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# Llyn Padarn

[SH 569 616]–[SH 574 614]

## Introduction

The north-west side of Llyn Padarn exposes the basal Cambrian succession in the historical type area of the Cambrian System and is one of the few localities in the Arfon area where the relationship between the Precambrian Arvonian volcanic rocks and the Cambrian can be adequately demonstrated. The Cambrian succession displays complex interdigitation of volcanic and sedimentary facies.

Early workers found the general geological succession difficult to interpret, as shown by the sometimes heated controversy surrounding the study of these rocks, the history of which is outlined by Wood (1969). In brief, Ramsay (1866) considered the 'felsite' of the Padarn Ridge to have been intruded into Cambrian conglomerates but found it difficult to delineate a precise boundary between them, whereas Hicks (1878) claimed that, as the conglomerates overlie the volcanic rocks unconformably, the latter should be referred to his newly recognized Pebidian and Dimetian 'series' of Precambrian age. The opinions of later workers (Blake, 1888, 1892; Geikie, 1891) differed as to the number of conglomerate beds, their structural relationships and whether or not they represent a major marine transgression following a stratigraphical break.

Later, Morris and Fearnside (1926) described the Cambrian rocks in the area and established the stratigraphical succession used here; in keeping with the concept prevalent at that time of a general sub-Cambrian hiatus, they assumed that their 'Cilgwyn Conglomerate' formed the local transgressive base to the Cambrian.

Wood (1969) made a detailed map of the area north of Llyn Padarn and named the basal Cambrian rocks the 'Fachwen Formation'; it consists of conglomerates, sandstones and thin ignimbrites. He demonstrated that the Arvonian volcanic rocks and the overlying Fachwen Formation are folded together into a faulted syncline—anticline pair but show no significant unconformity.

Reedman *et al.* (1984) mapped a wider area of Arfon and named the Arvonian volcanic rocks the 'Padarn Tuff'. Locally they identified both unconformable and disconformable relationships between the Padarn Tuff and the Fachwen Formation and, by regional interpretation of the Bouguer Gravity Anomaly, showed that the Padarn Tuff was deposited in a fault-controlled basin.

## Description

The site extends along the north-east shore of Llyn Padarn by the Llanberis Lake Miniature Railway (Figure 3.12). Exposures at the northwest end are highly siliceous welded Padarn Tuff, showing little or no structure. They pass upwards into the sedimentary-volcanic sequence of the Fachwen Formation, but the actual boundary, and hence the base of the Cambrian sought by earlier workers, is difficult to identify. Wood (1969) mapped the boundary at the lowest horizon at which pebbles may be recognized approximately [SH 5689 6169]. South-eastwards the sequences exposed in the Fachwen Syncline and Gallt-y-Foel Anticline are mainly sedimentary in origin.

The basal conglomerate dips steeply to the south, and though of variable thickness, it is the thickest of several conglomerates (Figure 3.13). Most of the pebbles are of volcanic rock, but a few are sedimentary, and the matrix gradually becomes more clearly sedimentary upwards. To the south-east, beyond a dolerite dyke, is a 50 m sequence of the Fachwen Formation consisting of fine- to medium-grained sandstones with fine parallel lamination and cross-lamination. Some beds are quite coarse, with grains up to 1 mm in size. These pass up into red and green fine-grained tuffaceous silts, very finely laminated and resembling the overlying Llanberis Slates; they generally dip south-east at about 70°, although minor folding is present close to the major synclinal axis. Towards the core of the Fachwen Syncline are green-coloured, coarse, medium and fine sandstones and siltstones, often parallel-laminated and

occasionally cross-bedded.

To the south-east, after a break in exposure, is a bed of conglomerate dipping north-west at about 40°, the basal contact of which rests on an agglomerate bed that shows a strong fabric dipping north-west at about 70°. This passes down into welded tuffs identical in lithology to the Padarn Tuff. Below this, after another break in exposure, are beds of cross-bedded sandstone interbedded with a number of conglomerate horizons, which may reach several metres in thickness. Some are clast-supported and pebble-rich, with clasts of siliceous ruffs, red sandstones, green tuffaceous mudstones; basalts, jasper, quartzites and quartz schists; the variety of clast types contrasts with the relative uniformity of the pebbles in the conglomerates seen at the base of the Fachwen Formation. Other beds are matrix-supported and have few clasts, with a matrix of recrystallized material.

Crossing the faulted axis of the Gallt-y-Foel Anticline, beds of coarse to medium sandstones by the railway station dip south-east and pass upwards into red, green and purple slates of the Llanberis Slates Formation. The whole Fachwen Formation is about 400 m thick.

## Interpretation

This site displays the relationship between the Precambrian Arvonian rocks and the overlying Cambrian sediments and demonstrates marked facies variations within a small area. For example, whereas in the south-east limb of the Fachwen Syncline there are conglomerate horizons both above and below volcanic rocks, including a vitric tuff and an agglomerate, in the north-west limb only one bed of conglomerate is present and there are no volcanic rocks.

