Local Geological Site Proposal Form

To be submitted to panel meeting convenor

Site Name	Bilberry Hill Unconformity	
Grid Reference	SO 9980 7568	
Landowner	Birmingham City Council	
Site Surveyor(s)/Proposer(s)	Alan Richardson	
Boundary Map included?	Yes	
Date proposed	06.06.23	
Panel decision	Date	Decision

(status determined using standard condition monitoring form or NE reports in case of SSSI)

Summary paragraph

The north-south ridge of the Lickey Hills comprises five distinct hills: from north to south, Holly Hill, Rubery Hill, Rednal Hill, Bilberry Hill and Cofton Hill. Immediately to the south east of the viewing area on the summit ridge of Bilberry Hill an irregular exposure of pale rock superficially resembles a group of boulders. However, excavations have shown them to be in-situ protuberances of the underlying bedrock. The upper parts of the exposure consist of a quartzite breccia: the poorly-sorted, angular fragments having been derived from the underlying Lickey Quartzite Formation (LQF), from which it is separated by an erosion surface. In some places there is a poorly-sorted matrix of allochthonous sediments, which include rounded pebbles and well-rounded, frosted aeolian sand grains. All the clasts are strongly cemented together by silica. The LQF is heavily jointed, but the overlying breccia is not. The quartzite readily falls into small blocks, but immediately below the breccia a secondary cement has reinforced it, making it as resistant to erosion as the tough breccia above. This creates the illusion that the breccia and reinforced quartzite constitute a coherent bed, while in fact, an unconformity lies within this zone. There is no evidence of calcite as the secondary cement, suggesting that silica is responsible, and that this layer is a silcrete. This must be the result of diagenetic processes in a semi-arid terrestrial environment, removed from any marine influence in the groundwater. Consequently, there is little possibility of finding any fossil material for the purpose of dating the breccia. Displaced boulders of the silcrete can be found next to the 'Drovers Way' leading from the Country Park Visitor Centre to Laburnum Cottage, on the western flank of Bilberry Hill. They provide an opportunity for sampling without disturbing the outcrop above. The same unconformity can be located near the head of the path leading from the visitors' centre car park to Barnt Green Road Quarry, and can also be seen on the summit of Rednal Hill, to the north. Loose specimens of the silcrete have also been found at the base of the southern slope of Cofton Hill to the south, suggesting that this hill also has a protective capping of this resistant rock.

Designation Criteria

Scientific

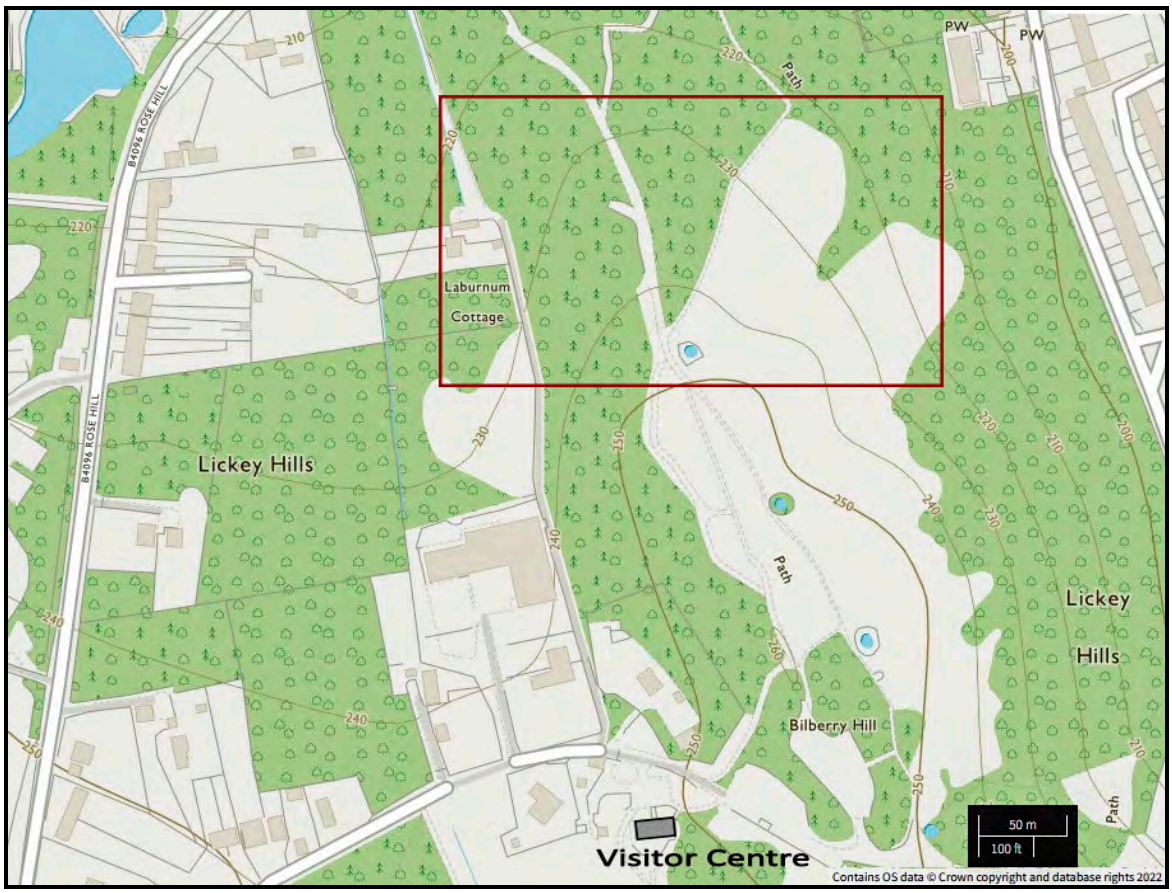
This site is enormously significant. The LQF is seen to be terminated upwards by unconformities at five locations: the Rubery Cutting /Leach Green Quarry (Silurian), Leach Green Lane (Carboniferous) Rednal Hill, Bilberry Hill and Warren Lane Quarry. The unconformable cover at Rubery has been shown to be Silurian. However, it seems more likely that the Bilberry Hill unconformity corresponds to a basal Triassic breccia identified in a 1937 trench excavation.

