
Chapter 3 Cambrian of North Wales

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Harlech Dome

The Harlech Dome (see (Figure 3.2)) exposes the largest area of Cambrian rocks in Wales and, together with the small hut well-exposed inlier at St Tudwal's Peninsula, shows the most complete and informative stratigraphical succession. The Harlech Dome is also the least controversial of the Cambrian areas studied during the late 19th century, its original assignment by Sedgwick to the Cambrian System (Sedgwick and Murchison, 1835) never having been seriously challenged; for although Hicks (1881a, 1891) claimed to have recognized pre-Cambrian rocks in the core of the Harlech Dome, his findings have never been accepted. It accordingly remains the best exemplar of Sedgwick's Cambrian concept.

Early workers distinguished a lower group of Harlech Grits, overlain by 'Lingula Flags'; these correspond broadly to the 'Harlech Grits Group' and 'Mawddach Group' of present usage (Allen and Jackson, 1985). Having studied the 'Lingula Flags', Belt (1867b, 1868) accepted Salter's (1866a) exclusion of the equivalents of the newly characterized Menevian Beds of St David's in South Wales, and he subdivided the main part of the 'Lingula Flags' into formations, namely the Maentwrog, Festiniog and Dolgelly, which have since been generally adopted. The Harlech Grits proved intractable until Lapworth observed that certain manganiferous strata (the Hafotty Formation) could be used as a stratigraphical marker, enabling a lithostratigraphy to be developed. The formational divisions were described by Andrew in 1910, but mapping of their outcrops was not completed until 1946 (Matley and Wilson, 1946). The stratigraphy of the Harlech Dome was revised and the nomenclature formalized by Allen and Jackson (1985).

Nicholas (1915) gave an excellent account of the St Tudwal's Inlier, his results being confirmed, with additions but only slight modification, by Young *et al.* (1994). Recognition of the manganiferous beds and other features of the Harlech Grits Group in the St Tudwal's succession enables a secure correlation with the Harlech Dome, whilst additional faunal information enhances the utility of the stratigraphical succession.

The formations recognized and their approximate correlation are shown in (Figure 3.1) and their general stratigraphical distribution in (Figure 3.2) and (Figure 3.3). These successions are correlated at the manganiferous base of the Hafotty and Trwyn y Fulfran formations and in the Merioneth Series, but between these levels the formations are not correlated one-for-one (Young *et al.*, 1994); thus, for example, the base of the Nant-y-big Formation appears to correlate with a level within the upper part of the Gamlan Formation. Allen and Jackson (1985) assigned all the formations from Dolwen to Gamlan to the Harlech Grits Group, and took the base of the Mawddach Group as the base of the Clogau Formation, but Young *et al.* (1994) assigned only the succession from the Hell's Mouth to Cilan formations to the Harlech Grits Group and did not refer any of the Nant-y-big Formation to the Mawddach Group.

The base of the Harlech Grits Group has been seen only in the Bryn-teg Borehole (Allen and Jackson, 1978), where it rests without strong angular unconformity, but with a probable hiatus in deposition, upon the Bryn-teg Volcanic Formation of possible Precambrian age. The Harlech Grits Group is interpreted as deltaic and prodeltaic deposits overlain by a sequence mainly comprising turbidites (Allen and Jackson, 1985, p. 5), together amounting to about 2 km of thickness. They represent the filling of a rapidly subsiding basin (Prigmore *et al.*, 1997). The Harlech Grits are biostratigraphically constrained at wide intervals: the Dolwen Formation contains a *Platysolenites* of possible Ibmmotian (early Cambrian) age (Rushton, in Allen and Jackson, 1978), the Hell's Mouth Formation has late Comley (Branchian Series) trilobites, and the Clogau and Nant-y-big formations have faunas of middle and late St David's age, as detailed below.

The Mawddach Group represents a further phase of subsidence characterized by clastic deposits about 2 km or more in thickness. This was followed by a period of sediment-starvation, giving rise to the thin, condensed Dolgellau Formation, with somewhat coarser clastic deposition in the succeeding Dol-cyn-afon Formation. These formations are fossiliferous at many levels and represent a fairly complete succession of Merioneth and Tremadoc rocks, only the basal zone of the

Merioneth remaining unproved in North Wales.

