Cader Idris

10

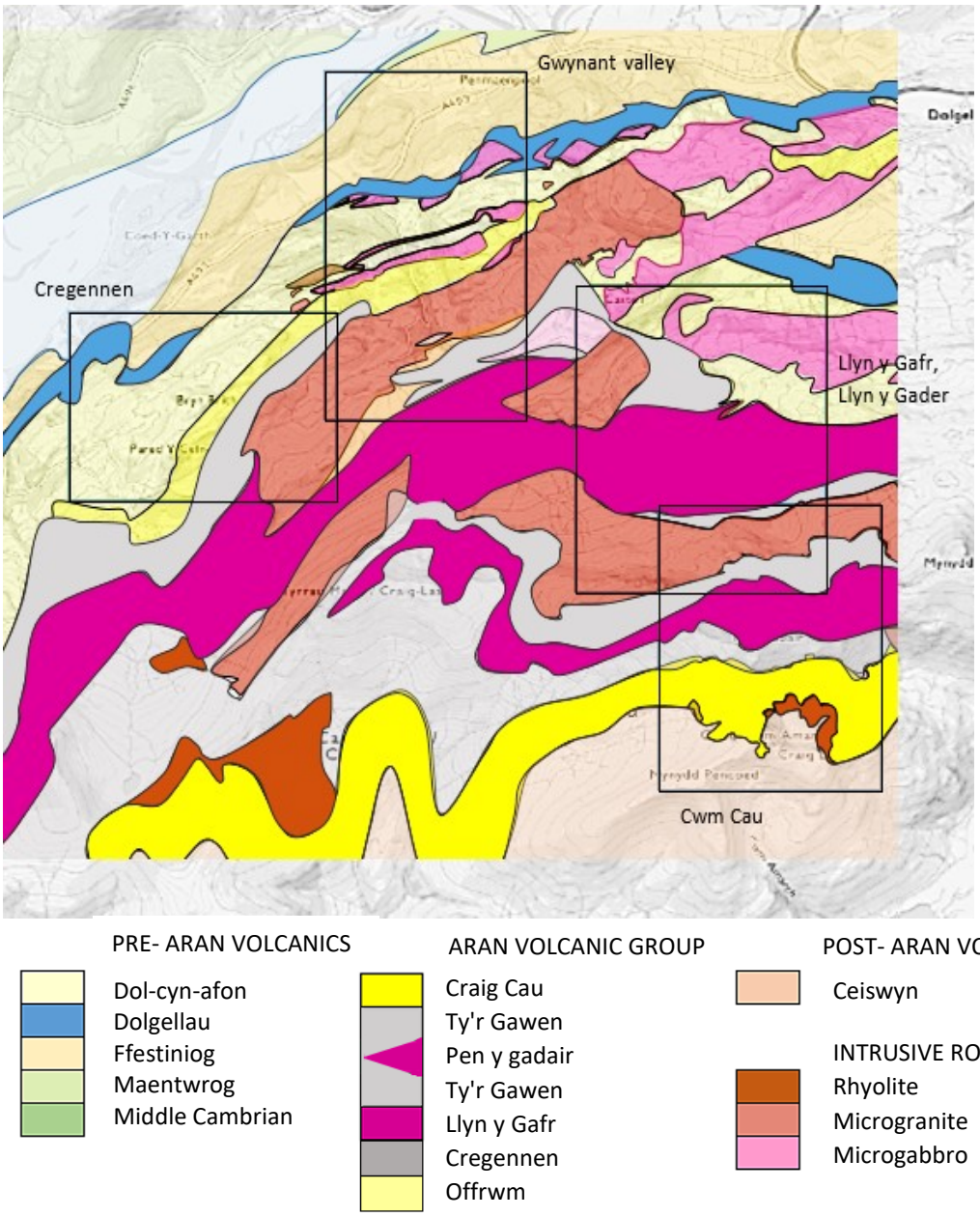


Figure 274: Field excursions.

By Ordovician times, the Avalonian microcontinent had detached from Gondwana, and could move freely across the Iapetus Ocean in response to subduction of oceanic crust. The plate tectonic setting was similar to present-day New Zealand. A number of volcanic centres developed across North Wales and were active for much of the Ordovician period.

The most complete succession of volcanic strata is found at Cader Idris where eruptions continued from early Ordovician Arenig times up to the Caradoc division in the late Ordovician. This may be due to the position of Cader Idris close to the junction of the north-south Rhobell fracture zone and the northeast-southwest Bala-Mawddach fracture zone. These deep faults form boundaries to the central crustal block of the Harlech Dome, and had been active during Cambrian times in controlling water depth and sedimentation. By the Ordovician period, the fracture zones could provide easy routes for magma to ascend from deep reservoirs at the subduction zone.

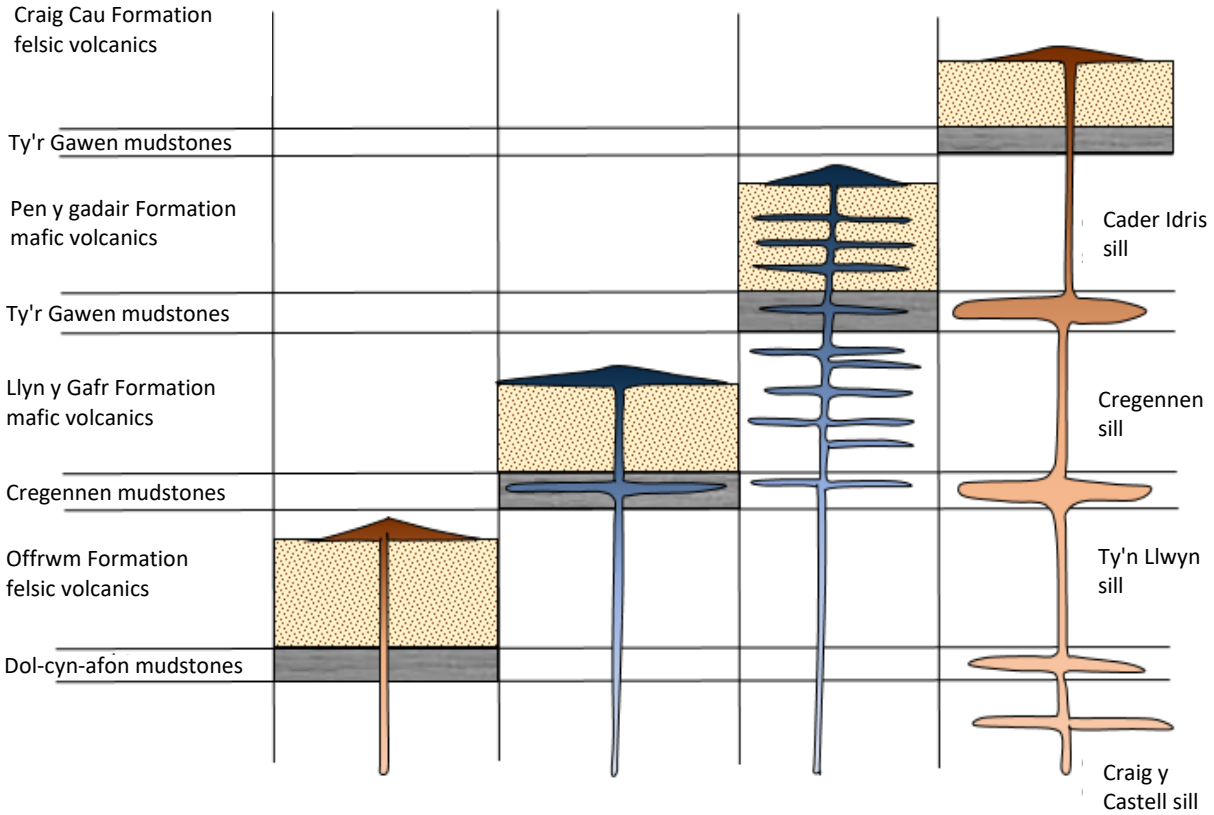


Figure 275: Cader Idris volcanic sequence.

Much of the Cader Idris volcanic sequence was directly erupted under water, or deposited into the sea from low volcanic islands. A particular feature of the Cader Idris rocks is their differentiation into high silica rhyolitic types and low silica basalts, with little material of an intermediate composition. This is characteristic of eruptions through thinned continental crust in an extensional back-arc basin environment.

