Arenig

12

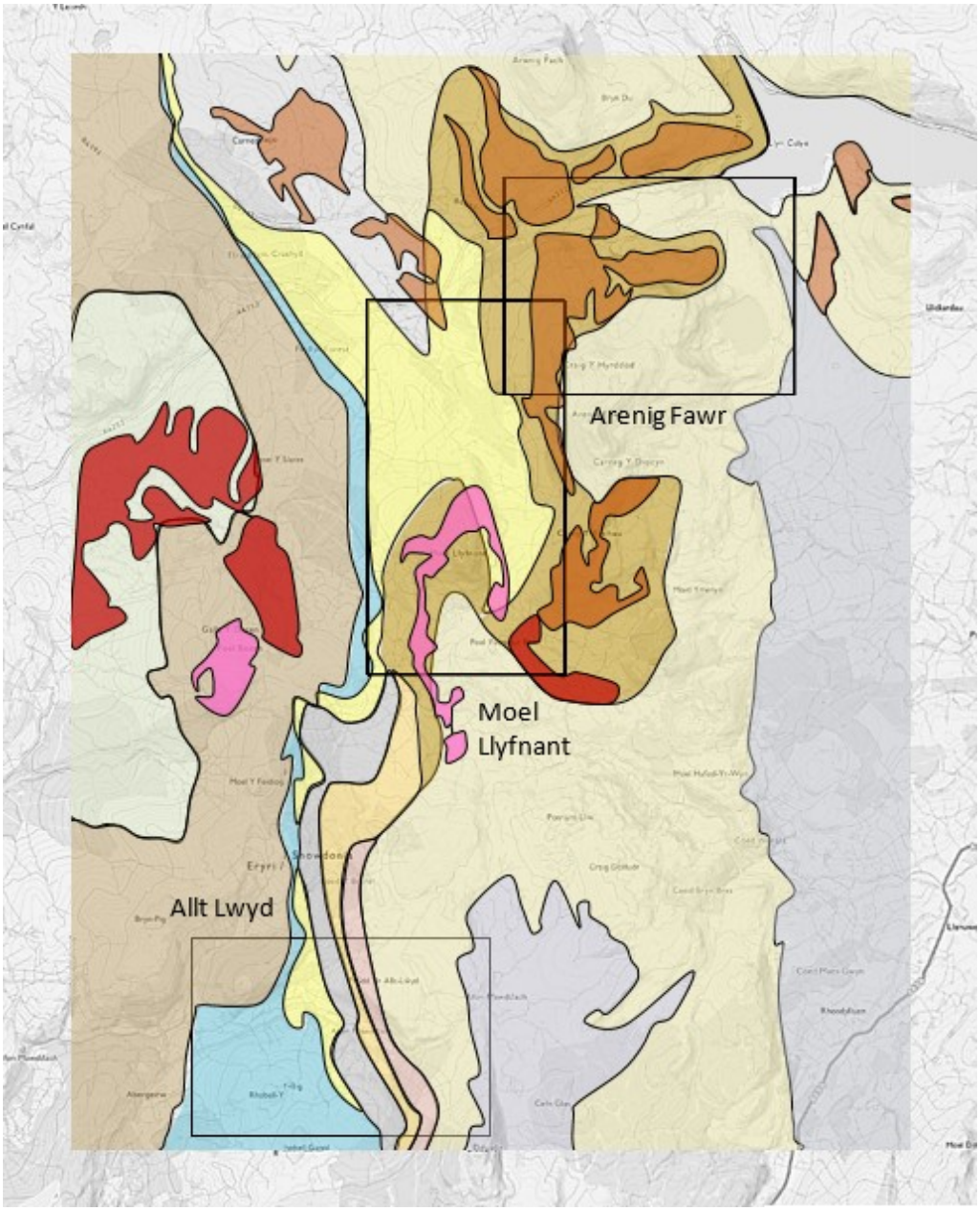


Figure 332:
Field excursions.

microgabbro
microtonalite
quartz latite

CAMBRIAN

Dolgellau mudstone, siltstone
Ffestiniog mudstone, siltstone, sandstone
Maentwrog mudstone, siltstone, sandstone

ORDOVICIAN

Nant Ffrancon mudstones
Aran Fawddwy felsitic tuff
Aran Volcanics mudstone, siltstone
Aran Volcanic Group
Dol-cyn-afon mudstone, siltstone
Benglog mafic ash
Benglog basalt
Allt Lwyd sandstone, siltstone

