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# A Carboniferous Fossil Forest in North Wales: Problems and Potentials Associated with Developing and Conserving a ‘Soft-Rock’ Site

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**Abstract** A small area of Duckmantian deposits at Brymbo, Wrexham, in North Wales contains a variety of sedimentary rocks laid down between two coal seams. The exceptionally well-preserved flora contains three dimensionally preserved *Calamites*, *Stigmarias* and lycophyte stems in their original positions of growth together with a varied flora of compression plant fossils. The site is protected as an SSSI and has been included in the Geological Conservation Review, and the ownership will be transferred together with adjacent scheduled buildings from the former iron and steel industry to a Heritage Trust. Its future seems secure but such soft-rock sites deteriorate through exposure to the weather. The plan to develop it as an educational and research site relies on its survival, and the only secure way is to enclose the site, which will then permit further excavation and exposure of the plant fossils.

**Keywords** Carboniferous · North Wales · Fossil Forest · Sedimentary rocks · Geoconservation

## Introduction

Geoconservation does not have the same priority in the general public’s mind as biological conservation. Interest in geology is stimulated by visiting different places to study the rocks, and teaching with the aid of notes on responsible fieldwork may temper any destructive tendencies to overcollect,

but there is a need to instil in the aspiring geologist the need to save sites for future research or educational use.

Geological sites are being lost all the time through quarrying and landfill, but legislation within the devolved regions of the UK can bring about the purchase of sites for National Nature Reserves and more regional action can result in Local Reserves of geological interest. Most of our geoheritage is not preserved in this way, but a great many sites have been given protection as a Site of Special Scientific Interest (SSSI) and included in the Geological Conservation Review (GCR). In Northern Ireland, they are known as Areas of Special Scientific Interest (ASSIs) (Thomas and Cleal 2005, 2012). Nevertheless, even these sites can lose much of their value if they are left to degrade or become covered with vegetation. The type of rock in the designated sites can control any action necessary to ensure its continued usefulness. There is an enormous difference between hard rock igneous and metamorphic sites and those made up of sandstone and shale. Exposures of these ‘softer’ sites may be constantly renewed if they are on the coast, but problems arise if they are inland. Sometimes the only option is to cover them up again to preserve them (boon, 2004).

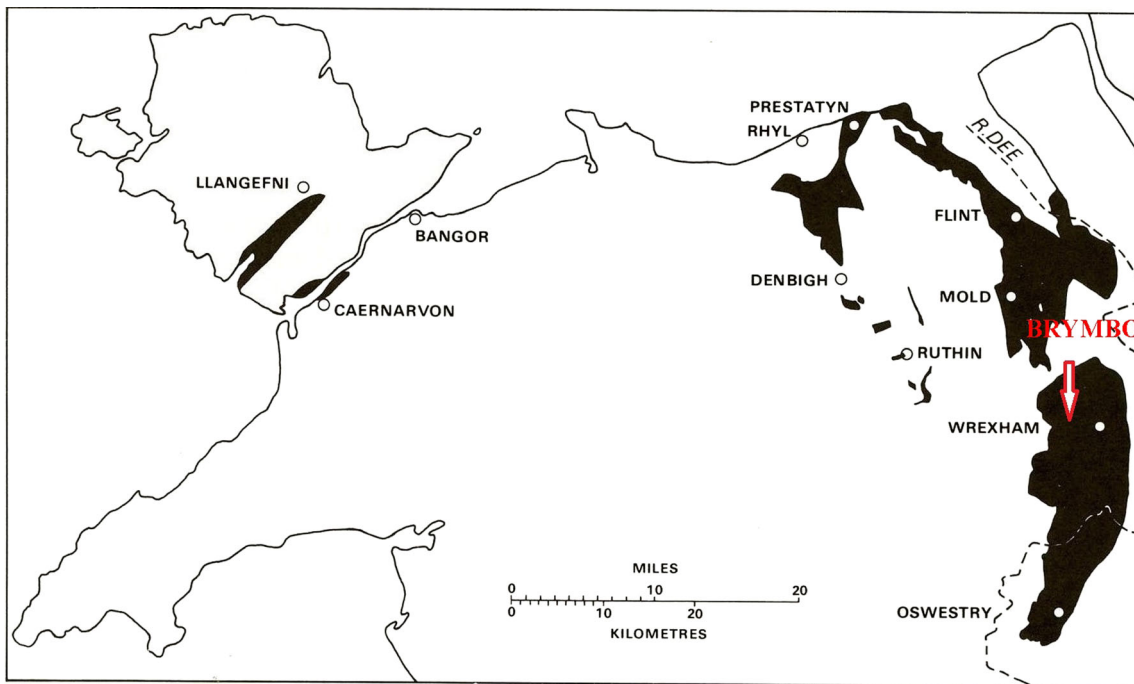
A new geological SSSI, which is also a new GCR site, in North Wales poses all the problems associated with these inland sites. Its study has revealed it to be an extremely valuable exposure for research and has the potential to be an excellent educational facility. However, the only satisfactory solution for the continued use of the site is to enclose it.

