Cwm Gwrelych–Nant Llyn Fach

Highlights

Cwm Gwrelych–Nant Llyn Fach provides the best exposed sequence of lower and middle Westphalian strata in Europe, with extensive evidence of non-marine bivalves, plant macrofossils and, to a lesser extent, marine bands.

Introduction

This stream section, extending south from Pont Walby, 1 km east of Glyn Neath, West Glamorgan, Wales [SN 891 064]–[SN 906 039], is one of the most remarkable Westphalian sites in Britain, providing a more or less complete sequence of Langsettian, Duckmantian and lower Bolsovian strata. Despite its importance, however, there is no comprehensive account of the site in the geological literature. The best published treatment is by Robertson (1932), who mentions parts of the succession in different sections of the memoir. Parts of the site are also mentioned by Barclay *et al.* (1988). Two unpublished theses also provide information, on parts of the succession in greater detail than is available in the published literature (Matthews, 1955; Thomas, 1967).

Description

Lithostratigraphy

The full sequence exposed at Cwm Gwrelych–Nant Llyn Fach is *c.* 500 m thick (Figure 4.16). The base of the section is in the upper part of the Middle Shales Formation. At the top of the formation here are 1.1 m of dark grey shales with marine fossils — the Subcrenatum Marine Band (see below). Compared with elsewhere in the coalfield (e.g. Vale of Neath), only the lower, transgressive phase of the marine band is developed, the upper, regressive phase being cut out by the erosive base of the Farewell Rock Formation.

The Farewell Rock Formation here consists of *c.* 45 m of mainly coarse grey sandstones (Figure 4.18). This outcrop was not dealt with in detail by Bluck (1961), in his sedimentological analysis of the formation, but evidence from neighbouring exposures suggests that the sediments were derived from the north.

Overlying the Farewell Rock is the base of the Productive Coal Formation. This is the lowest part of the Coal Measures Group in South Wales, and Cwm Gwrelych–Nant Llyn Fach may be taken as the stratotype (Figure 4.18(a)). The lower 60 m comprises mainly of shales, and include a series of marine bands, plant and non-marine bivalve beds. It compares well with the sequence at Nant Llech, which is the classic exposure for this part of the Langsettian in South Wales (discussed further below). The main difference is that there is no evidence at Cwm Gwrelych of the Astell Coal, or of its plant fossil bearing roof shales, which, at Nant Llech, immediately overlie the Farewell Rock. The distribution of the Astell Coal is generally patchy, however, being associated with relatively high-energy, fluvial deposits (Bluck, 1961).

This marine-influenced sequence is terminated by the Cnapiog Coal. This coal is no longer exposed here, being obscured by old workings, but its position is clearly marked by a thick seat earth (analysed by Wilson, 1965). It occurs widely in South Wales, sometimes under the alternative names Garw or Rhasfach coals.

The subsequent 35 m consists of dark grey, laminated shales with numerous bands and lenses of ironstone (known as 'mine' by earlier authors). This ironstone-bearing interval occurs over large areas of South Wales, and yielded much of the iron ore extracted from the coalfield during the 19th century and before (Joseph, 1880). Three significant ironstone bands can still be located here (the Cnapiog, Little Blue and Blue veins) and two others have been recorded, but are now obscured by old workings (the Garw and Spotted veins). The sequence is clearly lacustrine, except for an emergent interval represented by a seat earth *c.* 24 m above the Cnapiog Coal.

Overlying the interval of ironstones is a coal known as the Grey Coal, which includes a 2 m thick seat earth. The succeeding 27 m consists of a sequence of coarsening upwards cycles, each capped by a coal, including the Rhyd and Bluers coals. It represents a change from lacustrine to fluvial deposition, which can be recognized over large areas of the South Wales Coalfield. Detailed correlations of the coals between here and other parts of the coalfield have presented difficulties, as is shown by Robertson (1932, text fig. 2). Most probably, the Grey and Rhyd coals correlate with the Pumpquart and Trichwart coals, two of the most important seams in the western part of the main South Wales Coalfield. To the east, these coals are thought to coalesce to form the Lower Four Feet Coal, the lowest seam to be exploited commercially on the east crop (Howell, 1927).

