

to be of Triassic age. Adjacent to a fissure in Warren Lane Quarry, a small exposure of a sedimentary breccia contains lithic clasts of an earlier breccia, which are likely to have been eroded from the summit of Bilberry Hill.

Site Summary:

The Warren Lane Quarry lies within the Lickey Hills Country Park, and has been granted LGS status. Extraction of stone ceased when the site was given over to use as a gun proofing range in WW1, and the quarry faces have remained largely undisturbed since then. The area is now used by the CP Rangers as a secure storage yard, but all the quarry faces remain accessible.

The main face of the quarry is terraced: the upper half is easily accessed from the base of the quarry, but is overgrown and ungrouted. The lower part is well-exposed and regularly maintained by the Lickey Hills Geo-Champions in association with the CP Rangers. Despite extensive fracturing of the rock, the outward dip of the beds minimises any risk resulting from rock falls. The main face trends NW – SE: at the NW end a subsidiary excavation exposes two faces at right angles to one another, enclosing two sides of the remains of an ammunition store dating from the First World War.

The dominant lithology is the Lickey Quartzite (BGS Lexicon - LQ). It is well-cemented, and in thin section exhibits tightly-sutured grain boundaries. Greenish clay partings separate some beds. Some iron staining on the otherwise pale outcrop may be the result of oxidation of iron-rich clays, but could have been derived from the adjacent Triassic deposits. The Warren Lane Quarry exposes the western limb of the 'Lickey Anticline', with bedding dipping to the southwest at around 50°. Bedding planes occasionally exhibit isolated asymmetric ripples, as well as a cross-bedded channel infill, and there are thin beds of clay. Behind the storage containers in the middle of the quarry, one bedding plane carries a feeding trail trace fossil (Fig. 20). Above the remains of the outer wall of the First World War ammunition store, at the north-western extremity of the quarry, an apparently concordant unit of reddish pebbly sandstone interrupts the otherwise monotonous well-sorted quartzite. The single layer is exposed on the two adjacent faces above the ammunition store. The quarry faces are at 90° to one another so that the unit is cut through creating two isolated exposures (Figs. 1 & 9).

On the smaller north-western face, the unit is seen to taper downwards before pinching out completely (Fig 11). On both faces, the unit is seen to contain angular fragments of the grey Lickey Quartzite (Fig 4), and in places has cross-cutting junctions with the quartzite (Fig. 10). The uppermost part of the fissure is filled with well-sorted aeolian sandstone (Figs. 12 & 13). However, the presence of well-rounded pebbles reflects the fact that water was the last agent of transport before deposition. It is possible that this reflects a Triassic event, with sand derived from earlier Permian deposits.

In thin section (Figs 19 - 28), the grain size, sorting and clast compositions of the quartzite and the matrix of the pebbly sandstone are similar. However, the Lickey Quartzite exhibits closely sutured clast boundaries, suggesting a depth of burial in excess of 1000m. This mosaic texture is absent from the pebbly sandstone, suggesting it has not experienced the same depth of burial. Weathered surfaces of the pebbly sandstone exhibit a rough sandy surface with protruding quartz pebbles (Fig 8.). In contrast, the Lickey Quartzite is so well-cemented that exposed surfaces remain smooth, and the single pebble so far recorded has fractured flush with the surrounding matrix (Fig. 7).

Despite the pebbly sandstone unit appearing to be concordant with the Lickey Quartzite, the included angular fragments of the latter, and sharp, irregular contacts perpendicular to bedding, show that its formation post-dates the quartzite's lithification; and the lack of sutured boundaries between the grains in the sandstone demonstrate a different burial history. It can therefore be interpreted as a fissure infill. [The term 'Neptunian dyke' seems inappropriate for a concordant structure which would more appropriately be described as a 'Neptunian sill', however, 'fissure infill' is considered a more useful term.] The fact that the fissure opened along a steeply dipping bedding plane indicates that the folding of the quartzite into the Lickey Anticline had already occurred before the extensional episode responsible for its opening.

There are other small, isolated occurrences of the pebbly sandstone, which may be remnants of the same fissure, and the rocks are cut in a number of places by near-vertical, northeast-southwest trending fractures marked by fault breccias. Above the ammunition store, adjacent to the fissure, on its south west side, the rocks have been crumpled and brecciated by faulting. Above this fracture zone, the Lickey Quartzite has an irregular junction with a poorly-cemented breccia which contains clasts of an earlier breccia, which may have been eroded from the summit of Bilberry Hill (Figs. 11, 15 & 16).

Designation Criteria:

Scientific: The site is crucial to the understanding of the chronology of structural events affecting the Lickey Quartzite formation, and may provide evidence of the nature of the unconformity between the Ordovician Lickey Quartzite and the Silurian Rubery Sandstone, as well as a more recent unconformity.

