Chapter 9 Arenig to Ashgill of North Wales

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Introduction

In North Wales the Ordovician occupies a broad tract surrounding the Cambrian of the Harlech Dome and extends eastwards to the Bala area and westwards over most of Ll■n (the Lleyn Peninsula). In addition, the lower parts of the Ordovician are preserved on Anglesey and the upper parts are well developed in the Berwyn Hills (Figure 9.1). All these strata formed part of Sedgwick's concept of the Cambrian System (Sedgwick and Murchison, 1835), and when Lapworth (1879a) proposed the Ordovician they became part of the type Ordovician System.

In outline, the Ordovician of the North Welsh Basin consists of mudstones, siltstones and sandstones of great aggregate thickness deposited in oxygenated waters commonly of no great depth (above wave base). Basin subsidence was roughly balanced by deposition, except perhaps during parts of the Caradoc, when Prigmore *et al.* (1997) considered subsidence at a maxi mum. The stratigraphical sequences are fairly complete, although there are breaks below and within the Arenig, there is generally no evidence for the Llandeilian Stage and the Pusgillian Stage is proved only locally in the Berwyn Hills. All the rocks in Wales from the sub-Arenig unconformity to the hiatus below the Ashgill fall within the Gwynedd Supergroup (Woodcock, 1990).

The stratigraphy of North Wales is complicated by the interfingering of deposits from local volcanic centres with the marine clastic deposits accumulating in the unstable Welsh Basin. Many local successions have been described and more than 100 formational names proposed. Rushton and Howells (1998) synthesized a stratigraphical framework for the Tremadoc to Caradoc of Snowdonia, though they did not review the Ashgill Series, nor the areas of Anglesey and the Berwyn Hills. They distinguished as volcanic 'groups' the products of each volcanic centre. For the marine sequence that envelops the volcanic groups of North Wales, Rushton and Howells (1998) proposed the new term 'Ogwen Group' (Figure 9.2), which commences with the basal Arenig rocks of North Wales and extends up to the top of the Nod Glas Formation. The Ogwen Group, being restricted to North Wales, is much less comprehensive geographically than the Gwynedd Supergroup. It excludes the underlying Rhobell Volcanic Group and also the contemporaneous volcanic groups that are enclosed by it, whereas all these volcanic rocks are explicitly included in the Gwynedd Supergroup.

The Arenig Series is widely developed as a transgressive sandstone facies that rests on gently folded Cambrian and Tremadoc rocks around the Harlech Dome, although it appears to be conformable on the upper Tremadoc at the eastern margin of the Welsh Basin. In North Wales the Arenig is typically much less complete than in South Wales (Figure 9.3), though in Ll■n all three stages are represented (Beckly, 1988). Contemporaneous faulting makes the palaeogeography of the Arenig Series complicated (Beckly, 1987; Traynor, 1990). The lower Llanvirn (Abereiddian) is widely developed as graptolitic mudstones, but the Liandeilian is proved only in Cwm Pennant, south-west Snowdonia, where it is represented also by graptolitic rocks. The Llanvirn saw the commencement of the first large eruption of basin margin volcanic rocks in North Wales, namely the Aran Volcanic Group.

During the Caradoc the Aran volcanic activity ceased at about the beginning of the Harnagian, and farther north new volcanic centres of the Llewelyn and Snowdon groups became active through the Soudleyan and Longvillian and into the Woolstonian. Interbedded sandstones and siltstones contain shelly faunas of a shallow neritic environment (Brenchley, in Bevins *et al.,* 1992). With the cessation of volcanism, continued subsidence allowed black graptolitic mudstones with local phosphoritic limestones of the Nod Glas Formation to cover the whole region.

The Ashgill Series appears to rest with non-sequence on the Nod Glas Formation, and at Bala it is certainly unconformable on older rocks. This widespread stratigraphical break marks the base of the third megasequence (the Powys Supergroup) recognized by Woodcock (1990) in the Welsh Basin. However, Pratt (1991) suggested that the Nod Glas Formation may represent a horizon of end-Caledonian decollement that in many places masks its stratigraphical relationships. The Pusgillian and Cautleyan stages are proved only in the Berwyn Hills, but the Rawtheyan is more widely

developed as slates and siltstones deposited in oxygenated conditions and locally containing deep neritic shelly faunas. A glacio-eustatic fall in sea level during the Hirnantian brought about the deposition of sandstones, mass-flow deposits and, locally, the ferruginous oolitic Hirnant Limestone (Brenchley and Cullen, 1984), with a low-diversity brachiopod fauna, the *Hirnantia* Fauna.