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## The Site

Brymbo village is near the town of Wrexham, North Wales, UK, in an area that was once highly industrialised.

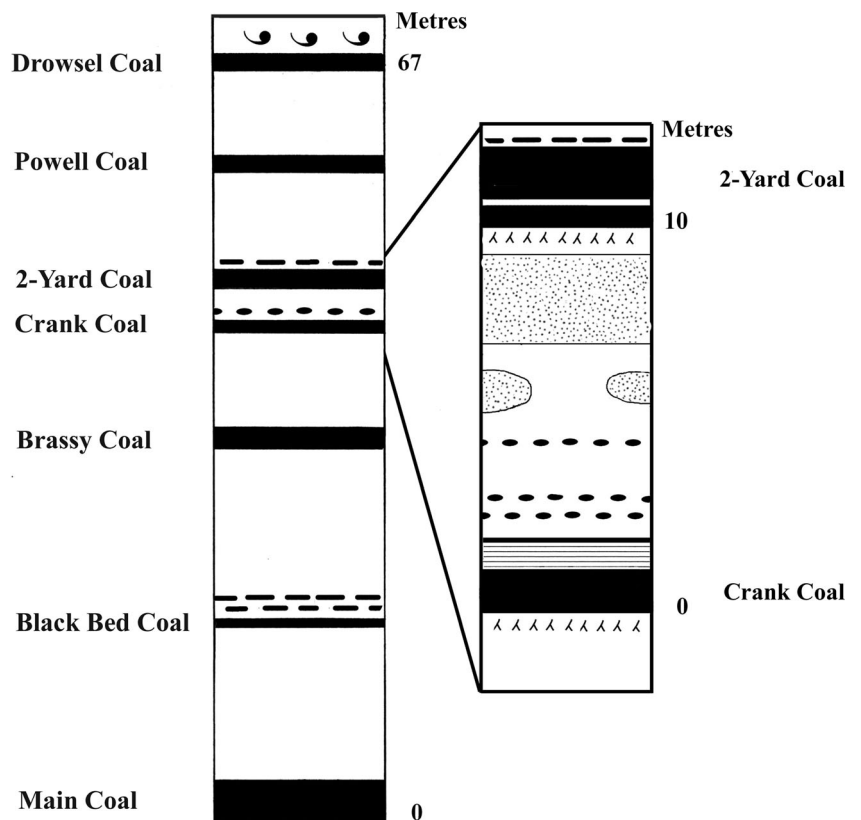


**Fig. 1** Geological map of the North Wales coalfields. The arrow shows the position of Brymbo

It lies at the northern extremity of the Denbighshire Coalfield, which is in the southern part of the Pennines Basin (Fig. 1). The Denbighshire Coalfield has a relatively

condensed succession of Pennsylvanian (Upper Carboniferous) strata overlying the Mississippian (Lower Carboniferous) Clwyd Limestone Group and, in turn, Silurian marine clastics.

