
Pared y Cefn-hir

[SH 666 152]

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Introduction

The Pared y Cefn-hir GCR site (Figure 6.25) incorporates the best-exposed succession of volcanic rocks of Arenig to Llanvirn age in North Wales. The succession forms the lowest part of the Aran Volcanic Group.

A notable aspect of the site is the strong topographical expression of certain volcanic units and igneous intrusions. These form a series of NE-trending ridges, of which Pared y Cefn-hir itself is the most prominent (Figure 6.26). Intervening depressions are formed of less-resistant grey mudstones. The volcanic rocks consist mostly of acid and basic tuffs, all emplaced subaqueously, some as ash-flow tuffs. There are subordinate basaltic pillowed lava flows. The igneous intrusions consist of sills of dolerite and microgranite, some with well-exposed chilled margins and contacts with country rocks.

The first detailed description and map of the igneous rocks of the Pared y Cefn-hir area was that of Cox and Wells (1921), in their account of the stratigraphy, structure and intrusive igneous rocks of the district between Arthog and Dolgellau. The petrography of certain intrusive igneous rocks was also described. The site was re-examined during the recent resurvey of the Cadair Idris district by the British Geological Survey (Pratt *et al.*, 1995), which included a petrological and geochemical study of the igneous rocks by Kemp and Merriman (1994) (see the Cadair Idris GCR site report).

Description

The stratigraphy of the Pared y Cefn-hir area presented below (Table 6.2) is based on the recent resurvey by the British Geological Survey (Pratt *et al.*, 1995), with the earlier terminology of Cox and Wells (1921) for comparison.

The Allt Llyd Formation consists of sandstones, siltstones and mudstones which crop out and are moderately well exposed in the vicinity of Gefnir Farm and Llyn Wylfa, but which wedge out immediately south of Llyn Wylfa. Petrographical analyses of the sandstones show that the majority are of volcanic provenance, composed of feldspar crystals and basalt fragments, while few, typically in the lower part of the formation, are quartzose sandstones of non-volcanic provenance. Acritarch floras from interbedded mudstones indicate an Arenig age.

The Offrwm Volcanic Formation rests conformably on the Allt Llyd Formation and is best exposed immediately north of Gefnir Farm. Here, it consists of units 1–15 m thick of silicic ash-flow and turbiditic tuff, most of which are separated by intervals of dark-grey mudstone up to 25 m thick. There are subordinate tuffaceous sandstones, probably also deposited as turbidites. Typically, the silicic tuffs are pale yellowish-grey weathering and fine-grained. Several tuff units are planar bedded at the top and some contain clasts of either fine-grained silicic tuff or contorted grey mudstone. A few contain siliceous nodules and several display a bedding-parallel welding foliation, best seen in the highest tuff unit, which is the most easily identifiable and persistent. It increases in thickness, from 8 m at Gefnir Farm to 15 m farther to the NE. Tuff units lower in the formation are probably also persistent but are difficult to distinguish from each other owing to intermittent exposure and numerous dolerite sills that complicate the succession. Thin sections show abundant glass shards and minute pumice fragments intensely altered to, and in many instances greatly obscured by, a microcrystalline quartzo-feldspathic aggregate. Feldspar crystals are abundant in some of the lowest tuffs. The interbedded mudstones are dark-grey and strongly cleaved. Graptolite faunas from a number of localities within the site area indicate the *Didymograptus artus* Biozone (early Llanvirn) (Pratt *et al.*, 1995).

(Table 6.2) Stratigraphy of the Pared y Cefn-hir area, showing correlations with earlier nomenclature.

Pratt et al. (1995)	Cox and Wells (1921)	Thickness (m)
Llyn y Gafr Volcanic Formation	Lower Basic Volcanic Series	> 100
Cregennen Formation	Moelyn, Crogenen and Bifidus slates	225
Cefn-hir Member	Cefn Hir Ashes	45
Bryn Brith Member	Bryn Brith Beds	55
Offrwm Volcanic Formation	Lower Acid Volcanic Series	90
Allt Llyd Formation	Basement Series	80