The proximal turbidites and silty mudstones that make up the greater part of the Harlech Grits Group and the manganese ore bed are all exemplified by the site on Barmouth Hillside, whereas details of the sedimentology and the important fossil-bearing horizon at the top of the Hell's Mouth Formation are seen at Trwyn Carreg-y-tir. At the Afon Llafar section the faunal succession in the mid St David's Series (Middle Cambrian) is seen and the hiatus of one zone at the base of the Maentwrog Formation is inferred, whilst at Porth Ceiriad the corresponding hiatus is more extensive but includes derived material illustrative of the horizon that is absent at Afon Llafar; Middle Cambrian metabentonites are also well exposed there.

The faunal succession of the Maentwrog Formation is exemplified at Nant y Graean and Nant Ganol, and the whole succession from the top of the Ffestiniog Formation into the Dol-cyn-afon Formation (Tremadoc) is well-seen in the important Cambrian–Ordovician Boundary section at Ogof Ddû. Although the rocks at Ogof Ddû are fossiliferous, faunas of the *Peltura scarabaeoides* Zone are better preserved at Moel Gron, and latest Merioneth faunas of the *Acerocare* Zone are known from Bryn-llin-fawr, discussed in Chapter 7 (on the Tremadoc Series).

[Barmouth Hillside](#)

[Trwyn Carreg-y-tir](#)

[Porth Ceiriad](#)

[Afon Llafar](#)

[Nant y Graean and Nant Ganol](#)

[Rhobell-y-big and Foel Gron](#)

[Ogof Ddû \(Rhiw-for-fawr\)](#)

Arfon area

The Cambrian rocks of the Arfon area, lying between the Harlech Dome and Anglesey (Figure 2.1), are strongly faulted and tectonized, such that the mudrocks are cleaved into good roofing-slates, which have been exploited in large quarries that mark the 'Carnarvonshire Slate Belt'. The stratigraphical succession in Arfon is less complete and less well dated than that of the Harlech Dome, but the base of the succession is of particular interest historically and stratigraphically for showing a debated conformable or paraconformable contact between

(Table 3.1) General stratigraphical successions proposed for the Arfon area

	Llanberis	Nantlle
(Arenig	Wood, 1969; Reedman <i>et al.</i> , 1984 Graianog Sandstone)	Morris and Fearnside, 1926
Merioneth	Marchlyn Formation (with Carnedd y Filiast Grit at top)	
age uncertain	Bronllwyd Grit	Cwmfrch Grit
Comley	Llanberis Slates	Llanberis Slates
	Fachwen Formation	Clog Grits
		Cilgwyn Conglomerate
		Tryfan Grits
Cambrian or Precambrian	Padarn Tuff	Padarn Tuff

Cambrian sedimentary rocks and underlying volcanic rocks, supposedly of Precambrian age. In his original description of the Cambrian System, Sedgwick (in Sedgwick and Murchison, 1835) included the roofing-slates of Llanberis in the

system, and it remained as part of the Cambrian in all later re-classifications of the Lower Palaeozoic rocks (Sedgwick, 1852; Cowie *et al.*, 1972, fig. 1).

Underlying the Llanberis Slates is a sequence of conglomerates, sandstones and tuffs, and quite apart from the problems in establishing their stratigraphy in such strongly folded and faulted ground, it has also proved difficult to map a satisfactory boundary between that sedimentary sequence and the volcanic rocks on which it rests (see site report for Llyn Padarn). When the downward extent of the Cambrian was being debated in the late 19th century (Blake, 1892), the very difficulty of interpreting the successions in Arfon added force to the protagonists' views (see Wood, 1969).

The stratigraphical succession is marked by lateral and vertical facies changes, but the general successions shown in (Table 3.1) have been proposed.

