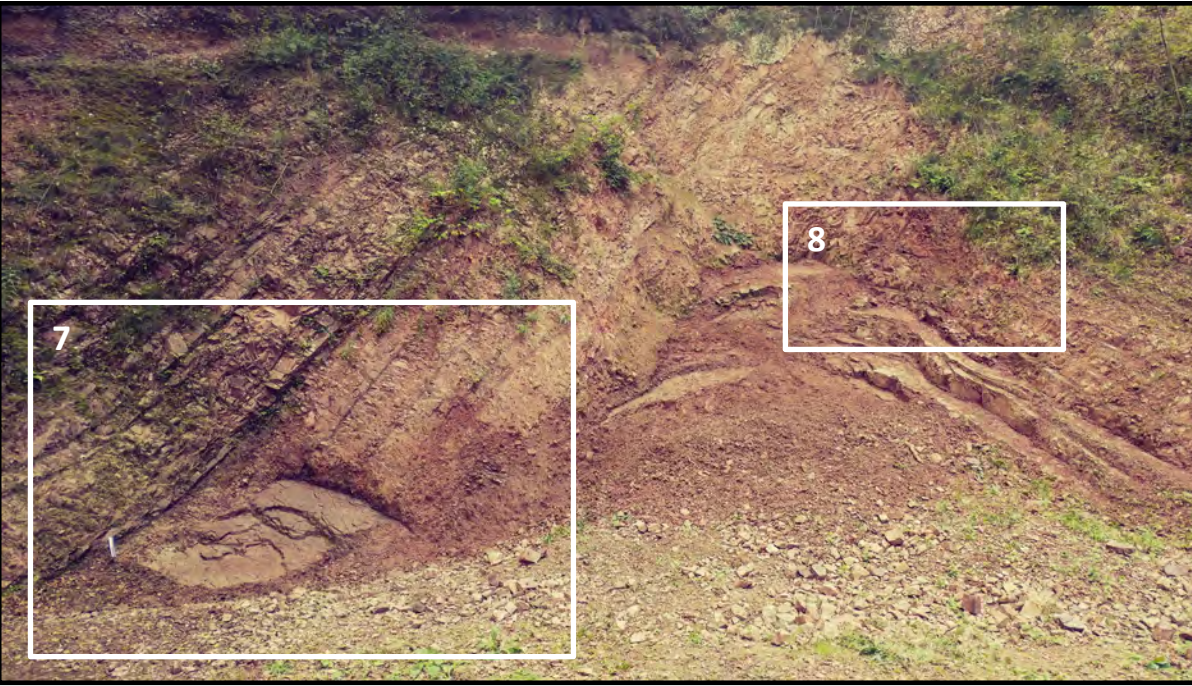


Photo 4. Locations of the enlargements shown in Photographs 5 and 6.



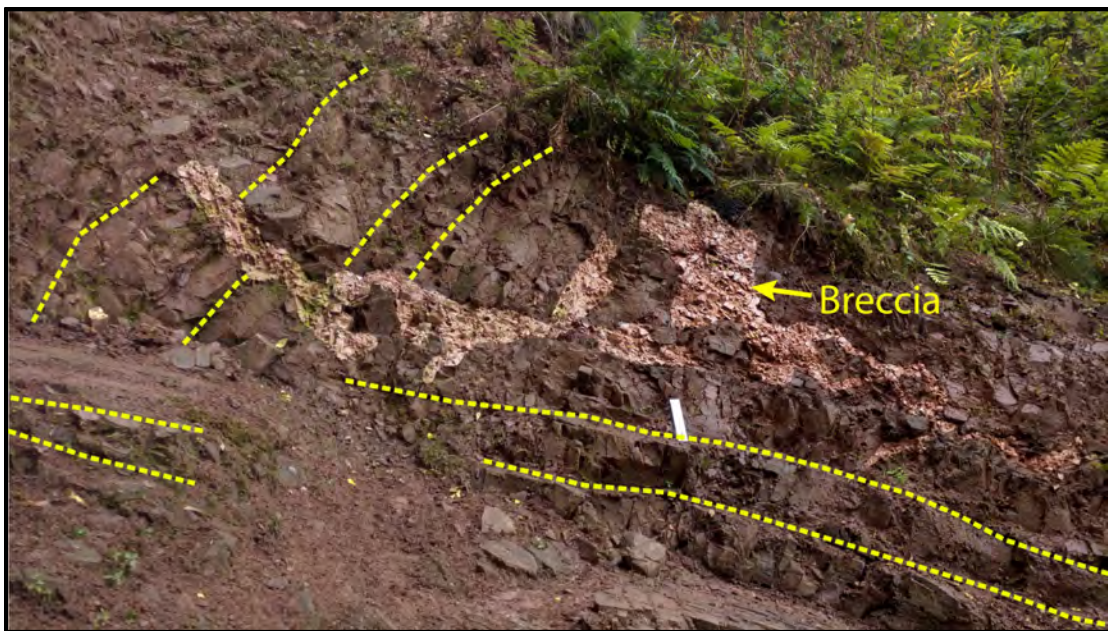
Photograph 5. The hinge of the recumbent fold. In places minor faults in the hinge have led to overlapping of the limbs.