Educational

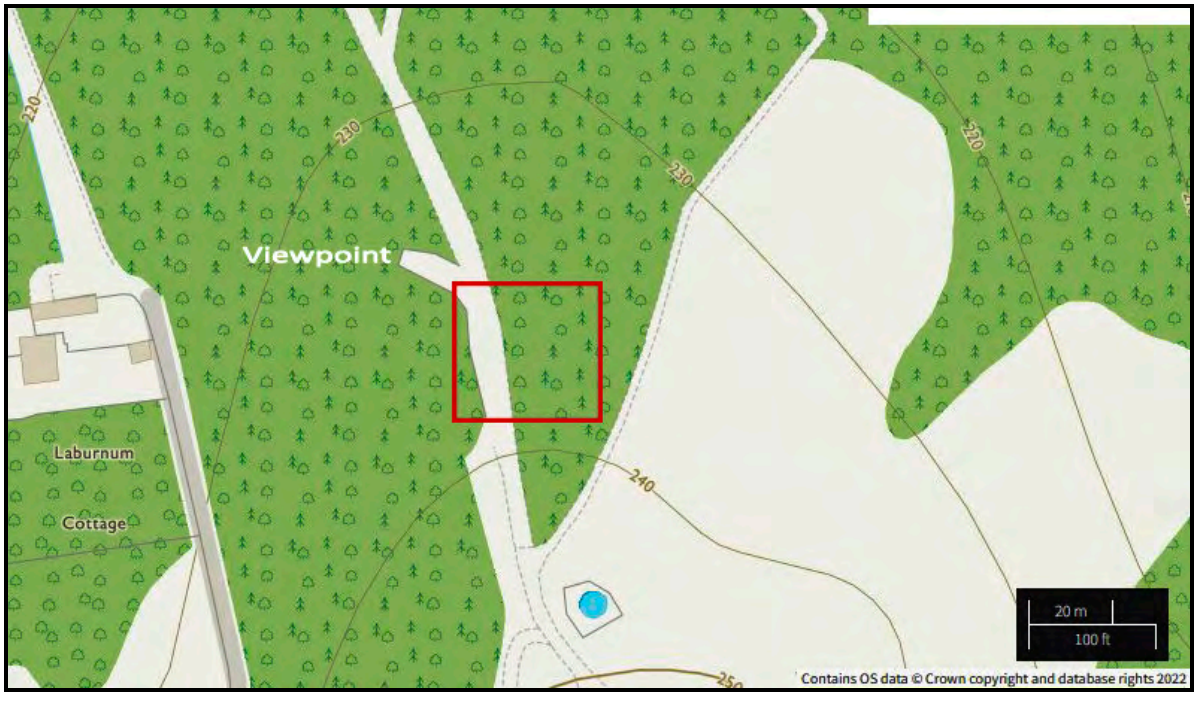
The site is used on guided geology tours of the Lickey Hills to illustrate the nature of an unconformity, as it is easier to access from the Visitor Centre than the Rubery Cutting site. Like Hutton's Unconformity on the Isle of Arran, it provides a good test of observational skills, as the development of a silcrete has masked the true location of the erosion surface.

Site Description

a) Boundary map



Map 1. Bilberry Hill Location Map – showing the area of enlargement in the Site Plan below.