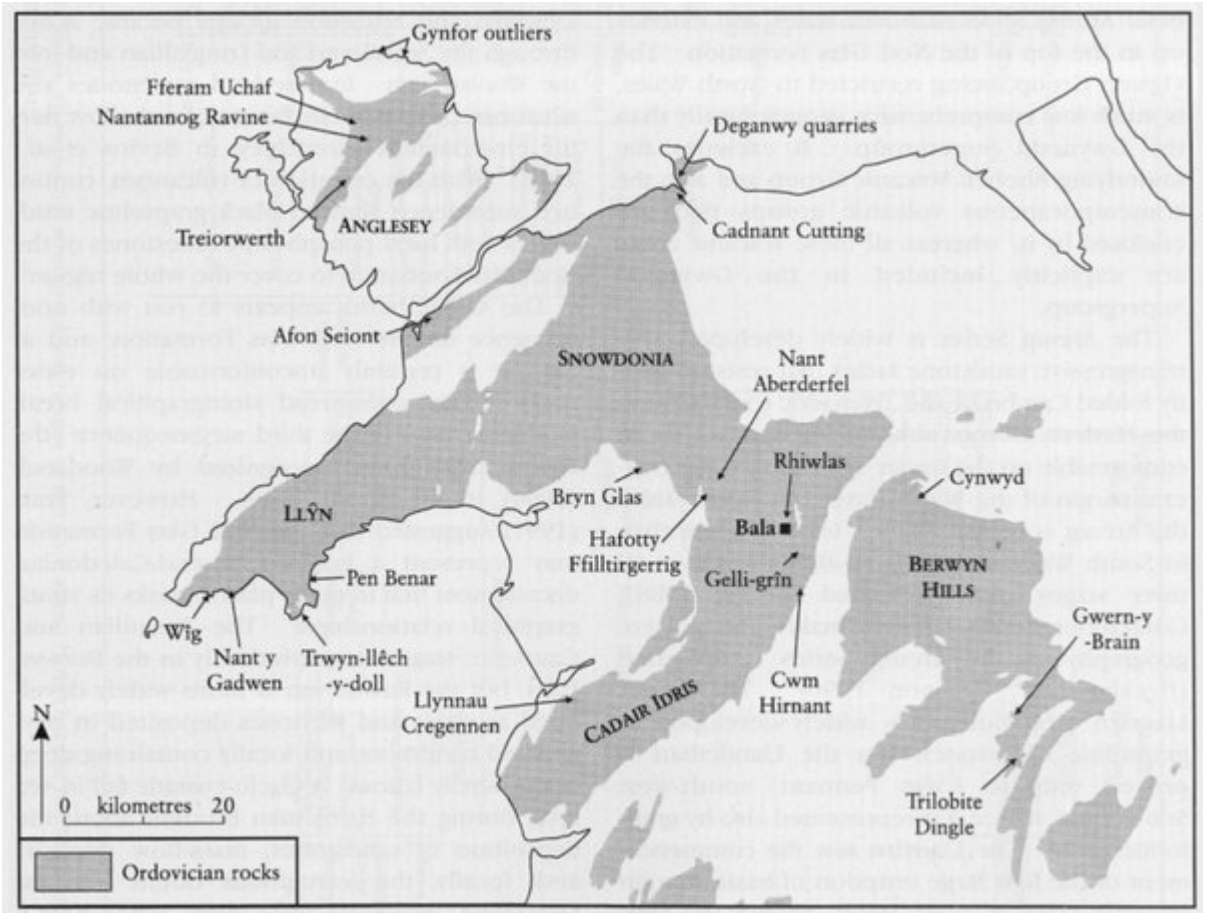
The Ordovician of Anglesey is rather different. It consists of the outlying remnants of sandstones and shales deposited on the prevailingly positive area of the Irish Sea horst complex (Bevins *et at,* 1992) during periods of marine high-stand, namely the Fennian Stage of the Arenig, the Llanvirn and the Costonian Substage of the early Caradoc. The facies and faunas differ from contemporaneous rocks of the Welsh Basin and contribute to the notion that Anglesey represents part of an independent terrane, the Monian Terrane. Tietzsch-Tyler (1996) reviewed correlations between south-east Ireland and Anglesey and inferred that the Monian Supergroup was deformed between late Cambrian time and the onset of Arenig deposition in Anglesey.

