Plynlimon

20

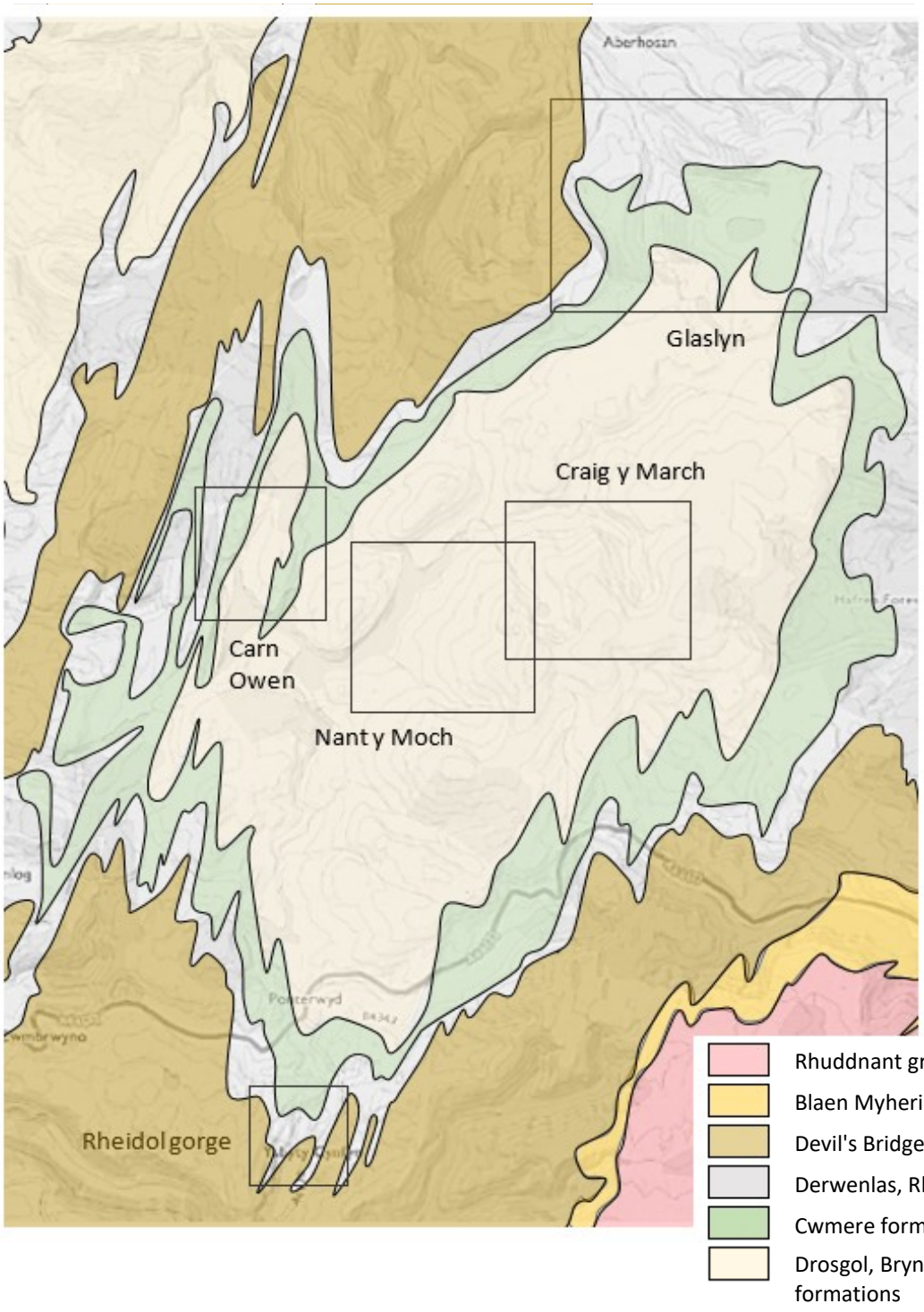


Figure 554: Field excursions.

In this chapter we focus on localities in and around the Plynlimon dome. This structure, similar to the Llyfnant dome to the north-west, is an uplifted area of Ordovician rocks which emerges as an **inlier** through younger Silurian strata. Superimposed on the dome are a series of parallel anticlines and synclines with north-south axes. The area is also cutby major east-west faults such as the Hafan and Camdwr faults which displace the minor folds. All of these structures were produced during the Acadian orogeny in Devonian times.

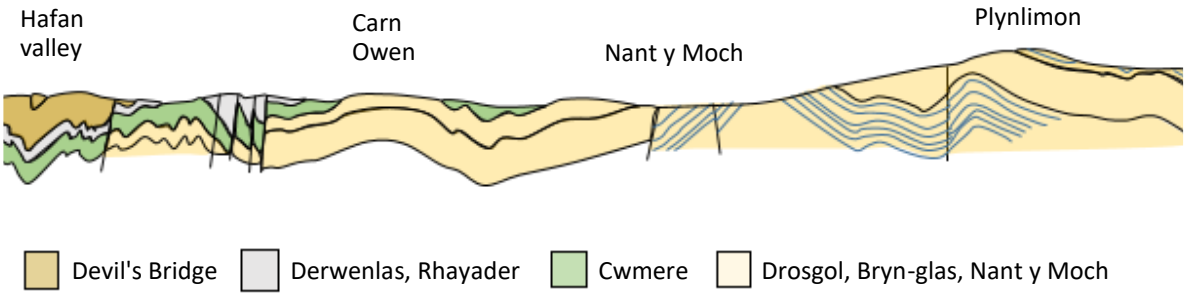


Figure 555: geological section across Plynlimon.

During the field excursions, we will consider the sedimentary processes which produced the groups of strata. Plynlimon lies closer to the deep central axis of the Welsh basin than the areas we have examined previously. An interpretation of the palaeogeography for late Ordovician times is given in fig.556. A downfaulted deep water trough lay along the north-south axis of the basin, bounded by fractures extending from the crustal basement. To the east, the large land mass of the Midland platform provided a source of mixed sand and mud which initially accumulated on the marginal shelf of the basin. To the west, the smaller Irish Sea landmass lay along the basin margin and produced a mud shelf.

Sediments accumulated in the central trough around present day Plynlimon as a result of various geological processes. Turbidite flows discharged into the basin from the south of Wales and travelled along the basin axis, depositing mud and silt distal turbidite sequences. In the intervals between sediment flows, quiet deposition of hemipelagic muds continued in the deep water of the basin. Superimposed on the finer trough sediments are stratified delta fan deposits, produced by turbidite flows which discharged clouds of sand, silt and mud from the shelf margin. We also find more chaotic mélanges of mud and sand representing landslips from the shelf margin, probably due to slope failure during earthquakes.