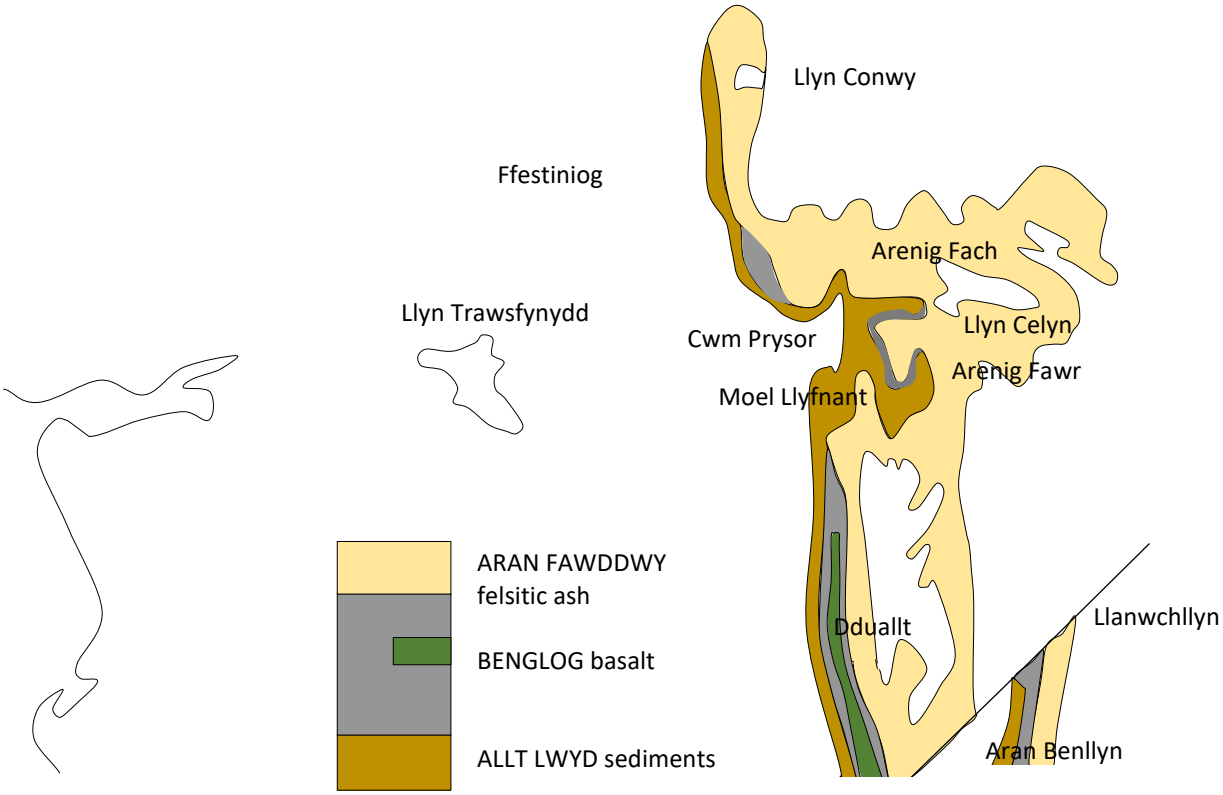


Figure 333: Outcrops of the Aran Volcanic Group.

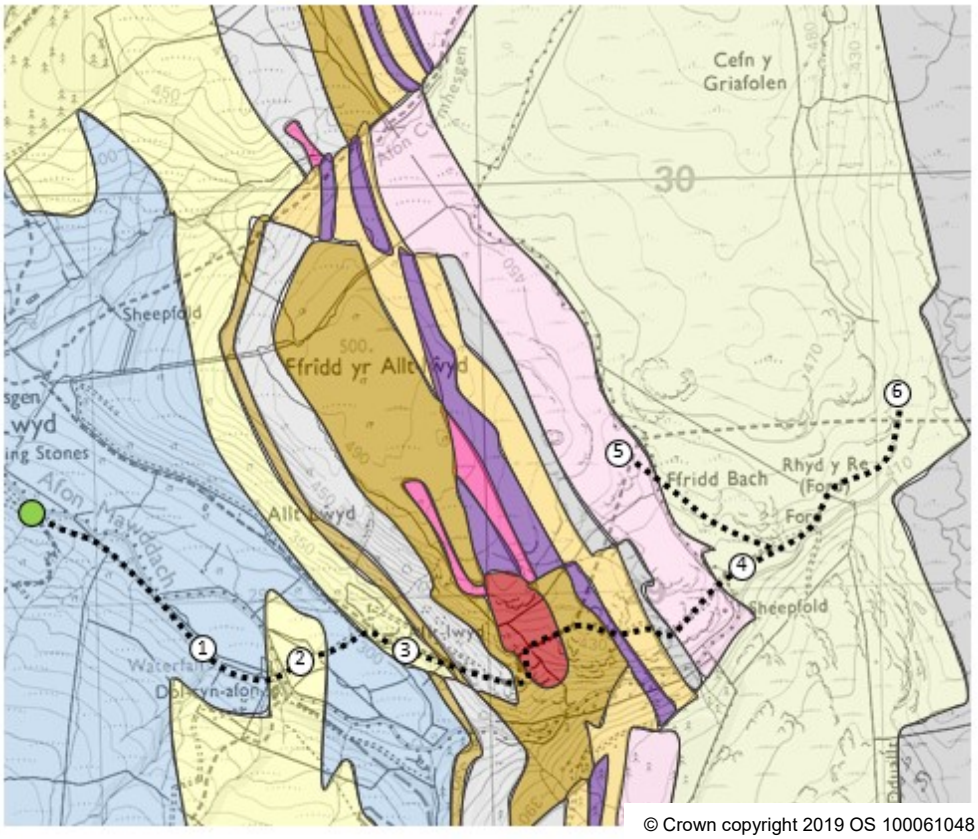
In this chapter, we continue our investigation of the Aran Volcanic Group where it outcrops around the eastern margin of the Harlech Dome. A large thickness of rhyolitic ignimbrite again occurs at the top of the sequence, where its resistance to erosion produces the higher mountain summits in the Arenig district. However, the basaltic volcanics which were prominent on Cader Idris and in the Aran mountains are now reduced in volume and eventually disappear northwards (fig.346).