The sites featuring the basal Arenig show the overstep and overlap by the Arenig transgression: at Bryn Glas the basal sandstone is of Moridunian age (as inferred from the Hafotty Ffilltirgerig site) and is paraconformable on the Tremadoc; at Trwyn-llêch-y-doll the sandstone is probably Fennian and rests unconformably on Middle Cambrian; at Wîg the basal Arenig is again Moridunian but is much more argillaceous and rests on Precambrian; and at Treiorwerth and the Gynfor outliers in Anglesey the basal rudites and sandstones are Fennian and rest on Monian rocks (Precambrian and Cambrian?). Important Moridunian, Whitlandian and Fennian faunas are present in faulted contact at Nant y Gadwen, and the passage from Arenig to Llanvirn is seen in the Afon Seiont. The Llanvirn site at Llynnau Cregennen yields faunas that date the lower parts of the Aran Volcanic Group. The upper Arenig and Llanvirn of Anglesey are represented at Nantannog and Fferam-uchaf

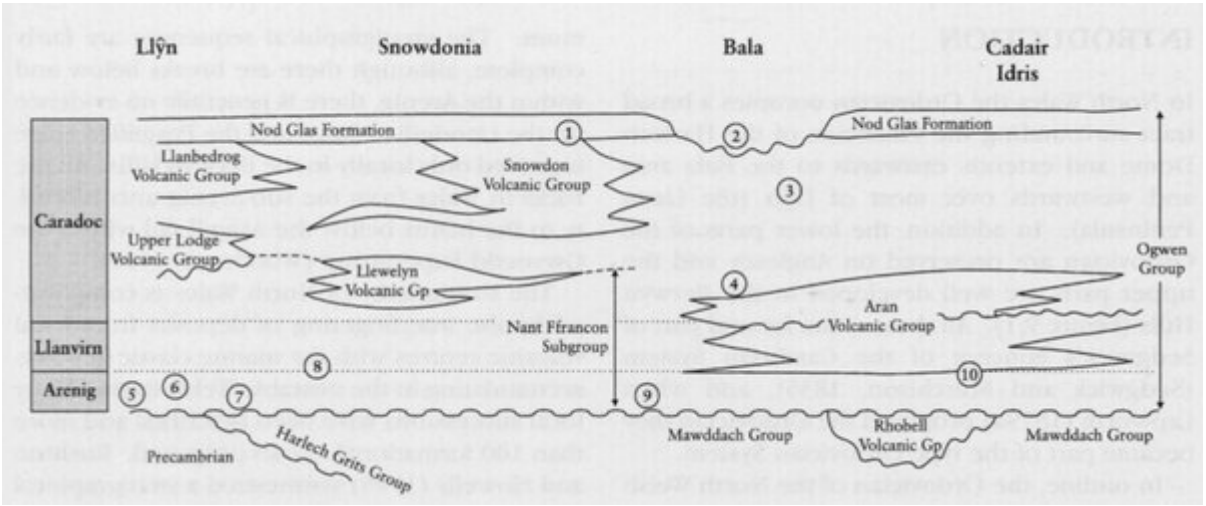
There are no sites in the Llandeilian, but an early Caradoc fauna from Nant Aberderfel dates the ending of the Aran Volcanic Group activity. Trilobite Dingle is a classic site for Harnagian trinucleid trilobites. Mid-Caradoc stratigraphy and faunas are shown at Gelli-grîn. The black mudstones of the Nod Glas Formation overlie rocks of Woolstonian age, namely the top of the Snowdon Volcanic Group at Cadnant Cutting (where the Nod Glas Formation is known locally as Cadnant Shales) and the Gaerfawr Formation at Gwern-y-Brain; at the latter site the Nod Glas Formation yields a stratigraphically important association of graptolites, conodonts and shelly fossils.

The unconformable base of the Ashgill is seen at Rhiwlas in the Bala area, where the Rhiwlas Limestone of Rawtheyan age rests on Woolstonian strata; Cynwyd in the northern Berwyn Hills is a classic site for later Rawtheyan faunas. The sedimentological effects of the end-Ashgill glacio-eustatic fall in sea level are shown by the sites at Deganwy and Cwm Hirnant.