**Fig. 2** A generalised sequence through the Denbigh Coalfield succession showing the main coal seams, together with a detailed graphical log of the sequence exposed at Brymbo





**Fig. 3** The sediments of the sequence at Brymbo showing the mudstones above the Crank Coal followed by massive sandstone containing casts of two arborescent lycophyte stems (*arrowed*). The *one on the left* has been

removed leaving only a cast. There are fine shales above the sandstone leading to the upper coal seam (2-yd seam) which is also *arrowed*

Coal has been mined in the area from at least the year 1410, and mines are recorded as being active in 1540 in ‘Harwd’ which is the old name for the village of Brymbo. However, Brymbo is best remembered not for its coal but for iron whose production commenced in 1796 with steelmaking beginning in 1885 and continuing until its closure in 1990. Many of the historic structures including the original eighteenth century blast furnace and foundry were retained in what is currently being developed as a ‘heritage area’.

After the dismantling of the steelworks, opencast mining of coal on the site worked the upper part of the Middle Coal Measures (Bettisfield) Formation of Duckmantian (Westphalian B) age, within which the most productive seams in the coalfield are found (Fig. 2). A small area of exposed Carboniferous rocks near the heritage area was not opencasted when an important assemblage of plant fossils was discovered. This is the Fossil Forest to be discussed here.



**Fig. 4** An arborescent lycophyte stem projecting above the shale. Weathering has now destroyed it

### The Scientific and Educational Value of the Exposure

The Fossil Forest site is approximately 1000 m<sup>2</sup> in size with about 14 m of Coal Measures of middle Duckmantian age exposed (Fig. 3). Two coal seams are included in the sequence with the lower, 0.8-m thick, Crank Coal being underlain by a palaeosol containing the basal portions of arborescent lycophyte stems. It is overlain by laminated mudstones with fragments of pteridosperms, such as *Neuropteris*, *Karinopteris* and *Aulacotheca*, ferns, such as *Sydneia*, *Euspenopteris* and *Palmatopteris*, together with *Calamites* and lycophytes (Fig. 4). In its lower part, there is a thin band of ironstone nodules that



**Fig. 5** A lycophyte leafy shoot (*Lepidodendron*) bearing a terminal cone (*Flemingites*). The numerous dispersed megaspores (referable to *Lagenicula horrida*) scattered near to the cone are identical to those obtained from the cone. The megaspores are approximately 1 mm in size

**Fig. 6** A split ironstone nodule containing the part and counterpart of the pteridosperm *Karinopteris jacquotii*



have yielded plant remains of pteridosperms, ferns, *Calamites* and lycophytes (Fig. 5) with many of them being fertile (Appleton et al. 2011, Thomas and Seyfullah 2015a).

Erect arborescent lycophyte stems have been found rooted at a horizon about 1.25 m above the coal where there is a coal parting. Some of the stems can be seen to be expanding at their bases, but no recognisable *Stigmaria* survive at this level, presumably having been incorporated with the original peat bed that became converted into the coal. In total, over 20 arborescent lycophyte bases have so far been identified at Brymbo ranging up to 2.5 m in height and 1.5 m in diameter (Fig. 6). At a slightly higher horizon than the lycophyte bases, a complete *Stigmaria* with the basal part of the vertical stem was uncovered (Fig. 7). The complete spread of the dichotomising base is nearly 5 m and the trunk 1.7 m tall (Thomas and Seyfullah 2015b). The *Stigmaria* with its trunk was removed in fragments from the site in 2008 and is currently being prepared for future exhibition (Fig. 8).

*Stigmaria* is one of the iconic plant fossils of the Carboniferous, and fragments of the narrower parts of the rhizomorph are found in most museum collections.