We begin by making a transect from the Upper Cambrian sediments of the Allt Lwyd valley, across outcrops of the Aran Volcanic Group to Dduallt, reaching the upper Ordovician mudstones of the Nant Ffrancon formation which were laid down in the Welsh Basin after the volcanic episode ended.

We then move northwards to the Arenig mountains to carry out two further excursions, reaching the summits of Moel Llyfnant and Arenig Fawr and examining the large disused Arenig granite quarries.

Allt Lwyd

4 miles: approximately 2 hours



- Microtonalite
- Microgabbro
- Nant Ffrancon siltstone
- Aran Fawddwy felsic tuff
- Benglog basalt
- Benglog mafic tuff
- Benglog tuffaceous-mudstone
- Allt Lwyd sandstone
- Allt Lwyd mudstone, siltstone, sandstone
- Garth Grit sandstone
- Dol-cyn-afon mudstone, siltstone
- Dolgellau mudstone, siltstone

Figure 334: Field excursion.

Start: A vehicle can be parked near the road bridge at Cwm Hesgen in the Allt Lwyd valley [SH788292].

1: Follow the track towards Dol-cyn-afon. Outcrops of Dolgellau mudstone are seen alongside the track, and in the crags above a large waterfall on the southern side of the valley.

Tight folds can be seen in the mudstones, oriented along a north-south axis (fig.335). This folding is likely to have occurred at the end of Cambrian times as a result of the breaking away of the Avalonian microcontinent from Gondwana. The folds resulted from vertical movement of Precambrian basement blocks beneath the Harlech Dome along the north-south oriented Rhobell fracture zone.

Figure 335: (left) Outcrops of Dolgellau mudstone above the waterfall. (right) Fold in Dolgellau mudstone.

2: Continue to the disused farmhouse of Dol-cyn-afon. Mudstones of the late Cambrian Dol-cyn-afon formation are exposed in the river banks.

The end-Cambrian earth movements followed the deposition of the Dolgellau and Dol-cyn-afon mudstones, and were in turn followed closely by the Rhobell volcanic episode. Basaltic lavas and ashes of the Rhobell formation were found at the nearby locations of Moel y Big and Craig y Dinas, but no equivalent strata occur at this point in Cwm yr Allt Lwyd. It is likely that we are now beyond the limits of the Rhobell volcanic cone.

Figure 336: Dol-cyn-afon farmhouse, with mudstones of the Dol-cyn-afon formation exposed in the river banks.

3: Cross the bridge over the river and follow the track as it passes a farm and ascends diagonally across the screes on the valley side of Allt Lwyd. Please note that the track is not a public right of way where it crosses the field, so please ask permission if agricultural work is in progress.

We have now reached the outcrop of the lower Ordovician Allt Lwyd formation. Large blocks can be examined in the scree, and bedrock is exposed higher up the hillside.

The Allt Lwyd formation begins with the Garth Grit member (fig.337). It is a pale grey, coarse-grained sandstone consisting mainly of quartz grains. Faint traces of bedding can be seen. This is a high energy beach deposit, laid down as the area began to submerge after the Rhobell volcanic episode.

Figure 337: Garth Grit, showing faint bedding.