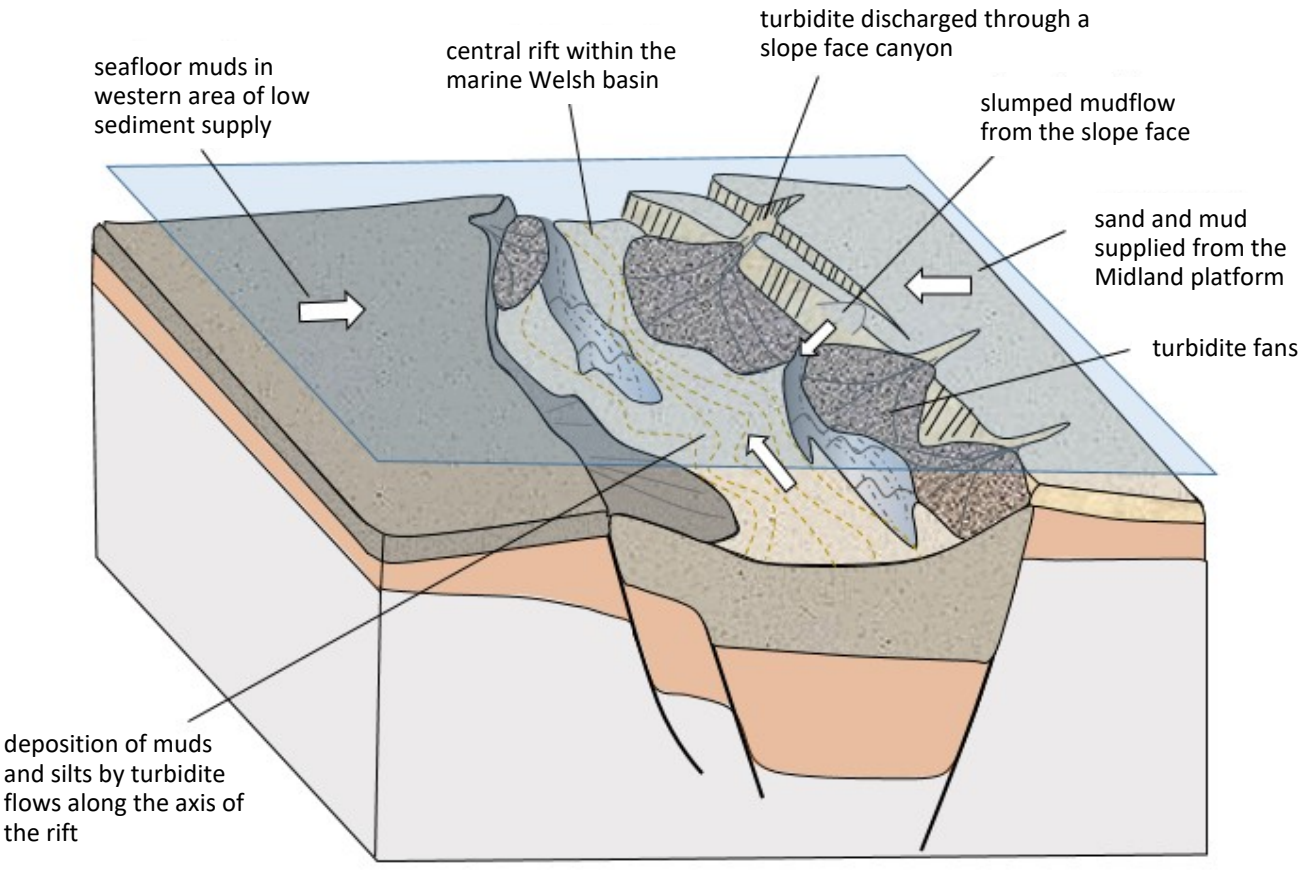


Figure 556: Depositional environments in the upper Ordovician Welsh basin.

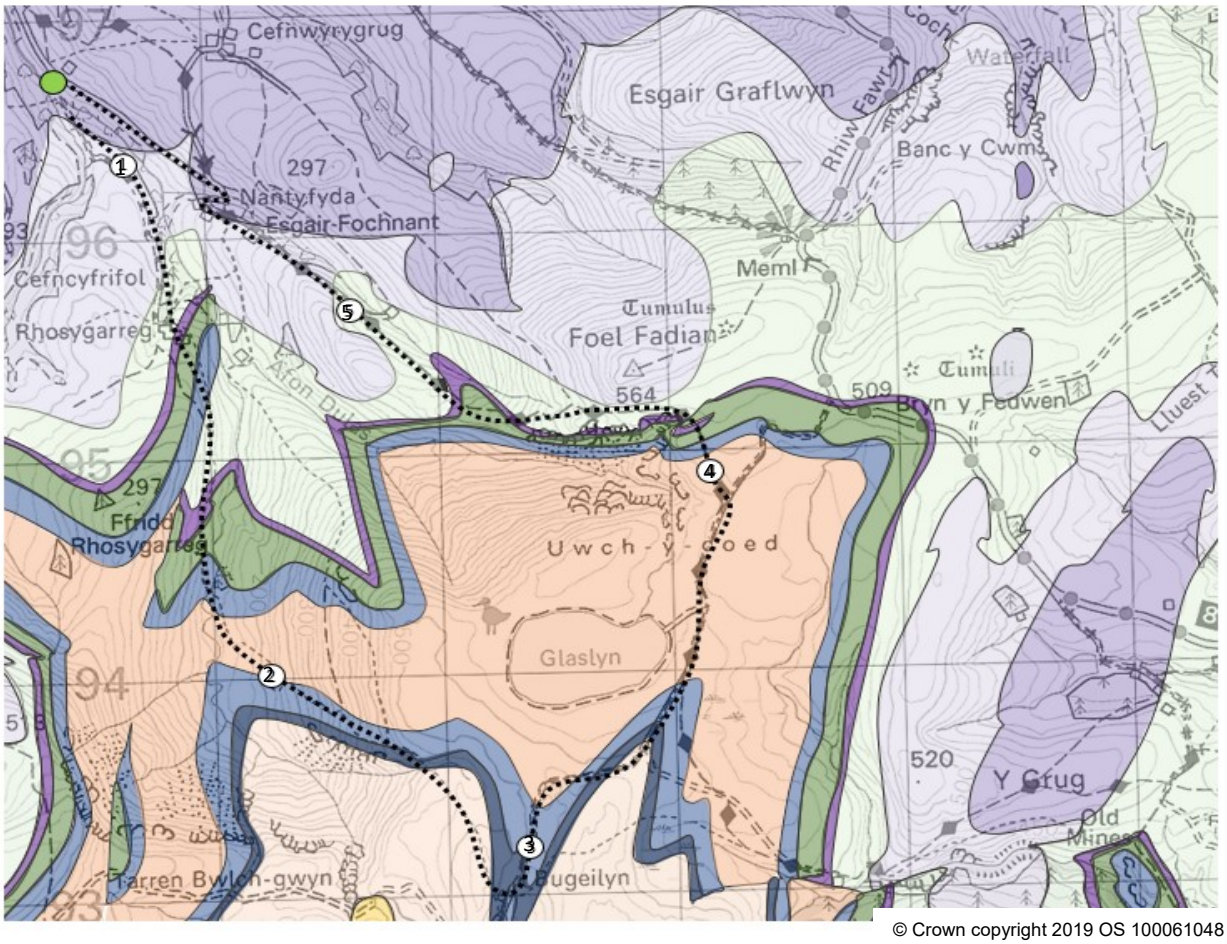
At Plynlimon, the earliest rocks outcropping belong to the Nant-y-moch Formation. This is a group of thinly-bedded turbidites produced in relatively deep water conditions before the onset of the late Ordovician ice age. It contains fining-upwards Bouma sequences of sand, silt and mud.

The Nant y Moch formation is overlain by the Drosgol and Brynglas formations. These strata include sandstones, mudstones and slump mélange deposits produced during the glacial period of low sea level when the supply of coarse sediment was at its maximum. The most prominent sandstone in the group is the **Pencerrigtewion member**, which often forms craggy outcrops on mountainsides.

The proportion of mudstone increases upwards through the Brynglas formation, with the overlying Cwmere formation almost entirely composed of mudstones and shales. This reduction in grain size can be related to the deepening of the marine basin following the late Ordovician ice age. Turbidites gradually increase in importance, with the overlying Devil's Bridge formation composed principally of distal turbidites.

Glaslyn

6 miles: approximately 3 hours



SILURIAN
- Glaslyn mudstone, sandstone
- Cwmere mudstone
- Llandovery Mottled Mudstone

ORDOVICIAN
- Bryn-glas slumped mudstone, siltstone, sandstone
- Drosgol slumped mudstone, siltstone, sandstone

SILURIAN
- Blaen Myherin mudstones
- Foel Fadian mudstone, sandstone
- Rhayader mudstone
- Monograptus Sedgwickii shale
- Derwenlas mudstone

Figure 557: Field excursion.

This excursion examines upper Ordovician and lower Silurian strata outcropping in spectacular cliff faces around the northern edge of the Plynlimon dome.

Start: From the village of Forge, follow the upper Dulas valley for about 5km to Ty'n y Fedw. Park by the roadside [SN804968].

1: Take the track to Rhosygarreg farm, then continue along the footpath towards Tarren Bwlch-gwyn. The scarp face ahead of you is composed of mudstones and thin sandstones of the Glaslyn formation.

2: The path skirts around the left side of the valley, climbing above the cliff face of Tarren Gesail which is composed of Brynglas mudstones with thin siltstone and sandstone bands.

Figure 558:

Tarren Bwlch-gwyn.