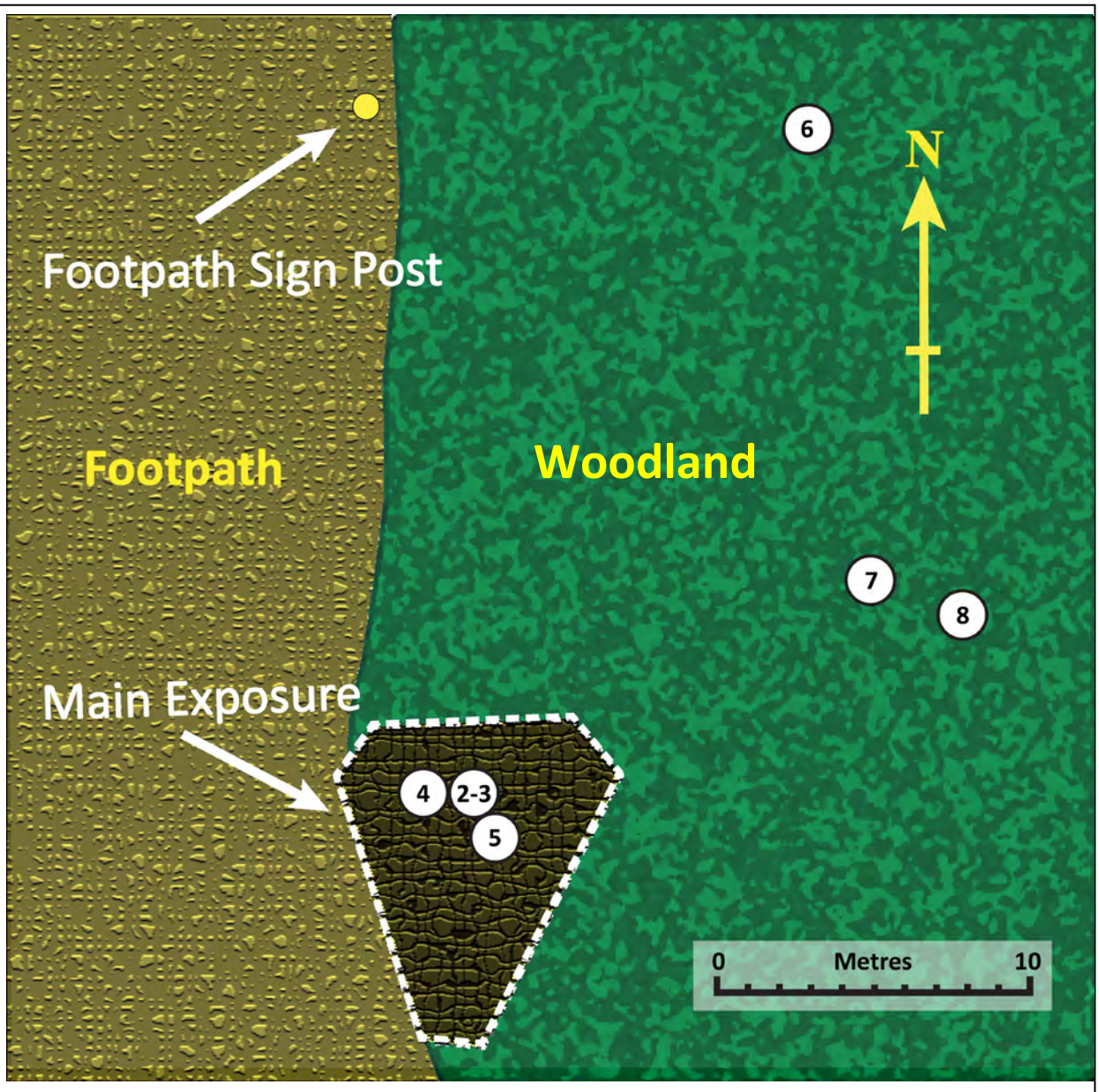
Map 2. Site Plan of the Bilberry Hill Unconformity. The area indicated is enlarged in Map 3: the photograph reference plan.

b) Access and site management

The site has open access: it is unfenced, and lies adjacent to a public footpath in the Lickey Hills Country Park. The Lickey Hills Geo-Champions maintain the site with the support of the Park Rangers.

c) Nature of site

The main exposure describes a more-or-less triangular area adjacent to the footpath. A number of small isolated outcrops lie within the woodland beyond. The plan below shows the locations.



Map 3. Photograph Reference Plan – location is shown on Map2.
Plan of the exposures of the Bilberry Hill Outcrop. The numbers correspond to the locations of the photographs which follow.

Despite bearing the appearance of a group of boulders, the main outcrop consists of *in situ* exposures of breccia lying unconformably on Lickey Quartzite.

Photo 1 – The main exposure of the Bilberry Hill Unconformity site showing the locations of subsequent photos.

Photo 2 – Quartzite breccia of unproven age rests with unconformity on the Ordovician Lickey Quartzite Formation. Note that the abundant jointing in the LQF does not continue into the breccia.

Photo 3 – Breccia, in which the dominant clast lithology is Lickey quartzite, lies unconformably on the LQF. The breccia has been darkened for clarity. Joint blocks of quartzite below the silcrete are loose and readily removed.