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: As the most extensive exposure of the western limb of the Lickey Anticline, the Warren Lane Quarry enhances our understanding of the relationship between these structures and the adjacent geological formations, and the resulting geomorphology of the Lickey Hills, which may have been landscape features repeatedly since the Silurian.

Historical Associations: The Lickey Hills Local History Society's Publication, 'The Bilberry Hill Gun Proof Range' offers the following:

The Warren Lane Quarry was home to the Bilberry Hill Gun Proof Range

The Great War led to a huge increase in gun and munitions manufacture. Small arms were still proofed at the Birmingham Gun Barrel Proof House, but large field guns and howitzers required much larger testing facilities.

One such site was 'Bilberry Hill Quarry' [Now known as 'Warren Lane Quarry'], requisitioned by the Government, possibly because it was close to the Austin factory. The National Archives have a copy of the 1917 bye laws under the Defence of the Realm (Consolidation) Act of 1914.

During World War 2, the quarry was used for testing Lewis and Bren guns.

Inside the old quarry site, formerly the Bilberry Hill Gun Proof Range, three concrete structures still survive. The gun butts consist of two huge concrete structures now providing storage space for equipment. When in use they would have been filled with sand or earth to absorb the impact of the artillery shells.

The foundations and outer blast wall of a concrete ammunition store occupy the north-western corner of the quarry, and an interpretation panel at the entrance to the quarry gives a fuller background.

<https://thelickeyhills.uk/wwi-project/>

See Figure 34 for more details.

Naturalness: The sediments and sedimentary structures provide evidence of the environment of deposition, and when compared to those higher and lower in the LQ sequence reflect changes in the nature of the sedimentary processes. The faults, fissures and the inclination of the bedding reflect the tectonic forces to which the rocks were subjected. The fissure infills, possibly of Triassic sediments, are the consequence of a long period of burial, deformation and uplift, during which the surface environment had

changed significantly. If they can be correlated with the summit ridge breccias, they would provide evidence of the Lickey Ridge being a topographic feature of great antiquity.

Rarity: The relationship between the fissure infills and the host formation is very unusual, and the apparent conformity of the two can lead the unwary to make incorrect interpretations. The quarry is one of only two locations where trace fossils have been identified in the LQF.

Typicalness: It constitutes part of the Type Area for the Lickey Quartzite (Defined by the BGS as: “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: Warren Lane Quarry is one of the Lickey quartzite quarries which were once prominent features of the local industrial landscape. They provided road stone in the early 20th century, but were abandoned in the 1920s.

Fragility: The fissure infills are very limited in extent and the rock is highly fractured, making it highly vulnerable.

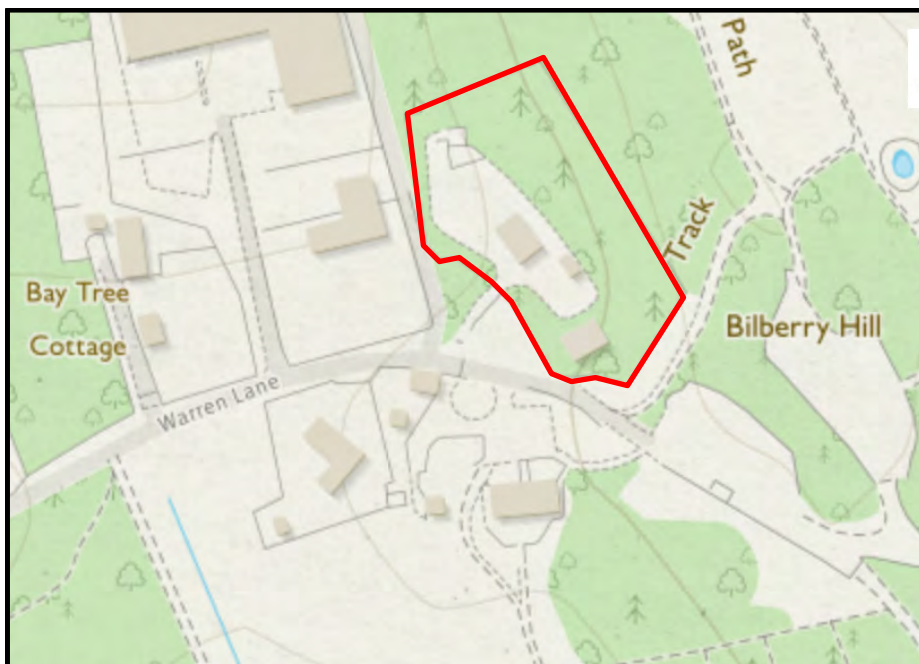
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Maps:



Warren Lane Quarry location



Warren Lane Quarry Site Map

Photographs:

