CRAIG Y GARN

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Introduction

The Craig y Garn GCR site represents an important dip section through one of the main eruptive centres of the 2nd Eruptive Cycle of Caradoc volcanic activity in Snowdonia. It lies within the eastern half of an elongate synformal outlier of the main outcrop of the Snowdon Volcanic Group. This outlier is interpreted as the site of a volcanotectonic collapse structure whose location and development was in part influenced by north- to NE-trending fractures in the underlying basement.

Formerly known as the Llwyd Mawr Ignimbrite, the strata, which were originally described by Sedgwick (1843) and later by Ramsay (1881) and Harker (1889), were regarded as rhyolitic lava flows and tentatively correlated with similar lavas on Moel Hebog. This account draws on the work of Roberts (1969) whose detailed mapping and studies of petrography and deformation led to their re-interpretation as ash-flow tuffs (ignimbrites). Roberts also confirmed the earlier suggestion of Shackleton (1959) that within this thick (over 700 m) intracaldera sequence there is no evidence for any appreciable subdivision. Later deformation studies by Roberts and Siddans (1971) used variations in the compactional strain, as seen in lithic clasts and pumice, to identify two separate eruptive pulses. However, a more recent geochemical study by Howells *et al*. (1991) shows little evidence for trace element compositional variation throughout the sequence and reconfirms the original suggestion that Llwyd Mawr represents one of the thickest accumulations of welded ash-flow tuffs related to an individual volcanic centre in Britain.

The Craig y Garn site includes the basal contact of the tuff sequence with marine mudstones of Llanvirn age. Elsewhere the tuff sequence is overlain by Longvillian age strata and thus an upper Soudleyan to Longvillian age is likely. In the northern half of the site intrusive rhyolite domes and a possible vent breccia may represent resurgent activity within the caldera. Lithological and geochemical studies (Howells *et al*., 1991) include the Craig y Garn rocks within the Pitts Head Tuff Formation and confirm a correlation with the outflow facies on Moel Hebog (Reedman *et al*., 1987), as described in the Moel Hebog to Moel yr Ogof GCR site report.

The site is partly included in the 1:50 000 scale Geological Sheet 119 (Snowdon) (1997) but has not been resurveyed in detail.

Description

The site encompasses some 3 km² along the western side of Cwm Pennant and includes the minor hills of Craig y Garn and Llywd Mawr (Figure 6.37). Scattered exposures extending eastwards and north-eastwards from the slate quarries at Hendre-ddu (5180 4442) show many of the features typical of a major ash-flow tuff.

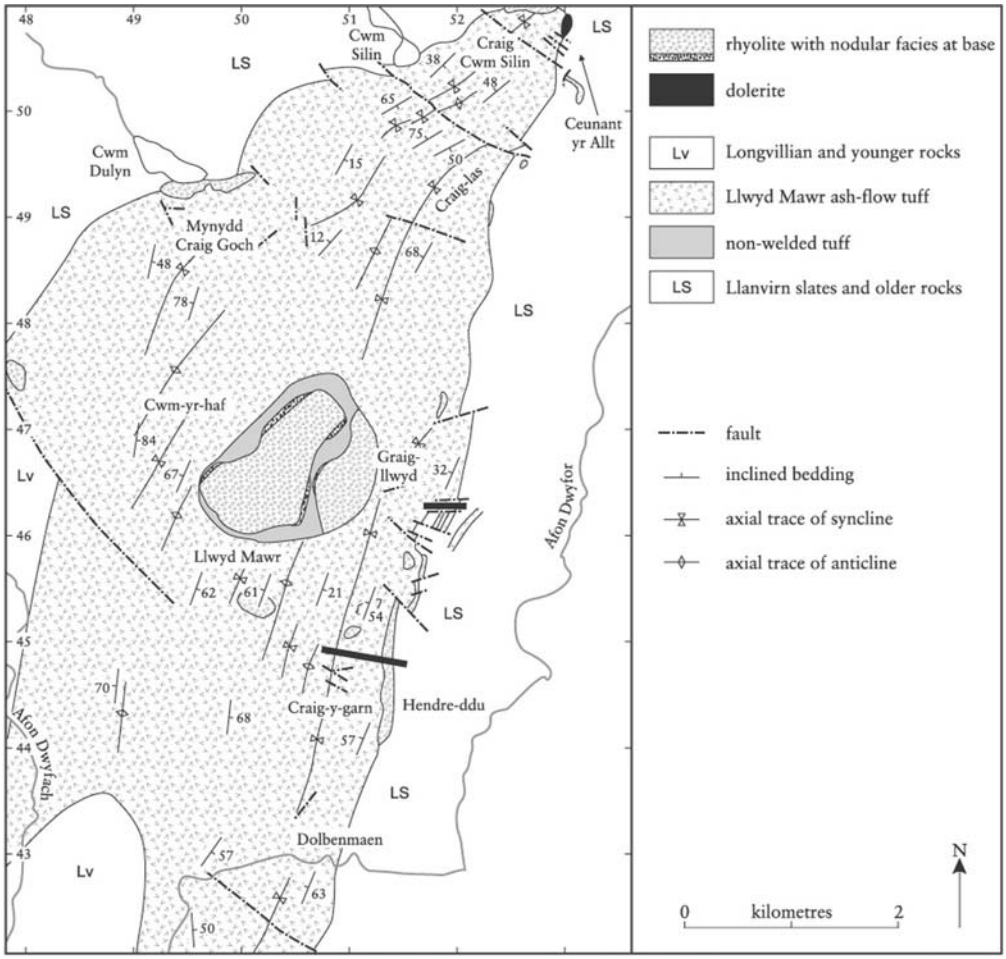

Figure 6.37: Map of the Llwyd Mawr Centre (after Roberts, 1969).