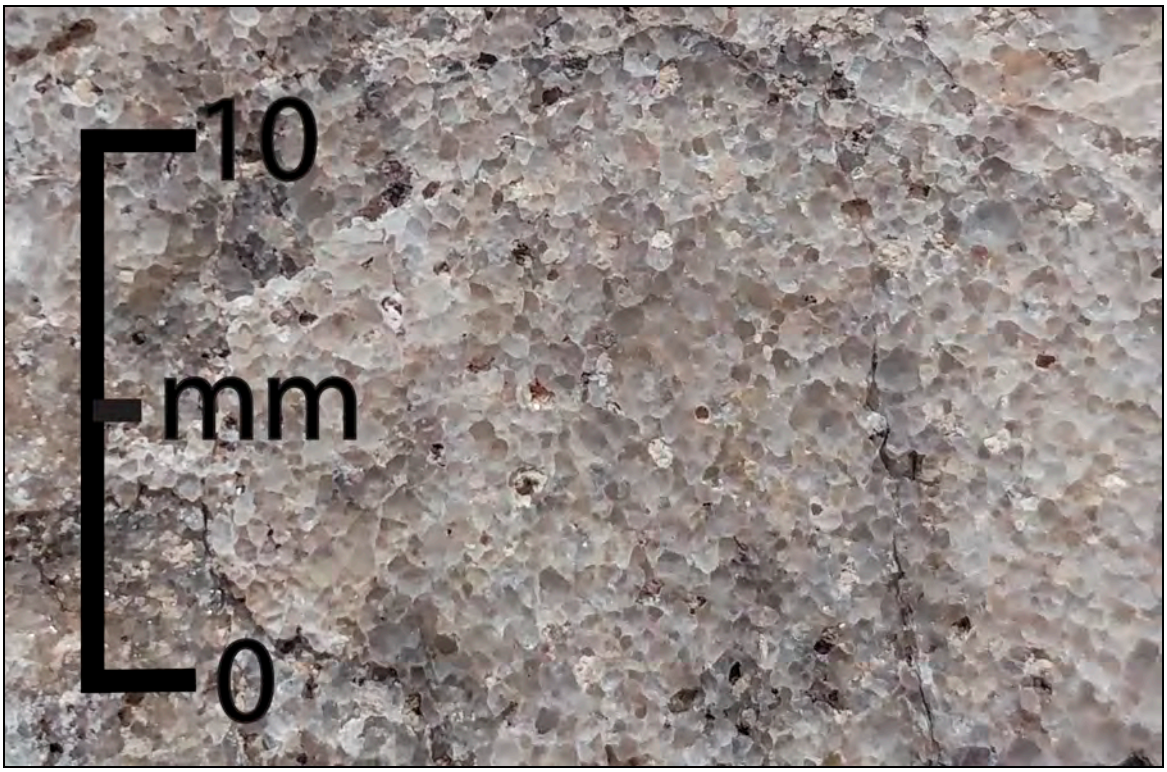


Photo 3a – Polished section of Lickey Quartzite. The LQF lithology at this site is a very well-sorted quartz arenite. White patches and empty cavities record the decomposition of feldspar grains. Weathering of the feldspar to kaolinite could have provided a source of silica for the development of the silcrete: $2KAlSi_3O_8 + 2H^+ + H_2O \leftrightarrows Al_2Si_2O_5(OH)_4 + 2K^+ + 4SiO_{2(aq)}$

Photo 4 – In contrast to the Lickey Quartzite, the breccia is very poorly sorted, and contains fragments up to 20cm in length. This picture has been enhanced to highlight the size and angularity of the large clast of Lickey Quartzite in the centre of the image. The lettering '4a' relates to the location of the rock in the following photo, as well as Photograph 1.

