Porth Ceiriad

[SH 3056 2469]–[SH 3106 2482]

Introduction

Porth Ceiriad displays a good succession of the higher St David's and lowest Merioneth series (Middle Cambrian and Upper Cambrian) and exposes more clearly than elsewhere in Britain the nature of the St David's–Merioneth contact. It is a key site for interpreting Cambrian stratigraphy in North Wales.

Nicholas (1915) described the geology of the area and included references to earlier work. He named the main stratigraphical divisions and identified the presence of a non-sequence at the Middle-Upper Cambrian contact. In the next year he gave a detailed account of the trilobite fauna (Nicholas, 1916), some species of which were revised by Lake (1906–1946). Young *et al.* (1994) revised the whole succession, reviewed the faunas and provided new sedimentological and microfloral information.

The stratigraphical units are as follows:

Nicholas (1915)	**Young *et al.* (1994)**
Maentwrog Beds	Maentwrog Formation
Nant-pig Mudstones	Nant-y-big Formation
Upper Caered Mudstones	
Caered Flags	Ceiriad Formation (restricted)

Description

At the western end of the section the basal beds of the Nant-y-big Formation conformably overlie green siltstones of the Ceiriad Formation, dipping south-east at 30°. Nicholas (1915) described the section and Young *et al.* (1994, fig. 4) logged the basal part. The lower part of the formation consists of crudely graded or massive siltstone interbedded with laminated siltstone; it contains several interbeds of metabentonite (Roberts and Merriman, 1990). The thicker siltstone beds are interpreted as turbidites. Fossiliferous levels near the base and 50–60 m above the base contain trilobites of the *fissus* Zone.

Nicholas (1915) recorded a transition from blue-grey and greenish-grey mudstones to dark-grey laminated mudstone, which he assigned to his 'Nant-pig Mudstones'. Young *et al.* (1994) considered that the sedimentary facies of silty turbidites linked the darker beds with the underlying division and referred both to the same formation, their 'Nant-y-big Formation'. The lower part of the darker mudstones yields trilobites of the *fissus* Zone.

Towards the top of the formation silty turbidites are less dominant, giving way to dark-coloured laminated mudstone with coarse-grained layers. The upper 15 m of the formation contain thicker (>20 cm) sandstones, locally very pyritous and containing carbonate concretions. Trilobite faunas from the upper beds are referred to the *parvifrons* Zone. The top 20 cm of the Nant-y-big Formation consists of hard siltstone cemented with carbonate (Figure 3.6); this is the lower part of Nicholas' (1915) 'Calcareous Grit' unit, and was recorded by Young *et al.* (1994) as consisting of two beds (their Beds 1 and 2) overlain by a surface of disconformity.

Overlying the Nant-y-big Formation are beds of coarse conglomeratic sandstone regarded by Young *et al.* (1994, p. 344) as the local base of the Maentwrog Formation. Young (in Young *et al.,* 1994, p. 342) recognized four beds above the surface of disconformity: Bed 3 consists of coarse sandstone with clasts of Bed 2, possibly the source of Nicholas' trilobite fauna, which Young *et al.* (1994) assigned to the *brachymetopa* Zone. Bed 4 is possibly a bentonite, Bed 5 a sandstone that has yielded a sparse acritarch flora supposedly of Upper Cambrian age, and Bed 6 is an eroded bioclastic limestone.

Above the calcareous base are seen 34 m of typical Maentwrog Formation, consisting of fine sandstone in thick beds (up to 40 cm), interbedded with thinner layers of dark-coloured mudstone (Figure 3.6). These beds show bioturbation and sedimentary structures (Crimes, 1970a) and early diagenetic concretions (Crimes, 1966). Bose (1983) interpreted the sediments as having been deposited in a shallow sea through the action of storms, and Crimes (1970a) reported that the current action flowed from a southerly quarter. The Maentwrog Formation contains acritarchs of early Upper Cambrian age and poorly preserved trilobites compared with *Olenus* and *Homagnostus obesus* (Belt), consistent with the fauna of the *Olenus* Zone (Young *et* at, 1994, p. 345; see site report for Nant y Graean).