The Padarn Tuff Formation represents a welded ignimbrite flow deposited under subaerial conditions. The base of the Fachwen Formation is recognized by the appearance of pebbles, which constitute the first indication of aqueous reworking of the Padarn Tuff. However, the recognition of this boundary is difficult, as the matrix of the lowest pebble-bearing horizon is indistinguishable from the underlying ignimbrite. The presence of glass shards and feldspar crystals in this matrix suggests that the pebbles were incorporated contemporaneously in the ignimbrite, or very shortly after emplacement of the flow (Wood, 1969). The basal conglomerate also appears to lie conformably on the eutaxitic texture of the Precambrian welded tuffs at this locality.

The complex facies variations within the Fachwen Formation and the interdigitation of volcanic and sedimentary facies are significant. The conglomerates and cross-bedded sandstones are waterlain but are associated with welded tuffs, similar to those of the Padarn Tuff, which suggests subaerial emplacement and indicates that there was at least local temporary reversion to subaerial conditions. Furthermore, the siltstones of the Fachwen Formation closely resemble the overlying Llanberis Slates Formation, which is indisputably of marine origin. The Fachwen Formation thus shows strong similarities to both the underlying and overlying divisions.

Wood (1969) concluded that there was no important break in deposition at the base of the Cambrian conglomerates and that the Cambrian is essentially conformable on the Arvonian. However, Reedman *et al.* (1984) record that at some other localities there is major discordance between the underlying welding fabric in the tuffs and the base of the overlying sedimentary rocks. This they took to indicate that erosion and tilting of the Precambrian volcanic deposits occurred prior to sedimentary deposition. Where the relationship between the welding fabric in the tuffs and the basal conglomerates is concordant, as in the Llyn Padarn section, they found that the tuffs were intensely welded right up to the basal contact and suggested that any non-welded tuff was removed prior to deposition. Reedman *et al.* (1984) proposed that the lenses of conglomerates and sandstones represent alluvial fans and fluvial deposits close to fault scarps. They found variation in angular relationships across faults, suggesting rotation of fault-blocks prior to and during sedimentation. The conglomerates of Bangor and Anglesey, considered coeval with those of Llyn Padarn, rest with slight unconformity on the Arvonian, and so this contact must represent a period of significant upheaval, rather belied by the sequence exposed at Llyn Padarn. This view supported Tucker and Pharaoh's (1991) determination of an isotopic age of  $614 \pm 2$  Ma for the Padarn Tuff — much older than the base of the Cambrian, which is about 543 Ma.

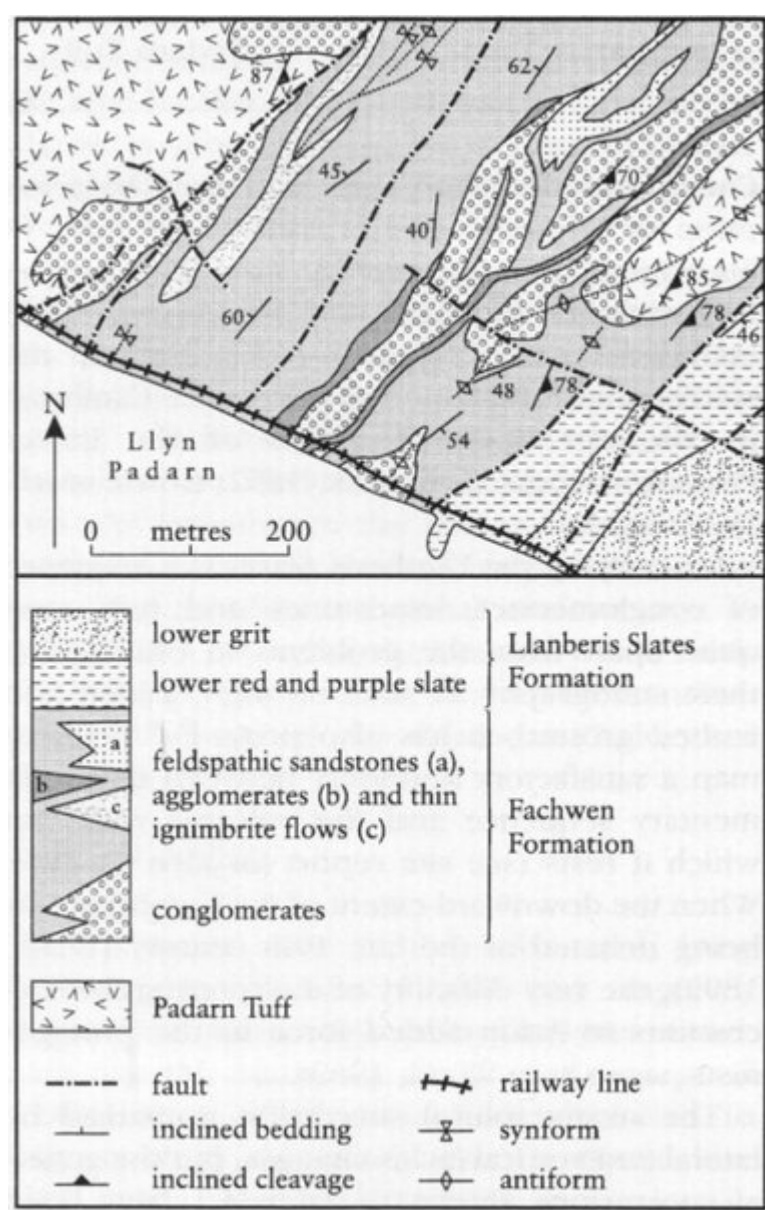
Throughout the sequence exposed, the energy of deposition appears to have diminished upwards and may indicate general deepening. Conglomerates deposited in high-energy environments give way to sandstones and then to