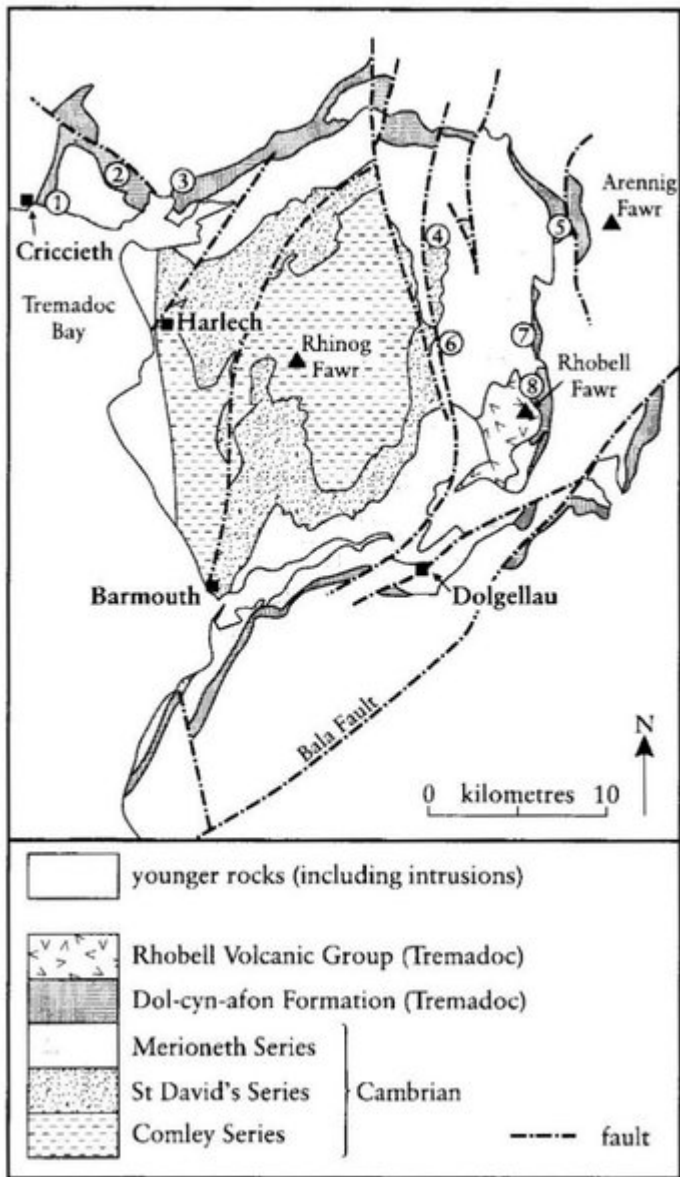
The Padarn Tuff was formerly regarded as Precambrian, in the sense that it underlies the historical type Cambrian, part of which, the Llanberis Slates Formation, is dated palaeontologically. The nature of the contact between the Padarn Tuff and the overlying Cambrian was not clearly established, so the tuff was appropriately mapped as 'Cambrian or Precambrian' by the British Geological Survey (1988a). The Padarn Tuff has since yielded an isotopic date of 614 ± 2 Ma (Tucker and Pharaoh, 1991) and is now considered to be well within the Precambrian.

The sequence from the Fachwen Formation to the Llanberis Slates Formation records deposition in a deepening sea, and trilobites from the top of the Llanberis Slates indicate a mid-Comley age. The St David's Series is unproved in the Arfon area, and the Bronllwyd Grit Formation remains of uncertain age, though Wood (1969) correlated part of it with the Gamlan Formation in the Harlech Dome, which is of St David's age.

