
Great Orme, Gwynedd

[SH 750 841]–[SH 783 828]

Introduction

The Great Orme at Llandudno is one of the classic Dinantian localities in Britain. The site includes the limestone cliffs around the Great Orme peninsula (Figure 8.12) and the quarried exposures near its summit. An almost complete succession of the Carboniferous Limestone in the area is seen, totalling about 400 m in thickness, although the basal unconformity with Lower Palaeozoic strata is not visible and uppermost Brigantian beds are not present.

Morton applied his classification of the Carboniferous Limestone in North Wales (Morton, 1870) specifically to the Llandudno area in 1898, and further detailed descriptions of the area can be found in Smyth (1925a) and Neaveverson (1937). A more recent account of the key sections at the Great Orme, including the type sections of many newly recognized formations, is provided by Warren *et al.* (1984) who erected a formal lithostratigraphy for the Dinantian strata between Prestatyn and the Great Orme (Figure 8.2). The site offers the best available and most continuous section of late Dinantian carbonates in north-west Wales and is one of the most important research sites of Lower Carboniferous age in Britain.

Description

Dyserth Limestone Group

Warren *et al.* (1984) defined three formations in the Dyserth Limestone Group, two thick carbonate units separated by a thin mudstone. The Dyserth Limestone Group in the Great Orme area has been attributed entirely to the Asbian Stage and is one of the thickest Asbian shelf successions in the British Isles (Warren *et al.*, 1984). The lowest unit, the Llandudno Pier Dolomite, is about 140 m thick. Its type section is on the eastern side of the peninsula, from near the pier [SH 783 828] northwards to 200 m beyond the toll gate [SH 782 833]. With the exception of a few areas of crinoidal limestone, the unit is made up of bedded medium- to coarse-grained dolomites with little preservation of depositional textures (Warren *et al.*, 1984). Other exposures of this formation occur on the south-facing slopes overlooking the town [SH 771 823] and on the shore at the western extremity of the Great Orme [SH 750 841]. Warren *et al.* (1984) recorded the brachiopods *Gigantoproductus* sp. *maximus* group and *Megachonetes* cf. *papilionaceus* from near the top of the formation, but other fossils are largely indeterminable.

The type section of the Tollhouse Mudstone lies on the landward side of Marine Drive some 200 m north of the toll gate [SH 781 823]. Warren *et al.* (1984) recorded 1.2–2 m of calcareous mudstone and earthy limestone from this locality, containing *Gigantoproductus*, *Linoprotonia*, *Megachonetes*, *Schizophoria*, *Bellerophon*, *Aviculopecten* and ostracodes. The same mudstone is also exposed immediately below the Great Ormes Head Lighthouse [SH 756 843].

Much of the exposure in the steep cliffs around the Great Orme is of the Great Orme Limestone (Figure 8.12). The type section is on the eastern side of the Orme in the crags NNW of Happy Valley [SH 781 832]–[SH 779 834], where about 140 m of the total estimated thickness (175 m) are visible. The Great Orme Limestone develops a large-scale stepped topography on weathering, resulting from the cyclic alternation of resistant massive limestones and softer rubbly beds. Warren *et al.* (1984) recognized nine cycles at the type section, defined by the rubbly bands that lie at the top of each cycle. These cycles can be traced around the peninsula. Warren *et al.* (1984) provide a log showing the thickness of each cycle and the contained fauna. This includes typical Asbian fossils such as the corals *Dibunophyllum bourtonense* and *Palaeosmilia purchisoni*. The uppermost part of the Great Orme Limestone is not as well exposed, but does occur, on Craig Rofft to the west of Wyddfif [SH 776 832]. Here a sandstone occurs in the succession, and above it a fine-grained limestone containing *Chaetetipora*, a calcareous demosponge first described by Smyth (1925b) as a meandrine form of *Chaetetes* (Warren *et al.*, 1984).

Gronant Group

Above the Dyserth Limestone Group are 70 m of limestone belonging to the Gronant Group within which Warren *et al.* (1984) recognized two units: the Bishop's Quarry Limestone (used by Smyth, 1925a), and the Summit Limestone.

The mostly dark-coloured and well-bedded Bishop's Quarry Limestone is markedly different from the massive or rubbly pale-coloured Great Orme Limestone beneath. Warren *et al.* (1984) estimated the thickness of the formation as about 20 m, with the best exposure, in Bishop's Quarry [SH 766 831], showing the upper 10 m. The section consists of limestones typically 0.15–0.5 m thick separated by mudstone partings, and has yielded a rich brachiopod fauna that is typical of early Brigantian times (Warren *et al.*, 1984). The bivalve *Posidonia becheri*, indicative of the P₁ Zone, is found in the lowest exposed beds in the quarry.