The first detailed mapping of Cader Idris was carried out by Cox and Wells (1920) who identified four main divisions of the volcanic succession, separated by quiet deposition of marine muds during volcanically dormant periods. An initial phase of high silica felsic eruptions produced rhyolitic ashes and ignimbrites. This was followed by two periods of basalt lava and ash eruptions, before a final return to felsic ignimbrite eruptions. Further studies by Ridgeway, and then the British Geological Survey, have led to the current classification of the Cader Idris rocks into seven formations (fig.275):

- The **Dol-cyn-afon formation** at the beginning of the Ordovician marks the quiet deposition of conglomerates, sands and muds in the shallow waters of the Welsh basin. This followed earth movements at the end of Cambrian times. The first large scale volcanic activity was a phase of rhyolitic ignimbrite eruptions, perhaps from volcanic islands, to produce the **Offrwm formation**.
- The next sequence of rocks, the **Cregennen formation**, are perhaps the most varied deposits in the Cader Idris area. The formation is dominated by marine muds, but also locally contains basaltic ash and lava, and rhyolitic agglomerates transported by water-born debris flows.
- We now reach the **Llyn y Gafr** and **Pen y gadair formations**, two phases of submarine basalt pillow lava and ash eruptions. These were separated by a dormant period during which muds were quietly deposited as the **Ty'r Gawen formation**. Pillow lava was erupted from submarine fissures, accompanied by the intrusion of numerous microgabbro sills at a shallow depth beneath the sea bed. Sills were often emplaced at mudstone horizons, which provided an easy pathway for magma.
- The final volcanic phase at Cader Idris, the **Craig Cau formation**, saw the accumulation of great thicknesses of rhyolitic ignimbrite. This was accompanied by the emplacement of a series of microgranite and microdiorite

intrusions beneath the volcanic centre, including the Cader Idris and Cregennen sills.

An important factor controlling the distribution of volcanic centres around the Harlech Dome is the presence of deep fracture zones. Magma was more easily able to reach the surface along these fractures than through the intervening solid blocks of the lower crust.

Passing beneath the Cader Idris area is the northeast – southwest oriented **Bala-Mawddach fracture zone** (fig.278). The principal active branch of this fracture zone during Ordovician times lay in approximately the position of the deep valley which now runs along the northern edge of Cader Idris past the Gwernan lake.

Figure 276: Gwernan Lake

By the end of the Ordovician, the main focus of fault movement had transferred to the present-day Tal-y-Llyn valley, within upper Ordovician mudstones to the south of the Cader Idris volcanic centre.

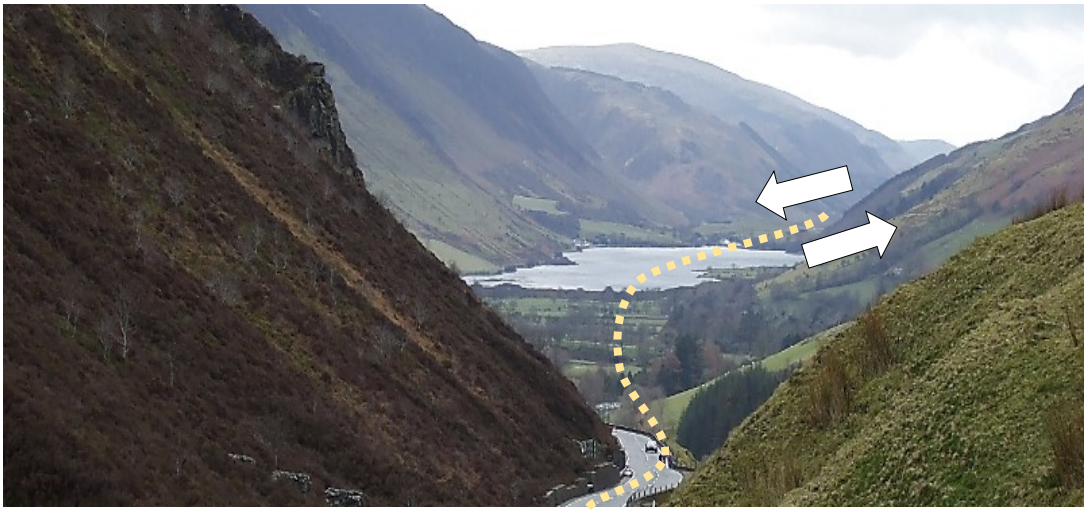
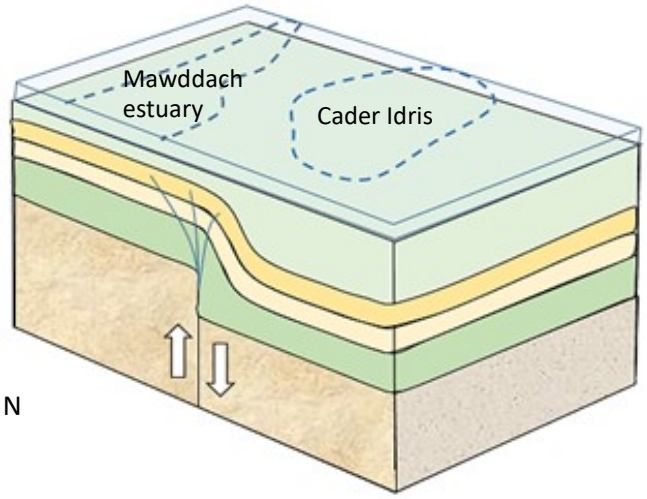
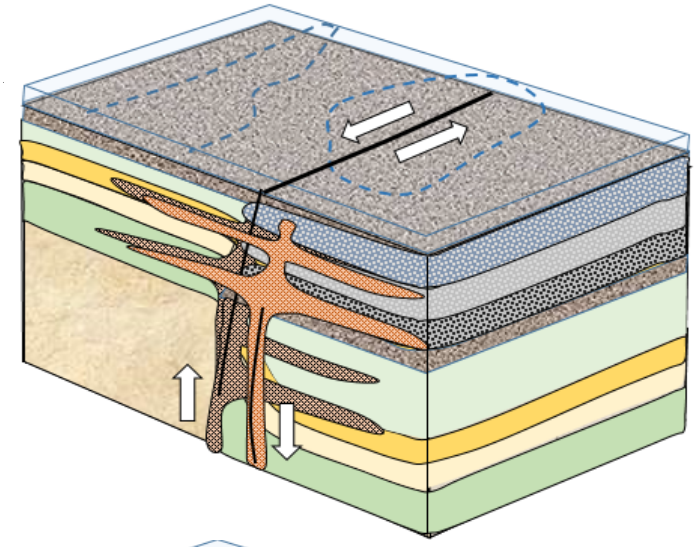


Figure 277: Tal-y-llyn.

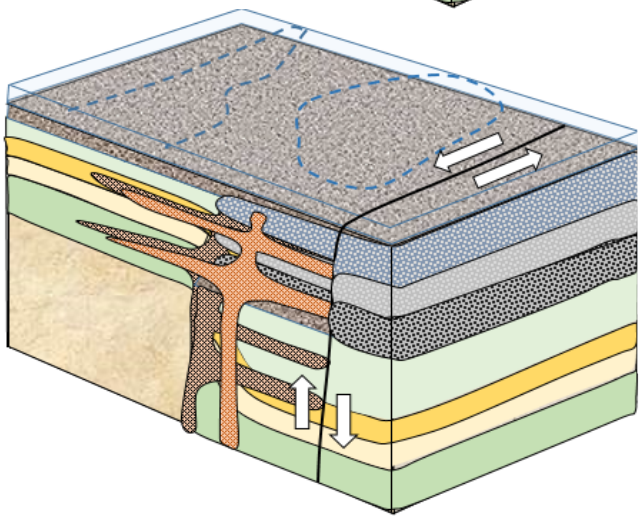


In late Cambrian times, uplift of the basement below the central Harlech Dome took place along bordering fracture zones. The fracture to the south of the Dome lay close to the present day Gwernan valley, between the Mawddach estuary and the main mountain mass of Cader Idris.



During the phases of Ordovician volcanicity, the fracture zone provided an easy pathway for magma to rise to high crustal levels, where eruptions took place and sills were intruded.

When the early fractures became filled by solidified intrusions, new parallel fractures opened to maintain upwards magma flows.



By the end of the Ordovician volcanic episode, the fracture zone around Cader Idris had become a solid mass of igneous intrusions. In order to maintain horizontal and vertical fault movement on the southern margin of the Harlech Dome, a major fracture opened through softer sediments immediately to the south of Cader Idris along the present day Tal-y-llyn valley.