All photographs – Alan Richardson

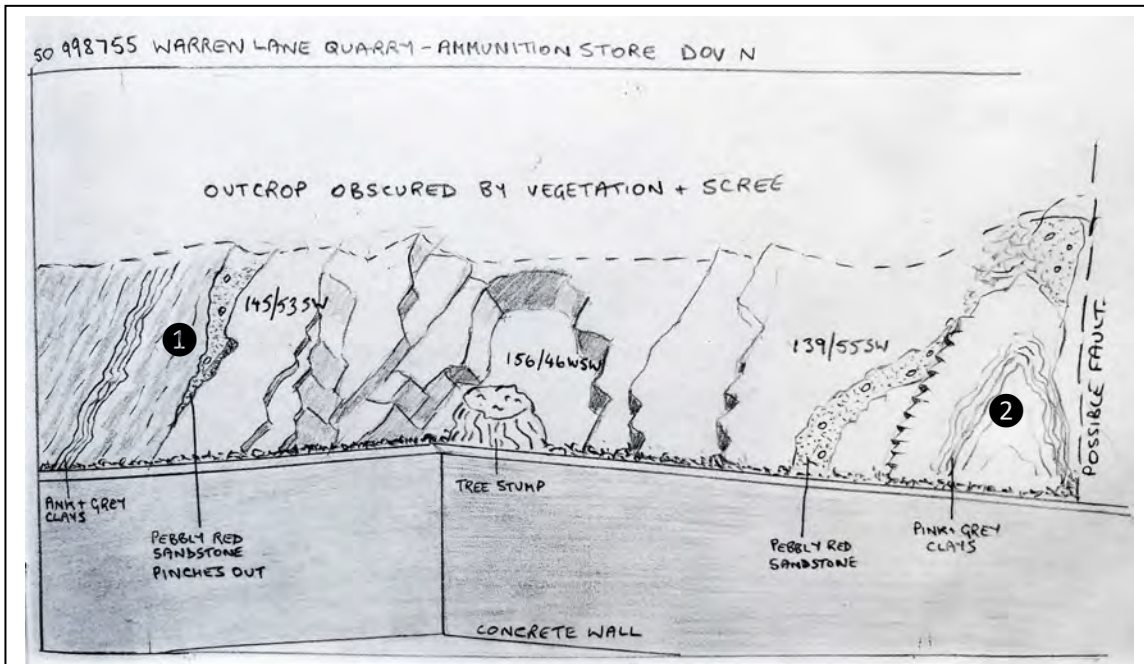


Figure 1 – Field sketch from the ammunition store – direction of view (DOV) North.

- ① On the left, above the NW wall, the infilled fissure can be seen to pinch out downwards.
- ② On the right, above the NE wall, the fissure infill has irregular contacts with the Lickey Quartzite, and is terminated to the right by a fault.



Figure 2 – 2019: The fissure infill above the NW wall of the ammunition store.



Figure 3 - Close up of Figure 2, showing the area covered by Figure 4.

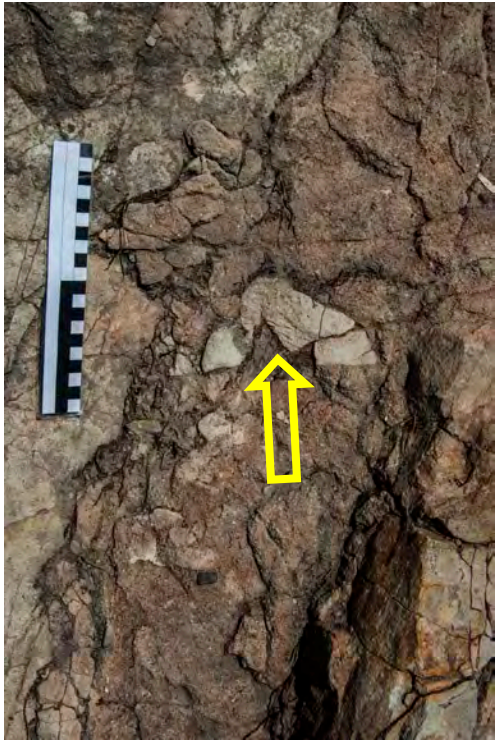


Figure 4 - The reddish pebbly sandstone fissure infill containing pale grey angular fragments of Lickey Quartzite.



Figure 5 – A 2001 view to show the location of Figure 6. Note the deterioration of the exposure since 2019.



Figure 6 – Colour enhancement highlights the reddish fissure infill to show it has an irregular boundary with the Lickey Quartzite, perpendicular to bedding. Yellow circle identifies the pebble illustrated in Figure 7.