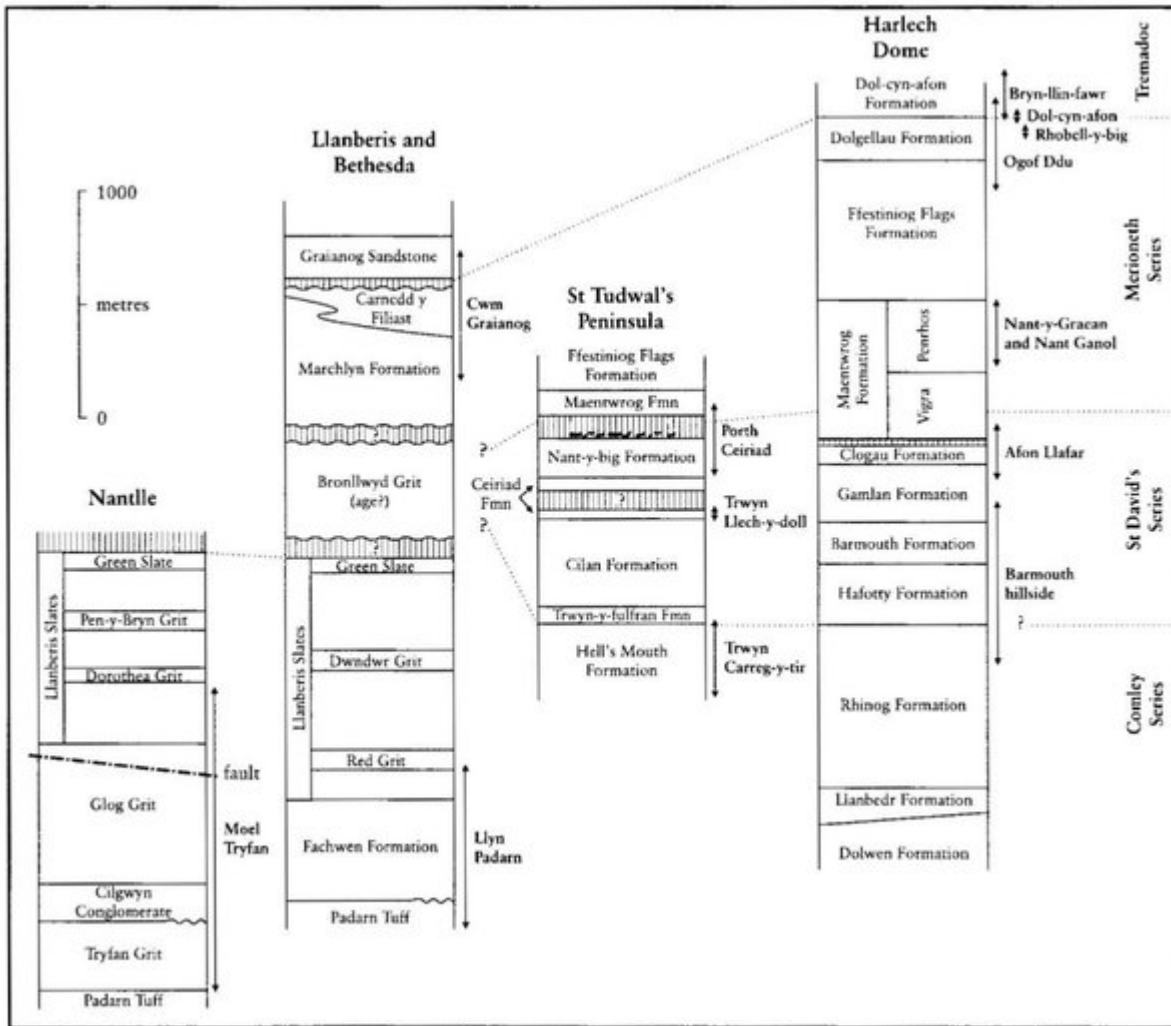
The Marchlyn Formation has yielded fossils of the lower parts of the Merioneth Series and is overlain locally by the lower part of the Dolgellau Formation (Shackleton, 1959), but over the remainder of its outcrop pre-Arenig erosion has removed all later Merioneth strata.

The lower part of the succession at Llanberis is shown at Llyn Padarn, where the problems of the basal contact of the Fachwen Formation and lateral variations in the conglomerate units are evident. Parts of the succession up through the Llanberis Slates Formation are exposed around Moel Tryfan, though the overlying Bronllwyd Grit Formation is not represented in the GCR. The Marchlyn Formation and its contact with the Graianog Sandstone are well shown at Cwm Graianog.