3: Continue to Bugeilyn, then follow the gravel track to Glaslyn.

The path takes us across the Cwmere, Derwenlas and Rhayader mudstones. We see from the geological map that the Cwmere Formation outcrops in a complex pattern of folds around the Ordovician inliers. It consists of thin interbedded turbidite and anoxic hemipelagic mudstones, with occasional beds of turbidite siltstone and sandstone.

Figure 559:

(above) Glaslyn turbidite sandstones and mudstones exposed in the cliff face of Foel Fadian.

The plateau of Uwch-y-coed where the lake is situated is composed of sandstones and thin mudstones of the Glaslyn formation. This group of strata is equivalent in age to the Cwmere formation, but is lithologically distinct. The Glaslyn rocks were deposited from mixed sand and mud turbidity currents, probably as a number of small overlapping turbidite fan lobes in the basin trough at the base of the shelf slope. The strata are a succession of thin, parallel-laminated and cross-laminated turbidite sandstones representing Bouma B and C units, along with finer silt and mud of the D and E units. These deposits are interbedded with hemipelagic mudstones produced by mud settling to the basin floor between turbidite events. The sandstones make up about half of the total rock outcrop.

4: Take the footpath to the head of the cliffs at Foel Fadian. Around this point are outcrops of Cwmere mudstones, Derwenlas mudstones and the Monograptus shales.

At the base of the Cwmere formation is the Mottled Mudstone, which represents the postglacial recolonisation of the basin by burrowing organisms before the development of the deep anoxic marine basin in later Silurian times.

5: Descend along the path to the Dulas valley, examining exposures of Derwenlas mudstone alongside the path. Bedding planes can be seen to wedge-out and mud layers appear to have been cut by overlying beds. These structures are due to soft sediment deformation as water-saturated muds slid down a submarine slope after deposition, perhaps in response to earthquake activity.

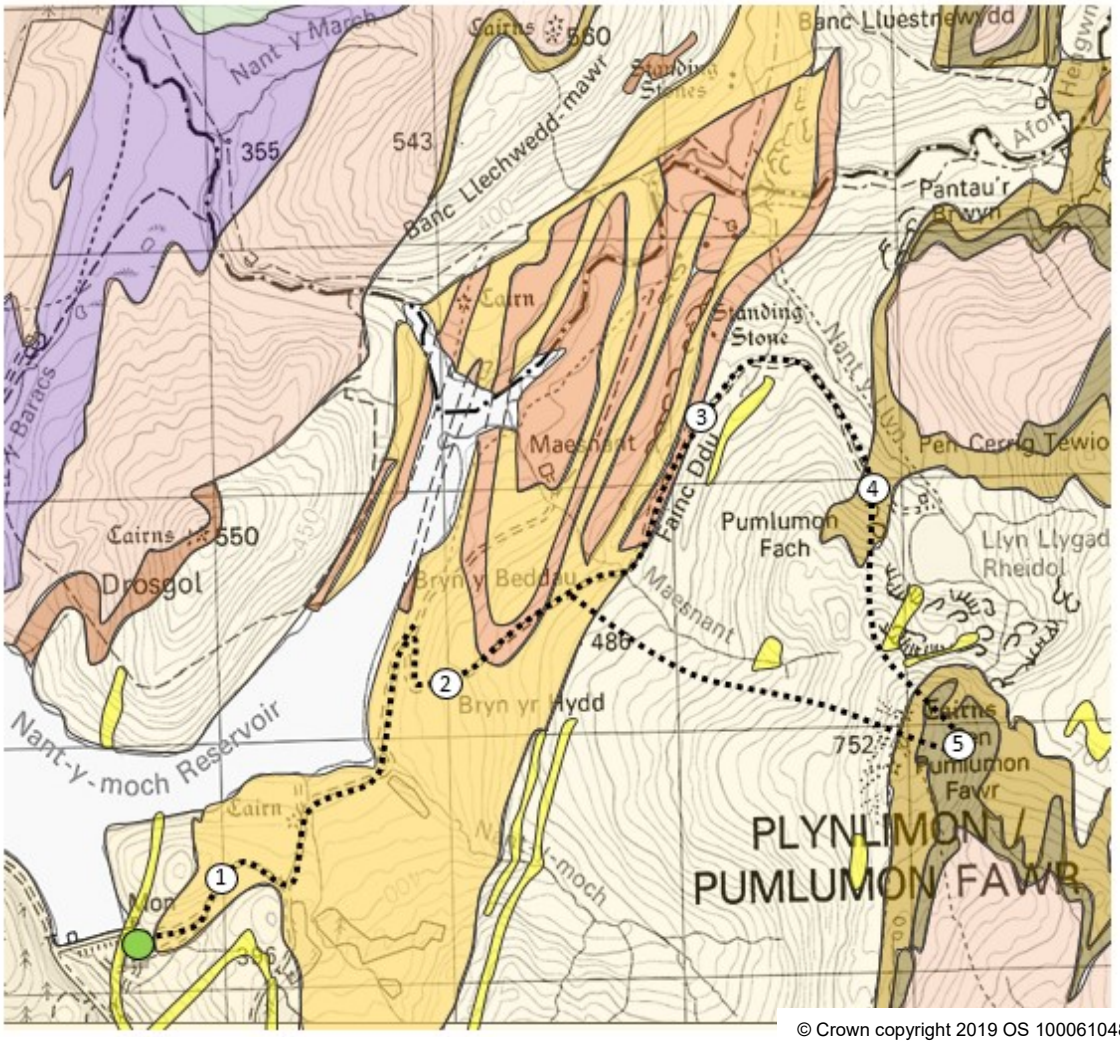
Figure 560:

Derwenlas mudstone, showing slide planes which developed in the soft sediment .

Return along the Glyndwr's Way footpath, past Esgair Fochnant farm, to reach the road and parking point.

Nant y Moch

7 miles: approximately 4 hours



ORDOVICIAN
- Drosgol slumped mudstone, siltstone, sandstone
- Drosgol sandstone
- Nant y Moch mudstone, siltstone, sandstone
- Nant y Moch mudstone

SILURIAN
- Derwenlas mudstone
- Cwmere mudstone
- Bryn-glas slumped mudstone, siltstone, sandstone

ORDOVICIAN
- Lluest-y-graig mudstone, sandstone
- Pencerrigtewion mudstone, siltstone, sandstone
- Pencerrigtewion sandstone

Figure 561: Field excursion.

In this excursion, we ascend from the Nant y Moch reservoir to the summit of Plynlimon, climbing through a sequence of progressively younger Ordovician strata.

Start: Park at the eastern end of the Nant y Moch dam [SN756862].

1: Examine outcrops of the Nant-y-moch formation in the roadside cuttings east of the parking area.

The Nant y Moch formation at this point consists of fine grained greywacke sandstone containing a mixture of quartz grains and tiny rock fragments, overlain by finely laminated mudstones. This fining-upwards sequence is consistent with deposition from a turbidite flow in a lower fan environment. At locations around Plynlimon, palaeocurrent indicators have shown transport of sediment down a slope towards the west. This suggests turbidite flows carried sediment from a marginal shelf of the Midland platform, westwards

into the central deep water trough of the Welsh basin.

2: Continue to a T-junction, then take the minor road to the left along the Hengwm valley alongside the reservoir. Turn to the right up the gravel track at Bryn yr Hydd which leads to Llyn Llygad Rheidol reservoir. As the track rises up the hillside, we have a panorama across Nant y Moch (fig.562). Sandstones and mudstones of the Nant y Moch formation form the central core of the Plynlimon dome, surrounded by outcrops of the overlying Drosgol formation whose lower strata are mainly mudstones.