Figure 278: Development of the Bala-Mawddach fracture zone

Cregennen

3 miles: approximately 2 hours

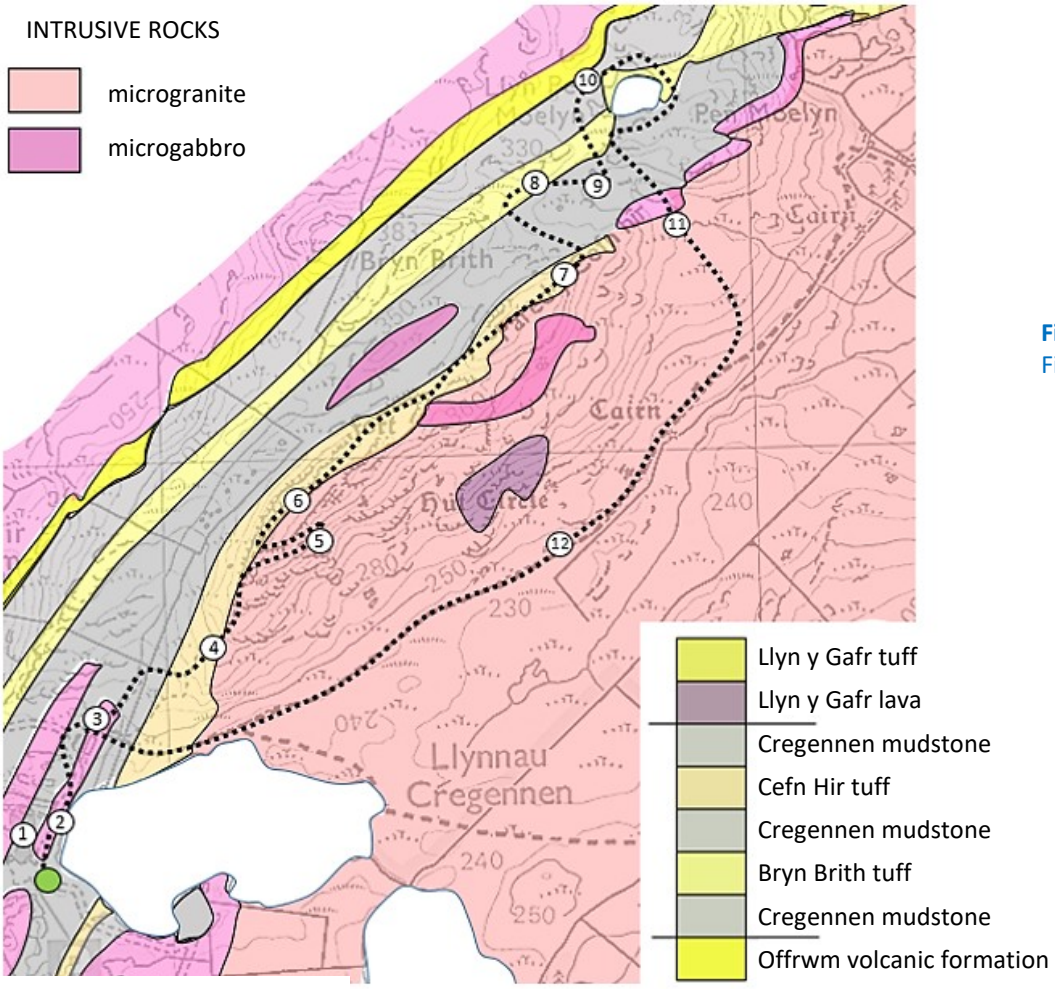


Figure 279: Field excursion.

The objective of this excursion is to examine the Offrwm and Cregennen formations in outcrops above the Cregennen lakes, and also to investigate several large sill intrusions related to the later volcanic phases at the Cader Idris centre.

Start: A car park is provided at Llynnau Cregennen [SH659142].

1: Examine outcrop of gabbro on the hillside above the car park. This is medium-grained mafic rock emplaced as a thick sill. It is probably a shallow intrusion into sea-bed muds, related to basalt eruptions of the later Pen y Gadair formation. This and other sills which run parallel have been mapped for ten kilometres between Arthog and Dolgellau, following the line of the Bala-Mawddach fracture zone.

Figure 280: Gabbro sill intrusion, Cregennen.

2: Examine an outcrop of graptolitic shales in a small slate quarry alongside the road.

Unlike trilobites which were restricted to shallow coastal waters, graptolites were free swimming or drifting colonies of organisms which could inhabit sea areas from inshore to open ocean. We find that graptolites become the dominant fossil type within the Welsh Ordovician suggesting an open, though perhaps shallow, marine basin across the Avalonian microcontinent in this area. The fine mud, which has subsequently been metamorphosed to a low grade slate, indicates a sediment supply from low surrounding land areas, or from marine shelves where finer sediment could be remobilised by bottom currents and transported into offshore waters.

Figure 281: (left) Quarry in Cregennen slate alongside Llyn Cregennen. (right) Fossils of the graptolite *Didymograptus*.

3: Turn off the surfaced road before it begins to descend to the Mawddach estuary. Take the footpath towards Pared y Cefn Hir. After crossing a stile, head for the low crags on the hillside at the base of the mountain to the left.

4: Examine a sequence of pyroclastic deposits within the Cefn Hir Member of the Cregennen Formation. These are sedimentary rocks composed of a variety of volcanic fragments from fine ash to pebbles and larger blocks. Much of the fine material is basaltic, whilst larger blocks are often of rhyolite.

Pyroclastic rocks are often formed by air-fall of ash and larger volcanic debris onto the slopes of a sub-aerial volcano. However, the fine uniform layering of the finer ash suggests redeposition by water currents in the seas around the volcanic vents. The coarser material shows grading, with the largest debris at the base of thick poorly sorted layers. It is likely that the coarse deposits were discharged from the margins of a volcanic island into the deeper waters of the basin by a simple slumping mechanism or as high energy turbidity flows on steeper sea-bed slopes.

The Cregennen Formation represents a phase of very varied volcanic activity, with both submarine eruptions of basaltic lava and ash, and sub-aerial eruption of rhyolites onto volcanic islands. In addition to the eruption of ash, rhyolitic volcanoes can extrude viscous lava. This does not flow far from the vent, but instead builds up into a dome of brittle blocky debris. This coarse material could then slump into the surrounding waters, forming deposits of the type seen at Cregennen.

Figure 282: Cefn Hir pyroclastic deposts.

5: Re-join the path up the hill. Pass a line of crags on the right which exhibit further coarse pyroclastic sediments of the Cefn Hir member. Turn immediately to the right and contour around the face of Pared y Cefn Hir until a block scree is reached in a gully in the hill slope. Ascend the scree to locate the margin of the Cregennen microgranite.

The Cregennen microgranite is a huge sill intrusion with a maximum thickness of 500m. It is one of a series of sill offshoots from a magma conduit which was active beneath the Cader Idris volcanic centre during Craig Cau Formation times in the late Ordovician.

The microgranite is seen to be packed with darker xenoliths. These consist mainly of microgabbro, representing the first magma which was emplaced within the Cregennen sill. Whilst this mafic material was still semi-solidified, the main inflow of magma of felsic composition split the microgabbro intrusion and incorporated many fragments into the microgranite melt.

At this location, the lower basic margin of the Cregennen sill forms the back face of the gulley, with microgranite outcropping in the lower ground occupied by the Cregennen Lakes. It is likely that the many small scale joints within the microgranite made it susceptible to river erosion during Tertiary times, then glacier erosion during the Pleistocene.

Figure 283: (left) Margin of the Cregennen microgranite, showing a mixture of angular and rounded xenoliths of dark microgabbro in the lighter microgranite. (right) Detail of xenoliths.

6: Ascend the head of the gulley to re-join the path to the summit of Pared y Cefn Hir. The path ascends through a gulley formed by the outcrop of a basalt lava.

Looking eastwards from the summit of Pared y Cefn Hir, the Cregennen formation sequence can be related to the outcrop pattern. Resistant pyroclastic rocks form the ridges of Pared y Cefn Hir ahead, and Bryn Brith to the left. Two pyroclastic horizons within the Cefn Hir member are separated by a softer mudstone which forms a small valley within the crest of the ridge.

Mapping has shown that the pyroclastic members merge together as they are followed inland towards Mynydd-y-gader, with the intervening mudstones becoming thinner then disappearing. This suggests that the source of the pyroclastic material lay a short distance to the east, perhaps on an emergent volcanic island.

7: Continue along the crest of Pared y Cefn Hir, crossing a gulley and climbing back up to the summit ridge. An area is reached where the outcrops exhibit spectacular pyroclastic deposits containing large blocks of flow banded rhyolite in a fine ashy matrix (fig.285). The matrix is darker, and has a basaltic composition. The rough stratification of this material, and orientation of the longer axes of clasts, suggests that it was transported and deposited under water. A possible mechanism for its origin is that ash and larger

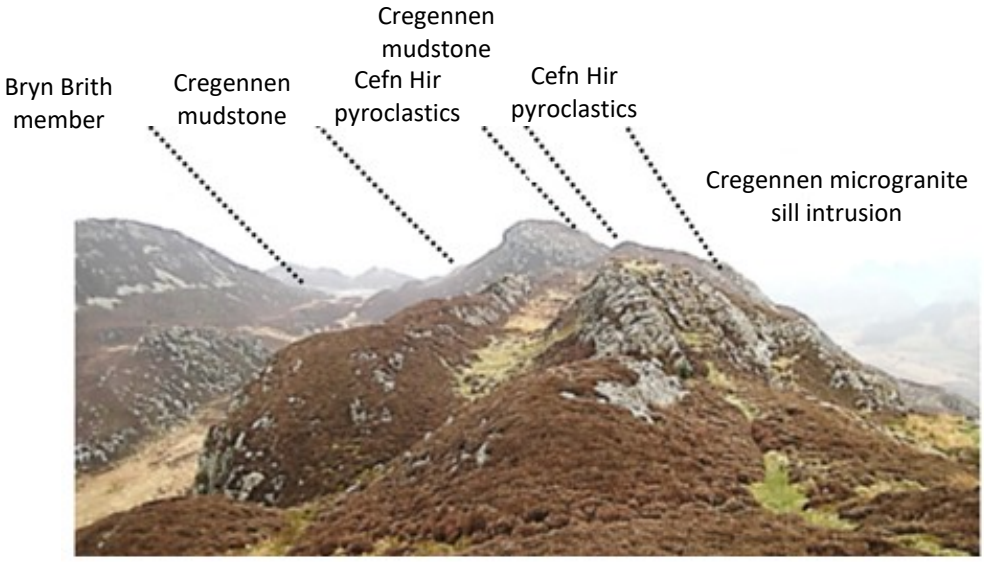


Figure 284: Ridges of Pared y Cefn Hir and Bryn Brith, formed by outcrops of the Cefn Hir and Bryn Brith members

volcanic debris accumulating on the margins of a volcanic island slumped under gravity into the deeper waters offshore.