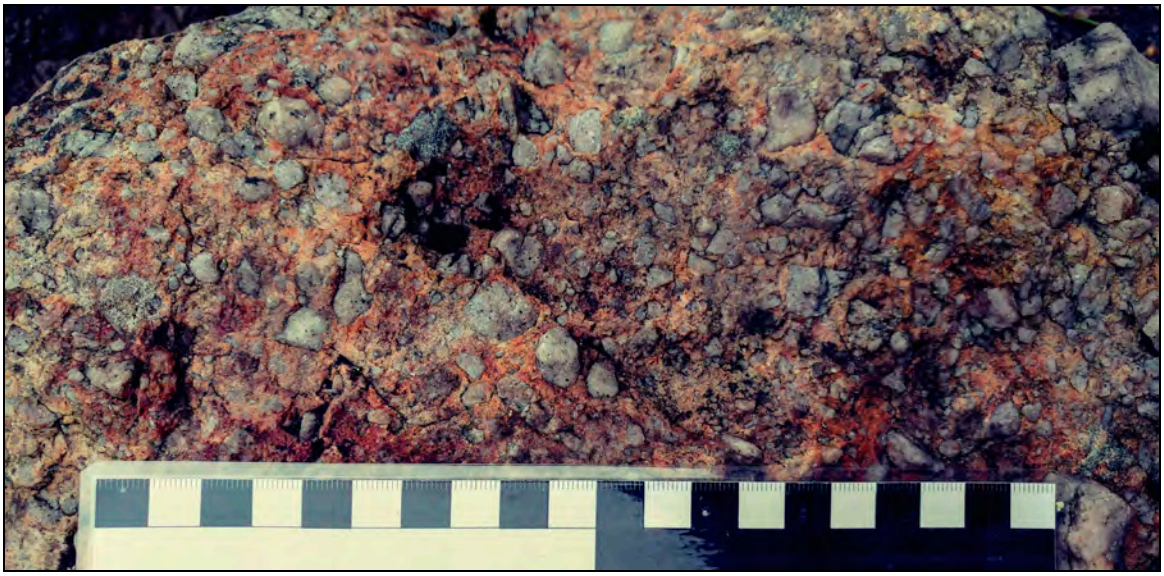


Photo 4a – In places smaller clasts of quartzite exhibit a higher degree of rounding and are enclosed in an iron-stained matrix that includes a small proportion of well-rounded, frosted sand grains suggesting they were subject to aeolian transport before entering their final environment of deposition.

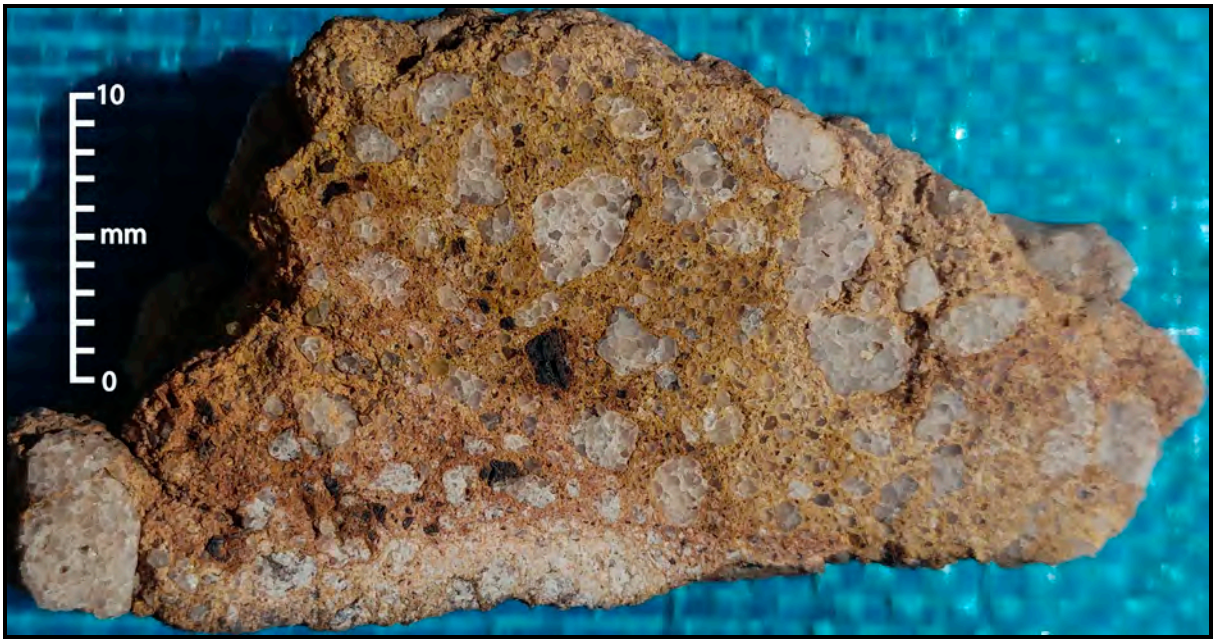


Photo 4b – Polished section of the matrix of the breccia. The clasts of well-sorted Lickey Quartzite are easily identified.

Photo 5 – This picture has been enhanced by darkening the breccia so that the two formations can be distinguished. The unconformable breccia is draped over the irregular erosion surface that truncates the Lickey Quartzite Formation. Note that the upper part of the LQF is not splitting into blocks along the joints; however, the lower part of the exposure is undercut below the lower limit of the silcrete. The silcrete has reinforced the breccia and cemented the joints in the upper part of the quartzite.

Photo 6 – To the east of the ridge crest, the unconformity appears again. The uppermost part of the exposure is breccia, underlain by pale Lickey Quartzite. At the base of the silcrete, erosion has exploited the joints in the quartzite, resulting in the undercutting of the silica-reinforced layer.

Photo 7 – The blocky weathered upper surface reveals the presence of breccia. The overhang, level with the bottom edge of the photo scale, marks the base of the silcrete.