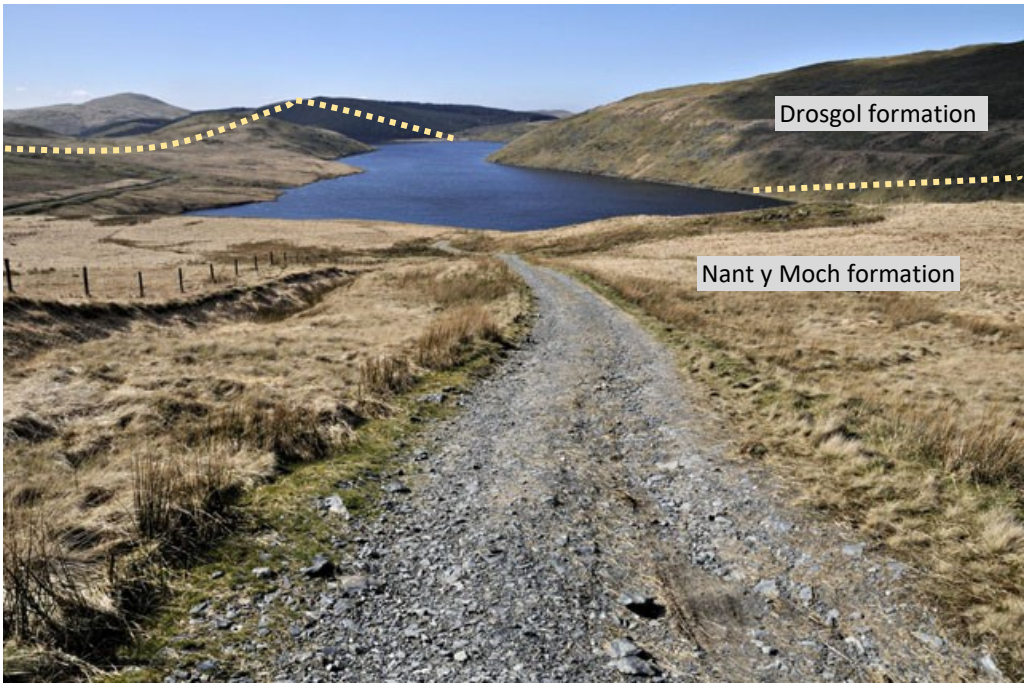


Figure 562: View across Nant y Moch reservoir.

3: Continue towards Fainc Ddu. A series of rocky ridges are separated by flat areas of peat where lakes have developed.

It is interesting to introduce the concept of a sedimentary **facies**. This term refers to a particular rock type which has formed under particular environmental and depositional conditions. The Nant y Moch formation in this area has been divided into two sediment types:

the **Craig y Dullfan facies**, composed of sand, silt and mud sequences formed in a proximal turbidite fan;

the **Maesnant facies** made up of fine grained distal turbidite muds which flowed along the axis of the basin, along with muds deposited between the turbidite events. These two facies types alternate through the Nant y Moch formation.

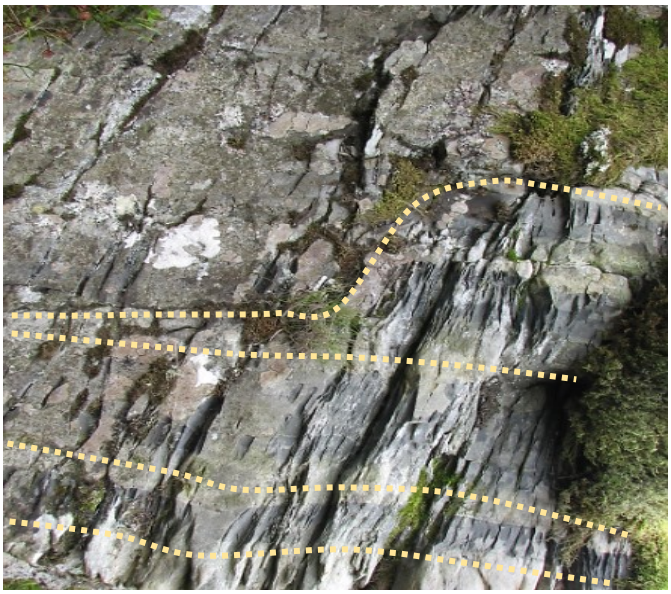


Figure 563:

Eroded channel in a fan turbidite deposit at Fainc Ddu

The Craig y Dullfan rocks form the rocky ridges of Fainc Ddu, whilst the Maesnant mudstones form the hollows in which peat bogs and lakes have developed. An eroded channel in a Craig y Dullfan turbidite sequence is shown in fig.563.

4: Continue along the track as it curves around the hillside into the Nant y Llyn valley. At the head of the valley is Llyn Llygad Rheidol reservoir.

You may wish to walk up to the lake to observe the Drosgol mudstones and siltstones which outcrop in a series of north-south oriented folds.

5: If you would like to make an ascent of Plynlimon, an easy but steep route follows the grassy slope above the western side of the lake basin, then ascends between the crags of Pencerrigtewion sandstone to reach the mountain summit. A more direct return route then leads down the Maesnant valley to re-join the reservoir track.

Return down the gravel track to the minor road alongside Nant y Moch reservoir, and then back to the parking area.

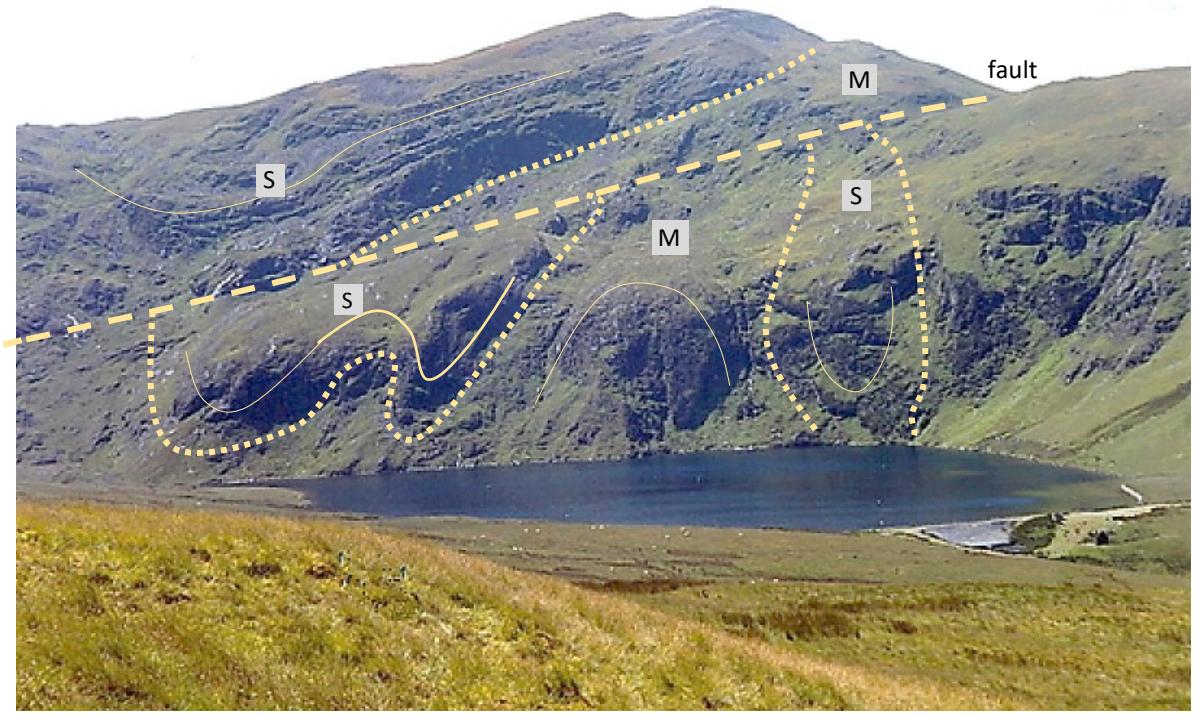
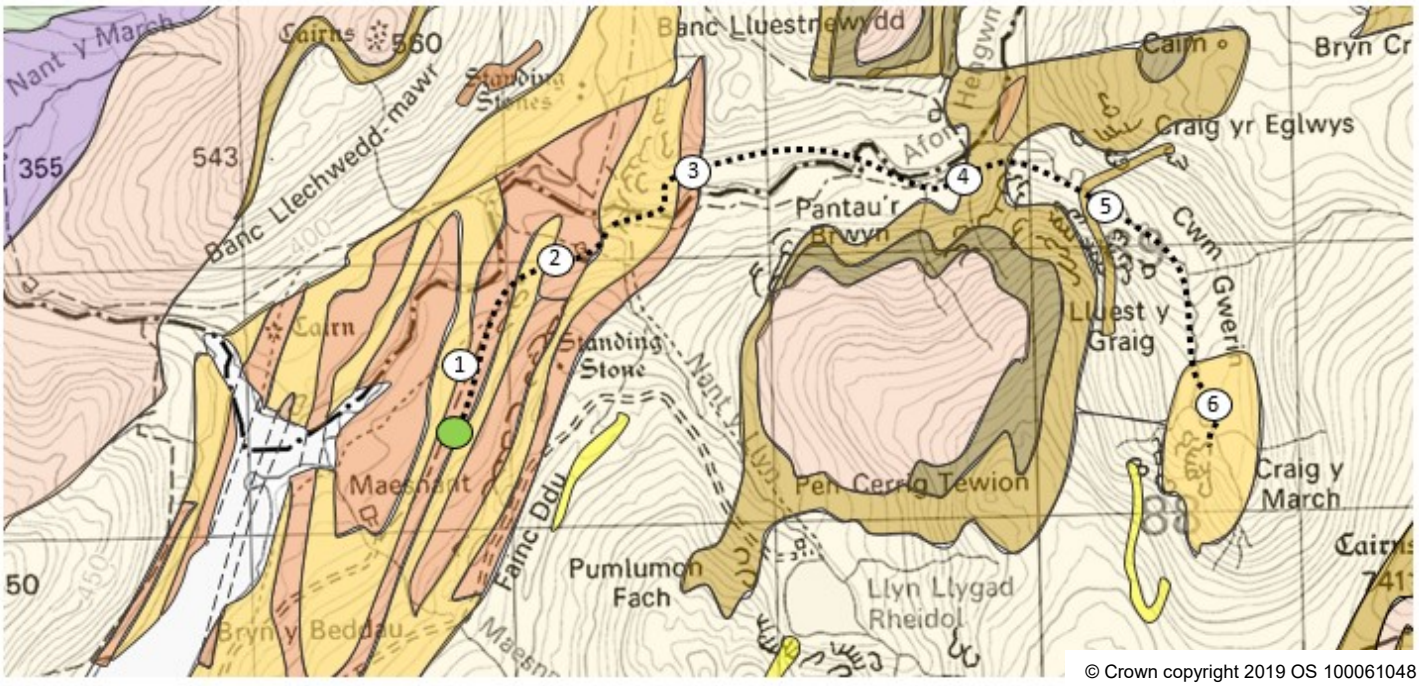