Continuing upwards in the sequence, the next beds found are dark grey mudstones with contrasting bands of pale grey siltstone. Worm burrows can be found on bedding surfaces (fig.338), and in places the rocks are bioturbated. These beds were probably deposited in an estuarine environment, where quiet accumulation of mud was interrupted periodically by currents carrying fine silt. The mud was extensively colonised by burrowing animals, in a similar way to present day estuaries.

Figure 338: Worm burrows in mudstone.

As the track reaches the end of the large scree slope, bedrock exposures of mudstone appear. The mudstones are overlain by sandstones composed mainly of quartzose grains derived from felsic volcanic ashes. Volcanic centres were becoming active in the Welsh Basin in early Ordovician times, and the erupted ashes could be redistributed by water currents to produce bedded sandstones.

The hillside ahead to the north is composed of microtonalite, a fine grained silica-rich igneous rock. This circular outcrop may represent a small volcanic vent from which rhyolitic ash or lava was erupted in mid- to late-Ordovician times. The contact between the intrusion and the sandstone country rock can be seen. The contact is irregular, with evidence of sill-like incursions into particular sandstone layers. The microtonalite has well developed sets of cooling joints, allowing it to break into cubic blocks.

Figure 339: Contact between bedded sandstone (left) and blocky microtonalite (right).

4: Continue along the track as it rises over the microtonalite intrusion then descends into the valley leading to Waen y Griafolen.

Along the left side of the track, we pass small crags of volcanic sandstone belonging to the Allt Lwyd formation, before reaching the outcrop of Benglog basalt at the point where the track crosses a bridge over a tributary stream. The basalt outcrop creates a waterfall in a small gorge to the left of the track.

Figure 340: Benglog basalts: (left) Pillow and roll structures. (right) Vesicular basalt.

5: To examine the Benglog basalt in more detail, it is worth making a detour from the main track to follow the tributary valley upstream. Leave the track just beyond the bridge, and walk up the grassy hillside. Keeping above the stream, continue up the valley until a point is reached where a number of dry stone walls converge at the river bank. The stream can be crossed at this point. Continue north-westwards up the hillside to reach prominent crags of basalt.

The basalts exhibit a rough pillow structure. Some pillows have a characteristic spherical shape, whilst others take the form of elongated rolls. Ash is present between the pillows. Vesicular cavities are present at some horizons, produced by chemical weathering of the original calcite infill.

The lavas appear to have been erupted rapidly, and perhaps explosively, onto the sea floor from volcanic vents associated with the Rhobell fracture zone.

6: Return to the main track, and continue eastwards towards Waen y Griafolen. The first outcrops alongside the track consist of unwelded felsic ashes of the Aran Fawddwy formation. As the track is followed eastwards, the rocks become more massive welded ignimbrites. These beds form the peak of Dduallt which is ahead to the right. The eruptive centre for the ash flows is likely to have lain close to the Rhobell fracture zone, either in the Aran mountains to the south or the Arenig district to the north.

Figure 341: (left) Felsic ashes at the base of the Aran Fawddwy formation. (right) Welded ignimbrite.

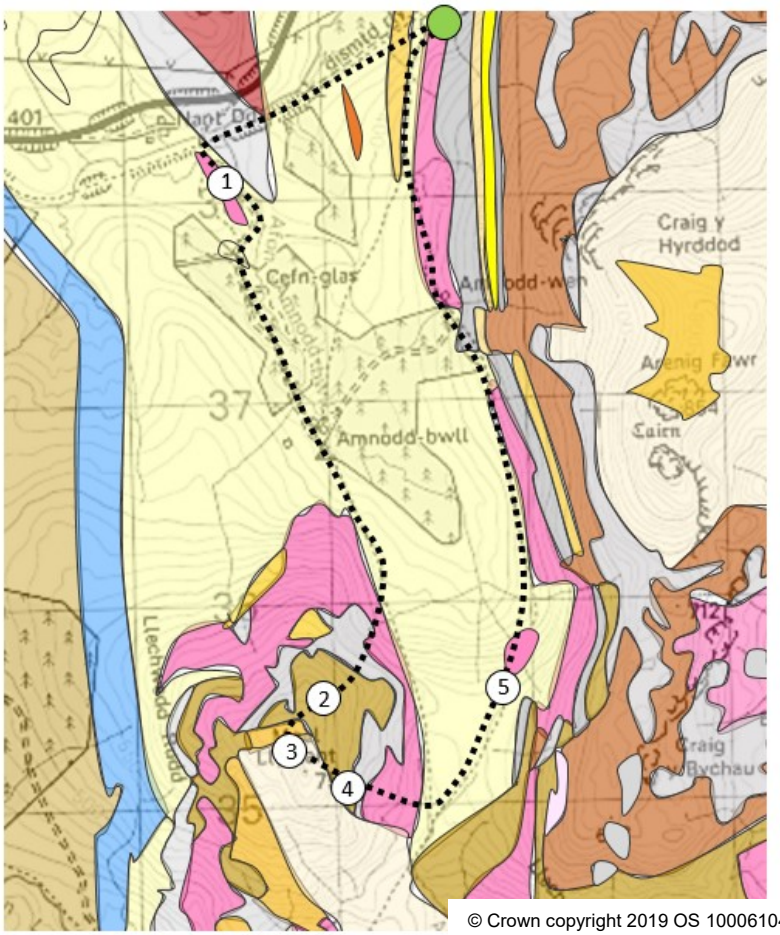
The path ascends a grassy slope to reach a stile through a dry stone wall. From this point, a panorama opens up across the large blanket bog of Waen y Griafolen. It is interesting to continue onto the bog, taking care to avoid deep wet areas of sphagnum moss. The blanket bog has developed in a rock basin cut in mudstones of the upper Ordovician Nant Ffrancon formation. The mudstones can be examined in some of the deep river valleys cut through the peat and glacial deposits.