The Cregennen Formation comprises 60 m of mudstone at the base, which crops out, but is poorly exposed, immediately NW of Bryn Brith where it rests sharply on the upper acid tuff of the underlying Offrwm Volcanic Formation. Basic tuffs in the middle of the Cregennen Formation constitute the Bryn Brith Member and are particularly well exposed on Bryn Brith. Here a single unit of massive, coarse-grained, poorly sorted basic tuff, 55 m thick and probably emplaced from debris flows, passes upwards into 10 m of finer grained, planar-bedded turbiditic tuff. The massive tuff is composed chiefly of abundant ragged fragments, up to 5 mm across, of vesicular, altered basalt, but it also contains numerous subangular blocks of bedded basic tuff up to 30 cm across, the bedding of which is highly contorted, indicating incorporation in an un lithified state. The Bryn Brith Member is overlain by 65 m of mudstone, which is poorly exposed in the low ground between Bryn Brith and Pared y Cefn-hir. The Cefn-hir Member lies at the top of the formation and is well exposed on the central and southern parts of the prominent ridge of Pared y Cefn-hir. On the southern part of the ridge a 2 m-thick bed of silicic ash-flow tuff lies in the middle of the member but underlying beds of basic tuff, 1–15 m thick, wedge out north-eastwards. Consequently, on the central part of the ridge the silicic tuff lies at the base of the member. Here, it is overlain by 2–3 m of mudstone followed by 25 m of massive, coarse-grained, blocky and poorly sorted basic tuffs, which form a series of debris flow units 1–10 m thick. Each unit has finer grained, planar bedded, turbiditic tuff at the top, in some cases up to 2 m thick. The basic tuffs are petrographically similar to those of the Bryn Brith Member but feldspar crystals are more common, and blocks of bedded basic tuff are accompanied by those of basalt, silty mudstone and acid volcanic rock. Basaltic pillow lavas, up to 5 m thick, occur locally near the top of the member at the SW end of the ridge. The mudstones of the Cregennen Formation have yielded graptolites suggestive of the *Didymograptus artus* Biozone, and fragmentary trilobites obtained from mudstone within the Bryn Brith Member SW of Bryn Brith suggest a similar early Llanvirn age (Pratt *et al.*, 1995). Basaltic pillow lavas of the overlying Llyn y Gafr Volcanic Formation are locally well exposed immediately south of Llynnau Cregennen.

The igneous intrusions are mostly dolerite sills which range in thickness from a few metres to c. 100 m. They occur typically within mudstones, which most probably facilitated intrusion. Dolerite exposures near Llyn Wylfa and Gefnir Farm display narrow (up to 0.5 m) chilled margins against mudstone country rocks. In each case mudstone 'flames' penetrate from 2 cm to as much as 1 m into the sill, and indicate that the sediment was un lithified at the time of intrusion. The dolerites are typically composed of plagioclase, clinopyroxene, iron-oxide and accessory apatite. Extensive alteration has produced a range of secondary minerals; albite replacing plagioclase, actinolite (along with chlorite) replacing pyroxene, titanite replacing iron-oxide, and intergrowths of chlorite, epidote, quartz and stilpnomelane replacing the groundmass of porphyritic rocks. In spite of the alteration, primary subophitic and ophitic igneous textures are preserved. The chilled margins tend to be vesicular and porphyritic with feldspar phenocrysts in a groundmass of feldspar microlites and chlorite.

The Cregennen microgranite sill, which is 500 m thick, crops out extensively in the eastern part of the site. It has intruded the Cregennen and Llyn y Gafr formations. It is particularly well exposed on the eastern side of Pared y Cefn-hir where there is a distinct lower marginal facies developed up to 10 m from the contact. The microgranite proper is characterized by granophyric intergrowths of feldspar and quartz, but there are some alkali feldspar phenocrysts and accessory amounts of apatite and zircon. The feldspars have been altered to epidote and pumpellyite, and late stage stilpnomelane crystals are common. The marginal facies has abundant hornblende and biotite, but geochemically it is similar in composition to the microgranite (Kemp and Merriman, 1994). The contact between the basic margin and microgranite proper is marked by a conspicuous xenolithic zone several metres thick (Figure 6.27). This zone is interpreted as earlier, partly crystalline magma that was disrupted by the intrusion of the main part of the microgranite (Pratt *et al.*, 1995).

Interpretation

The sandstones of the Allt Llyd Formation are interpreted as shallow-marine deposits (Pratt *et al.*, 1995), with a volcanoclastic component derived from the contemporaneous erosion of pre-existing volcanic rocks, most probably of the Rhobell Volcanic Group (Kokelaar, 1979).