The basal 4 m of the Summit Limestone is present in Bishop's Quarry, with other exposures in old workings close to the summit of the Great Orme. The formation here comprises grey or brownish-coloured limestones with conspicuous chert. A coral–brachiopod fauna recorded by Warren *et al.* (1984) from these beds includes *Caninia cambrensis*, *C. juddi*, *Diphyphyllum lateseptatum*, *Antiquatonia*, *Gigantoproductus*, *Linoprotonia*, *Pugilis pugilis* and *Spirifer*.

Interpretation

The entire Dinantian succession on the Great Orme has been regarded as Asbian and Brigantian in age (Warren *et al.*, 1984). However, the discovery of Chadian, Arundian and Holkerian strata along the eastern side of the Clwydian range between Dyserth and Llandegla (Somerville and Strank, 1984b,c; Somerville *et al.*, 1986, 1989; Davies *et al.*, 1989), together with the absence of diagnostic fossils through much of the Llandudno Pier Dolomite, raises the possibility that pre-Asbian strata may be present in the Carboniferous Limestone of the Great Orme. The presence of a brachiopod–bivalve fauna of probable P_{ic} age near the base of the Bishop's Quarry Limestone (Brigantian) close above the top of the Great Orme Limestone (Asbian) has been taken to indicate the presence of an unconformity between these two formations and that the lowest Brigantian strata are missing on the Great Orme, as in the Prestatyn area (Warren *et al.*, 1984).

The Great Orme Dinantian succession lies on the North Wales Shelf close to the shelf margin (Figure 8.1) and (Figure 8.3). Little is known of the depositional characteristics of the Llandudno Pier Dolomite, although it was, at least in part, a bioclastic limestone. Warren *et al.* (1984) regarded the dolomite as secondary in origin, perhaps forming by the reflux of fluids during relative sea-level fall, and inferred that this mostly took place at the close of early Asbian times.

The Great Orme Limestone displays a cyclicity defined by the presence of rubbly bands and the stepped topography produced by weathering. By comparison with other late Asbian shelf successions in North Wales, it is likely that each cycle is capped by a palaeokarstic surface and a palaeosol clay, but in these natural exposures the cycle boundaries are grassed over. In the absence of modern sedimentological work, more detailed interpretations are not possible.