Above the Bluers Coal are *c.* 40 m of mainly mudstones and thin coals with associated seat earths, representing emergent conditions. Most of the coals are little more than thin smuts, except for a 60 cm thick seam *c.* 30 m above the Bluers Coal. This 60 cm thick coal is a well known marker horizon in this area, known as the Queen or Enoch coal, but was never worked commercially here. The most detailed information on this part of the sequence is by Matthews (1955).

Overlying this interval of coals and seat earths are about 10 m of fluvial channel sandstones, which in turn are capped by a thin coal known as the Little Yard, and then by 18 cm of dark blue 'marine' shales, which is the Vanderbeckei Marine Band. Bloxham (1964) showed that it represents brackish to inshore conditions.

Above the Vanderbeckei Marine Band are some 250 m of 'typical' Coal Measures strata, representing a return to non-marine, mainly fluvial conditions (Figure 4.19). This interval consists mainly of a sequence of coarsening upwards cycles, many capped by a coal, and probably representing floodbasin lake sediments. It is the most important interval of coal-bearing strata in South Wales, the result of the maturation of the delta complex covering the area, and the tectonic quiescence of the surrounding hinterland. Seams identified in this interval include (in ascending order) the Yard, Nine Feet, Upper Four Feet, Driver and Two Feet Nine coals. The most widely accepted scheme of correlation of these seams with the rest of the coalfield is that given by Robertson (1932) and Barclay *et al.* (1988), although there have been some disagreements as to detail (e.g. the position of the Nine Feet Coal here relative to that of the same name found near Swansea — Matthews, 1955). It is nevertheless clear that these coals are mostly of very wide geographical distribution within the coalfield.

Above this is what Robertson (1932) referred to as the 'Upper Marine Group'. It commences with a series of fluvial sandstones with erosive bases, each of which is succeeded by a fining upwards channel-fill sequence. The sandstones are easily recognizable in this exposure as they form clear waterfalls. Thomas (1967) has shown that the sudden change represented by the 'Upper Marine Group' is a widespread phenomenon, recognizable throughout South Wales, and that the sandstone bodies form discrete and easily identified marker-bands (e.g. the Cockshot Rock, (Figure 4.20)).

Elsewhere in the coalfield, this interval contains a number of marine bands. At Nant Llyn Fach, however, only two marine bands have been identified. The lowest occurs *c.* 1 m above the Cockshot Rock, and is probably the Aegiranum Marine Band, which is the most widespread of the group in South Wales (Ramsbottom, 1979a). At a slightly higher level, Robertson (1932) also recorded a thin shale band with fish fragments, which might be the Edmondia Marine Band.

Above the Aegiranum Marine Band, the strata represent tranquil, backswamp conditions, with gradually coarsening upwards cycles with coals. The latter include the Gorllwyn, Gorllwyn Rider and possibly the Pentre coals.

The top of the section here extends into the Llynfi Beds of the Pennant Formation. The contact with the underlying Productive Coal Formation is along a small fault, however, and so details of the junction are not preserved.

Biostratigraphy

Marine bands

The lowest marine band in this section, immediately below the Farewell Rock Formation, is only partially preserved here. However, in the upper preserved part are numerous specimens of *Gastrioceras subcrenatum* (Frech), clearly indicating that it is the Subcrenatum Marine Band. This therefore marks the junction between the Namuiian and Westphalian series in this section.

A short distance above the Farewell Rock Formation are a further five shale bands with marine or brackish fossil assemblages (Leitch *et al.,* 1958; Bluck, 1961). None have yielded ammonoids, and the lower four contain little more than fish teeth and scales, but it is likely that they correlate with the bands M_1-M_5 identified at Nant Llech.

The 'marine' shale overlying the Little Yard Coal yielded only poorly preserved *Lingula* and rare fish fragments. This suggests brackish rather than fully marine conditions, a view supported by geochemical evidence (Bloxham, 1964). However, it is overlain by a shale containing a non-marine bivalve assemblage of the *Anthracosia ovum* Subzone, which is widely regarded as a guide to the position of the Vanderbeckei Marine Band.

The marine bands above the Cockshot Rock again yield assemblages dominated by inarticulate brachiopods and fish fragments, which are not biostratigraphically diagnostic. It is widely assumed that they represent the Aegiranum and Edmondia marine bands, but this is based mainly on their lithostratigraphical position in the sequence.