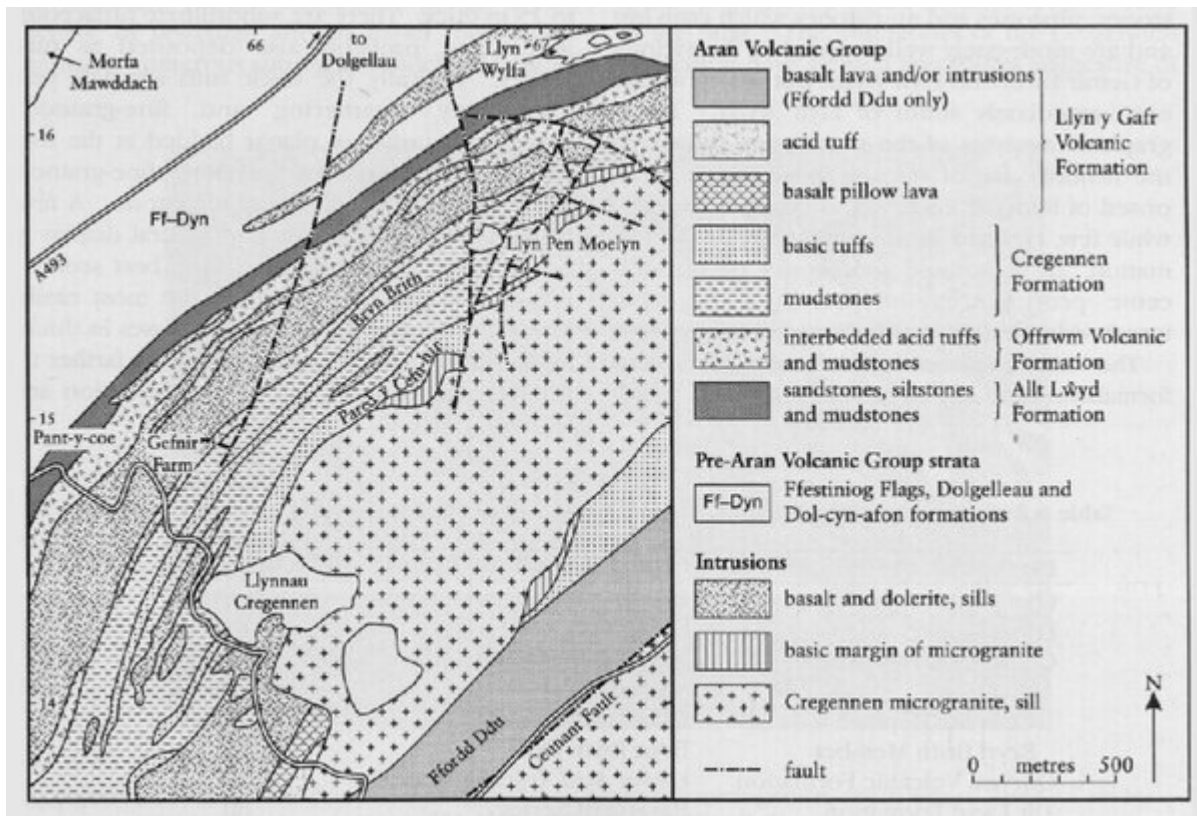
The absence of sandstones and shallow-water bedforms in the Offrwm and Cregennen formations suggests deeper-water conditions, possibly established by marked local subsidence. The tuffs of these formations are the products of contemporaneous explosive acidic and basaltic volcanism. This is clearly indicated by the presence of welding fabrics in silicic ash-flow tuffs in the Offrwm Volcanic Formation, while the presence of unabraded glass shards and/or pumice fragments in both acid and basic tuffs is regarded as being further evidence for contemporaneous volcanism, even though they are present in debris flow deposits and turbidites. The latter formed by the resedimentation of pyroclastic material during or soon after explosive volcanism. The fact that these tuffs are interbedded with mudstones clearly indicates subaqueous emplacement. The source of this volcanism has not been identified (Pratt *et al.*, 1995), but the occurrence of basaltic pillow lavas near the top of the Cefn-hir Member and in the overlying Llyn y Gafr Formation suggests that the effusive basaltic volcanism took place at an unknown source possibly closer to the site area.