Figure 285: Basaltic debris flow containing rhyolite fragments.

Figure 286: Volcanic ash, Bryn Brith.

8: Descend the northern side of Pared y Cefn Hir and cross the small valley formed by Cregennen mudstone to reach an outcrop of the Bryn Brith member. As in the case of the Cefn Hir rocks, the Bryn Brith rocks are of pyroclastic origin. They contain water-transported volcanic fragments which have accumulated to produce volcanic sandstones. Some larger pebbles are present, along with occasional sedimentary slump structures characteristic of deposition at the base of a submarine slope.

9: Continue down the valley to reach the site of a small slate mine. Specimens of the graptolite *Didymograptus,* and very occasionally trilobites, can be obtained from shales on the waste tip.

Figure 287: Small slate quarry below Llyn Pen Moelyn.

10: Walk up the small valley to the left which leads to Llyn Pen Moelyn. Examine outcrops of the Offrwm Volcanic Formation in the crags to the north of the lake.

These rocks are rhyolitic ashes and ignimbrites. Some ash bands show bedding, which suggests they were produced by air-fall. In places, cross-bedding is found, so deposition may have been into the waters around a volcanic vent.

The thicker strata have been deposited from ash-flow clouds. There is a strong, welding foliation parallel to the bedding planes, which is picked out by darker fiamme structures produced by flattening of volcanic glass. The foliation is deflected around large nodules of silica and fragments of pumice.

11: Return down the stream valley past outcrops of Cregennen microgranite to reach the broad valley along the base of Pared y Cefn Hir.

12: Take the path along the base of the mountain to reach the car park.

If returning to Dolgellau along the minor road past Cader Idris, it is worth visiting outcrops of the Lower Basic pillow lavas which have been mined for iron ore in historic times. Turn right at the T-junction south of the Cregennen lakes. After a short distance, the ruined farmhouse of Hafotty-fach is reached. Pass through a gate to reach a parking area. Walk back to Hafotty-fach and climb up the slope to reach the rear of the building. A short distance to the west are the remains of excavations in which samples of pillow lava containing specular hematite iron ore can be found.

Figure 288:

(above left) Ruins of Hafotty-fach farmhouse.

(above right) Iron ore working behind the farm building.

(right) Specular hematite deposits which formed in the cavities between lava pillows, carried by hydrothermal fluids from the cooling basalt.

Gwynant valley

5 miles: approximately 2 hours

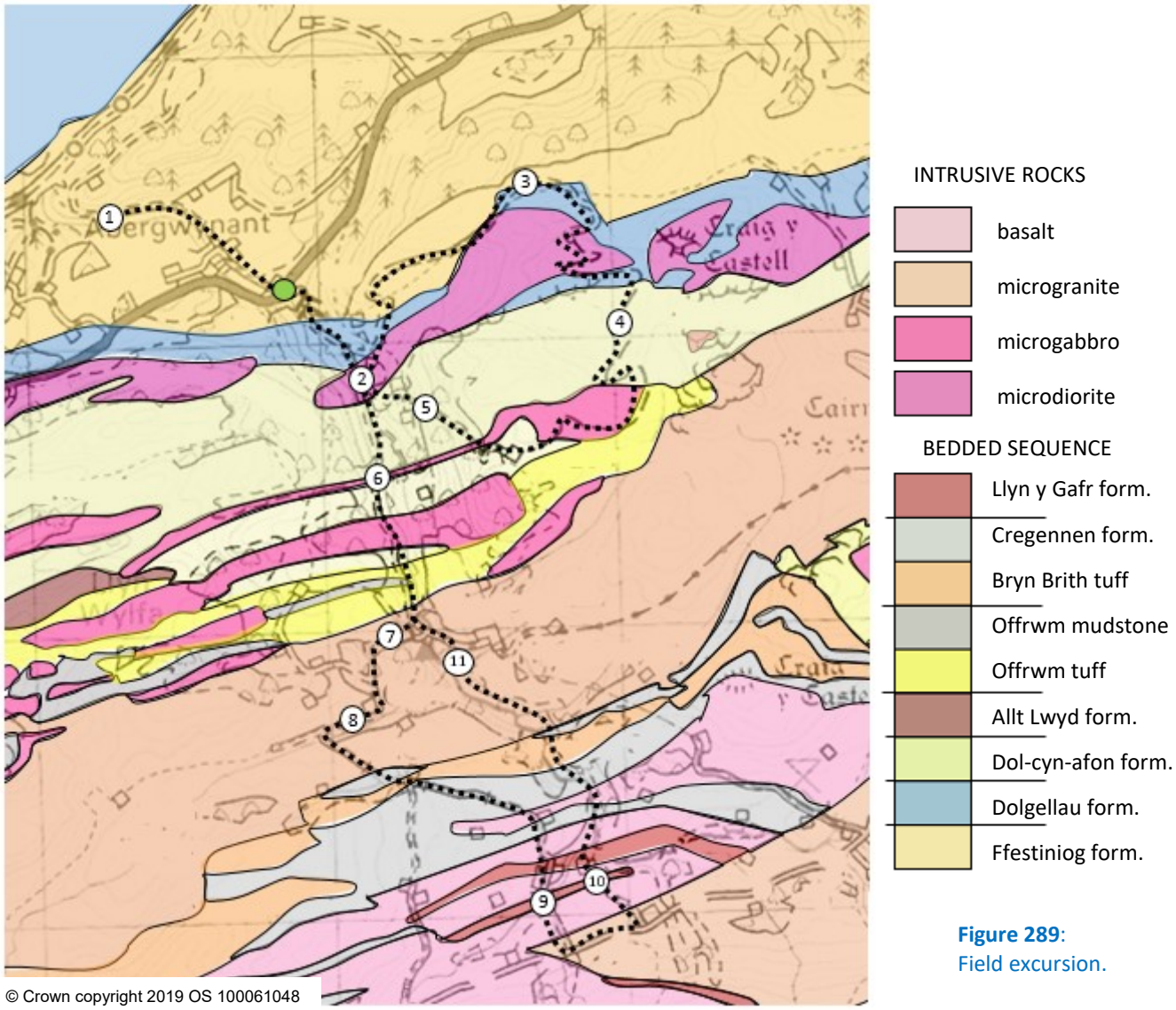


Figure 289: Field excursion.

In this excursion we carry out a transect from the upper Cambrian rocks alongside the Mawddach estuary, to the rhyolitic and basaltic volcanic rocks of the Offrwm, Cregennen and Llyn y Gafr formations. In addition, we will examine a number of sill intrusions associated with later phases of the Cader Idris volcanic centre.

Start: Park at the minor road junction near Abergwynant bridge on the main road from Dolgellau to Fairbourne [SH679172].

1: Take the farm road to Abergwynant. Where the road crosses a stone bridge, follow the track alongside the river to the woodland. Continue through the woods to reach the disused railway alongside the Mawddach estuary.

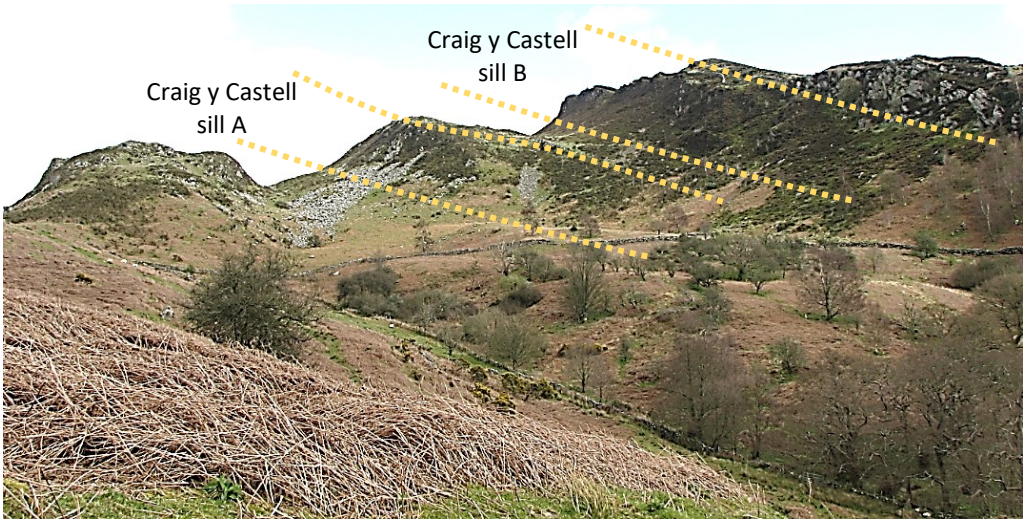
Figure 290: Ffestiniog beds at Abergwynant woods

Outcrops of the Ffestiniog formation are seen in crags alongside the old railway, and along the Abergwynant woodland footpath. The Ffestiniog strata are shallow water sandstones, siltstones and mudstones.