Non-marine bivalves

These are widely distributed throughout the section. The lowest occur in two bands, known as C_1 and C_2 (Leitch *et al.,* 1958), between the M_5 Marine Band and the Cnapiog Coal. The C_1 assemblage includes *Carbonicola crispa* Eagar, C. *proxima* Eagar and *C. pont:lex* Eagar (Eagar, 1962), which evidently belongs to the C. *proxima* Subzone (upper *C. lenisulcata* Zone). Interestingly, an almost identical assemblage occurs in the Pennines from above the Amaliae Marine Band, which is a correlative of the M_5 Marine Band.

The C_2 assemblage has not been studied in such detail, but is reported to yield *?Carbonicola bipennis* (Brown), and *C.* cf. *martini* Trueman and Weir. It is difficult to place this assemblage using these names in isolation, but there may be a comparison with the bivalves from the *Carbonicola torus* Band in the Pennines (Eagar, 1954, 1956). If correct, it belongs to the basal *C. communis* Zone.

Other C *communis* Zone assemblages occur in the interval of ironstones, between the Cnapiog and Grey coals. Robertson (1932) mentions, among others, *Carbonicola pseudorobusta* Trueman suggesting the subzone of that name.

Matthews (1955) recorded from the Rhyd and Bluers roof-shales *Carbonicola cristagalli* Wright and *C. rhomboidalis* Hind. Calver (1956) and Ramsbottom *et al.* (1978) identify a C *cristagalli* Subzone at the base of the *A. modiolaris* Zone, although Trueman and Weir (1947) note that these taxa can also occur in the upper *C. communis* Zone. In the absence of species of *Anthraconata,* it is impossible to locate this biozonal boundary here.

The lowest unequivocal evidence of the *A. modiolaris* Zone is from near the Bluers and Queens coals, which have yielded forms similar to *Carbonicola venusta* Davies and Trueman (Matthews, 1955). According to Trueman and Weir (1947) this species characterizes the basal part of this zone.

From immediately over the Vanderbeckei Marine Band, Matthews (1955) reported a shale containing *Anthracosia ovum* Trueman and Weir, *A. planitumida* Trueman, *A. aquilinoides* (Tchernyshev) and A. cf. *concinna* (Wright). This clearly belongs to the *A. ovum* Subzone (upper *A. modiolaris* Zone), and compares closely with assemblages from just above the Vanderbeckei Marine Band elsewhere in South Wales (Jenkins, 1962; Woodland and Evans, 1964; Archer, 1968).

This is the highest level in the section from which non-marine bivalves have been reported. However, these higher strata have been described mainly from a sedimentological standpoint (Thomas, 1967), and further investigation may reveal evidence of the upper *A. modiolaris* and *A. similis–A. pulchra* zones.

Plant macrofossils

Plant remains are also extremely abundant through the sequence. The most complete records are by Matthews (1955). However, he did not figure the specimens and their present location is unknown, which makes it impossible to verify the identifications.

The lowest plant remains originate from a shale c.2 m above the Farewell Rock, and appears to correlate with the P_2 bed at Nant Llech. Leitch *et al.* (1958) record from here an assemblage typical of the *Lyginopteris hoeninghausii* Zone, including *L. hoeninghausii* (Brongniart) Gothan, *Paripteris gigantea* (Sternberg) Gothan, *Karinopteris acuta* (Brongniart) Boersma and *Neuralethopteris neuropteroides* (gusta) Josten. The latter identification is of particular interest as, if it is correct, it tends to indicate a position no higher than the *Neuralethopteris jongmansii* Subzone (lower *L. hoeninghausii* Zone).

At Nant Llech, a second, lower horizon yields plant remains, and is known as P_1. However, this seems not to be exposed at Cwm Gwrelych.

Matthews (1955) mentions plant remains from several levels in the upper Langsettian part of the sequence here: from above the Rhyd Coal, below the Bluers Coal, between the Bluers and Queen coals, and from below the Vanderbeckei Marine Band. Some of the identifications (e.g. *Alethopteris serlii* (Brongniart) Goppert from below the Bluers Coal) are clearly in error. However, the presence of *Laveineopteris loshii* (Brongniart) Cleal *et al.* in many of the assemblages appears to support a position in the *L. loshii* Subzone (upper *L. hoeninghausii* Zone).