Figure 7 – A dark quartzite pebble in the Lickey Quartzite. A joint fracture has cleaved the pebble so that its margin lies flush with the smooth surface of the quartzite matrix. Note how this contrasts with the weathered surface of the fissure infill (to the left of the image), on which each sand grain protrudes from the surface.



Figure 8 – By way of contrast, pebbles in the less well cemented infill are more resistant than their surrounding matrix, and weathering leaves them standing proud of the weathered surface. See Figure 9 for location.

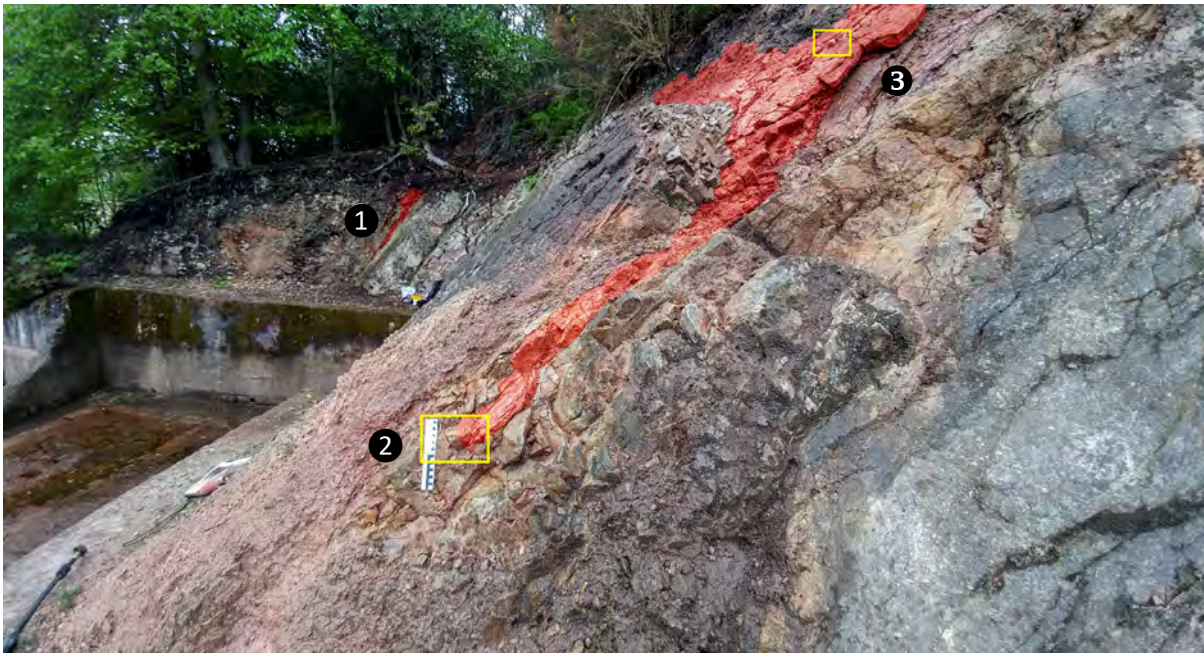


Figure 9 - The view westwards over the ammunition store. The fissure infill has been coloured to clarify its distribution. ❶ In the background, above the blast wall of the store, the tapering fissure can be seen to pinch out (Figure 11). ❷ In the foreground, it is seen to end abruptly against the quartzite at a junction perpendicular to bedding (Figure 10). ❸ A prominent pebble protrudes from the fissure infill (Figure 8).



Figure 10 – The scale bar rests on a bedding plane. The fissure infill on the right has been coloured to emphasize the nature of the junction with the quartzite where it cuts across the bedding.