Conclusions

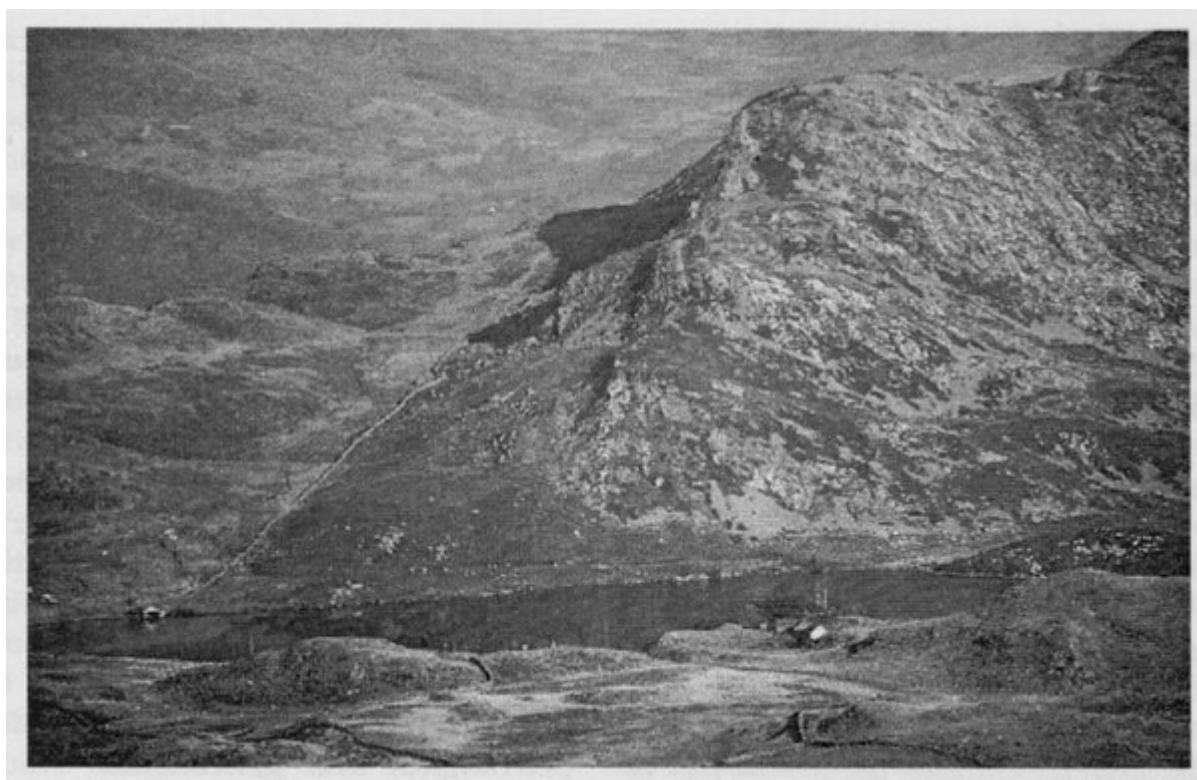
The well-exposed volcanic and intrusive igneous rocks of the Pared y Cefn-hir GCR site are of national importance as they represent the best exposures of the Aran Volcanic Group of Arenig to Llanvirn age. They are also of importance as a succession of subaqueously emplaced volcanic rocks and for the associated igneous intrusions. The exposures are easily accessible for educational purposes and the site complements the Cadair Idris GCR site.

The volcanic rocks consist of acid and basic tuffs that were emplaced subaqueously, some as ash-flows and others as debris flow deposits and turbidites. Ash-flow tuffs are only distinguishable where evidence of welding fabrics can be seen, with some difficulty and uncertainty, in some of the acid tuffs. The presence of abundant angular glass fragments in both the acid and basic tuffs suggests that they were a product of explosive volcanism. These deposits contrast with the sandstones derived from reworked volcanic material which dominate the Allt Llyd Formation. The site includes a number of dolerite sills, some showing evidence for emplacement into unlithified sediment, which in turn is evidence that intrusive activity was approximately contemporaneous with the volcanism. Silicic magmatism represented by the Cregennen microgranite sill however, is clearly later than that indicated by the silicic tuffs of the Offrwm, Cregennen and Llyn y Gafr formations.

[References](#)



(Figure 6.25) Map of the Pared y Cefn-hir area.



(Figure 6.26) View of the Pared y Cefn-hir area from the SW. The prominent ridge is formed by the Cefn-hir Member and the rocky slopes to the right are in the Cregennen microgranite. (Photo: D.G. Woodhall.)

Table 6.2 Stratigraphy of the Pared y Cefn-hir area, showing correlations with earlier nomenclature.

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(Figure 6.27) Basic xenoliths in the margin of the Cregennen microgranite, south side of Pared y Cefn-hir [SH 6651 1506]. (Photo: D.G. Woodhall.)