siltstones, albeit with local reversals when shallow-water conglomerates and subaerial welded tuffs were deposited. The trend towards deeper-water sedimentation culminated in the marine deposition of the thick and uniform Llanberis Slates Formation. Contemporaneous subsidence is invoked to effect the change from sub-aerial to submarine conditions over the interval of deposition of the Fachwen Formation, and to accommodate its thickness.

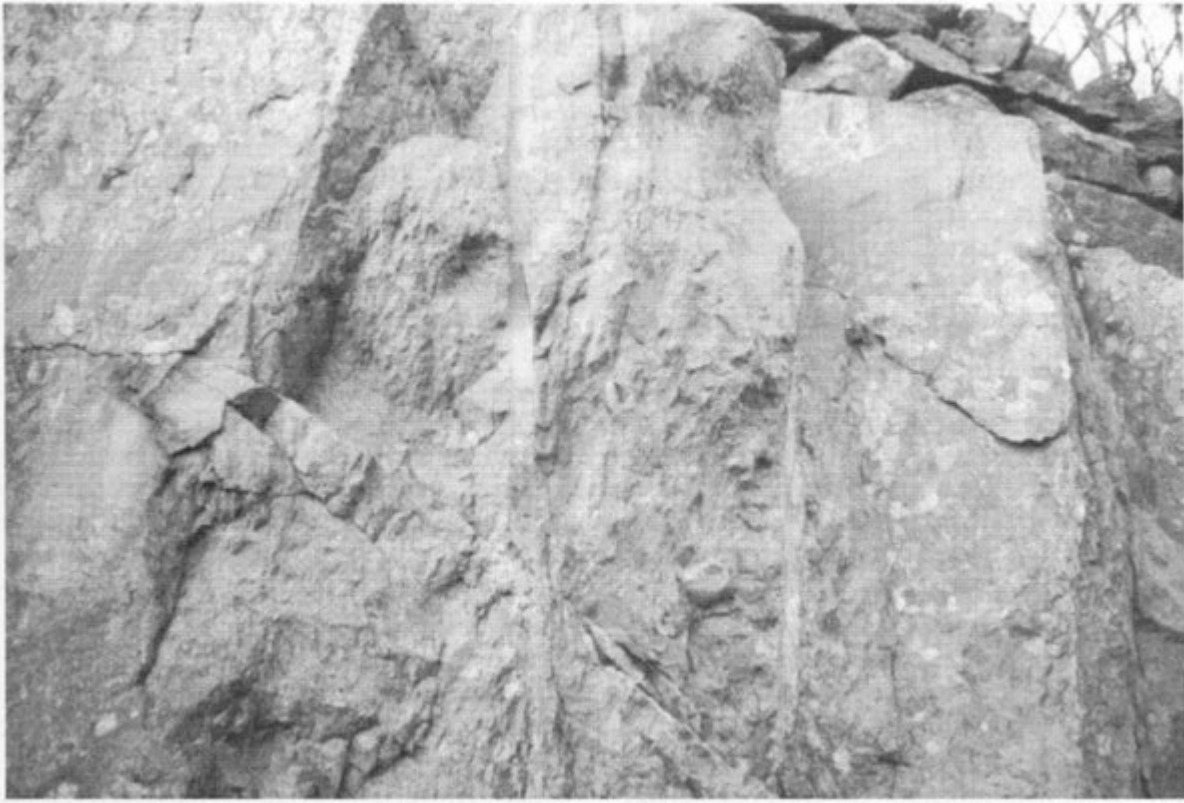
## Conclusions

This site is of historical importance, being the subject of controversy among Victorian geologists as to the nature of the base of the Cambrian in the type area. It exposes sequences that, in the light of modern interpretations, show affinities with both the Precambrian volcanic rocks below and the Cambrian slates above, and provides evidence for the nature of the local base of the Cambrian. The rocks were laid down in shallow water, are underlain by volcanic rocks emplaced on land and overlain by finer-grained, deeper-water sediments. Abrupt variations in rock type occur over a small area. The evidence regionally indicates that a break in sedimentation probably occurred across this boundary, although this is not evinced by the sequence at Llyn Padarn.

## References



(Figure 3.12) Geology of the section along the north side of Llyn Padarn through the Fachwen Syncline and Gallt-y-foel Anticline, after Wood (1969), with stratigraphical terminology modified by Reedman et al. (1984).



*(Figure 3.13) Conglomerate and sandstone of the Fachwen Formation (Lower Cambrian), dipping to the left and cleaved almost vertically. Railway cutting, north side of Llyn Padarn, Snowdonia. (Photo: J.K. Prigmore.)*