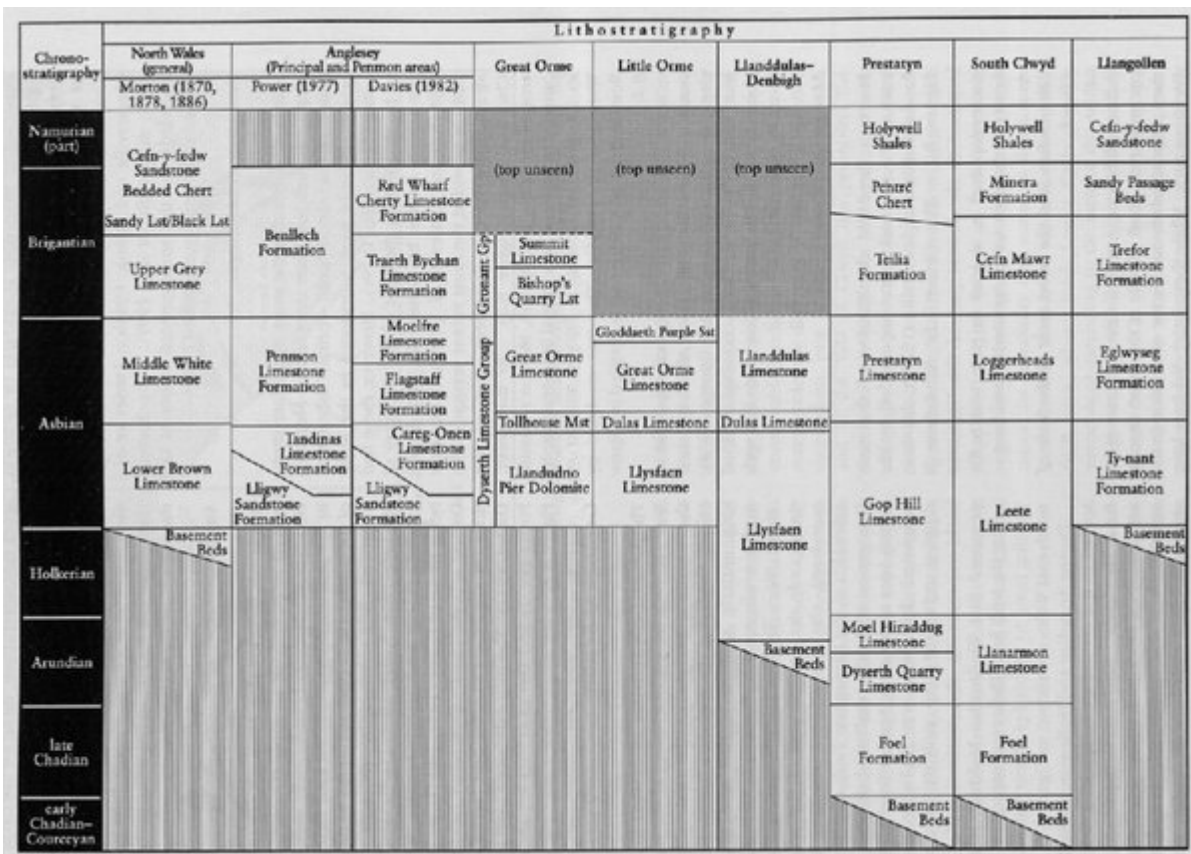
Conclusions

The Great Orme is a classic Dinantian site and the type locality for a number of fossil species. Virtually the whole of the Lower Carboniferous succession in north-west Wales is exposed and the locality includes the type sections of the majority of its formations. Given the importance of the site, it is perhaps surprising that little, if any, modern sedimentological work has yet been undertaken. There is also the possibility that a micropalaeontological study would yield more precise information about the age of the Llandudno Pier Dolomite and hence its correlation with other units in North Wales. The site thus has great potential for future research.