2: Return to the main road junction and take the minor road up the Gwynant valley. At the top of the hill, take the track to the left which climbs towards the summit of Craig y Castell.

3: Outcrops of grey and black slates of the Dolgellau formation are seen at the side of the track as it climbs the hillside. Graptolites are present.

4: The track ascends across thick sill intrusions, which also outcrop on the adjacent peak of Craig y Castell to the east. The sills have a composition varying from microgabbro at the base to microdiorite in the middle and upper portions. This suggests that gravity settling of mafic crystals such as pyroxene took place after magma of an intermediate silica composition was intruded.



A-B Craig y Castell sills
C Ty'n Llwyn sill
D Cregennen sill

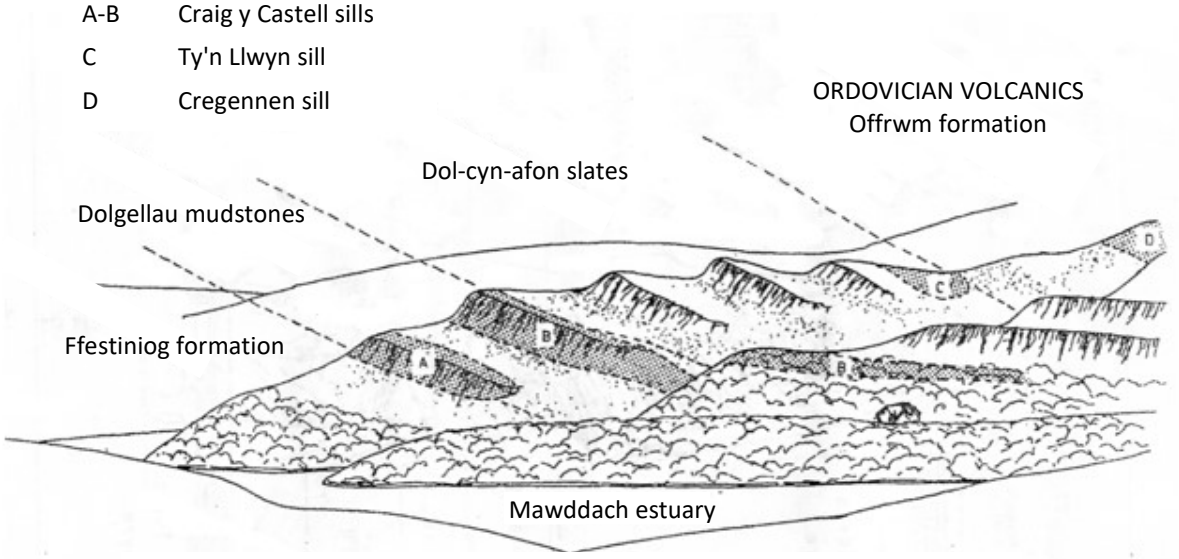


Figure 291: Sill intrusions above the Gwynant valley.

A series of sills form escarpments on the saw-tooth skyline above the Gwynant valley. It is thought that this group of intrusions are co-magmatic, being fed from the same magma chamber through a connecting vertical fissure during late Ordovician Craig Cau Formation times when rhyolitic ignimbrites were being erupted at the surface. The pattern in which the sills lie above one another, up-arching the overlying strata, is termed a **cedar tree laccolith**.

Figure 292:

(left) Craig y Castell microdiorite.

(right) Cregennen microgranite.

It is noticeable that the sills become progressively more felsic upwards. The Craig y Castell sills at the base have an intermediate composition containing a large proportion of dark pyroxene and amphibole crystals, whilst the Cregennen and Cader Idris sills at the top of the sequence are composed largely of quartz and feldspar. The branches of the laccolith appear to have acted as high level magma reservoirs, with the lowest density microgranite melts able to ascend to the highest crustal level before reaching lithostatic equilibrium and spreading sideways.

5: Descend from Waen Fechan to the Gwynant valley.

6: Turn left to follow the road up the Gwynant valley. Examine the large microgabbro intrusion in the cliffs above the bridge over the river.

7: At Kings Youth Hostel, examine outcrops of Cregennen microgranite alongside the road as it climbs up through woodland at the head of the valley.

8: Just beyond a ruined chapel building, take a footpath to the left which descends to a footbridge over a deep gorge cut in the Cregennen microgranite.

9: Return to the road, and continue up the valley to Cefn-yr-Owen farm. The road descends beyond the farm to reach a bridge over a small stream. To the left, a river cliff is cut in basalt lavas and ashes of the Llyn y Gafr formation (fig.293).

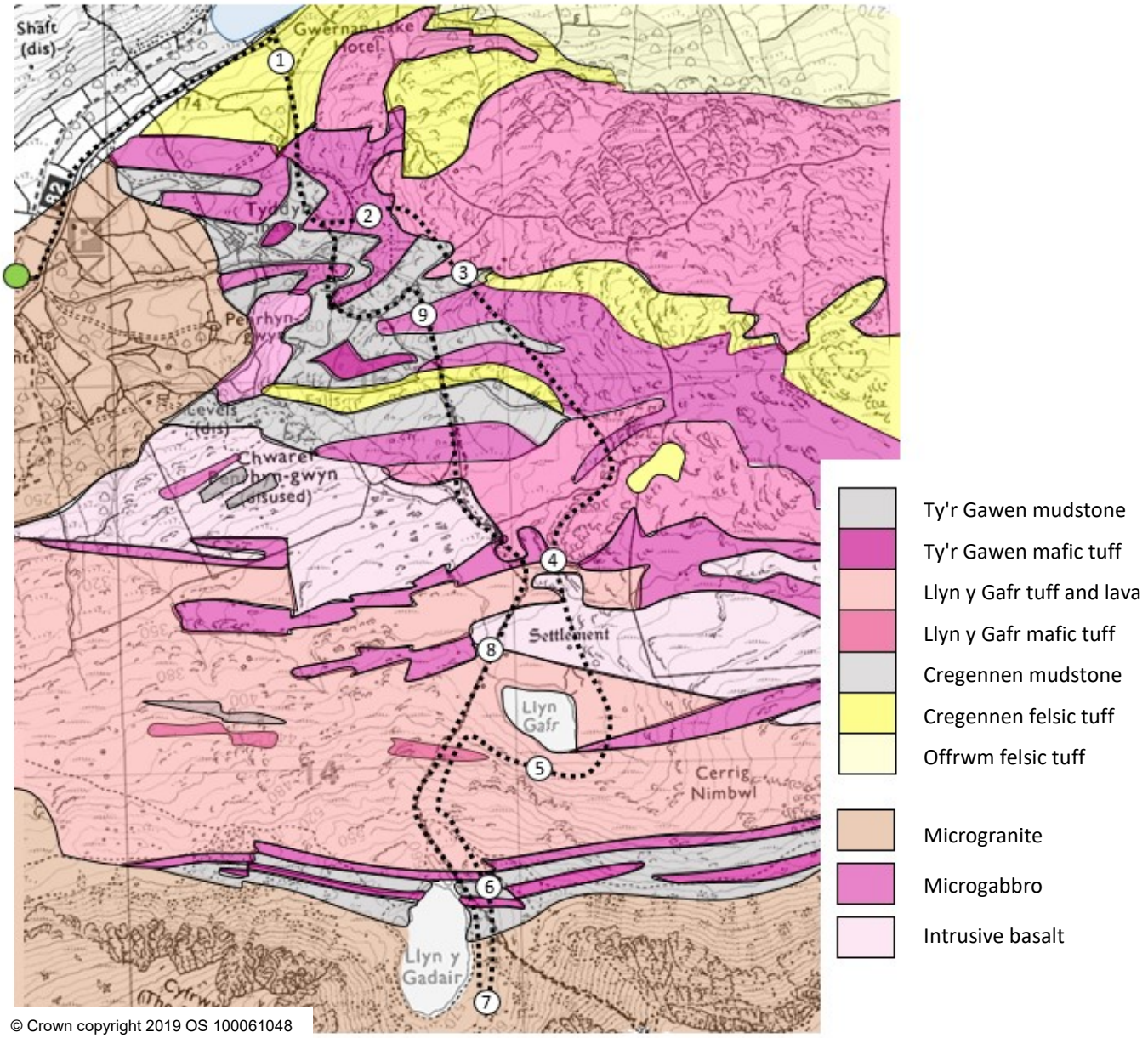
Figure 293: The stream gorge at Cefn-yr-Owen. Basalt Lavas and ashes of the Llyn y Gafr formation are exposed in the river cliffs.