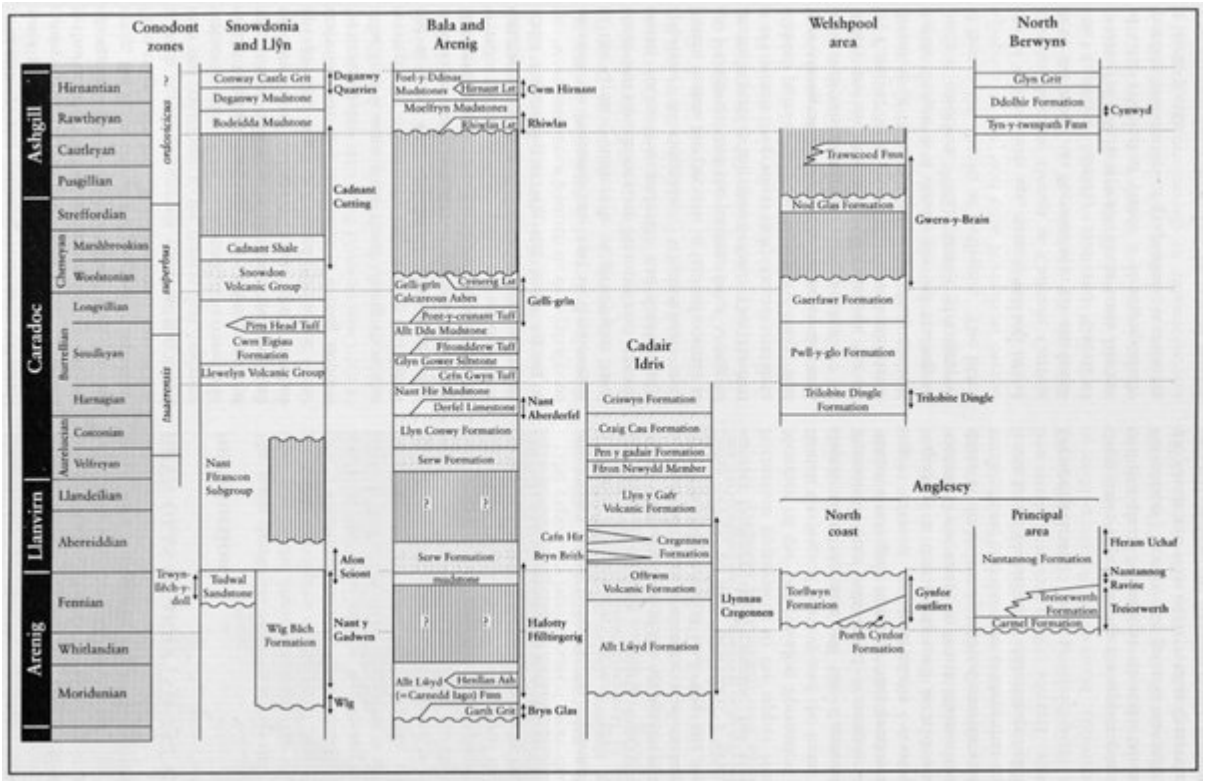
References



(Figure 9.1) Distribution of Ordovician (Arenig to Ashgill) rocks in North Wales, after British Geological Survey (1994c), showing the location of GCR sites. For the Tremadoc site at Pen Benar, see Chapter 7.



(Figure 9.2) Schematic section to show the general stratigraphical relations of the main divisions that make up the Ogwen Group in North Wales, after Rushton and Howells (1998). The positions of GCR sites are shown as follows: 1, Cadnant Cutting; 2, Rhiwlas; 3; Gelli-grîn; 4, Nant Aberderfel; 5, Wîg; 6, Nant y Gadwen; 7, Trwyn Llêch-y-doll; 8, Afon Seiont; 9, Bryn Glas and Hafotty Ffilltirgerig; 10, Llynnau Cregennen.



(Figure 9.3) Correlation of the principal Arenig to Ashgill sites in North Wales, showing the stratigraphical ranges of the GCR sites. Note that the Actonian and Onnian substages of the Streffordian Stage are not separately distinguished in this figure.