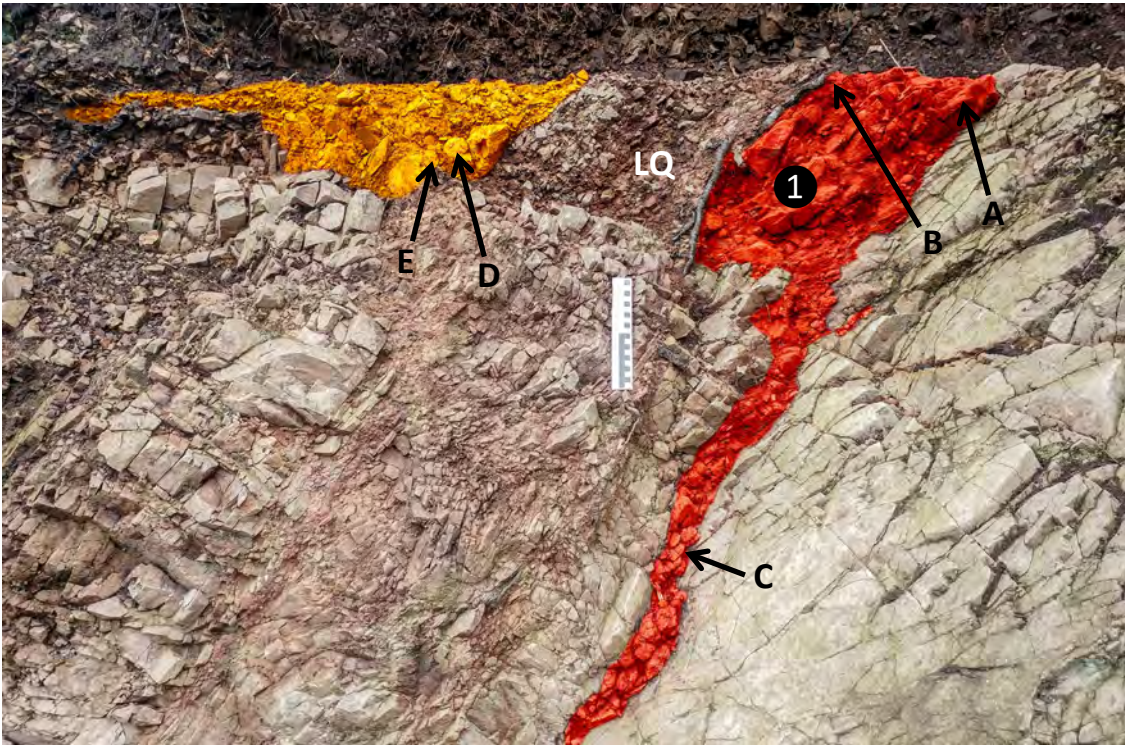


Figure 11 – At the top of the image, the dark soil layer, which rests on a more or less horizontal rock surface, has been cut back. The fissure infill (coloured red) tapers downwards through the Lickey Quartzite: Specimen WLQ1 was recovered at A; WLQ1a at B; specimen WLQ2 was taken at C. The Rock at LQ has been very heavily fractured, but is undisturbed Lickey Quartzite. The yellow-coloured area is a breccia, which contains clasts of breccia containing only fragments of Lickey Quartzite. Specimens WLQ3 and WLQ4 were recovered at D and E respectively. There are no fragments of this breccia in the fissure.



Figure 12 – Specimen WLQ1, with a selective enlargement showing the well-rounded, frosted grains, suggesting aeolian transport.



Figure 13 – WLQ1a: Well-sorted aeolian sandstone from the upper part of the exposed fissure



Figure 14 – WLQ2: Fissure infill material including a well-rounded pebble. Although the sand grains of the matrix must have experienced prolonged aeolian transport, the presence of well-rounded pebbles is evidence of a final episode of movement by water.



Figure 15 - WLQ3: A clast of Lickey Quartzite breccia from within a layer of more recent breccia resting on Lickey Quartzite. This may be a fragment of the Bilberry Hill Breccia exposed on the hill above.



Figure 16 - WLQ4: A second clast of Lickey Quartzite breccia from within the layer of breccia close to the fissure. The deposition of this layer must post date the fissure infill, otherwise breccia clasts would have fallen into the open fissure.



Figure 17 – Lickey Quartzite clasts are concentrated at the base of the fissure, showing that they were the first fragments to fall in when the fissure opened.



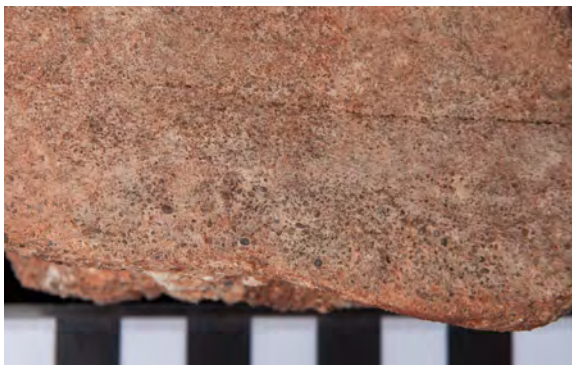
Figure 18 – Below the fissure ①, a well-defined, persistent joint is filled with sandy material, comparable to the matrix of the fissure infill. This suggests that it had been opened before the fissure filled.



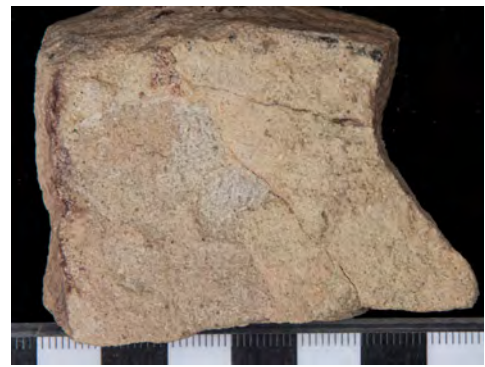
Figure 19 – Enlargement of the sand-filled joint adjacent to the fissure.