Interpretation

Porth Ceiriad is one of the few places in Britain where the Middle-Upper Cambrian boundary is identifiable with faunal control, and it has yielded the hest Middle-Upper Cambrian succession of acritarch floras. In the English Midlands the Middle-Upper Cambrian boundary is well constrained in the Merevale No. 3 Borehole by trilobites and bradoriids (Rushton, 1978) but is not exposed. In the Harlech Dome there are good exposures (e.g. Pratt *et al.,* 1995), but faunal control is poor except in Afon Llafar (see site report, below).

The succession shows progressive shallowing from turbidites deposited in relatively deep water to dark, condensed muds with concretions, accompanied by pauses in deposition and disconformity, fbllowed by storm sediments in the Maentwrog.

The faunal and lithological characteristics allow correlation of the Nant-y-big Formation with the upper Gamlan and lower Clogau formations of the Harlech Dome (see site description below); these represent the *fissus* and *parvifrons* trilobite zones, but the overlying *punctuosus* Zone, present in the upper Clogau Formation (Allen and Jackson, 1985, p. 12), is absent from the Nant-y-big Formation on account of the non-sequence in the calcareous sandstone beds. The Maentwrog Formation can also he correlated lithologically and biostratigraphically between Porth Ceiriad and the Harlech Dome. However, whereas at Porth Ceiriad *Olenus* and *Homagnostus obesus* occur about 30 m above the base of the Maentwrog, in the Harlech Dome they appear 140 m or more above the base and are underlain by agnostoid trilobites, occurring near the base of the formation, that are thought to represent a highest Middle Cambrian horizon (Allen *et al.,* 1981, p. 307).

A regressive phase, recognizable across Avalonia and Baltica, caused a break that represents four trilobite zones in the St Tudwal's area, whereas the corresponding break in the Harlech Dome is of only one zone, the *brachymetopa* Zone (cf. (Figure 2.2)). The more pronounced break in the St Tudwal's area reflects the influence of the Anglesey-Wexford positive area to the north-west. However, at St Tudwal's the calcareous sandstone beds that bound the Middle-Upper Cambrian non-sequence contain clasts with fragmentary trilobites of that same zone, the *brachymetopa* Zone (Young *et al.,* 1994, p. 345). The clasts were presumably derived from a late Middle Cambrian shallow-water calcareous unit, not known *in situ* but of fairly local origin, that was formed during the regressive *brachymetopa* phase (Conway Morris and Rushton, 1988, p. 101) and soon afterwards derived into a transgressive early Upper Cambrian deposit (Young *et al.,* 1994). They are the only definite representative of the *brachymetopa* Zone in Britain, for although Cobbold and Pocock (1934) assigned the forchhanzmeriGrit, in the upper part of the Upper Comley Sandstone of the Wrekin area, to this zone, Rushton (1974) questioned the zonal assignment of their fauna.

The acritarch floras recorded by Martin (in Young *et al.,* 1994, fig. 7) show considerable turnover between the Nant-y-big and Maentwrog formations and are potentially valuable for correlation with successions of acritarch floras in other parts of the world (Molyneux *et al.,* 1996).