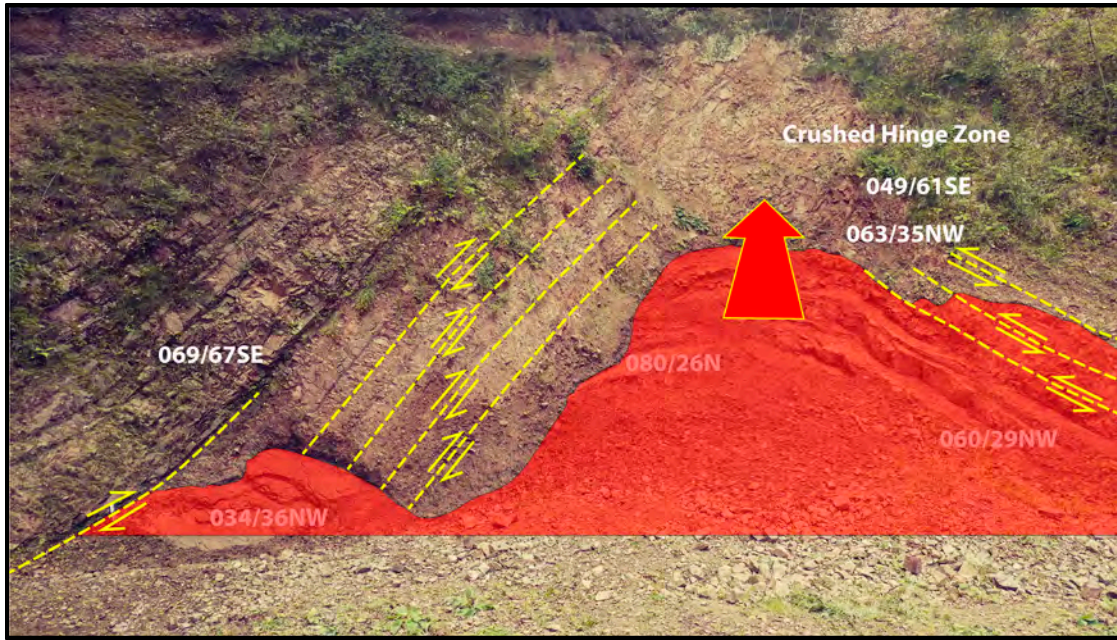
Photograph 6. The south east face of the quarry where the nature of the large-scale faulting is most apparent. The areas covered by Photographs 7 and 8 are shown



Photograph 7. The 20cm photo scale rests on a layer of fault breccia, which dips in conformity with the bedding of the upper limb of the fold. In the middle of the image, the fault is seen to step across the bedding of the lower limb. Above the 'step-over' several zones of breccia lie parallel to bedding.



Photograph 8. Patches of fault breccia have been digitally lightened to enhance their visibility. The dotted yellow lines identify bedding planes. Fracturing has disrupted the hinge of the fold, and the upper limb has been thrust over the lower one.



Photograph 9. SP000753 – face in the SE corner of the quarry, showing the zones of fault breccia in the displaced upper limb on the left of the image. The red shading represents the main plane of the thrust. On the right, where the thrust meets the lower limb of the fold, the movement has been accommodated along several clay-rich bands. Brecciation of the hinge has rendered it more susceptible to erosion, resulting in the recess in the quarry face. [2023 Alan Richardson]



Photograph 10. SP001753 - Composite panorama of the SE and SW faces of Barnt Green Quarry. The thrust is shown in yellow; the fold is highlighted in white: note the anomalous 'Z' profile in the folding. [2023 Alan Richardson]



Photograph 11. SP001753 - Archive photograph of the fold structures. 1904. Photo P237646 Bilberry Hill. 'Overfolded Cambrian Quartzite', reproduced courtesy of the British Geological Survey, UKRI 2019.

Source:<http://geoscientific.bgs.ac.uk/assetbank/action/viewAsset?id=78462&index=0&total=1&viewSearchItem>



Photograph 12. SP001753 - The main (SW) face of the Barnt Green Road Quarry after restoration works in 2010. The hinge of the recumbent syncline can be seen at the top of the face in the right hand half of the picture. [2010 Lickey Hills Geo-Champions]



Photograph 13. SP001753 June 2020 Overhanging trees and encroaching vegetation is obscuring the structures unique to this locality. [June 2020 Malcolm Coghill]



Photograph 14. April 2023 As well as low vegetation, trees are now establishing themselves on the quarry faces, and will soon obscure any views of the fold structures. (2023 Alan Richardson)

Alan Richardson – 23 April 2023