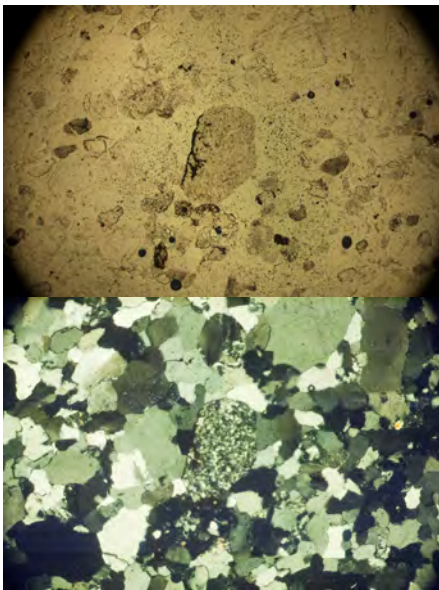
Figure 20 – Cruziana: trilobite feeding trail in Lickey Quartzite, exposed on the main face, behind the storage containers in Warren Lane Quarry.



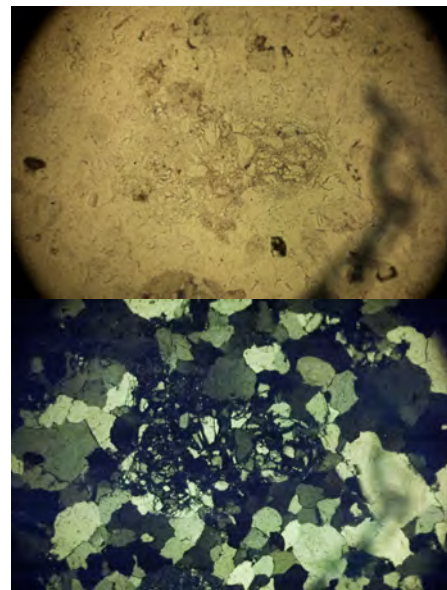
21. Sandstone fill in the fissure.