10: Continue along the road to the T-junction, then turn left. After a short distance, take the lane on the left to Tynycaenant farm. From this point, a footpath follows the river back to Kings Youth Hostel.

11: Re-join the road at Kings, and walk down the valley to the parking point.

Llyn y Gafr and Llyn y Gader

4 miles: approximately 2½ hours



This excursion takes us from the fault valley at Gwernan lake, up across a series of volcanic formations to the base of the huge Cader Idris sill intrusion at Llyn y Gader, then returns past basalt outcrops at Llyn y Gafr and microgranite on Mynydd y Gader.

Start: A car park is available at Ty Nant [SH698153].

1: Walk back along the minor road to the Gwernan Lake Hotel, then take the footpath to Cader Idris which begins at a gate opposite the entrance to the hotel.

2: Continue along the footpath to the top of the hill above Tyddyn mawr farm, then branch off up the hillside to the left to reach outcrops of pyroclastic rocks belonging to the Cregennen formation.

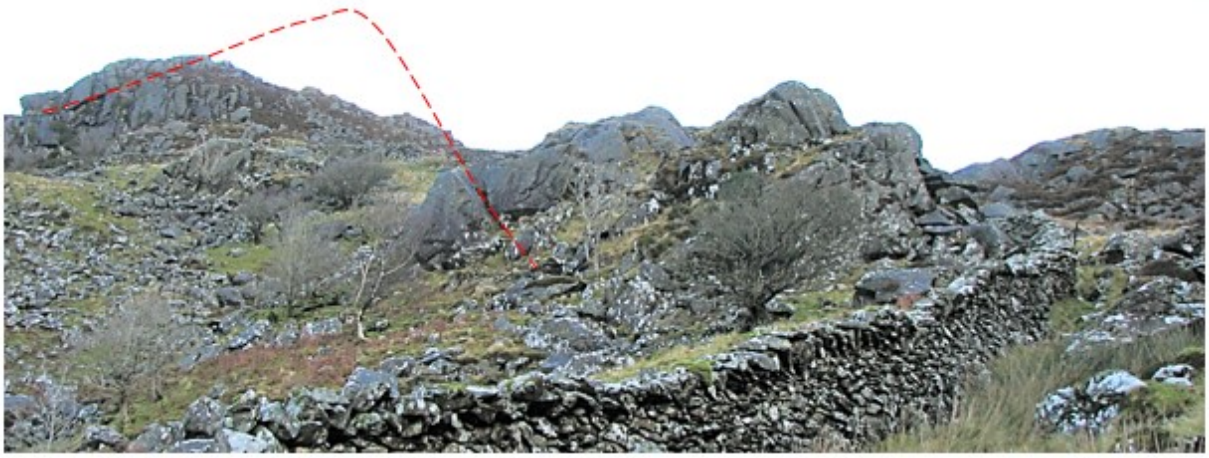
A variety of rock types is found, with similarities to the pyroclastic beds which can be seen at Pared y Cefn Hir during the Cregennen field excursion. Bedded ashes are present, along with coarser debris flows containing rhyolite fragments in a basaltic ash matrix (fig.295). A shallow water depositional environment is likely.

Figure 295: Outcrops of the Cregennen formation, Mynydd y Gadair. (above) Debris flow, with rhyolite fragments in a basaltic ash matrix. (right) Layered basaltic and rhyolitic ashes, showing evidence of deposition by water currents on the sea bed.

3: Skirt around the end of Mynydd y Gadair, examining outcrops of microgabbro (fig.296).

Across the summit slope of Mynydd y Gadair, the microgabbro forms a northwards-dipping sheet overlying pyroclastic rocks which dip southwards. The intrusion at this point is therefore a transgressive dyke, ascending through the volcanic succession.

Just before Llyn y Gafr is reached, the microgabbro sheet is seen to change its orientation, becoming a conformable sill intrusion. It is likely that the Mynydd y Gadair intrusion is co-magmatic with the basalt lavas and ashes of the Pen y gadair formation which outcrop around the summit of Cader Idris.



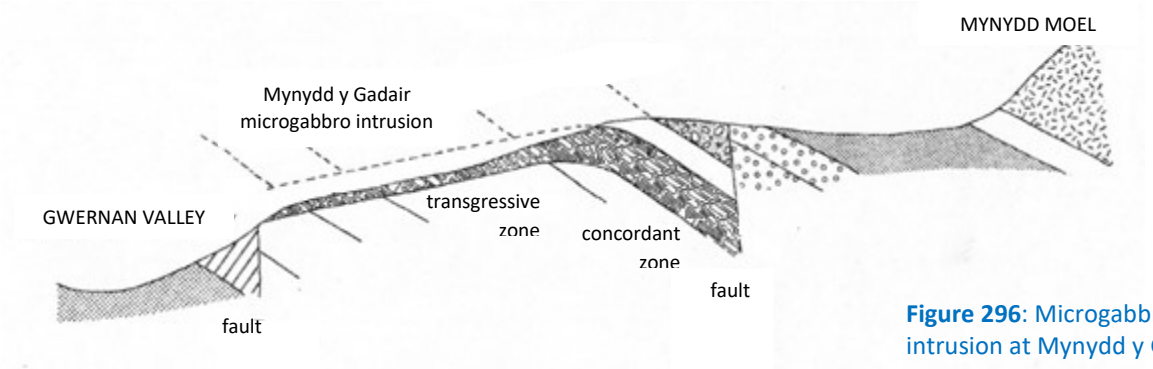


Figure 296: Microgabbro sheet intrusion at Mynydd y Gadair.

4: Continue around the eastern end of Llyn y Gafr, then ascend the hillside to reach outcrops of the Llyn y Gafr formation. At this point, a mixture of basalt lavas, basaltic and rhyolitic ashes are seen. The nature of the volcanic eruptions were varying between low silica and high silica types, and between quiet lava flows and explosive ash clouds. In the outcrop illustrated in fig.297, we see evidence of a rhyolitic ash accumulating on the irregular surface of a basalt lava. The light coloured rhyolitic ash is overlain by a uniform bed of basaltic ash. It is likely that the materials were deposited under water.

Figure 297: Rhyolitic ash deposited on an irregular surface of basalt lava.

5: Cross the hillside above Llyn y Gafr, keeping above the level of the screes to examine outcrops of basalts of the Llyn y Gafr formation. Pillow structures can be found, indicating that the lavas were erupted under water (fig.298).

Figure 298: Pillow structures in basalt, Llyn y Gafr.

6: Join the footpath which ascends to the cirque basin of Llyn y Gadair. Beds of the Ty'r Gawen Formation are exposed in the outlet channel from Llyn y Gadair. This formation is unusual in being defined by lithology rather than a position within the stratigraphic succession. The Ty'r Gawen formation consists of mudstones laid down on the sea bed during inter-volcanic episodes, and Ty'r Gawen strata occur both below, within and above the Pen y Gadair basaltic formation.

7: The Cader Idris microgranite sill is reached, with its outcrop making up most of the scarp face of Cader Idris above the deposits of scree (fig.299). The geology of the summit area of Cader Idris will be discussed in the following excursion to Cwm Cau.

8: Return to the Gwernan Lake hotel along the direct footpath.