Figure 564: Llyn Llygad Rheidol. Outcrops of Drosgol siltstones (S) and mudstones (M) outcrop as a series of anticlines and synclines.

Craig y March

7 miles: approximately 4 hours



ORDOVICIAN
- Drosgol slumped mudstone, siltstone, sandstone
- Drosgol sandstone
- Nant y Moch mudstone, siltstone, sandstone
- Nant y Moch mudstone

SILURIAN
- Derwenlas mudstone
- Cwmere mudstone
- Bryn-glas slumped mudstone, siltstone, sandstone

ORDOVICIAN
- Lluest-y-graig mudstone, sandstone
- Pencerrigtewion mudstone, siltstone, sandstone
- Pencerrigtewion sandstone

In this excursion we venture into one of the most remote areas of Plynlimon to view large fold structures picked out by the beds of Ordovician sandstone. We see anticlines and synclines with a north-south axial trend superimposed on the major dome structure.

Start: Take the minor road along the Hengwm valley past Nant y Moch reservoir. Park at the point where the road becomes a gravel track [SN775879].

1: Walk along the track below the crags of Fainc Ddu.

The rocks forming the cliff face above the track are fan turbidites belonging to the Craig y Dullfan facies of the Nant y Moch formation (fig.566). Numerous thin sequences of sandstone, siltstone and mudstone are present, along with some coarser and thicker graded grits.

2: Towards the end of the cliffs of Fainc Ddu, mudstones of the Maesnant facies outcrop alongside the track. These deposits are a sequence of distal turbidites interbedded with hemipelagic mud.

3: Cross the footbridge over the Afon Hengwm. Continue along the side of the valley below Banc Lluestnewydd, keeping to the higher and less marshy ground away from the river. On the hillside opposite, a series of folds are visible in outcrops of Pencerrigtewion sandstone (fig.567). The Pencerrigtewion Member occurs within the Drosgol formation of upper Ordovician age, and is thought to have formed at the peak of the ice age when global sea levels were lowest. A large area of the Midland platform was exposed to erosion, producing sand which rivers discharged into the central trough of the Welsh basin.

Figure 566:

Outcrops of Nant y Moch sediments at Fainc Ddu:

(above) Fan turbidites of the Craig y Dullfan facies.

(below left) Turbidite channel conglomerate in Craig y Dullfan facies.

(below right) Mudstones of the Maesnant facies.

5: Cross the river, choosing a shallow point within one of the meanders downstream from the ruined farmhouse at the mouth of the Afon Gwerin.

Climb up past the waterfall on the Afon Gwerin.

On the hillside above is a rock formation known as Craig yr Eglwys. This is part of a syncline in the Pencerrigtewion sandstone with a north-south orientation of the axial plane of the fold.

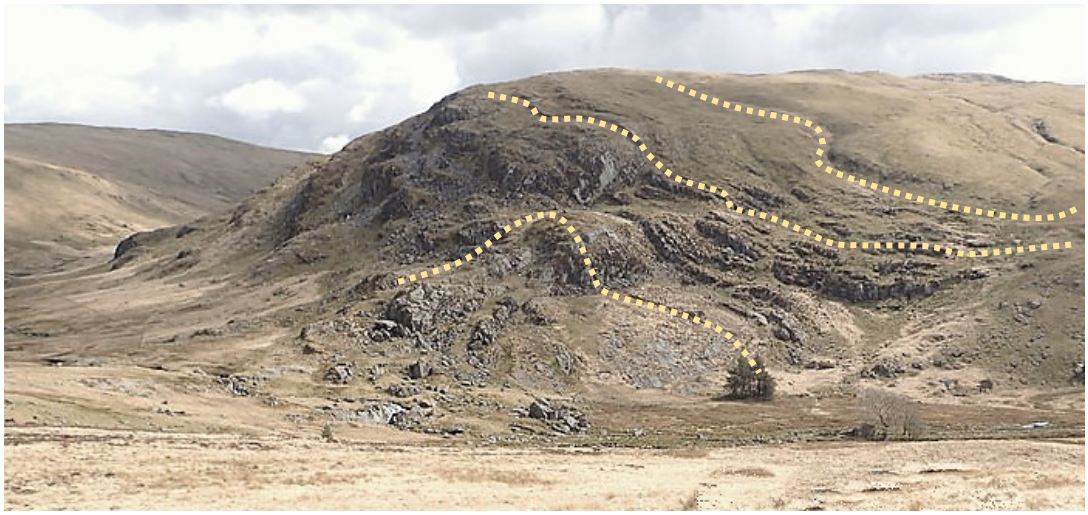


Figure 567: Folded Pencerrigtewion sandstone at Fainc Ddu.

Figure 568:

Craig yr Eglwys, a syncline in Pencerrigtewion sandstone.

6: Continue along Cwm Gwerin, following the line of the wire fence to the rocky headland of Lluest y Graig. This outcrop is again formed by the hard and resistant Pencerrigtewion sandstone.

Cross the fence, then follow the Afon Gwerin towards the head of the valley where Craig y March appears as a prominent outcrop (fig.569). This is formed by the eroded remnants of a large anticline in sandstones. The rocks, belonging to the Craig y Dullfan facies of the Nant y Moch formation, are proximal turbidites discharged in deltaic fans at the base of the marine trough.

The orientation of the anticline is roughly north-south. This fold lies just inland of the central core of the Plynlimon dome. The folds at both Craig y March and Craig yr Eglwys are noticeably asymmetric, with a vergence towards the west. In early Devonian times, the already rising Plynlimon dome may have created an obstruction against which the overlying sedimentary strata were pushed by crustal compression from the Midland platform in the east, forming a superficial sequence of asymmetric folds on the side of the major dome structure.

Return along Cwm Gwerin, then cross the Afon Hengwm and continue around the hillside of Banc Lluestnewydd to reach the footbridge and gravel track back to the parking point.