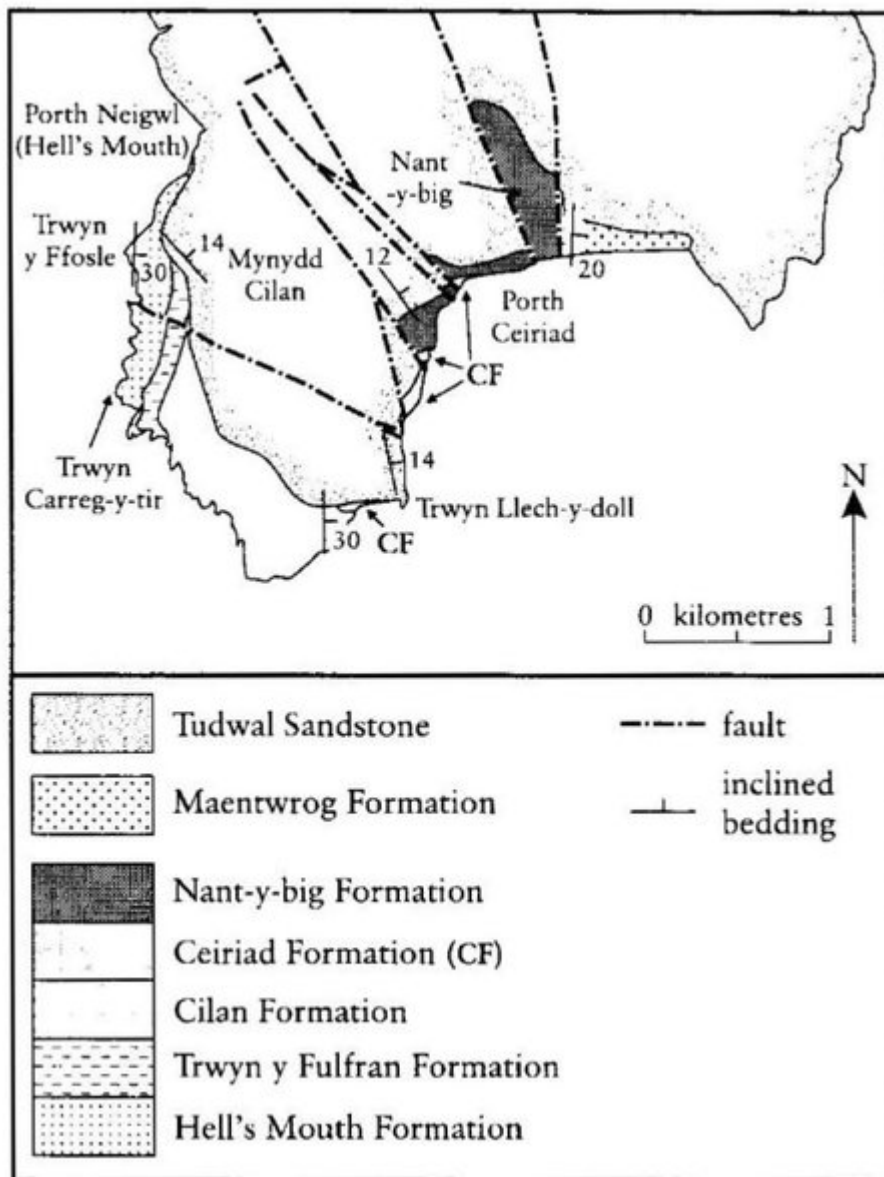
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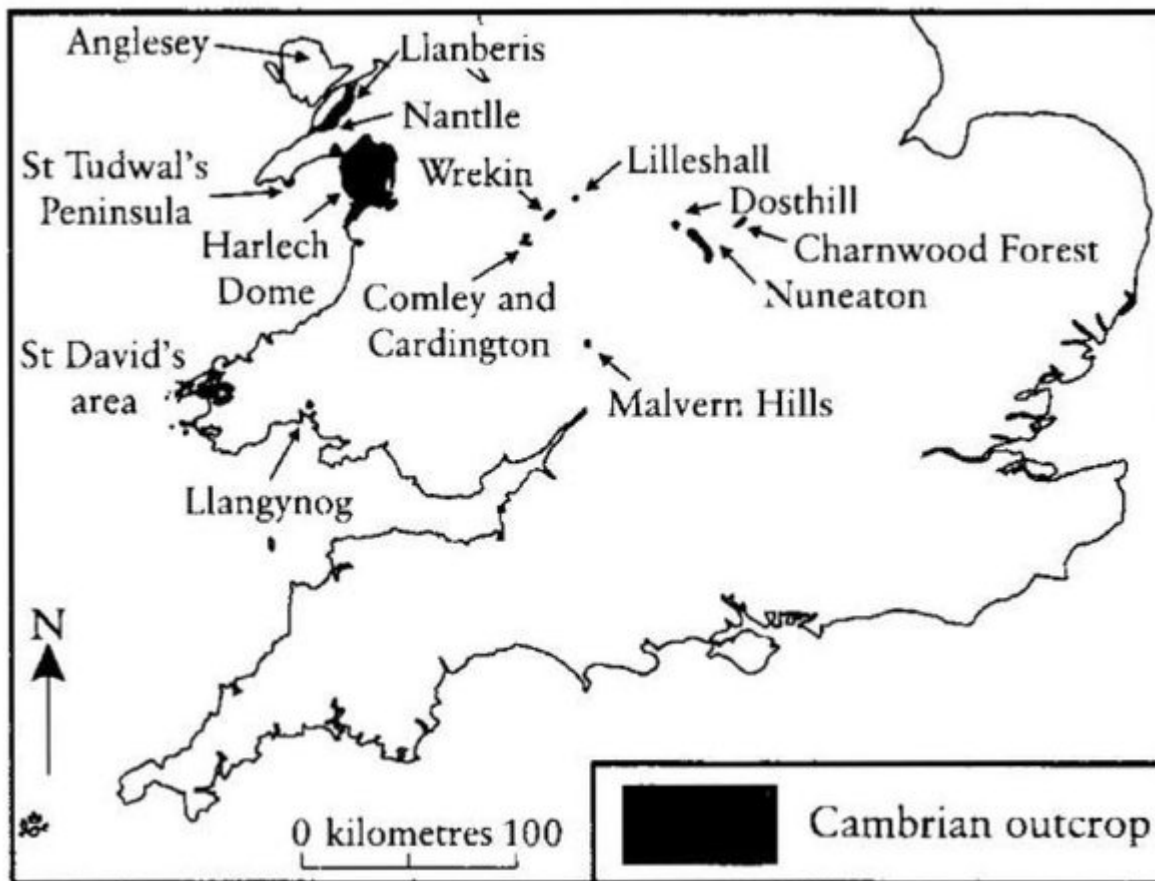
(Figure 3.2) Geological sketch-map of the Harlech Dome, after the British Geological Survey (1994b). Cambrian and Tremadoc GCR sites are as follows: 1, Ogof Ddû; 2, Tyn-Ilan and Wern; 3, Y Garth; 4, Afon Llafar; 5, Amnodd Bwll; 6, Nant-y-graeon; 7, Bryn-Ilin-fawr; 8, Rhobell-y-big and Dol-cyn-afon.



(Figure 3.1) Correlation of the principal Cambrian sequences in North Wales, modified from Rushton (1974, fig. 2). The arrows in this and succeeding figures indicate the stratigraphical ranges of individual GCR sites.



(Figure 3.3) Geological map of St Tudwal's Peninsula, after Nicholas (1915) and Young et al. (1994).



(Figure 2.1) Distribution of Cambrian outcrops in England and Wales.

	Llanberis	Nantlle
	Wood, 1969; Reedman <i>et al.</i> , 1984	Morris and Fearnside, 1926
(Arenig	Graianog Sandstone)	
Merioneth	Marchlyn Formation (with Carnedd y Filiast Grit at top)	
age uncertain	Bronllwyd Grit	Cwmffyrch Grit
Comley	Llanberis Slates	Llanberis Slates
	Fachwen Formation	Glog Grits Cilgwyn Conglomerate Tryfan Grits
Cambrian or Precambrian	Padarn Tuff	Padarn Tuff

(Table 3.1) General stratigraphical successions proposed for the Arfon area