In the Duckmantian, Matthews (1955) records plant remains from the roof shales of the Yard and Nine Feet coals. The latter, in particular, is a well known source of plant fossils throughout South Wales. Both assemblages probably belong to the *Lonchopteris rugosa* Zone, but the material will need revising for this to be confirmed.

Interpretation

This is the only site in Europe to show, a more or less continuous exposed succession through the Langsettian, Duckmantian and lower Bolsovian stages; only a short interval in the Duckmantian is not exposed, having been covered by a newly constructed road. When combined with the nearby Vale of Neath section, it provides a virtually complete sequence from the Chokierian(?) to mid-Bolsovian, thus spanning some 7 stages.

This section may be regarded as the type for the Productive Coal Formation in South Wales (and in effect in Britain as a whole). There are other sites in South Wales which either provide a more complete picture of parts of the section, such as Nant Llech for the basal Langsettian, and Cwm Twrch for the interval associated with the Vanderbeckei Marine Band. Cwm Gwrelych–Nant Llyn Fach is the only reasonably complete sequence, however, and provides the standard against which the others have to be compared.

The closest comparison is with exposures to the west, in Pembrokeshire, such as at Amroth and Tenby–Saundersfoot. None of these exposures to the west provide as full a sequence as at Cwm Gwrelych–Nant Llyn Fach, and are subject to greater tectonic disturbance. Furthermore, the Pembrokeshire sections reveal a number of differences in detail, such as in the distribution of fluvial channel sandstones, and in the development of lacustrine sediments in the lower Langsettian.

On the east crop of the coalfield, approximately coeval strata occur at Wernddu Claypit. In comparison, however, the sequence here is significantly condensed, as a result of its proximity to the Usk Axis.

Elsewhere in Britain south of the Wales–Brabant Barrier, Langsettian to Bolsovian strata are only known from the Bristol–Somerset Coalfield. Exposure here is very poor, however, the only good outcrop being at Cattybrook Brickworks (see Chapter 6), which is restricted to a short sequence just below the Vanderbeckei Marine Band. The most complete evidence from this coalfield came from the Ashton Park Borehole (Kellaway, 1967). This revealed a sequence generally similar to that at Cwm Gwrelych–Nant Llyn Fach, except that there are rather fewer coals and non-marine bivalve horizons, and the Langsettian part is more condensed.

Trueman (1933), among others, argued that South Wales should be regarded as the type-sequence for the 'Coal Measures' of Great Britain, and the excellent exposure could have justified having the stratotypes for the Westphalian stages here. However, the SCCS decided that relatively restricted assemblages usually found in the marine bands in South Wales was an obstacle to such a proposal, and has instead nominated sites in the Pennines coalfields (Langsett, Duckmanton Railway Cutting and River Doe Lea — see Chapter 2) as boundary stratotypes for the lower 3 stages (a