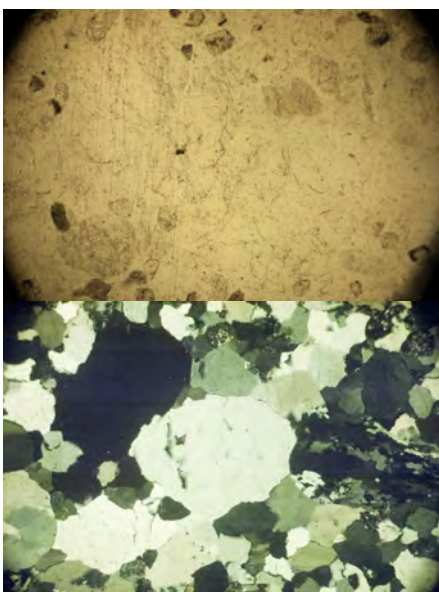
22. Lickey Quartzite



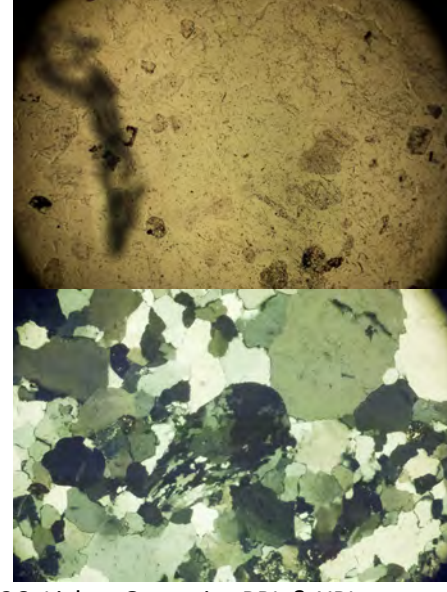
23. Lickey Quartzite PPL & XPL



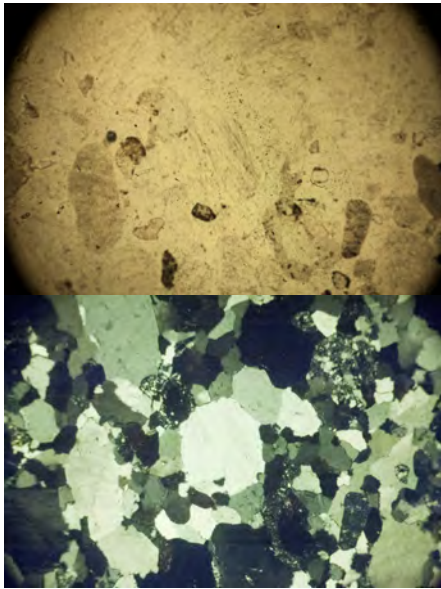
24. Lickey Quartzite PPL & XPL



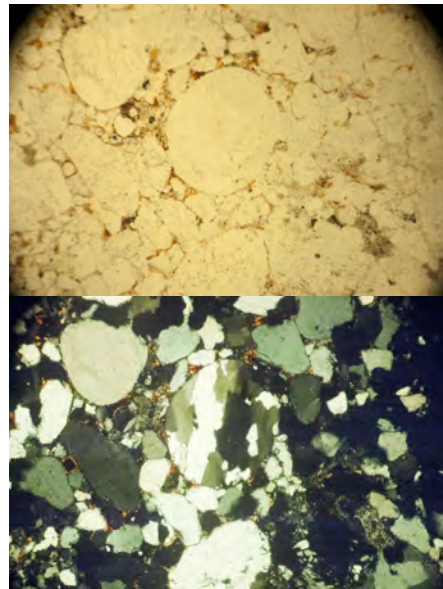
25. Lickey Quartzite PPL & XPL



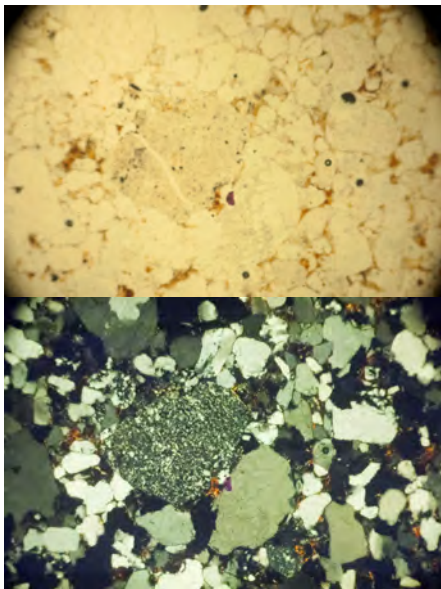
26. Lickey Quartzite PPL & XPL



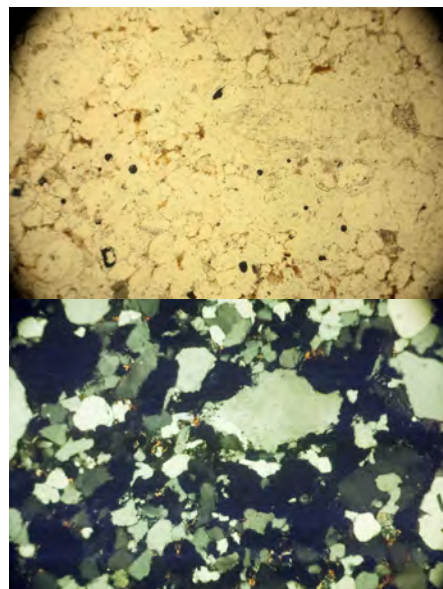
27. Lickey Quartzite PPL & XPL



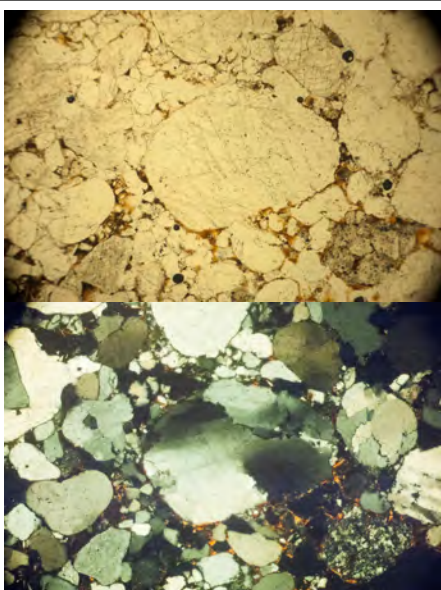
28. Sandstone fissure infill PPL & XPL



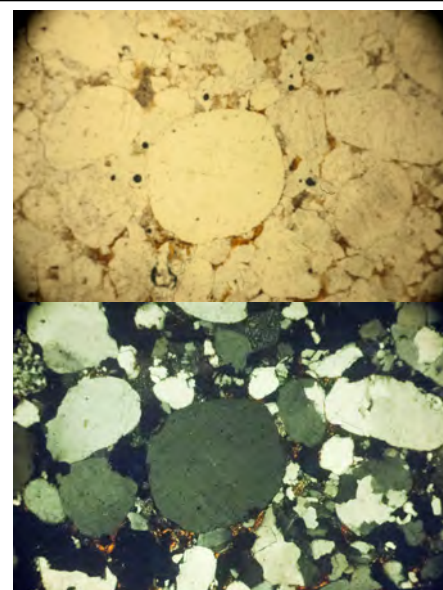
29. Sandstone fissure infill PPL & XPL



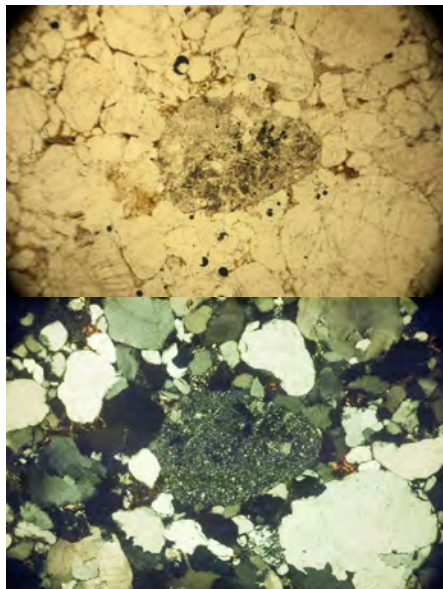
30. Sandstone fissure infill PPL & XPL



31. Sandstone fissure infill PPL & XPL



32. Sandstone fissure infill PPL & XPL



33. Sandstone fissure infill PPL & XPL

All the thin section photographs are of two thin sections: one of Lickey Quartzite, and one of pebbly sandstone fissure infill. Both were taken from the exposure above the rear (NE) wall of the ammunition store (Location 2).

The LQ here is a mature, well-sorted orthoquartzite. The grain boundaries are tightly sutured – there is no matrix.

The fissure infill is also mature. Although similar to the LQ in grain size, sorting and composition, the boundaries between the well-rounded grains are not sutured, and gaps between grains contain matrix and reddish iron oxide cement.

THE FIRST WORLD WAR PROOF RANGE IN THE QUARRY

The Proof process tests a gun using an overcharged cartridge, or Proof Load, which is fired through the gun in a testing range. This exposes it to pressures greater than it would normally experience, and reveals any weakness.

At the Bilberry Hill Proof range, both civilians and soldiers were involved in the process. The proof procedure was largely managed by civilians, whilst the field guns were handled by experienced soldiers from the Royal Garrison Artillery.

The field guns tested here were 4.5" howitzers. This range was originally built to carry out proof tests on field guns and gun carriages that had been brought back from the Front for repair. It also proof tested new field guns.

1 Gun barrels were lifted onto a gantry by means of a hand crane and lowered onto the gun carriages.

2 Proof shells were kept in the main store of the magazine.

3 A separate small store held the detonators.

4 The concrete 'dog-leg' entrance is certain and flat in the event of an explosion.

5 The field guns and carriages were brought to the range from the Austin Motor Company, probably on lorries built at the factory.