Photo 8 – Despite some small patches of breccia, this exposure is almost entirely Lickey Quartzite. In the picture on the left the excavation has unearthed the vertical face of the exposure. The floor of the excavation revealed the quartzite below the silcrete – blocks could be easily plucked out by hand. The picture on the right shows the upper surface. Both views show the quartzite to be heavily jointed, but resistant to erosion because of silcrete development.

d) Geological units or landscape features present

Quartz arenite of the Ordovician Lickey Quartzite Formation, and quartzite breccia which is probably Triassic.

e) How this site complements existing sites

It is almost certain that this site corresponds to the fissure infills ('Neptunian dykes') recorded in the Warren Lane and Kendal End Quarries. The uppermost fill in the WLQ fissure is an aeolian sand, which adds weight to the suggestion that the infill and quartzite breccia are of Triassic origin. An important clue to the age of the breccia comes from Wills & Shotton's description of the geology exposed in a sewer trench excavation in Northfield, (Wills & Shotton,1938). They describe," a thick breccia entirely composed of angular blocks and smaller fragments of the Lickey Quartzite. This breccia matches very closely the Basal Triassic Quartzite Breccia recorded in boreholes in Birmingham (Boulton, 1933), which had never previously been seen at the surface. The blocks varied up to about a foot in diameter, were completely unrounded, and there was little, if any, sand or clay between them. The breccia was seen to rest unconformably with a rather high dip on chocolate-coloured Keele Clay … It passed upwards into soft red Bunter sand-rock with thin seams of breccia … and [then] into normal soft Bunter sand-rock." To provide a source of these fragments, the Lickey Quartzite must have been exposed at the time. Since the Lickey Ridge represents the highest part of the LQF, it is reasonable to suggest that it was exposed at this time, and that the development of the silcrete in the semi-arid conditions of the Triassic, has done much to preserve it as a topographical high ever since.

Site Condition

The site remains in good condition as a consequence of regular maintenance by the Geo-Champions. Pressure washing of the exposures has been fundamental in revealing the site's significance.

Why is the site at least regionally important?

Connectivity with landscape Site provides evidence of a landscape scale process/change/feature	Alan Richardson suggests that the breccia was lithified as a silcrete, and consequently preserved the Lickey Hills as a persistent landscape feature for a considerable span of geological time. The LQF is heavily jointed, but by and large, these fractures do not affect the breccia. In the uppermost quartzite, immediately below the erosion surface, the joints have been sealed during the development of the silcrete. Consequently, the silcrete constitutes a strongly cemented cap rock, protecting the underlying LQF. Once formed, the silcrete would have become an impermeable barrier, preventing the groundwater from rising by capillary action. As a result, the sediments deposited conformably above the breccia would not have benefitted from the liberal precipitation of silica, and would have been more readily eroded.
Diversity Value of site in reflecting geodiversity of a county	The unconformity on Rednal Hill is a continuation of the feature on Bilberry Hill, however, it is not visible at the ground surface, and can only be revealed by means of shallow excavation. Indeed, it is possible, if not probable, that Cofton Hill to the south is also capped by silcrete-reinforced breccia. (Fallen blocks of quartzite breccia have been found on the south side of Cofton Hill.) The unconformity on these southern Lickey Hills may correspond to the similar structures seen elsewhere at the base of the Triassic. However, we know of no location outside the Lickey Hills where this silcrete can be seen.
Education Sites provides opportunity for formal or informal education	Any field excursion to the Lickey Hills is likely to include this site: although small in extent, the unconformity is very clear. Like 'Hutton's Unconformity' on the Isle of Arran, the precise location of which is masked by the development of a calcrete, it offers an instructive challenge for those seeking to refine their observational skills.
Naturalness Value of site in reflecting past or present natural processes	The site provides a classic example of the evidence by which an unconformity can be identified, and reflects an interruption in the geological record, during which deformation, uplift and erosion occurred before processes of deposition resumed.
Rarity Rare or exceptional features	This is the best exposure of the silcrete breccia that appears to cap the three southern Lickey Hills, and may be regarded as the type section of this unit.