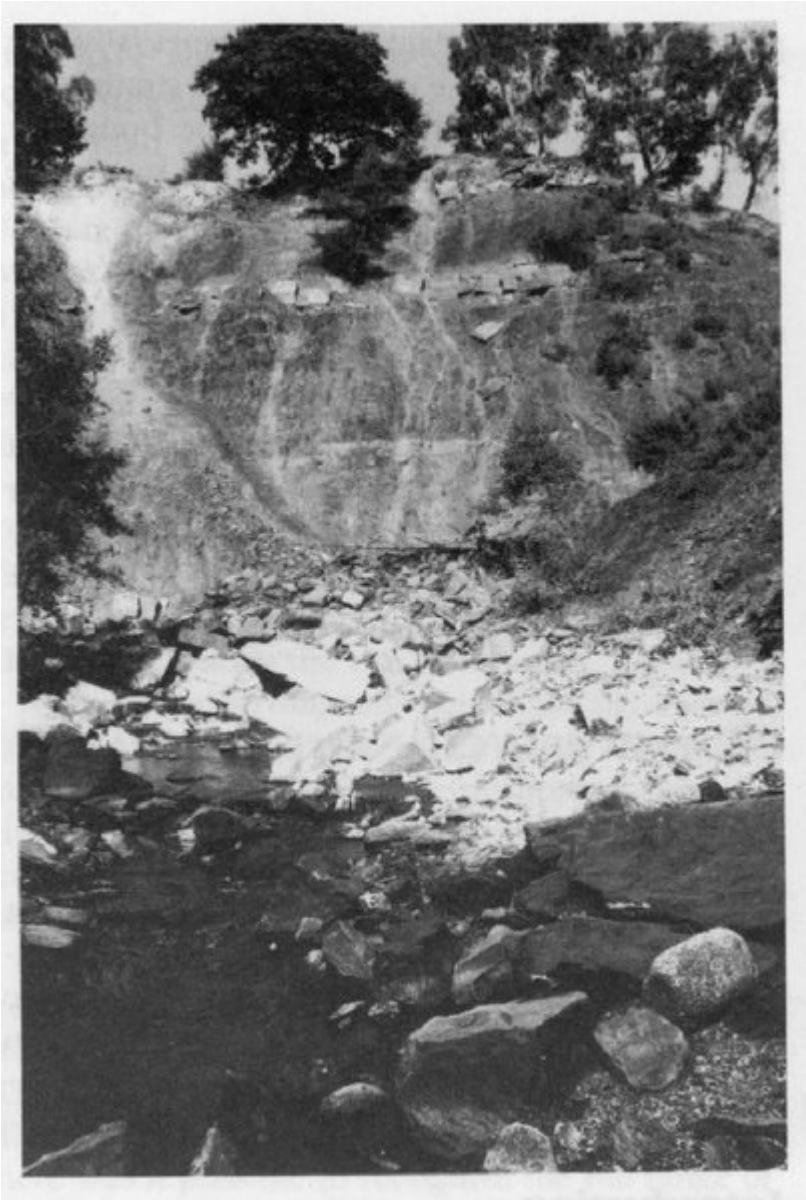
stratotype for the base of the Westphalian D has yet to be nominated). If ever a decision was taken to have unit stratotype(s) for the Westphalian, then South Wales provides the only candidate sections, that would be compatible with the criteria outlined by the SCCS. In such circumstances, Cwm Gwrelych–Nant Llyn Fach would clearly play a most significant role.

Despite its importance, there is no coherent account of the site. The most complete information is provided in unpublished theses (e.g. Matthews, 1955; Thomas, 1967). Even these are incomplete, however, tending to concentrate either on the biostratigraphy or sedimentology of particular parts of the sequence. There is clearly much potential for future work on this internationally important site.

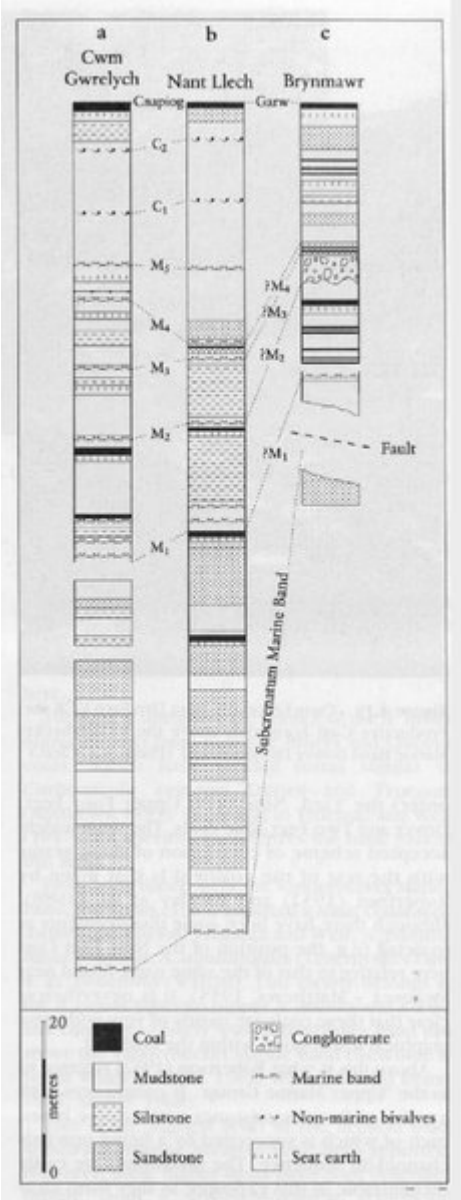
Conclusions

Cwm Gwrelych–Nant Llyn Fach is the only place in Europe to show a more or less complete and naturally-exposed sequence of lower to middle Westphalian coal-bearing strata (308–315 million years old). It contains abundant fossils, including the remains of non-marine bivalves, plants and marine shells, allowing detailed correlations to be established with other successions of this age.