The lower beds rest abruptly, but concordantly on dark bluish-grey micaceous mudstones and silty mudstones of the Nant Ffrancon Subgroup. Graptolites recovered from these strata are characterized by *D. murchisoni* (Shackleton, 1959; Howells and Smith, 1997) indicating the Llanvirn *D. murchisoni* Biozone. In contrast to the strata exposed beneath the ash-flow tuff on Moel Hebog there is no evidence for the Llandeilo or Caradoc stages, thus indicating the existence of a major volcanotectonic break at the base of the tuffs.

Throughout most of its eastern outcrop the base of the tuff sequence is underlain by a rhyolitic sill. The sill, up to 75 m thick, is exposed around the eastern flanks of Craig y Garn and comprises flow-banded and flow-folded rhyolite, locally autobrecciated and spherulitic at its lower contact. Contact metamorphism and alteration related to the intrusion of the sill has baked the overlying tuffs and protected them from cleavage development.

The sequence up through the tuff pile as exposed on Craig y Garn commences with a compact, silicified, blue-grey non-welded crystal-lithic-vitric tuff up to 3 m thick. The tuff contains a variety of clast types including rounded to weakly flattened pumice clasts, up to 10 cm in diameter, mudstone clasts, up 8 mm in length, and rare angular rhyolitic clasts, less than 2.5 cm, set in a devitrified matrix of glass shards, chloritized feldspar (mainly plagioclase and rarer anorthoclase), quartz crystals and dust. The mudstone clasts are common only in the basal 30 cm. The shards are typically well preserved and in thin section show Y-shaped or four-sided morphologies.

At about 4–5 m above the base the glass shards show increasing distortion and incipient welding, and a planar eutaxitic foliation is developed, although much of the foliation is obscured by spherulitic recrystallization. Quartz phenocrysts are rare above this level. The foliation dips consistently westwards and is concordant throughout. Above 10 m, spherulitic recrystallization reduces in intensity and welded textures are again evident. Shard distortion and collapse and flattening of pumice clasts and lapilli thereafter increases logarithmically upwards and at

around 17 m above the base a strong parataxitic foliation defined by flattened shards is present. Locally perlitic fracturing may be observed. Layers of radial and concentric siliceous nodules are commonly developed immediately below the parataxitic zone. The parataxitic foliation extends for the next 45 m. At 62 m, the tuff is strongly recrystallized; shards are flattened and outlines are completely destroyed. The textures continue to the top of the section.

The changes in the degree of deformation and recrystallization are matched by variations in joint style. Above the base, the joints are crudely perpendicular to the lower contact, and at about 18 m become crudely columnar with rectangular cross sections. At 18 m to about 58 m, the joints are platy and above 58 m polygonal forms dominate, with cross-sectional diameters increasing from 12 cm to 50 cm at 75 m above the base.

Immediately north of Llywd Mawr, along the northern margin of the site, an intrusive rhyolite dome can be seen cutting the tuffs. The dome is composed of flow-banded rhyolite with feldspar phenocrysts, and in places is fringed by an autobrecciated facies comprising blocks (less than 2 m in length) of flow-banded and flow-folded rhyolite and zones of siliceous nodules. The dome and its breccia carapace are surrounded by a non-welded vitroclastic tuff, locally agglomeratic with blocks of flow-banded rhyolite, welded tuff and rare mudstone.

Interpretation

The textural and lithological characteristics of the Pitts Head Tuff Formation on Craig y Garn and the general absence of interaction with the enveloping marine sediments indicate that this impressive thick sequence of rhyolitic tuff was emplaced subaerially, probably within a subsiding volcanotectonic depression or caldera. A volcanotectonic break, of unknown magnitude, is indicated by the absence of Caradoc strata in the east and compares with a full sequence on the eastern side of Cwm Pennant at Moel Hebog. This implies uplift and erosion in the vicinity of the caldera prior to collapse (Howells *et al.*, 1991). The lack of a decrease in the intensity of welding and general absence of non-welded tuff ledRoberts (1969) to infer that a large volume of tuff may have been removed by erosion and thus the 700 m thickness estimate must be regarded as a minimum. Lateral equivalents of the Pitts Head tuffs are exposed in the Moel Hebog area, where they represent the outflow facies from the caldera (see the Moel Hebog to Moel yr Ogof GCR site report).

The progressive changes recorded by the degree of flattening, foliation development and joint style are considered to result from the cooling of a single unit, albeit composed of more than one ash-flow, subsequently intensely recrystallized and altered. The widespread development of spherulitic recrystallization beneath the main zone of development of a parataxitic fabric probably resulted from the trapping of volatiles exsolving from the basal non-welded tuff.

The latter stages of caldera evolution were marked by the forceful emplacement of rhyolitic domes and sills along the caldera margin and within feeder pipes or vents already choked with an agglomeratic vitric-clastic tuff in the centre of the caldera. Geochemically and petrographically comparable to the tuffs, these domes and sills may represent the late degassed equivalent of the tuff magma.

Conclusions

The Craig y Garn GCR site preserves one of the thickest and most complete sections through a Lower Palaeozoic caldera fill in Britain. In excess of 700 m of welded rhyolitic ash-flow tuff was ponded or entrapped within a major volcanic depression that formed within the Snowdon Graben and marked the initiation of the 2nd Eruptive Cycle across Snowdonia in Caradoc time. The site is important for the preservation of textures typical of welded ash-flow tuffs and for its correlation with tuffs present on Moel Hebog, which are considered to have emanated from the same caldera (see the Moel Hebog to Moel yr Ogof GCR site report).

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