After visiting Waen y Griafolen, return along the track to Cwm yr Allt Lwyd.

Figure 342: The peak of Dduallt, composed of Aran Fawddwy ignimbrites. Waen y Griafolen blanket bog is in the foreground, where Nant Ffrancon mudstone lie beneath glacial deposits.

Moel Llyfnant

7 miles: approximately 3 hours



- Microtonalite
- Microgabbro
- Benglog felsic tuff
- Aran Fawddwy felsic tuff
- Aran mudstone, siltstone
- Allt Lwyd volcaniclastic sandstone
- Allt Lwyd sandstone, siltstone,
- Dol-cyn-afon mudstone, siltstone
- Dolgellau mudstone, siltstone
- Ffestiniog mudstone, siltstone, sandstone

Figure 343: Field excursion.

In this excursion we ascend the peak of Moel Llyfnant composed of resistant ignimbrites of the Aran Fawddwy formation. Near the summit we will examine old manganese workings and a large microgabbro sill intrusion.

Start: Park at the old Arenig Quarry railway station [SH826392].

1: Follow the old railway westwards. Near Nant Ddu Farm turn left over a stile and continue along the forestry track to Amnodd-bwll. The route crosses rough grassland on mudstones of the Dol-cyn-afon formation.

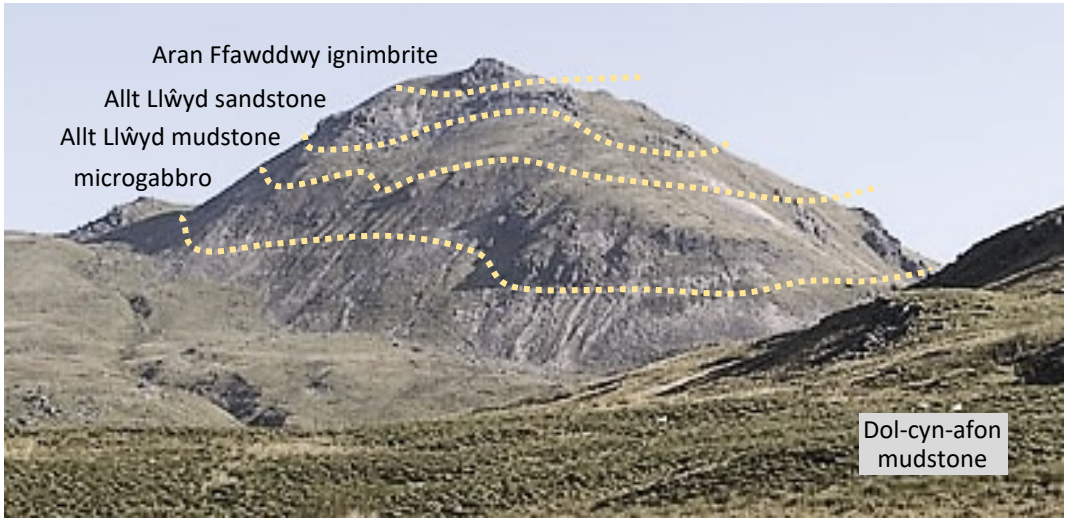


Figure 344: Moel Llyfnant.

Figure 345: Benglog pyroclasic ashes.

2: Continue along the track climbing the north slope of Moel Llyfnant. At the end of the track, bear left and follow the ridge towards the summit.