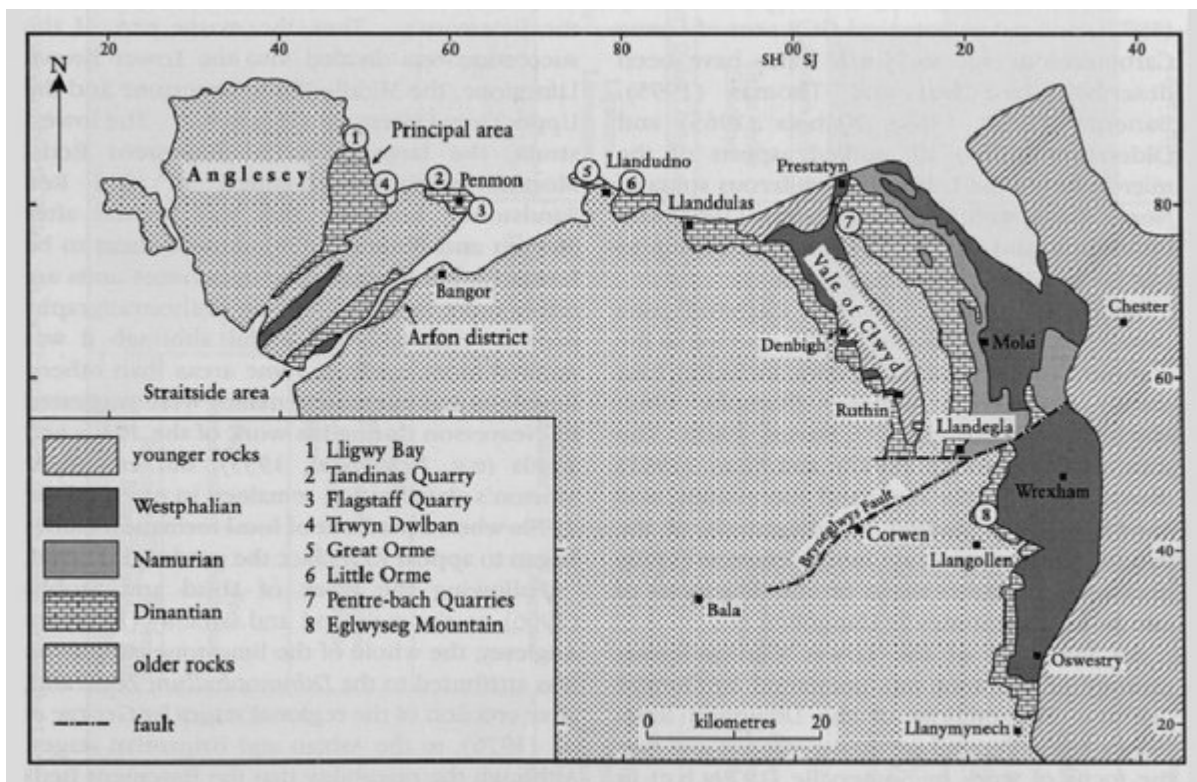
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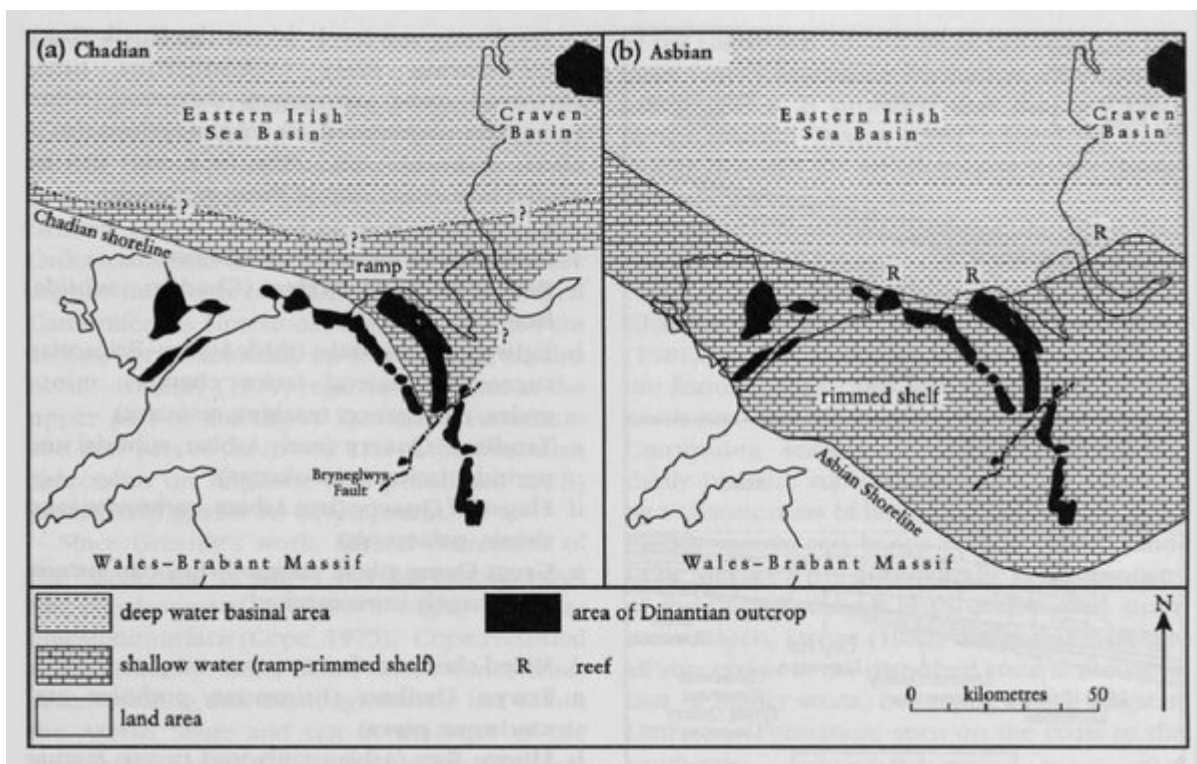
(Figure 8.12) Cliff and escarpment sections in the bedded and cyclic Great Orme Limestone (Dyserth Limestone Group, Asbian) near Ogof Hafnant at the Great Orme GCR site, Llandudno. (Photo: P.J. Cossey.)



(Figure 8.2) Simplified stratigraphical chart for the Lower Carboniferous succession of North Wales. In the central areas of the Great Orme, the Little Orme and Llanddulas to Denbigh, Warren et al. (1984) placed Brigantian strata in the Gronant Group and Asbian strata in the Dyserth Limestone Group. Compilation based on information from Power (1977), Somerville (1979a), Davies (1982), Somerville and Strank (1984c), Warren et al. (1984), Somerville et al. (1986) and Davies et al. (1989). Areas of vertical ruling indicate non-sequences. Not to scale.



(Figure 8.1) Geological map of North Wales illustrating the distribution of Carboniferous rocks and the locations of GCR sites described in the text. Based on [British] Geological Survey maps of the area (principally institute of Geological Sciences, 1979b).



(Figure 8.3) Palaeogeography of North Wales during Dinantian times illustrating (a) the situation after the Chadian transgression (after Somerville et al., 1989), and (b) the maximum extent of the shelf sea during Asbian times. After Warren et al. (1984).