Figure 569: Craig y March, an anticline in Nant y Moch sandstone.

Carn Owen

2 miles: approximately 1½ hours

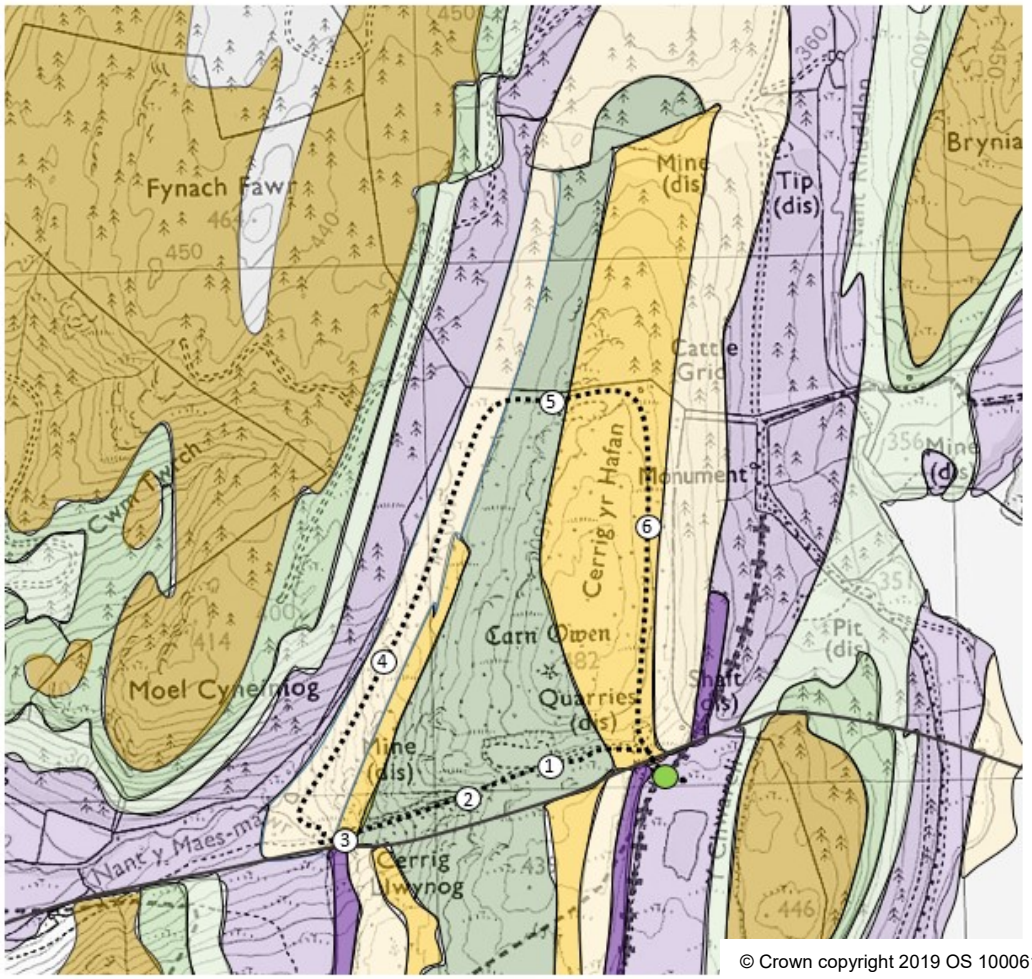


Figure 570: Field excursion.

ORDOVICIAN
- Llandovery Mottled Mudstone
- Bryn-glas slumped mudstone, siltstone, sandstone
- Pencerrigtewion sandstone
- Pencerrigtewion slumped mudstone, siltstone, sandstone

SILURIAN
- Borth mudstone
- Devil's Bridge mudstone, sandstone
- Rhayader mudstone
- Derwenlas mudstone
- Cwmere mudstone

The main objective of this excursion is to examine heavily contorted beds of mudstone and greywacke sandstone of the Drosgol formation. It is likely that these structures formed by **soft sediment deformation** before the deposits had been fully lithified.

Start: From Nant y Moch reservoir, follow the track to Carn Owen. Park at the entrance to the disused quarry [SN734880]. This quarry provided rock for construction of the Nant y Moch dam.

1: In the quarry we can examine a cross section through the Carn Owen pericline. This anticlinal structure appears on the geological map as an elongated oval exposing Ordovician Drosgol and Brynglas rocks at its core, surrounded by Silurian Cwmere mudstones. The crest of the anticline plunges downwards at its northern and southern terminations, and the fold is cut by the Hafan fault which crosses at a central point. Displacement of the surrounding outcrops suggests that movement on the Hafan Fault was mainly vertical.

In the first quarry we see outcrops of well-bedded massive sandstones belonging to the

Pencerrigtewion member of the Drosgol Formation (fig.571). These sandstones were deposited at the time of maximum glaciation in the late Ordovician ice age, when the waters of the Welsh basin were at their shallowest. The sandstones have a non-turbidite origin, and were probably emplaced by bottom currents.

Figure 571:

Pencerrigtewion sandstones in the eastern limb of the Carn Owen pericline.

2: Continuing into the main quarry area, we reach a cliff face of highly disturbed strata belonging to the Drosgol formation. Large curved slices of bedded sandstone can be seen, often in isolated rafts within a surrounding matrix of contorted mudstone and shale. The chaotic orientation of the different blocks of sandstone suggests that the sediments were deformed whilst still in a semi-lithified condition. A probable model is illustrated in fig.572.

In late Ordovician times, as sea level began to fall with the onset of the ice age, increased erosion of the Midland platform provided large amounts of mud and sand which accumulated on the basin shelf. Occasional slope failures occurred, producing mass movement of the semi-lithified strata. Sandstone beds were broken into separate sections, contorted and overturned in the huge gravity-driven flows, as we see today in the quarry face (fig.573).

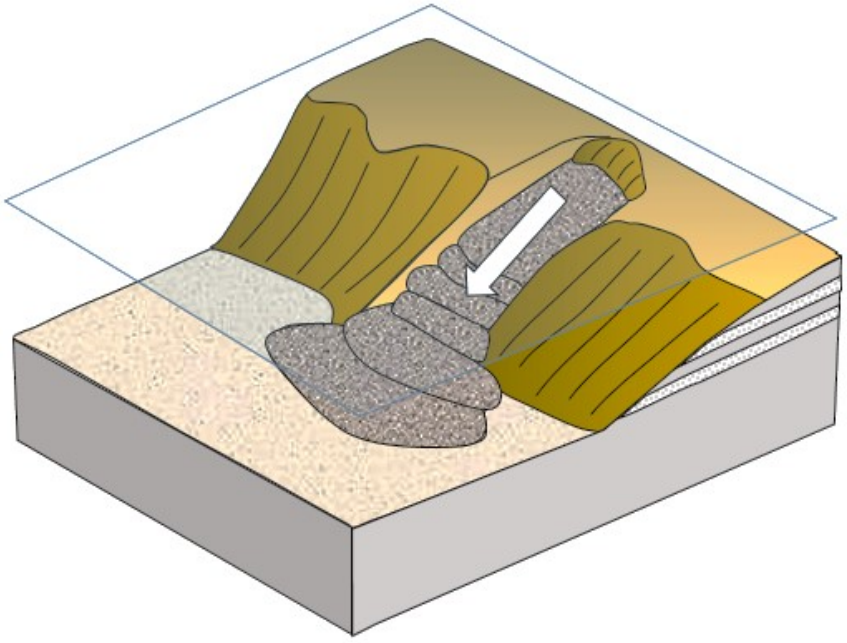


Figure 572:
Slumping of semi-lithified strata from the shelf margin into the deeper waters of the central basin.