6 The after-proof gun examination was conducted by qualified military or civilian inspectors. If approved without damage it was given a Proof Mark.

7 Along the back of the quarry was a high concrete wall. This supported the gentry and prevented displaced quarry rocks from landing on the range.

8 Shove testing the field gun, loaded with the proof shell, entered into the bunker for safety.

9 The gun was then fired by remote detonation from the bunker into one of the two large concrete proof butts.

The 4.5" Howitzer Field Gun
This was the standard British field gun of the First World War, having entered service in 1910. A highly mobile field gun with a high trajectory, it was last used by British forces in early 1942.

The Magazine
This had thick concrete walls built for extra safety, into the banks of a side section of the quarry. The jagged left wall shows where part of the quarry has been demolished. One side of the dog-leg entrance is evident, with the broken wall of the detonator store to its right. The centre rectangle is the base of the main store, which had brick walls and a pitched roof.

The Bunker
This 1920s photograph was taken shortly before it was demolished. It was used as a necessary safety measure when firing the gun. The two window slits were adaptations made in later years when the site was used as a small arms firing range – possibly for Home Guard training during the Second World War.

The Proof Butts
These were made of concrete, with an angled, laminated wood and metal ceiling (pictured left) and arched side openings. The butts were half filled with sand enabling shells to be retrieved and re-used. The design of the structure, combined with the sand, absorbed the impact pressure and protected the butts.

Testing the Field Guns
This photograph was taken in August 1916 – just three months before the end of the war. It is the best evidence of what was happening on site. It shows Bombardier Hudson Roberts and a civilian in a boiler suit outside the bunker about to test a reconditioned gun. Two gantry stanchions and the back wall are clearly visible.

For more information see the WW1 Project www.thelickeyhills.co.uk

Designed & illustrated by Archibald 2011 648-6419 Keith and Susan Woodford

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Lickey Hills Society

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Figure 34 - The interpretation panel for the Bilberry Hill Gun Proof Range located at the entrance to the Warren Lane Quarry.