3: We first pass outcrops of Allt Lwyd mudstone and sandstone similar to the sediments seen in the previous excursion in the Allt Lwyd valley.

At the shoulder below the summit, outcrops of pyroclastic ash belonging to the Benglog formation are reached (fig.345). The rock contains angular fragments of rhyolite in a rusty-weathering basaltic ash matrix. A rough stratification is present, suggesting that the material was laid down as a submarine debris flow on the margins of a volcanic island.

The summit area of Moel Llyfnant is composed of felsic ashes and ignimbrites of the Aran Fawddwy formation.

Figure 346: Moel Llyfnant summit.

Descend a short distance south from the summit to reach a rocky area where remains of manganese mining are visible. Manganese is present in hydrothermal quartz veins cutting the felsic ashes, and was probably emplaced in the late stages of the Ordovician volcanic episode. The ore was extracted in opencast and underground workings. A small level extends for a short distance to the lode and a filled-in shaft and two ruined buildings remain. Samples of ore can be found consisting of a mixture of black manganese oxide and cream manganese carbonate. The ore has an irregular form, or may be botryoidal – resembling a bunch of grapes.

Figure 347: Manganese mining at Moel Llyfnant: (left) Ore sample containing manganese oxide and carbonate. (right) Mine adit.

4: Descend the steep hillside past a jagged outcrop of resistant Allt Lwyd sandstones (fig.348). These rocks are composed of quartz and volcanic fragments.

Figure 348: Outcrop of Allt Lwyd volcanicalstic sandstone, below Moel Llyfnant summit.

Continue southwards between the rock outcrop and the fence to the foot of the slope. A large near-horizontal microgabbro sill is reached, which outcrops around much of Moel Llyfnant. The position of this intrusion suggests an association with the erupted basaltic ashes of the Benglog formation, seen higher on the mountain.

5: Follow the foot of hill to reach the saddle beneath Arenig Fawr. Turn right along a path which returns down the valley below Arenig Fawr, past Amnodd-wen, to reach the old railway.