References

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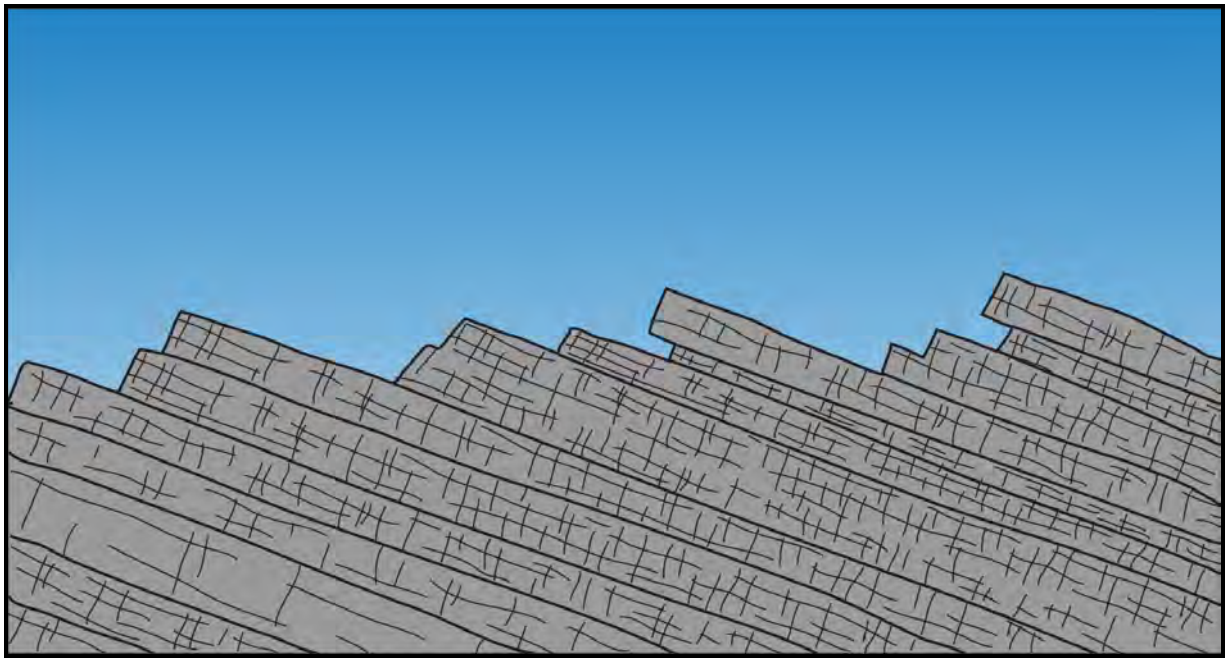
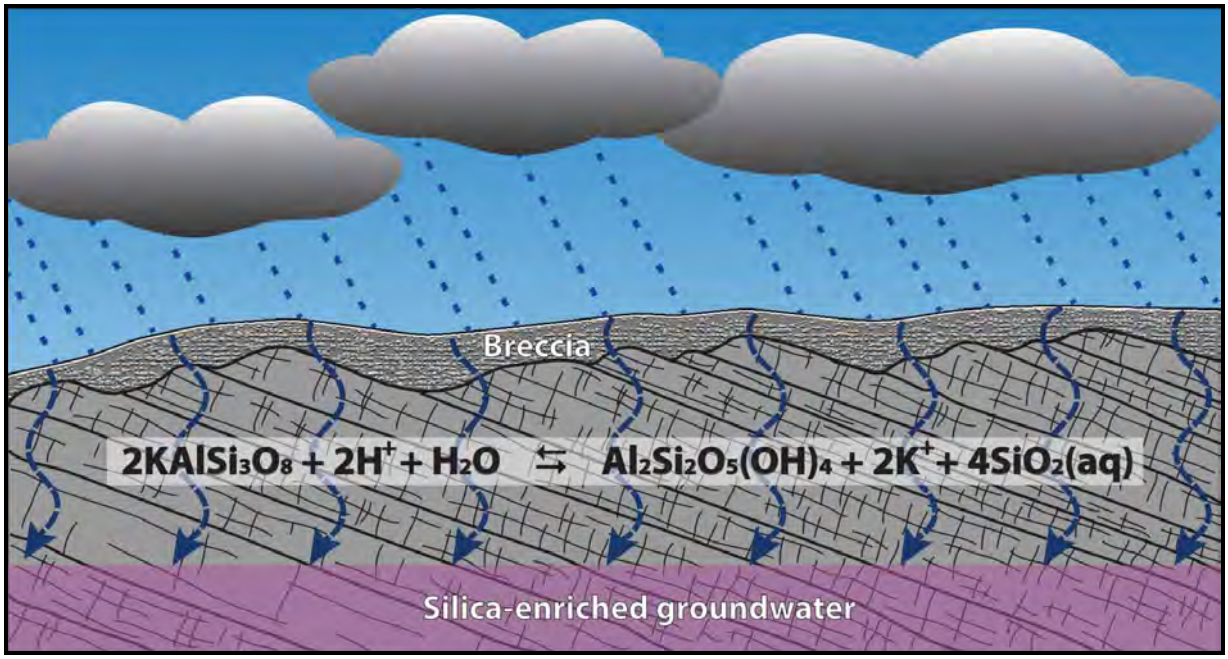
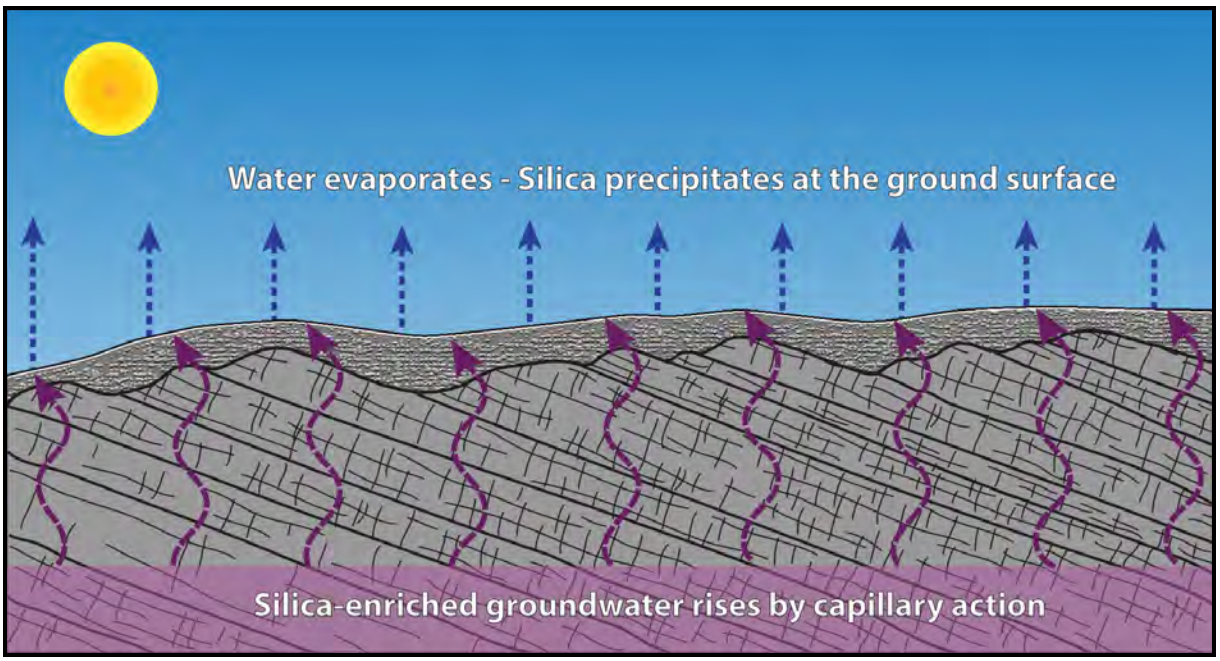
Appendix – *A Model for Silcrete Formation.*