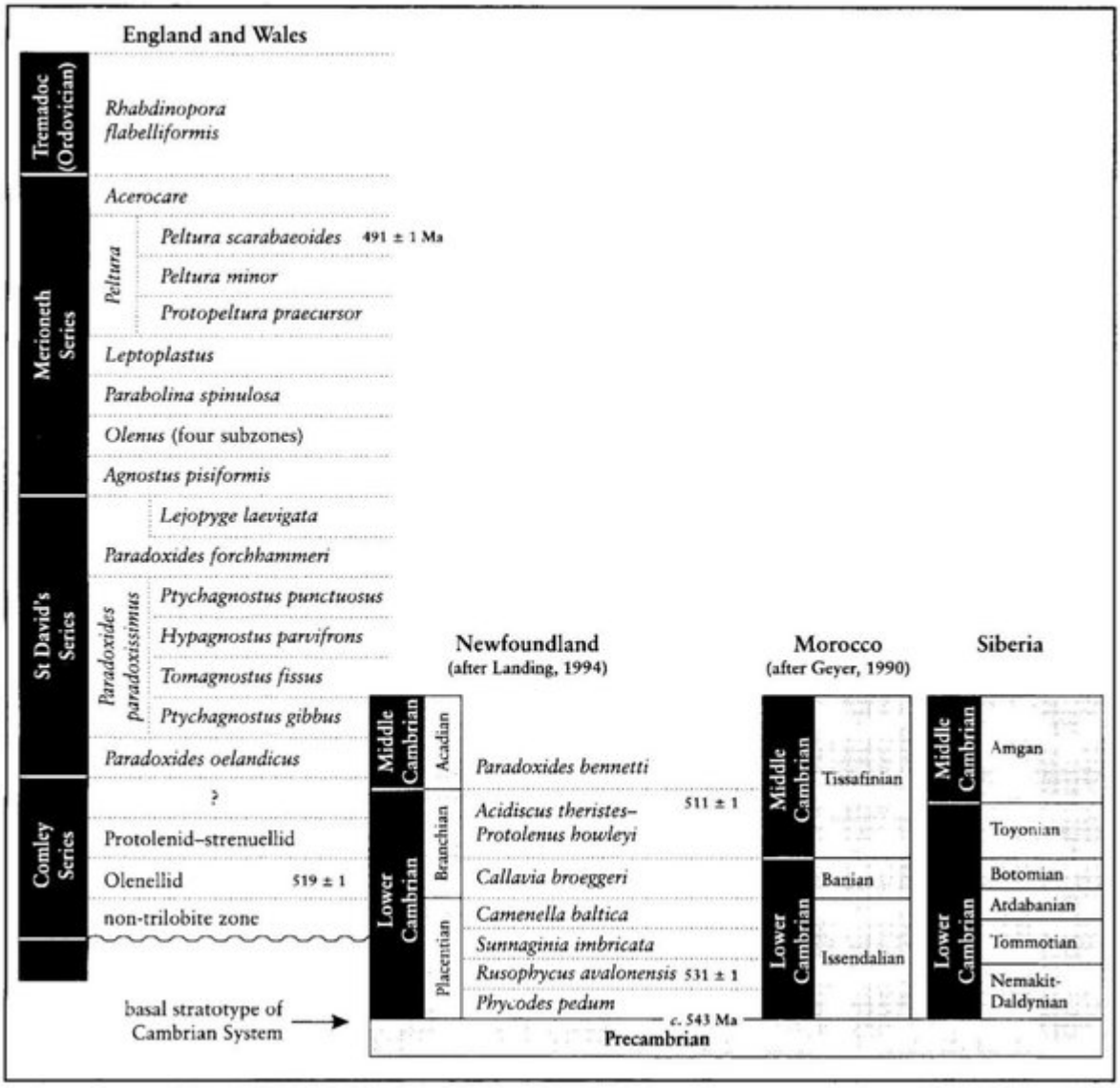
Conclusions

Porth Ceiriad is an important site for interpreting Cambrian history in North Wales in that it contains evidence of the conditions around the Middle–Upper Cambrian boundary. Overlying mid-Middle Cambrian beds there is evidence for shallowing, uplift and erosion, followed by early Upper Cambrian strata. Fragments of fossiliferous limestone that had been formed during the time of shallowing are the only evidence in Britain for the late Middle Cambrian '*brachymetopa*

fauna', which is known principally from Scandinavia.

References

(Figure 3.6) Middle–Upper Cambrian boundary at Porth Ceiriad, St Tudwal's Peninsula. The figures are standing in front of dark mudstones of the upper part of the Nant-y-big Formation. The composite calcareous unit at the boundary of the Nant-y-big and Maentwrog formations reaches beach level at the right of the photograph, and is overlain by sandstone beds of the Maentwrog Formation. (Photo: A.W.A. Rushton.)



(Figure 2.2) Cambrian chronostratigraphy and trilobite zones in England and Wales, with Lower Cambrian schemes for south-east Newfoundland and Morocco shown for comparison. The base of the Cambrian System is defined at the base of the Phycodes pedum Zone at Fortune Head, south-east Newfoundland. For sources of radiometric dates, see Davidek et al. (1998) and landing et al., 1998.