Arenig Fawr

9 miles: approximately 4 hours

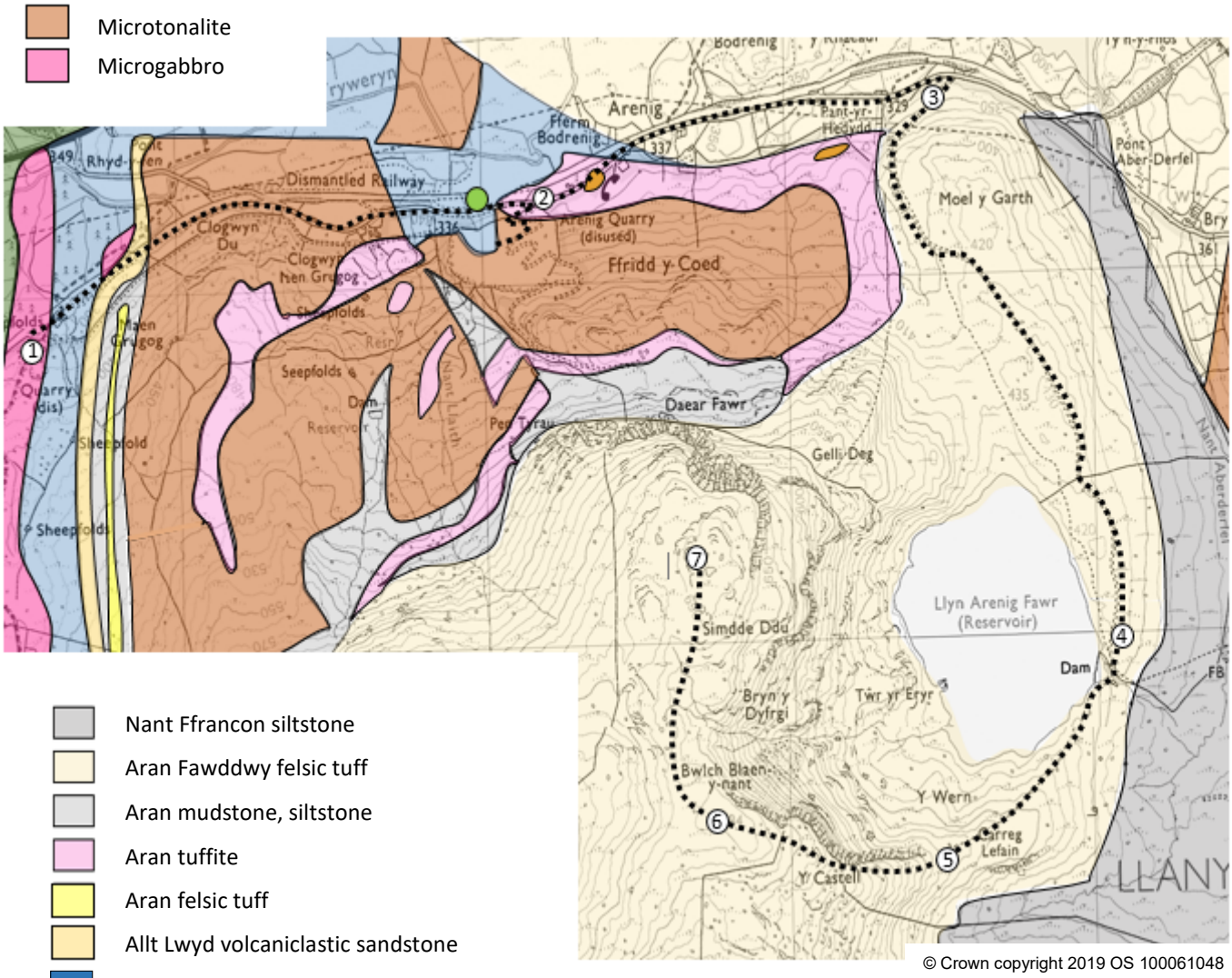


Figure 349: Field excursion

The objective of this excursion is to examine intrusive igneous rocks which have been quarried on a large scale, and also to investigate the sequence of felsic ashes of the Aran Fawddwy formation which make up the main mass of Arenig Fawr.

Although disrupted in places by faulting, Arenig Fawr has a simple geological structure with beds of mudstones, sandstones and volcanic ashes dipping gently to the east. Thick sills of microtonalite and microgabbro are present at different levels within the bedded sequence.

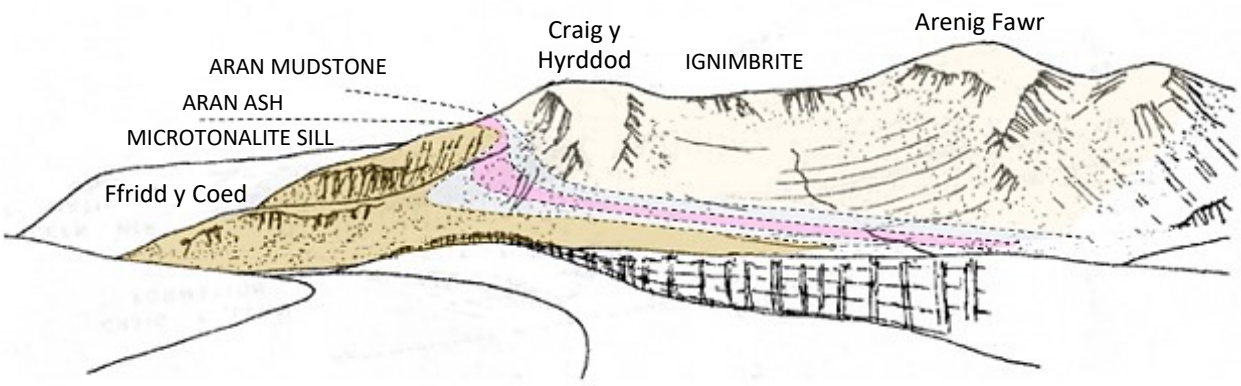


Figure 350: Geological structure of Arenig Fawr.

Start: Park at the old Arenig Quarry station [SH826392].

1: Follow the road westwards until it reaches the track bed of the old railway. Follow the track for a short distance before skirting around the hillside to reach a large disused quarry.

The quarry is cut into a thick sill of microgabbro (fig.351). This is probably associated with the eruption of basaltic ashes of the Benglog formation which outcrop higher up the hillside.

Figure 351: (left) Quarry at Amnodd-wen. (right) Microgabbro.

Below the microgabbro sill, in the vicinity of the quarry, are found conglomerates of the Allt Lwyd formation. These are similar to the Aran boulder bed which was examined in a previous excursion in the Aran mountains. The conglomerate contains rounded pebbles of felsic volcanic rock in a sandy matrix, and appears to be a beach deposit. This material was deposited during the marine transgression as the land area subsided into the Welsh basin after a phase of earth movements and volcanicity at the beginning of Ordovician times.

Figure 352: Allt Lwyd conglomerate.

Skirt around the southern side of the quarry and ascend the hillslope for a short distance. We reach outcrops of rhyolitic ashes of the Melau formation. The ashes are poorly bedded, with pyroclastic fragments of rhyolite, suggesting explosive eruptions from a volcanic island and accumulation of air fall ash onto the sea bed.

Figure 353: Rhyolitic ash.