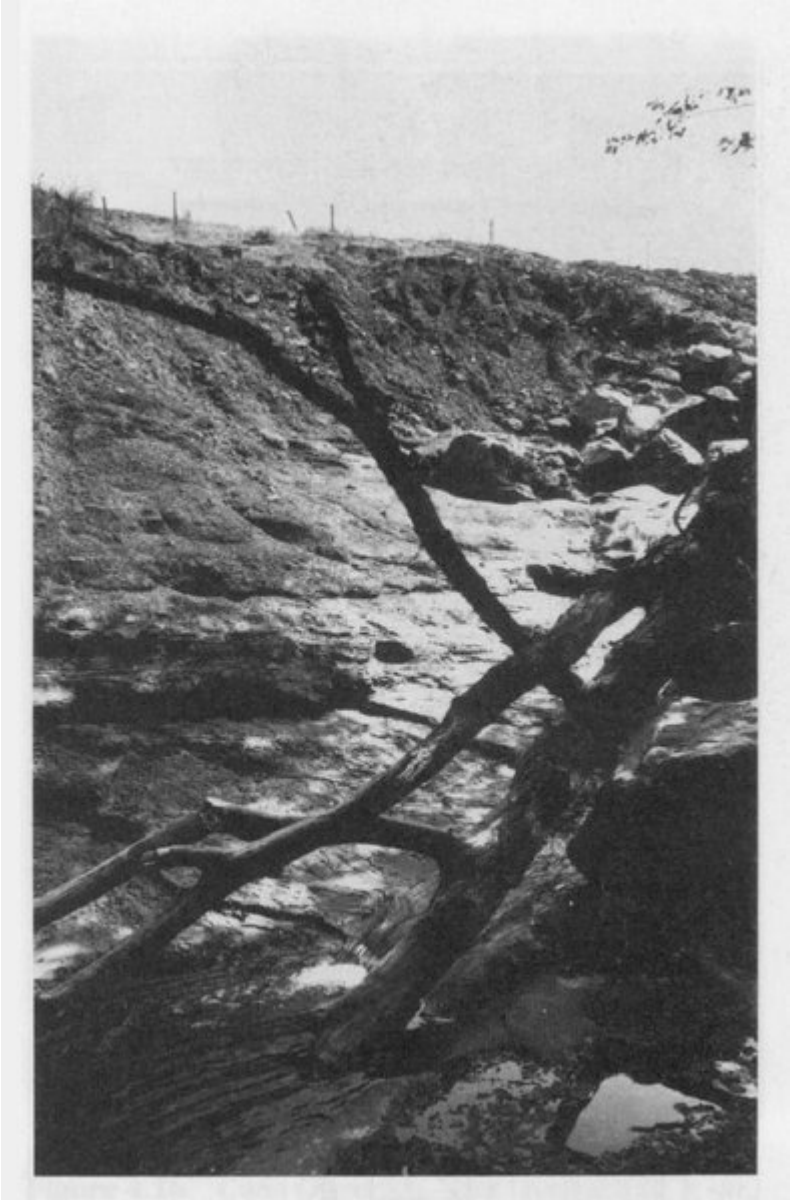
References



(Figure 4.16) Cwm Gwrelych–Nant Llyn Fach GCR site. Succession above the Parkhouse Marine Band (lower Langsettian). (Photo: C.J. Cleal.)



(Figure 4.18) Lower Westphalian successions in South Wales. (a) Cwm Gwrelych; (b) Nant Llech; (c) Brynmawr. Based on Leitch et al. (1958).



(Figure 4.19) Cwm Gwrelych–Nant Llyn Fach GCR site. Productive Coal Formation above the Vanderbeckei Marine Band (lower Duckmantian). (Photo: C.J. Cleal.)

(Figure 4.20) Cwm Gwrelych–Nant Llyn Fach GCR site. Cockshot Rock (upper Duckmantian). (Photo: C.J. Cleal.)