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# Cwm Graianog

[SH 625 630]

## Introduction

This site displays magnificent exposures of the Upper Cambrian Marchlyn Formation, including near its top the Carnedd y Filiast Member, overlain unconformably by the Graianog Sandstone of Ordovician (Arenig) age. The Marchlyn Formation is correlated with the Upper Cambrian Maentwrog and Ffestiniog Flags formations of the Harlech Dome but exemplifies much coarser facies. Trace fossils are abundant, and this is the type locality for the trilobite trace *Cruziana semiplicata*.

The stratigraphy of the region was studied by H. Williams (1927) and D. Williams (1930), the latter work describing Cwm Graianog in detail. Crimes described the trace fossils (Crimes, 1970b) and analysed depositional environments and palaeogeographical information (Crimes, 1970a). The Geological Survey mapped the area around Cwm Graianog (British Geological Survey, 1985), and the results are reported in Howells *et al.* (1985). The position and nature of the Cambrian–Ordovician unconformity at Cwm Graianog is considered in detail by Reedman *et al.* (1983).

## Description

This site is on either side of the corrie known as Cwm Graianog, the best exposures of Upper Cambrian strata occurring on the northern wall of the cwm. The Marchlyn Formation exposed near the bottom of the hillside consists of dark-grey mudstones with regularly spaced laminae, a few millimetres thick, of pale-grey fine sandstone and siltstone, which give the rock a striped appearance. These rocks dip east at about 40°. Up-sequence sandstones become commoner, with beds a few centimetres thick every 30 cm or so. They show parallel lamination and occasionally cross- and convolute lamination and become more frequent upwards. Well-sorted fine- to medium-grained sandstones up to 10 cm thick also occur.

The grain-size coarsens upwards into the Carnedd y Filiast Grit Member near the top of the Marchlyn Formation. Thickly bedded, massive, medium to coarse sandstones, 10–50 cm thick, occur in packets 5 m thick and overlie thinly bedded, fine- to medium-grained sandstones and siltstones. There are several of these upwardly-coarsening sequences, and they give a distinctive scarp and slack topography. Beds of granule and pebble conglomerate also occur, with quartz and feldspar pebbles that reach 2 cm across. Some beds pinch and swell laterally and may be lenticular, and many are well sorted throughout, but graded bedding is uncommon. Large-scale cross-bedding is common in the coarse sandstones and conglomerates; in places, bi-directional cross-bedding can be seen. Flute and groove casts occur on the bases of the finer sandstones. The tops of the coarser beds show ripple marks, of which Crimes (1970a, figs 21–25) illustrated several types. Some bedding planes are covered with mega-ripples with wavelengths of 60 cm (Figure 3.15).

This is the type locality for *Cruziana semiplicata* Salter (Crimes, 1970b), and it and other trace fossils abound: *Rusophycus*, *Phycodes*, *Planolites*, *Diplichnites* and *Dimorphichnus*. *Skolithos* occurs at the top of the succession, and Crimes (1970a) recorded a few blocks of mud-cracked sediment there. Interbedded mudstones yield the brachiopod *Lingulella davisii* (M'Coy).

Above the Carnedd y Filiast Grit is a 50 m thickness of flaggy mudstones and thin sand stones that have been correlated with the '*Lingulella* Band' at the top of the Ffestiniog Formation in the Harlech Dome. A diverse acritarch assemblage from here is indicative of a late Cambrian age (Reedman *et al.*, 1983).

In Cwm Graianog the Carnedd y Filiast Grit is overlain with slight angular unconformity (Figure 3.16) by the Graianog Sandstone — a dark-grey argillaceous sandstone, bioturbated and containing the trace fossils *Phycodes* and *Teichichnus*, with the oncolitic structure known as '*Bolopora undosa*' at its base; it yields an assemblage of acritarchs of Arenig age or younger (Reedman *et al.*, 1983).

## Interpretation

The lower parts of the Marchlyn Formation are coarser-grained than the contemporaneous Maentwrog and Ffestiniog formations, as developed in the Harlech Dome (Howells and Smith, 1997). The thin sandstones presumably represent deposition from waning-turbidity flows, such as turbidity currents or storm surges, and become thicker and more common upwards.

The coarser beds of the Carnedd y Filiast Grit Member, although interpreted as turbidites by Evans *et al.* (1966), generally lack graded bedding and do not show a typical event-bed sequence of sedimentary structures. On the contrary, analysis of the sedimentary structures and trace fossils indicate deposition under tidal influence in a sublittoral environment (Crimes, 1970a, b). Deposition of most of the sediments occurred at depths between wave base and low water, but the presence of mud-cracks at the top of the sequence implies periodic drying out, and the *Skolithos* ichnofauna is consistent with intertidal conditions (Droser, 1991).

The shallow-water features and coarse nature of the sediments suggest a local source for these rocks, and the restriction of this facies to the north-west part of North Wales suggests a source area to the north-west. Palaeocurrent indicators created by a variety of flow regimes indicated to Crimes (1970a, p. 152) that the source area probably lay to the north-west with a south-east-facing palaeoslope, with tidal flow from northwest to south-east. In contrast, the correlative Ffestiniog Flags Formation are finer-grained and were deposited from north-flowing currents.

The Marchlyn Formation thus records the upward transition from basinal deposition to shallow-water, storm and tidally dominated environments, even to intertidal conditions at the top of the formation, followed by temporary emergence, erosion and tilting before deposition of the unconformably overlying Graianog Sandstone of Arenig age. Although the unconformity between the Cambrian and Ordovician had long been inferred from considerations of the regional geology (for example the presence of the Dolgellau Formation, discovered by Shackleton (1959) at the head of Cwm Pennant, but absent at Cwm Graianog), angular unconformity proved elusive until identified at Cwm Graianog by Reedman *et al.* (1983).

## Conclusions

Cwm Graianog shows the best Upper Cambrian succession in the Arfon area. The lower part of the Marchlyn Formation is fairly fine grained, but the overlying Carnedd y Filiast Grit is coarse and was deposited in shallow, high-energy environments with a source area to the north or north-west. This is the type stratum for the trace fossil *Cruziana semiplicata*. The unconformity of the Ordovician on the Cambrian is more clearly visible at this locality than elsewhere in Snowdonia.

## [References](#)



(Figure 3.15) Cwm Graianog, Nant Ffrancon, looking north-west. Large ripples on the upper surface of a bed of quartzose sandstone in the Upper Cambrian Carnedd y Filiast Grit. (Photo: J.K. Prigmore.)



(Figure 3.16) The Cambrian–Ordovician unconformity at Cwm Graianog (arrowed). Overlying the Carnedd y Filiast Grit (close foreground, pale) are thinner bedded flags of the Marchlyn Formation (Merioneth Series) that are overstepped uphill by the base of the Graianog Sandstone of Arenig age. (Photo: J.K. Prigmore.)