**Fig. 7** The dichotomising *Stigmaria* rooting structure of an arborescent lycophyte together with the basal portion of the main stem

However, very few almost entire specimens have been found and preserved (Thomas & Seyfullah 2015b). The most famous are those of the Fossil Grove preserved in a small building in Victoria Park, Glasgow (McGregor and Walton 1972). Another group of *Stigmaria* was re-exposed at the new housing development at Middleton, Sheffield, but after charting them, they were covered over to preserve the remains from weathering (Boon 2004).

The following thin mudstone contains many *Calamites*, lycophyte stems and cones with some exposed surfaces strewn with dispersed megaspores, and in the next sandstone layer, large numbers of *Calamites* stems occur as pith casts in their original erect positions of growth (Fig. 9) (Thomas 2014). It is the erect, in situ, stems of *Calamites* that make the site so significant; but with the presence of in situ lycophyte stems, the complete *Stigmaria* and the wealth of compression and



**Fig. 8** The *Stigmaria* laid out before its restoration (A) with two of the four sections of stem (B, C)



**Fig. 9** A group of calamite pith casts of stems (arrowed) extending through and to the top of the sandstone unit. The most complete of the stem pith casts shows a branch pith cast coming off to the right and curving upwards

ironstone-preserved plant fossils, it is without doubt unique of both national and international importance being a SSSI and a new GCR site. This is an example of how the GCR is being kept up to date as new information becomes available. For further information on the British GCR and international palaeobotanical sites, see Cleal and Thomas (1995) and Thomas and Cleal (2005, 2012). Additional information on the local geology can be found in Calver and Smith (1974), Davies et al. (2011) and Webb et al. (1928).

Careful recording of the plant fossils has enabled different assemblages to be recognised from the various strata enabling tentative ecological interpretations to be made. Representative specimens of all the taxa have been deposited in the National Museum of Wales, Cardiff, together with an illustrated data base.

The ability to see the changing sediments between two coal seams together with their differing assemblages of plant fossils, lycophyte stems and *Calamites* in their original growth positions and the potential to handle a variety of plant fossils and understand how they were formed make the exposure a rare and ideal educational facility for students of all levels from primary schools to university level.

### Problems in Conserving the Site

The site is currently owned by Park Hill Development Company whose management has agreed that it will give the whole heritage area and the Fossil Forest to the established Brymbo Heritage Group. Its future therefore appears secure, but there are outstanding problems to be faced in saving the site for the future. The major threat faced in conserving the Fossil Forest is erosion and degradation through rain and frost, which is breaking up the exposed shale and destroying the plant fossils within it. The lycophyte stems and the

*Calamites* exposed in side view are also weathering with those preserved in shale (Thomas 2014, Figs 10, 11) having been nearly all degraded and broken up. Many of the in situ *Calamites* preserved in sandstone have not yet been uncovered, being only visible as circular sections on the top of the sandstone (Thomas 2014, Fig. 14).

Part of the Fossil Forest has been temporarily covered by a membrane covering with drainage piping to take away the surface water, although the rest is still exposed. The upper 2-yard coal is exposed in a face at the end of the site where it is exposed to weathering and erosion. Theft has also been a problem, although most probably by local people taking fossils for their own interest. For both these reasons, excavation has been stopped for the time being. There are plans to fence the site which should prevent access to the exposure by unauthorised persons. Park Hill Estates have recently developed the adjacent restored large area of levelled land with roads and lighting for future housing, a school and retail outlets. This should not only bring a certain amount of security for the site but an added impetus to develop the Fossil Forest and the rest of the Heritage Area.

Long-term conservation for research and teaching will be only possible if the site is protected against continuing erosion by the weather, and this could only be achieved in an environmentally controlled building. The exposure could ultimately be viewed from raised walkways and information supplied through displays of fossils and instructive interpretation boards. Here, as always, the question of finance arises with current estimates somewhere in the region of £250,000 for a basic steel building and £1–2 million for its complete development as a scientific and educational facility.

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