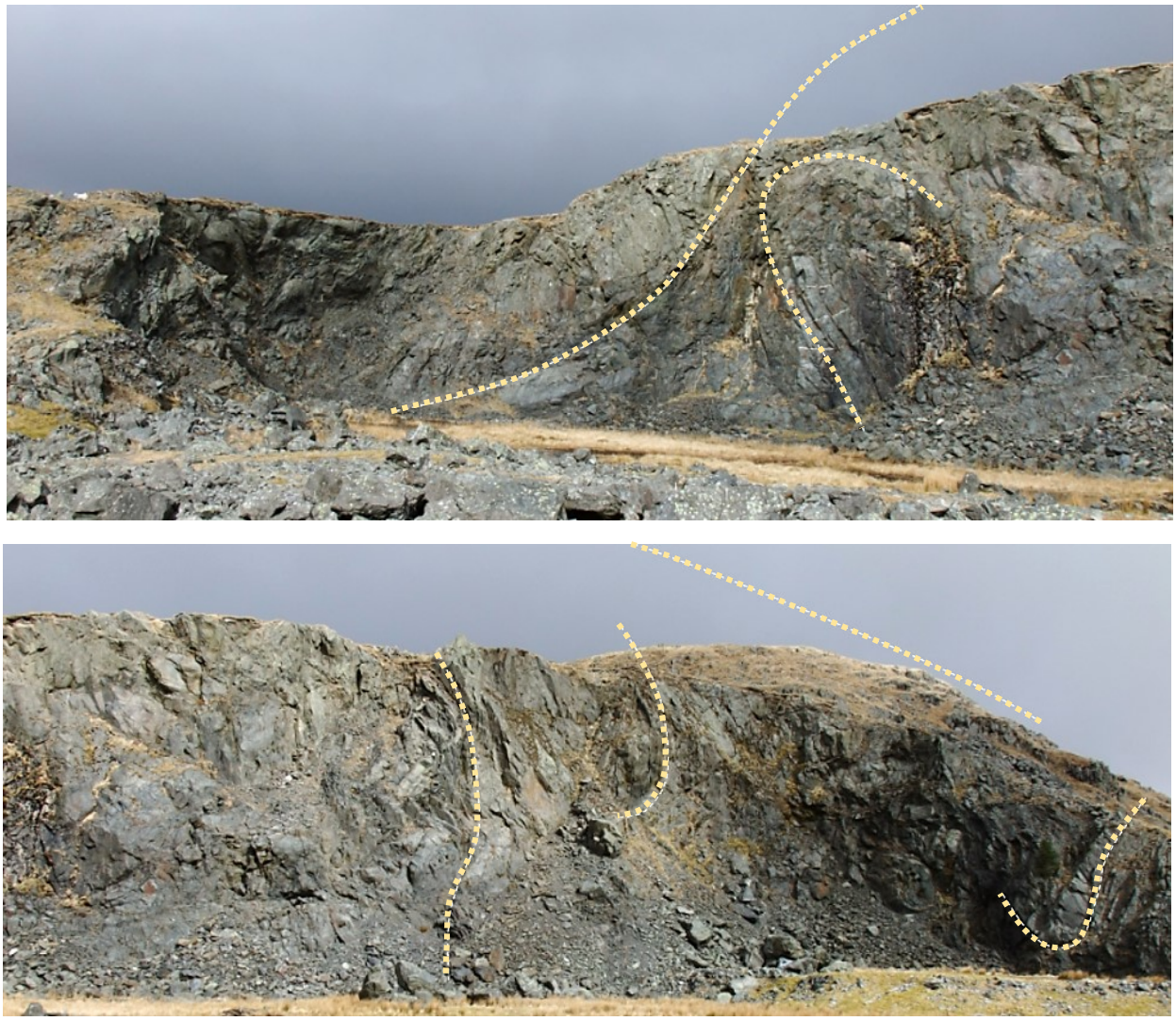


Figure 573: Carn Owen quarry. The contorted bedding in the sandstones is indicated.

3: Cross the quarry to the western end, where an inclined tramway descends past a series of adit tunnels of the Hafan lead mine. Originally, the highest workings of the mine were in the area now occupied by the quarry. Walk down the incline, noting more outcrops of the highly contorted slump deposits in the rock face to your right.

At the base of the incline we reach the western limb of the pericline, with uncontorted beds of Pencerrigtewion sandstone overlain by Brynglas and Cwmere mudstones which now dip westwards.

A series of adits of the Hafan mine can be seen, along with the remains of mine buildings and a waterwheel pit. Spoil tips contain samples of galena, sphalerite and chalcopyrite, within blocks of quartz and rusty brown crystalline masses of a mixed calcium-magnesium-iron carbonate known as ferroan dolomite.

The Hafan mine was worked on a substantial scale from around 1700. A series of mineral lodes run approximately parallel to the Hafan fault. The lodes are near-vertical, so were worked in long narrow cuts known as **stopes** which were accessed by the adit tunnels. A shaft was also sunk to reach ore below the valley floor level.

Ordovician Brynglas mudstones are exposed below the Hafan mine, and are overlain by the basal Silurian Cwmere mudstones. There is a change in colour from the lighter grey oxygenated mudstones deposited in shallower waters during the late Ordovician, and darker grey anoxic mudstones deposited as the basin deepened at the start of the Silurian.

Figure 574:

Hafan lead mine. Adits and shafts are found alongside and at the base of the incline.

4: Continue northwards up the slope which borders the Carn Owen pericline, following the craggy outcrop of the Pencerrigtewion sandstone.

5: Near the summit, a path leads to the right through the crags to an old quarry in the sandstone (fig.575). At this point we have reached the crest of the anticlinal fold, and the strata lie almost horizontally. Sedimentary structures can be examined in the sandstone beds and on the bedding surfaces. Large scale ripples suggest deposition by strong bottom currents, and examples of hummock and swale bedding indicate sand deposition during storms.

6: Cross the axis of the fold and return along the eastern flank of the pericline, following the outcrop of the Pencerrigtewion sandstones. Descend alongside the eastern quarry to reach the parking point.

Figure 575: (left) Slab quarry in Pencerrigtewion sandstone. (right) Bedding surface of Pencerrigtewion sandstone with large scale ripples.