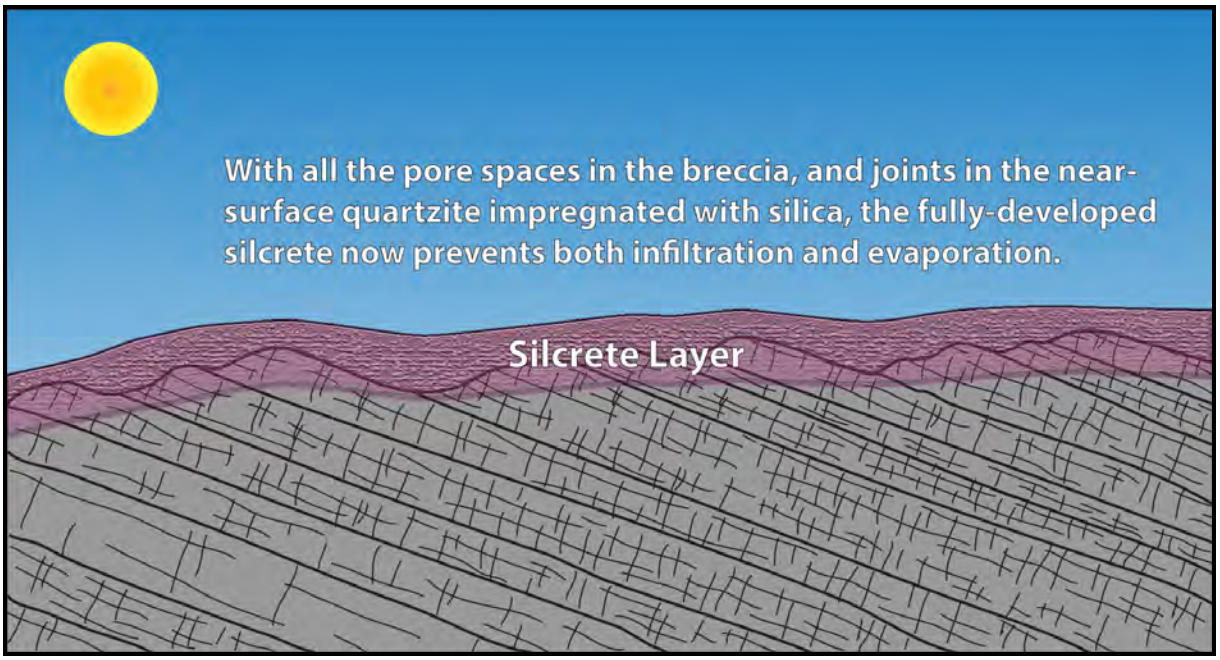
1 – Having been deeply buried, deformed and uplifted, the heavily-jointed Lickey Quartzite is uplifted and eroded.



2 – In a hot, predominantly dry climate, infrequent heavy rain infiltrates the ground and weathers K-feldspar grains to kaolinite, releasing silica into solution. At the surface mechanical weathering of the well-jointed quartzite produces a blanket of poorly-sorted, angular fragments,



3 – During periods of drought, ground water rises through the rock by capillary action. It evaporates at the surface, but any dissolved material is precipitated in near-surface joints in the quartzite, and pore spaces in the breccia.



4 – Eventually all near-surface pores and joints are fully impregnated, and the passage of water, in either direction, ceases. The lithified breccia and reinforced quartzite of the silcrete layer constitute a highly-resistant layer. Any sediments deposited above it are likely to be more easily removed, so that when erosion reaches the silcrete it all but ceases, preserving the topographical features on which the silcrete developed.

Alan Richardson – April 2023