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## Braich tu du

[SH 650 606]–[SH 648 630]

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### Introduction

The steep western slopes of the ridge of Braich tu du, which form the eastern side of the Nant Ffrancon Pass, exhibit a classic condensed section up through a heterogeneous sequence of acid ash-flow tuffs, intrusions and marine sedimentary rocks. The section includes representatives of both the 1st and 2nd eruptive cycles of Caradoc caldera activity in North Wales as well as evidence for the background sedimentation, which provides valuable information on the general palaeoenvironment.

The site (Figure 6.30) lies on the north-western limb of a major synclinal structure, the Idwal Syncline. Moderate to gentle south-easterly dips expose up to 1000 m of section younging from NW to SE.

The area was included in the original primary geological survey completed in 1852 (Ramsay, 1881) and was resurveyed by the Geological Survey in 1968. It is included in the 1:50 000 scale Geological Sheet 106 (Bangor) (1985), although no detailed descriptions are available in the literature.

### Description

The lower beds exposed at the north-western end of the GCR site comprise cleaved grey siltstones of the Nant Ffrancon Subgroup, which pass conformably into the overlying volcanic rocks of the 1st Eruptive Cycle belonging to the Llewelyn Volcanic Group (Soudleyan). This group comprises five formations, four of which are exposed in this section.

The Braich tu du Volcanic Formation is a heterogeneous sequence, up to 280 m thick, of rhyolitic flows and acid ash-flow tuffs, locally with basalt and basic tuffs. On the ridge of Braich tu du, the type locality for the formation, the sequence is dominated by two thick rhyolite flows separated by a welded ash-flow tuff with basalt lavas, basic tuffs and sedimentary rocks. The lower rhyolite, 60 m thick, is overlain by an intensely welded ash-flow tuff, up to 90 m thick (Figure 6.31). The tuff, characterized by small prismatic albite phenocrysts, has a weakly welded basal zone rich in lithic and cognate clasts. At 6–7 m above the base, welding is intense and chloritic clasts (up to 10 cm in length), representing flattened fiamme, are accentuated by quartzose recrystallization. Internally, the central part of the flow is characterized by highly contorted rheomorphic flow-folding and brecciation. The top is pervasively autobrecciated. The upper rhyolite is 45 m thick and, like the lower flow, displays excellent flow-banding and flow-folding with prominent columnar jointing and autobrecciation along the upper and lower contacts. Petrographically, the rhyolites contain up to 25% phenocrysts of sodic plagioclase and cryptoperthitic feldspar set in a devitrified groundmass of spherulitic intergrowths of quartz and feldspar.

Thin basalt lava flows and water-lain basaltic tuffs, associated with sandstones and siltstones, interdigitate throughout the sequence. The basalts and basic tuffs, originally considered by Howells *et al.* (1983) as part of the formation, have been re-interpreted as belonging to the Foel Grach Basalt Formation and indicate contemporaneity of the two formations (Howells *et al.*, 1991).

The Foel Grach Basalt Formation generally overlies the Braich tu du tuffs along strike; inter-digitation of the two formations shows them to be essentially contemporaneous. At Braich tu du up to 180 m of basalt lavas and tuffs are exposed, interbedded with marine sandstones and siltstones, but the formation wedges out rapidly to the south. The basalt flows are plagioclase-phyric, amygdaloidal and tend to have massive columnar-jointed cores with blocky brecciated carapaces. Primary flow alignment of phenocrysts and feldspar microlites is evident in thin section. The rocks are metamorphosed to lower greenschist facies grade with plagioclase phenocrysts altered to albite ± carbonate ± epidote ± white mica and hornblende to chlorite ± clinozoisite ± actinolite ± carbonate.

Two thin ash-flow tuffs, interlayered with sandstones and siltstones, comprise the Foel Fras Volcanic Formation at Braich tu du, and represent the outflow facies from the Foel Fras Volcanic Complex (Howells *et al.*, 1991). The tuffs, of trachyandesite composition, are bedded and non-welded, with extensive reworking of the upper contacts. They comprise fragmentary feldspar crystals and lithic clasts in a matrix of albite + quartz + sericite + calcite + anatase. Relict shards replaced by chlorite and cryptocrystalline silica are common. The lithic clasts are mainly of trachyte lava and microdiorite with variable amounts of sandstone and silty mudstone. A thick dolerite sill separates the formation from the overlying Capel Curig Volcanic Formation.

