Report on MGA and GeoLancashire field excursion to Brymbo and Llay - 27 June 2019

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Brymbo

At Brymbo are the *in situ* remains of a Duckmantian (Westphalian B, Pennsylvanian) 'forest', with fossil arborescent lycophyte and calamite stems in growth position. Stands of *Calamites* stems are said to be very rare, (Appleton et al. 2011). The exposures are a geological SSSI.

The site is associated with a historic iron ore processing complex which includes blast furnaces. The C19 steel works was connected to the mainline railway system and also to Minera limestone quarry, where limekilns produced quicklime for the blast furnaces. The remains of a Hoffmann kiln, of which there are only about three examples in the country, can be seen in the Minera quarry.

The Brymbo Heritage Project has secured funding from the Heritage Lottery Fund to create a visitor centre and to erect a building to cover the fossil plants, which weather rapidly as soon as they are exposed. Work on the building is expected to start soon. Currently visits are only by arrangement; for up to date information see their website (listed in bibliography below). A number of other projects are in hand, from growing traditional Welsh apple trees for cider-making to bee-keeping and nature conservation. An experimental bloomery is also planned, to smelt iron from siderite ore, as would have been carried out locally in the C12 and C13. Anyone with specialist knowledge or experience of operating bloomeries please get in touch. (Do we have any members that old?)

The party of twelve met at Brymbo in lovely weather, a good start to any field excursion! After a brief tour of the industrial archaeology we were led to an exposure of the Two Yard Coal, also known as the Hollin mine.



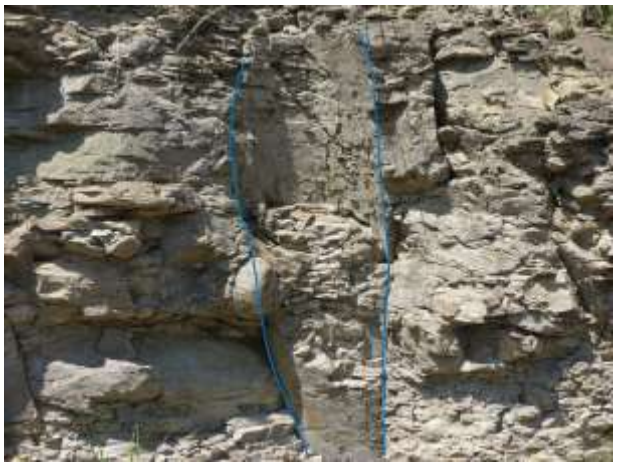
The most recent Brymbo blast furnace



Slag removal crucible from the modern steel works, now demolished.



Coal seam, 2m thick approx.



'Tree' *in situ*, diameter 0.7m approx.

The base of the exposure, which is located immediately above the unexposed Crank Coal, contained plant stems up to about half a metre in diameter preserved *in situ* mudstone. Stems over 1.5m diameter have been observed. Also seen were examples of *Calamites*, mostly in random orientations. Examples of *Stigmaria* were relatively common. Channels cutting through the mudstone were observed in a vertical face. The pair illustrated may represent the influx of coarse-grained sandy sediment splitting around a large lycophyte stem.



Calamites (~50mm diameter) and iron stained nodule.



Coarse grained sandstone filling channels in fine grained sandstone.

Between the 'tree' exposures and the coal was a horizon containing siderite nodules, the likely reason for the start of the local iron and steel industry. Siderite is iron carbonate, $FeCO_3$. Some siderite nodules contained preserved organic matter, especially rootlets. Iron stained nodules exhibited spheroidal weathering in the fine sandstones, possibly reflecting the processes of nodule formation.





Spheroidally weathered iron rich nodule, *in situ*, ~100m across. Spheroidally weathered nodule (left), siderite nodule (right) (scale 5cm).

Part of the siderite nodule shown in the figure was analysed by Hanson Cement, Ribblesdale Works, using XRF on a fused bead. As received, the nodule contained, oxide analysis, 47% Fe_2O_3. When heated to 1000°C, at which temperature the siderite has been calcined, the Fe_2O_3 content was 65% dry basis, equivalent to 46% iron, which is certainly ore grade. The formation of siderite nodules is extremely complicated, but in normal circumstances they form only in non-marine environments. In reducing conditions in marine water, the activity of sulphate reducing bacteria leads to the production of pyrite. Meteoric water contains very much lower levels of sulphate than marine water and, when all the available sulphate has been used to form pyrite, bacterial activity leads to the production of siderite. In the English Westphalian siderite is quite commonly found associated with coal seams. In many places, such as Cliviger in east Lancashire, it was mined for use as iron ore.

Examples of enigmatic trace fossils, both in vertical and horizontal orientation, were seen in the fine-grained sandstones beneath the channel sandstones. A discussion followed on whether these were formed by roots or by burrowing organisms. The segments are not parallel with bedding. However, the bifurcating example has a morphology similar to a root. A small majority of those prepared to hazard an interpretation favoured roots, but the segmented morphology defied explanation.



Trace fossils in fine-grained sandstone

Thanks were expressed to Tim for his enthusiastic and informative explanation of the site.

Llay Main colliery slack heap

Most of the group continued to Llay. The coal mine tip is being reworked by Hanson Cement as raw material for cement production. It is located between Brymbo and Wrexham and is not publicly accessible. You can read something about the mine at http://www.welshcoalmines.co.uk/North/LlayMain.htm. Figure 30 in the Flint Memoir is a log of the 750m deep No. 1 shaft. It shows the location of the aforementioned Hollin and Crank coals in the Westphalian succession.

Because the tip is being reworked there was plenty of coarse rock to be picked over. Abundant cobble sized fragments of coal were found, some extremely pyritic. Siderite nodules were also abundant, some with well-preserved plant matter. Fragments of sandstone exhibited ripple cross-bedding.



Siderite nodule with plant matter (lens cap ~50mm).



Ripple bedded sandstone (vertical scale ~100mm)

Thanks were expressed to Jason for showing us around and explaining the use of the shale as a component of the raw material recipe for cement manufacture.

Bibliography:

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Hains B A 1991. BGS Technical Report WA/91/4, Applied geological mapping in the Wrexham area: geology and landuse planning. (*This is available on the web and contains a stratigraphic column which includes the coal seams.* http://nora.nerc.ac.uk/id/eprint/510077/1/WA91004.pdf)

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Thomas B.A. et al. 2015. Stigmaria Brongniart: a new specimen from Duckmantian (Lower Pennsylvanian) Brymbo (Wrexham, North Wales) together with a review of known casts and how they were preserved. Geol. Mag. 152 (5), Cambridge University Press.

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Note: Tim Astrop will be presenting a paper at the October GA Conference in Manchester, https://geologistsassociation.org.uk/conferences/