2: Return towards Arenig station. The road passes the disused Arenig granite quarry. Take the track which leads up the hillside into the quarry workings.

Although named the Arenig Granite Quarry, the rock worked was actually a fine grained porphyritic microtonalite containing larger crystals of orthoclase feldspar. Near-vertical columnar jointing can be seen in the quarry face, and was produced during cooling of the sill at a shallow depth beneath the sea floor. An interesting feature is the presence of tube-like cavities in the rock, produced by the escape of streams of late stage superheated hydrothermal fluids through the semi-consolidated igneous rock. The fluids deposited calcite and other carbonate minerals which have now been removed by chemical weathering.

The intrusion is one of several very thick sills underlying Arenig Fawr, and probably had the same magma source as the erupted ignimbrites higher on the mountain. Unfortunately it is not possible to identify a volcanic vent pipe connecting the sill intrusions to the erupted ashes, but it is very possible that a vent is concealed beneath ignimbrites in the Arenig area.

Figure 354: (above left) Arenig Granite Quarry. (above right) Columnar jointing in the microtonalite sill. (below left) Porphyritic microtonalite. (below right) Tube cavity in microtonalite formed by chemical weathering of calcite.

3: Continue along the minor road to Pant yr Hedydd.Take the track uphill towards Llyn Arenig Fawr.

The scree covered lower slopes of Simdde Ddu above Llyn Arenig are composed of pyroclastic ashes, with the steeper summit crags of more resistant welded rhyolitic ignimbrites.

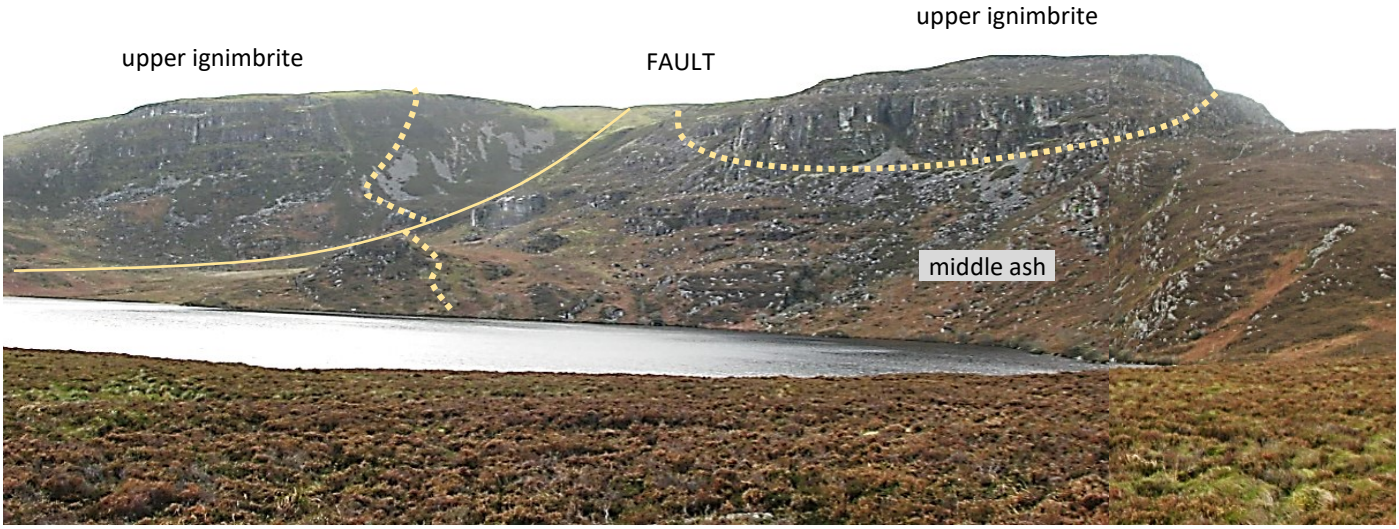


Figure 355: Llyn Arenig and Simdde Ddu.

4: Pass the outlet stream from the reservoir.

5: Continue up the mountain path to Careg Lefain.

6: Examine outcrops of ashes around the head of the cwm. The rocks show bedding characteristic of deposition under water. Coarse pyroclastic fragments are present in an ash matrix.

Figure 356: Pyroclastic deposits of the middle ash member.

7: Continue to Simdde Ddu summit. We pass upwards onto more resistant and massive beds of ignimbrite.

Figure 357: Upper ignimbrites near the summit of Simdde Ddu.

It is likely that the ashes were erupted as ash flows from a vent on a volcanic island, which flowed out into the shallow waters around the island. The ash deposit was sufficiently thick to retain enough heat for welding to occur after deposition.

Return to Arenig station by retracing your route.