Three distinct acid ash-flow tuffs, interlayered with sedimentary rocks and belonging to the Capel Curig Volcanic Formation, are well exposed between Bwlch yr Ole Wen [SH 6530 6206] and Clogwyn Lllys [SH 6500 6140]. These tuffs, originally mapped as two separate units (the 1st and 4th members) by Howells and Leveridge (1980), are now considered to be entirely within the 4th member (Howells *et al.*, 1991). In marked contrast to the primary character of the Capel Curig tuffs in the Capel Curig and Llyn Dulyn districts (see the Capel Curig and Llyn Dulyn GCR site reports), the tuffs here show no primary characteristics and are composed entirely of slumped tuff, block-and-ash tuffs, debris-flow deposits, accretionary lapilli-tuffs and thin primary ash-flow tuffs. The lowermost unit is dominated by well-bedded, thin tuffaceous sedimentary rock and is underlain by up to 20 m of coarse sandstone, which wedges out along strike against a thick dolerite sill. Within the sequence, interlayered sandstones and siltstones contain a sparse shelly fauna dominated by the brachiopod *Dinorthis*.

Cessation of volcanic activity at the end of the 1st Eruptive Cycle saw a period of shallow to offshore marine sedimentation of the Cwm Eigiau Formation. Above the prominent ridge and summit area around Penyrole-wen [SH 6534 6148], these strata are composed of well-bedded medium-grained fossiliferous sandstones with thin interlayers of siltstone and mudstone. These sedimentary rocks are described more fully in the Cwm Idwal GCR site account.

The 2nd Eruptive Cycle commenced with eruptive activity from the Llwyd Mawr Centre, with emplacement of acid ash-flow tuffs of the Pitts Head Tuff Formation. Along the lower slopes, north of Pont Pen-y-benglog, the northernmost expression of the Pitts Head Tuff Formation is exposed in the core of the Idwal Syncline. In contrast to the sections on Moel Hebog (see the Moel Hebog to Moel yr Ogof GCR site report) and Craig y Garn (see site report), the tuffs here are underlain and overlain by marine sedimentary rocks and deposition clearly took place in a submarine environment. The lower tuff, 30–40 m thick, has a thin non-welded base that grades up into white-weathering eutaxitically welded tuff with dark chloritic fiamme. Irregular zones of siliceous nodules are scattered throughout. More detailed descriptions of the formation and its confining sedimentary strata are provided in the description for the Cwm Idwal GCR site, covering the area located immediately to the south.

## Interpretation

The Braich tu du Volcanic Formation has been interpreted as representing the outflow facies from small-scale caldera-like structures that were active prior to the main 1st Eruptive Cycle centres in northern Snowdonia. The laterally restricted, but locally thick, accumulations of the Braich tu du tuffs south of their eruptive centre at Foel Fras, and their interdigitation with the Foel Grach Basalt Formation are interpreted by Howells *et al.* (1991) to reflect topographically controlled deposition within a series of small fault-controlled troughs. Within the troughs, subsidence kept pace with accumulation of the volcanic deposits and basalt effusion was controlled by fissures located along the trough margins.

The overlying Capel Curig tuffs were emplaced and reworked in a submarine environment. The tuffs contain accretionary lapilli indicating that they are the products of subaerial eruptions probably from a centre located to the south (Howells *et al.*, 1991).