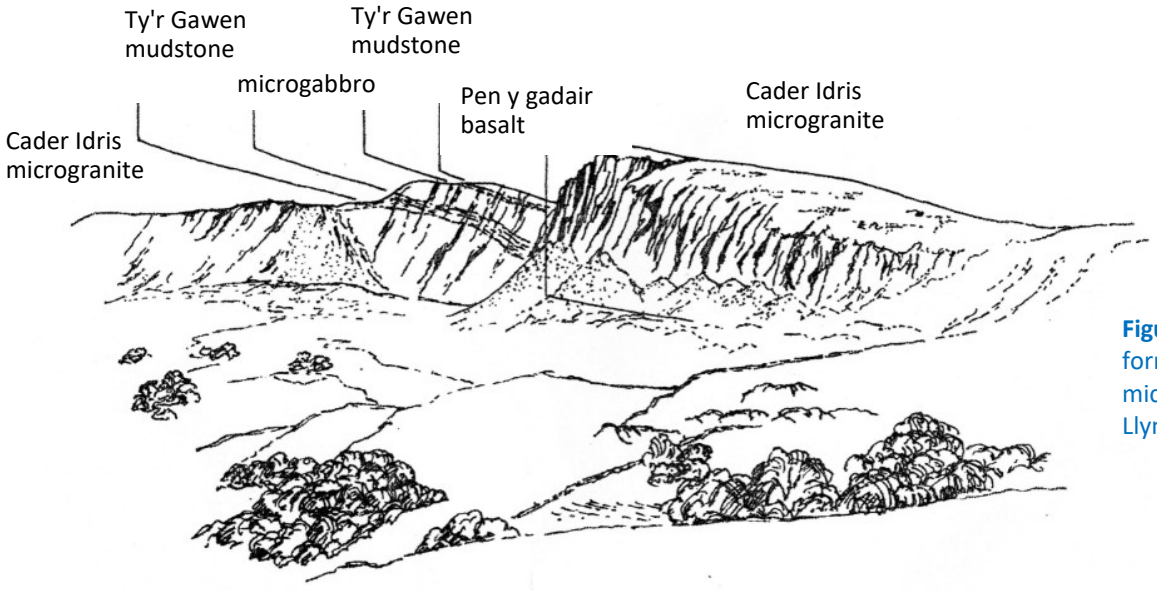
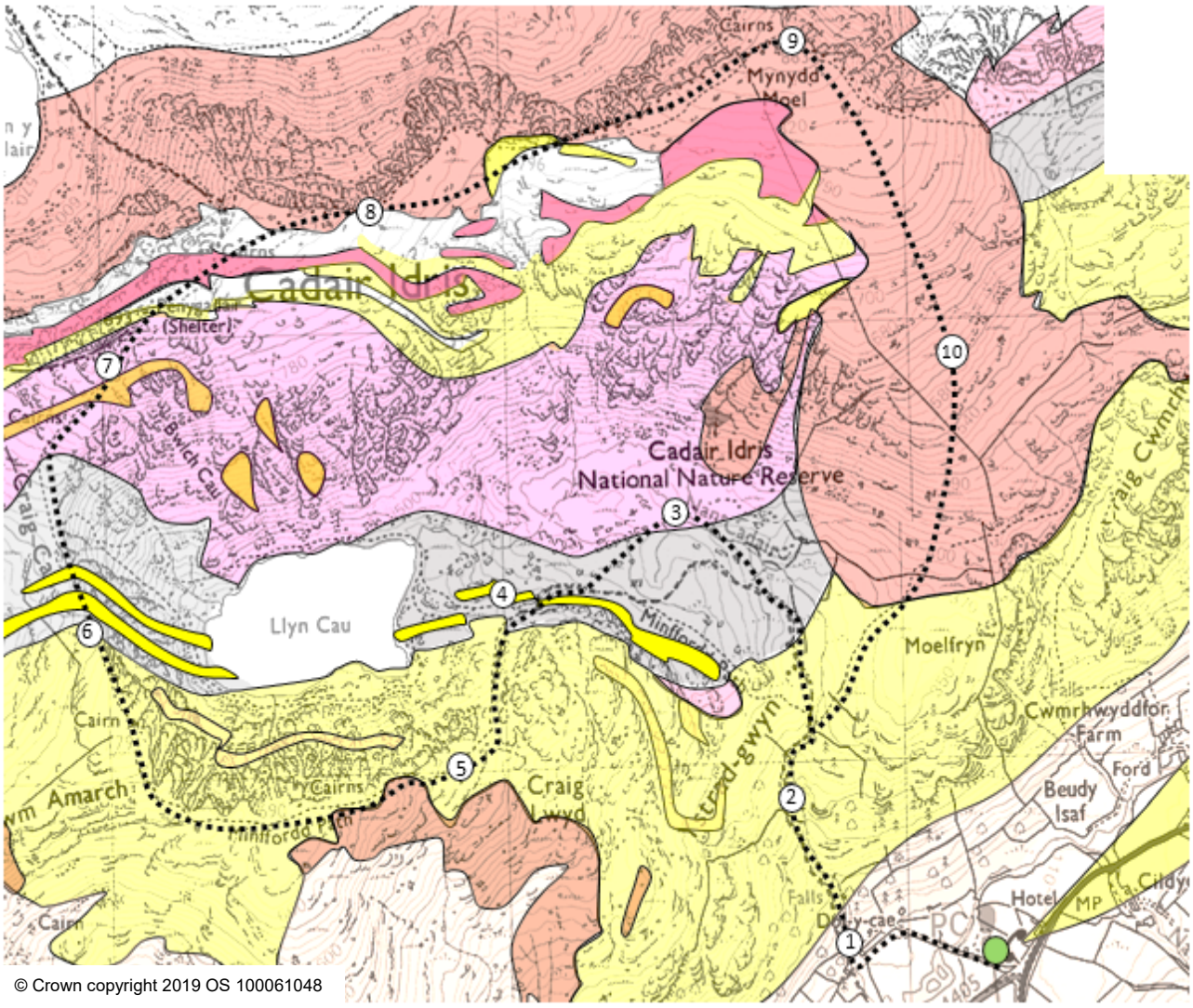


Figure 299: escarpment formed by the Cader Idris microgranite sill above Llyn y Gader.

Cwm Cau

4 miles: approximately 3 hours



- Ceiswyn mudstone, siltstone
- Craig Cau felsic tuffite
- Craig Cau felsi tuff
- Craig Cau mudstone
- Craig Cau basalt
- Ty'r Gawen mudstone
- Ty'r Gawen mafic tuffite
- Pen y gadair tuff, lava
- Pen y gadair felsic tuff
- Ty'r Gawen mudstone
- Microgranite
- Microgabbro

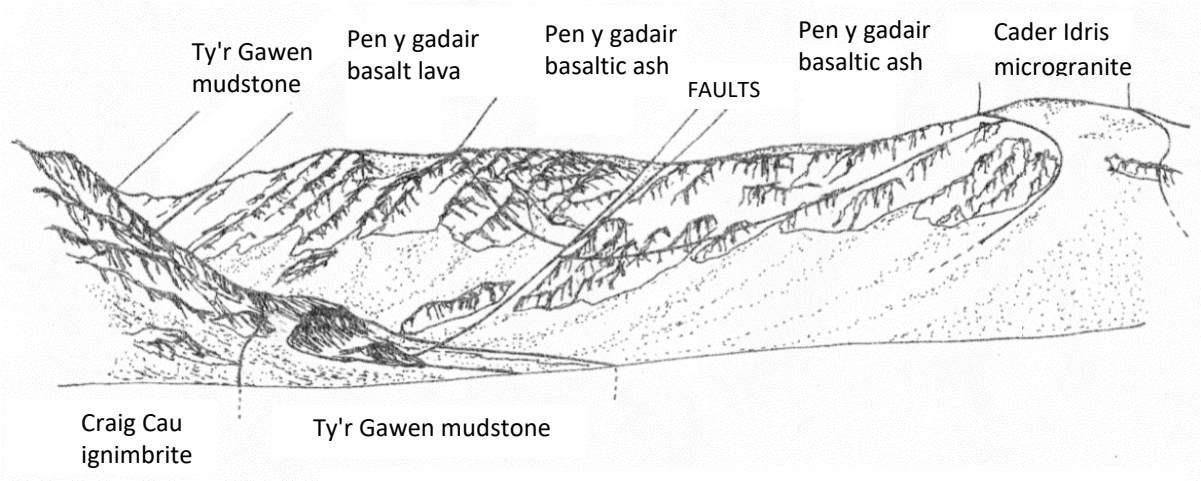
Figure 300: Field excursion

In this excursion, we follow the popular Minffordd path from the Tal-y-Llyn valley to the summit of Cader Idris, returning by a circular route above the cliffs of Cwm Cau.

Start: A car park is available at Minffordd [SH732116].

1: Take the path which ascends steeply alongside waterfalls.

2: Examine ignimbrites and shales as Cwm Cau is reached. Cwm Cau is developed along the outcrop of Ty'r Gawen mudstones which have presented less resistance to ice erosion then the more massive volcanic formations. However, the



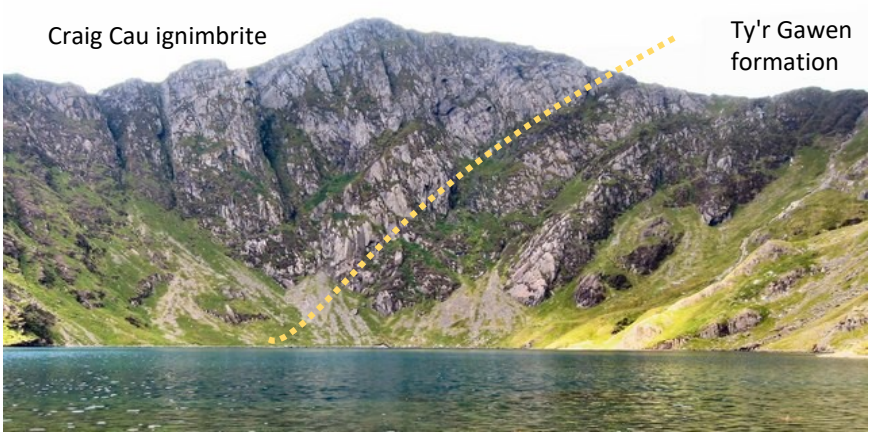


Figure 301:
(right) Outcrops above Cwm Cau.
(below) Llyn Cau at the head of Cwm Cau.

Ty'r Gawen sequence does include several thick ash bands which form rocky outcrops within Cwm Cau and are clearly visible in the back wall of the cirque above Llyn Cau. These ash bands represent isolated eruptions in the Welsh basin during a generally quiescent period.

3: Leave the main path and follow the river bank upstream. A gorge is reached which exposes the base of the Ty'r Gawen mudstones, then the highest beds of the Pen y gadair formation.