Rheidol gorge

5 miles: approximately 3 hours

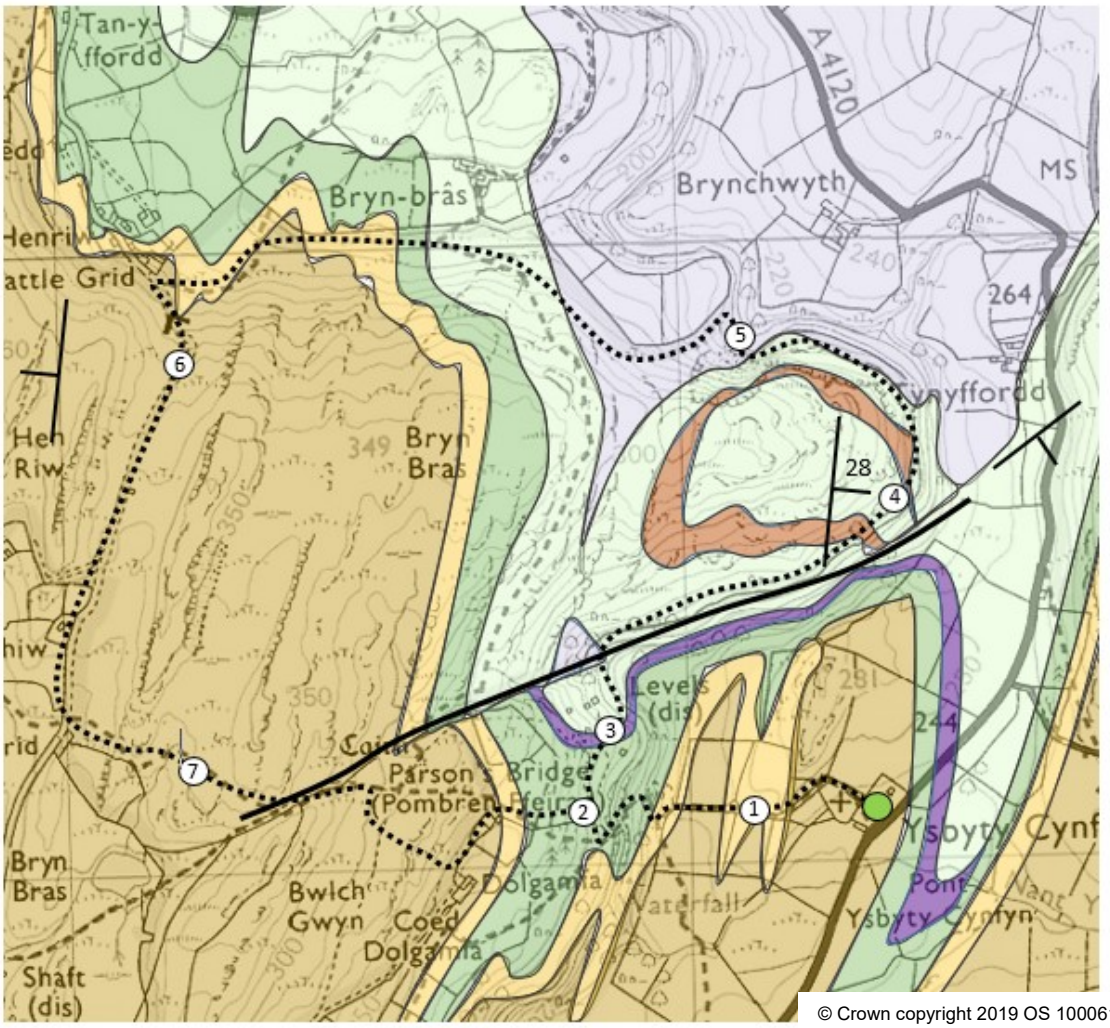


Figure 576: Field excursion.

- Derwenlas mudstone
- Derwenlas sandstone, mudstone
- Cwmere mudstone
- Devil's Bridge mudstone, sandstone
- Devil's Bridge sandstone
- Rhayader mudstone
- Monograptus Sedgwickii shale

The objective of this excursion is to examine the younger Silurian rocks of the Plynlimon area. After visiting Temple lead mine in a spectacular setting in the Rheidol gorge, we follow the river upstream to a location famous for graptolite fossil assemblages in the Cwmere and Derwenlas mudstones.

Start: Park next to the church at Ysbyty Cynfan [SN752791].

1: Go through the gate to the right of the churchyard and continue along the footpath across fields to reach the Rheidol valley.

When the wooded valley is reached, go through the gate and descend along the steep zig-zag path and steps to reach Parson's Bridge at the bottom of the gorge.

As you cross the bridge, look down at the large potholes cut by the river as it descends over the near-horizontally bedded mudstones and siltstones of the Rhayader formation.

2: Locate a narrow path which branches to the right at the end of the bridge to contour along the steep valley side. Follow this carefully upstream until the site of Temple lead mine is reached.

3: A large stone building housed a water wheel and ore crushing machinery. The ruins of dressing floors can be seen near the riverbank. A large circular recess in the rock platform marks the position of a water sedimentation tank with a rotary vane mechanism for gravity separation of heavier metallic minerals from the crushed ore. The ore concentrate produced was carried up the valley side to the village of Ystumtuen on a tramway incline.

Several adit tunnels can be seen at different levels on the hillside behind the crusher building. These worked a mineral lode parallel and just south of the Castell fault. The major fault joins the valley at this point and controls the course of the river for half a mile upstream of the mine.

Figure 577:
Temple lead mine. An adit tunnel is seen in the hillside to the left. The building on the right housed a waterwheel and ore crusher.

4: After examining the mine site, return to the footpath which runs along the valley through the woods. The path follows a leat which abstracted water from the river upstream, and carried it to the mine to operate the large water wheel. As well as operating the ore crusher, the water wheel provided power for pumping and haulage in the shafts inside the mine.

Continue upstream past waterfalls in the Afon Rheidol. After contouring along the valley side, the path ascends for a short distance through the woods. It is then possible to descend again to a flat open area of grassland alongside the river.

5: Ahead and to your left, you will see a large cliff face cut in mudstones of the Cwmere and Derwenlas formations (fig.578).

Figure 578:

Cliff in Cwmere and Derwenlas mudstones above the Rheidol gorge

This cliff, and the outcrops of mudstone alongside the river, were important field locations used by Professor O. T. Jones in 1909 to define the graptolite zones of the Lower Silurian.

Graptolites are important zone fossils as they are widely distributed across the Welsh basin and neighbouring regions. Unlike trilobites which live and feed only on shallow marine shelves, graptolites are free-drifting colonies of organisms which can be carried across ocean basins by marine currents. Graptolites can sink to the sea bed and accumulate in deep water sediments.

A further important characteristic of graptolites is their rapid evolution and diverse morphology. We saw earlier that Lower Ordovician graptolites in the Cader Idris area typically have a tuning-fork shape made up of two branches or **stypes** which carry the tiny cups or **thecae** in which the colonies of organisms lived. Further evolution by Silurian times led to graptolite forms with single stypes, including both straight and spiral forms. Examples from this location in the Rheidol gorge are shown in fig.579).

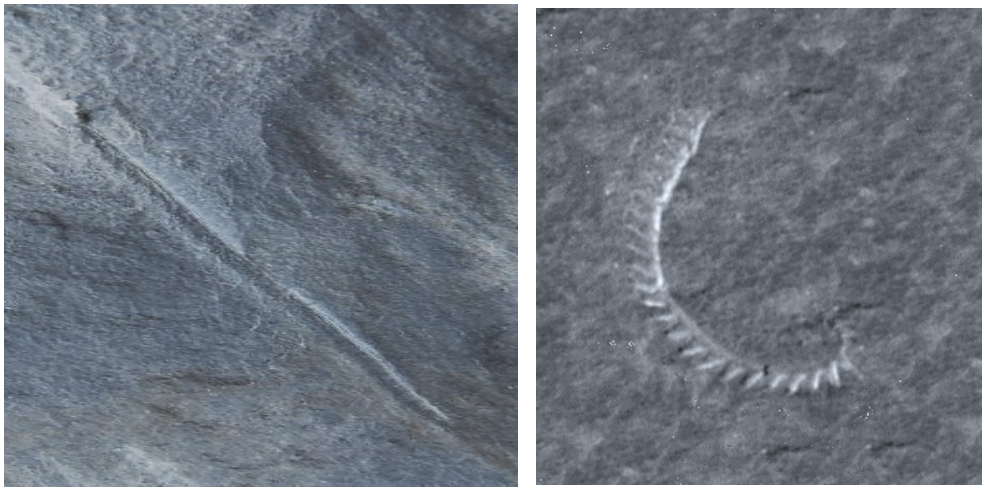


Figure 579: Graptolites from the Rheidol gorge: two species of *Monograptus.*

Graptolite specimens can be obtained from the mudstones in the rock outcrops alongside the river. Cleavage and bedding are both present, with the bedding picked out by slight differences in the colours of the mudstone layers. It is necessary to split the rock along bedding planes in order to find preserved graptolites.

6: After examining the mudstones, walk up the river bank to reach a fence bordering fields. Climb up alongside the fence to the top of the valley, then contour around the hill of Bryn Bras to reach a minor road to the village of Ystumtuen. Along this route, we pass upwards through the sequence of dark mudstones of the Derwenlas and Rhayader formations laid down in the deep waters of the Welsh basin in largely anoxic conditions. They are a mixture of distal turbidites and hemipelagic muds produced by quiet sedimentation from seawater.

Outcrops of Devils Bridge sandstone appear on the hillside as the road is reached. The Devils Bridge formation is again a turbidite deposit, but showing Bouma parallel-laminated B units and cross-laminated C unit sandstones. These coarser layers are overlain by D and E unit mudstones which usually make up about two-thirds of the whole turbidite deposit. Hemipelagic mud layers are also present between turbidite deposits. The overall coarsening of the Devils Bridge sediment in comparison to the underlying Derwenlas and Rhayader formations may be due to uplift and increased erosion of the landmasses around the Welsh basin which increased the supply of coarser sediment. Supply of sediment is thought to have been from the south-east.

7: Take the minor road towards Ystumtuen. Just beyond Penyrhenrhiw, take the footpath which runs up the hillside to the left. Skirt around the hillside of Bryn Bras. Remain on the footpath as it crosses a small valley, then cross a field to a gate. From this point, a footpath leads down past farm buildings to the edge of the woodland above Parson's Bridge. Cross a style and continue down the path through the woods, across Parson's Bridge, then back up the valley side to reach the parking point at Ysbyty Cynfal.