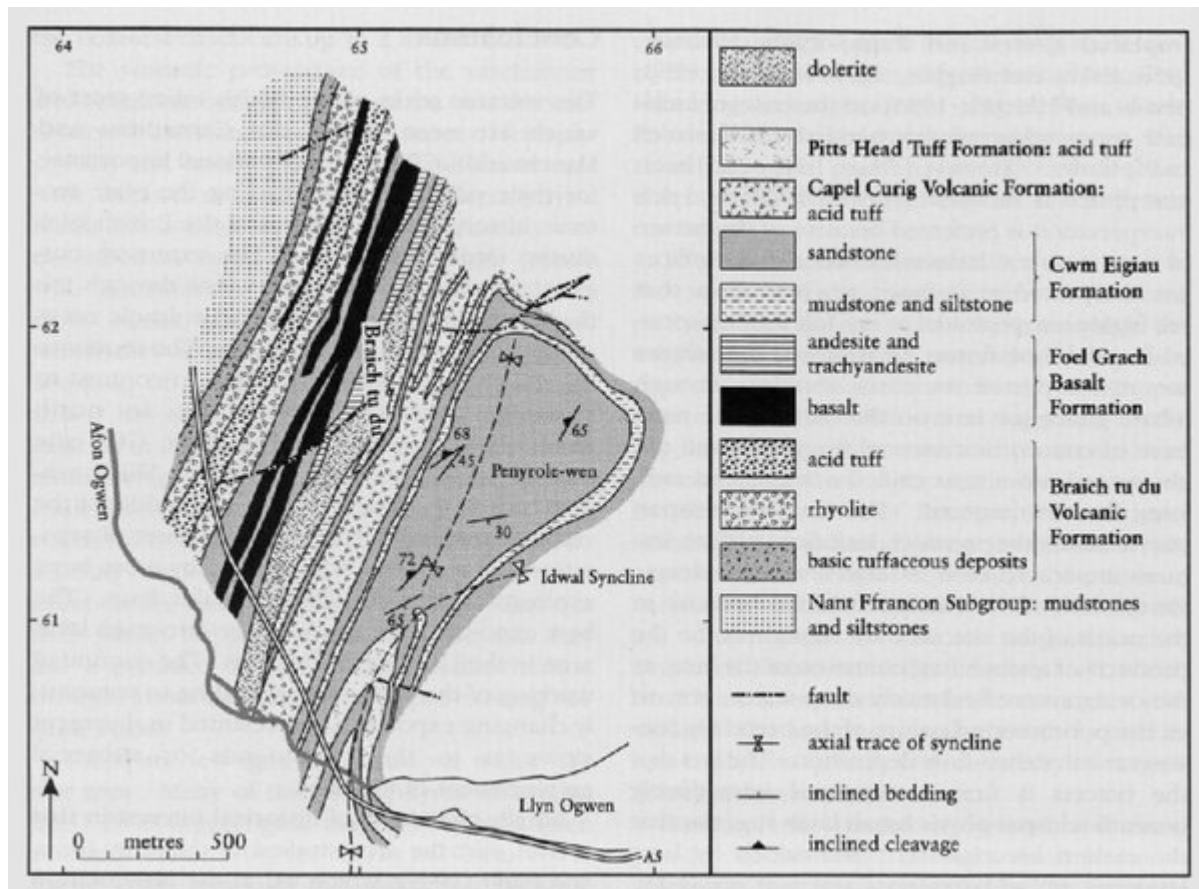
The sedimentary rocks above and below the Pitts Head tuff have been studied in detail by Orton (1988). Sedimentary features and bed-form analysis suggest that the underlying sedimentary rocks reflect a shallow shelf environment with shelf-ridge sands and interbar silts and muds, with the thicker, coarser sand bodies marking interbar storm events. Above the tuffs there is a fining-up sandstone-dominated sequence with trough cross-bedding, parallel lamination and winnowed fossiliferous beds, which is interpreted as accumulating in a transgressive non-barred wave-influenced shoreline (Reedman *et al.*, 1987). The contained shelly faunas, dominated by *Dinorthis*–*Macrocoelia* communities,

suggest water depths of less than 25 m (Pickerill and Brenchley, 1979). Thus, the Pitts Head tuffs were probably emplaced within a marine mid- to outer storm-dominated shelf environment. The tuffs clearly retained sufficient heat to weld upon emplacement and the streaming off of volatiles from the base of the tuffs facilitated the formation of irregular gas cavities and ductile deformation within the main body of the tuffs.

## Conclusions

The GCR site at Braich to du preserves an impressive section through a wide time-span of volcanic activity and sedimentation within the evolving Snowdon Graben. It contains representatives of most of the 1st Eruptive Cycle and the first major ash-flow tuff-forming eruptions related to the 2nd Eruptive Cycle. It is the type locality for the Braich to du Volcanic Formation with excellent exposed examples of welded acid ash-flow tuffs.

## References



(Figure 6.30) Map of the Braich tu du area. Adapted from BGS 1:25 000 Sheet 65/66 (1985).



(Figure 6.31) The lower rhyolite (R) and ash-flow tuff (1) members of the Braich tu du Volcanic Formation separated by a thin sequence of marine siltstone, sandstone and basic tuffaceous sedimentary rocks (S) on the NE slopes of Nant Ffrancon [SH 648 621]. The columnar joints in the welded tuff (1) are perpendicular to its base, which dips steeply to the right. Reproduced from Howells et al. (1991).