The Pen y gadair formation is mainly composed of basalt lavas exhibiting pillow structures. In places the basalts occur as massive lava flows. Incorporation of fragments of the solidified surface layer into a moving lava flow can produce an autobreccia texture. Amongst the basalt lavas are bands of volcanic ash produced by explosive submarine eruptions.

In Cwm Cau, the Pen y gadair basalt lavas and ashes form a fairly continuous volcanic sequence. Towards the coast, however, mudstone bands belonging to the Ty'r Gawen formation appear within the basalts and become increasingly dominant, with the basalts eventually disappearing completely. This suggests that the basalts were being erupted from sea-floor vents in the section of the Bala-Mawddach fracture zone near or a short distance to the east of Cader Idris.

4: Leave the river and cross Cwm Cau to re-join the Cader Idris path. Continuing up the valley, a large ice-smoothed outcrop of volcanic ash within the Ty'r Gawen formation is reached at the top of a rock step in the valley floor.

Figure 302: Roche moutonee produced on an outcrop of ash within the Ty'r Gawen mudstones, near Llyn Cau.

5: Climb the path to the ridge above Cwm Cau, then continue towards the peak of Craig Cau. The Craig Cau formation is exposed along the path.

The Craig Cau Formation is composed of rhyolitic ashes. The succession can be roughly divided into a lower group of ashes interbedded with thin mudstones, overlain by a single very thick rhyolitic ignimbrite. The lower group of ashes were deposited on the sea floor, and show evidence of the ash subsiding in places into the soft underlying mud. Slumping of the ashes has sometimes occurred down slopes on the sea bed. Occasional bands of basaltic ash are found amongst the lower rhyolitic ashes. Rapidly varying magma composition may be due to fractional crystallisation in the underlying magma chamber, and magma being tapped from different levels of the chamber.

The upper ignimbrite is a welded ash-flow tuff which reaches a maximum thickness of nearly 200 metres. A minor amount of unwelded ash, along with mudstone horizons, overlies the ignimbrite flow. The formation represents the final and most explosive phase of volcanism of the Aran Volcanic Group.

6: Cross the stile at the peak of Craig Cau, then continue along the ridge. Examine ash bands in Ty'r Gawen mudstone along the ridge of Craig Cau. The ashes are massive and unbedded, and exhibit a foliation caused by welding of fiamme. They seem to have formed under water, as ignimbrite the settling ash flows retained enough heat to weld together the flattened particles of volcanic glass.

After descending to the saddle above Llyn Cau, climb towards the summit of the mountain. As we traverse through the succession from the Ty'r Gawen mudstone downwards into the Pen y gadair formation, we find an agglomerate containing large blocks of basalt lava in a mudstone matrix. This is a submarine debris flow.

7: Ascend to the summit of Cader Idris.

Pillow lavas are prominent in the outcrops between the Craig Cau ridge and Pen y gadair. Individual flows are separated by thin ashes or mudstones. The thicker flows are massive at the base, with some indistinct columnar jointing, becoming pillowed at the top. The pillows are closely packed with little or no interpillow sediment and tend to decrease in size upwards within a flow. They display radial and concentric fractures caused by contraction during cooling.

Figure 303: Pen y gadair basaltic pillow lavas.

Beds of ash outcrop in the steep gully leading to the summit plateau of Penygadair. The rock is rhyolitic, and contains fragments of pumice. It was the product of an explosive eruption, perhaps from a sea floor vent, in contrast to the gentle effusive eruption of the pillow lavas.

8: Walk eastwards across the summit plateau, following the outcrop of the Cader Idris microgranite.

The microgranite forms a thick sill, which was emplaced along a mudstone horizon within the Ty'r Gawen formation. This lifted the overlying rocks to produce a laccolith structure. The steep cliff faces of Cyfrwy, Penygadair and Mynydd Moel expose columnar jointing in the microgranite. The margins of the intrusion show some mechanical disruption of the mudstones as the melt was injected, with xenoliths breaking away in places. Metamorphism of the mudstones has also occurred, with heat from the intrusion turning the rock into a brittle hornfels next to the margins of the microgranite.

9: Continue to the summit of Mynydd Moel, then examine outcrops on the hillslope as it descends towards Cwm Cau.

At this point, it appears that a boss developed from the roof of the sill and extended upwards to the ground surface to form a small volcanic vent. Magma was erupted explosively from this vent as rhyolitic ash.

Outcrops expose flow foliated rhyolite with near-vertical flow structures. This material is finer

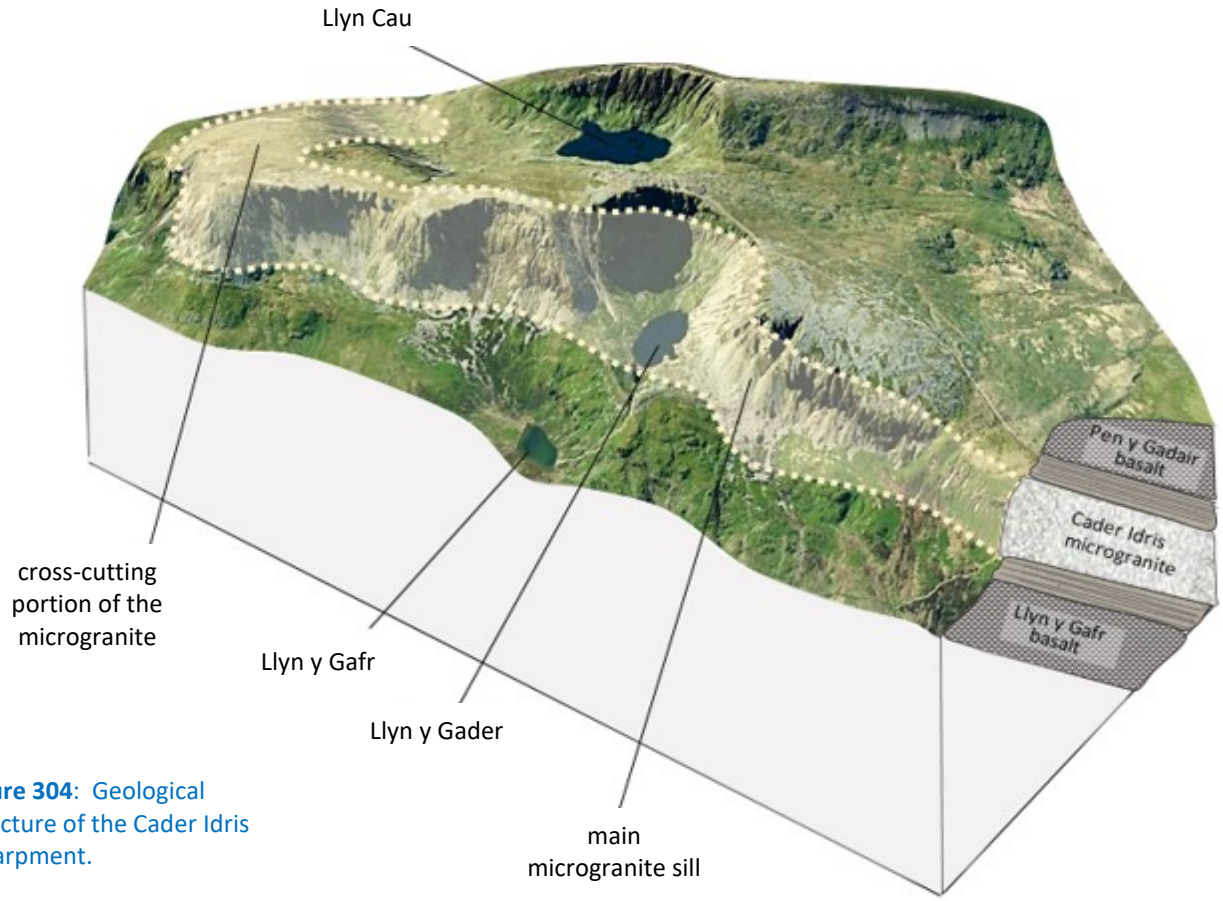


Figure 304: Geological structure of the Cader Idris escarpment.

grained than the body of the microgranite sill, indicating crystallisation of a dry viscous melt after loss of volatiles. The rock can be traced upwards through adjacent outcrops to a point where the flow foliation is lost and the material takes on the texture of rhyolitic ash. Horizontal bedding is observed, along with evidence of welding in thicker units.

Whilst the Mynydd Moel boss intrusion broke the surface and formed a small vent which explosively erupted ashes, this appears to have been on far too small a scale to account for the huge thickness of ignimbrite in the Craig Cau formation. The upper massive ignimbrite unit can be traced into the Aran and Arenig mountains, so was probably erupted from a large volcanic centre to the east of Cader Idris. We will investigate a possible location for this volcanic centre in the next chapter.

10: Descend to cross the river at the mouth of Cwm Cau and re-join the Cader Idris path, then continue down the steps alongside the waterfalls to Minffordd.

Figure 305: Rhyolite, Mynydd Moel.
(left) Flow foliation in the intrusion.
(right) layered ashes erupted from the vent.