Blaenau Ffestiniog

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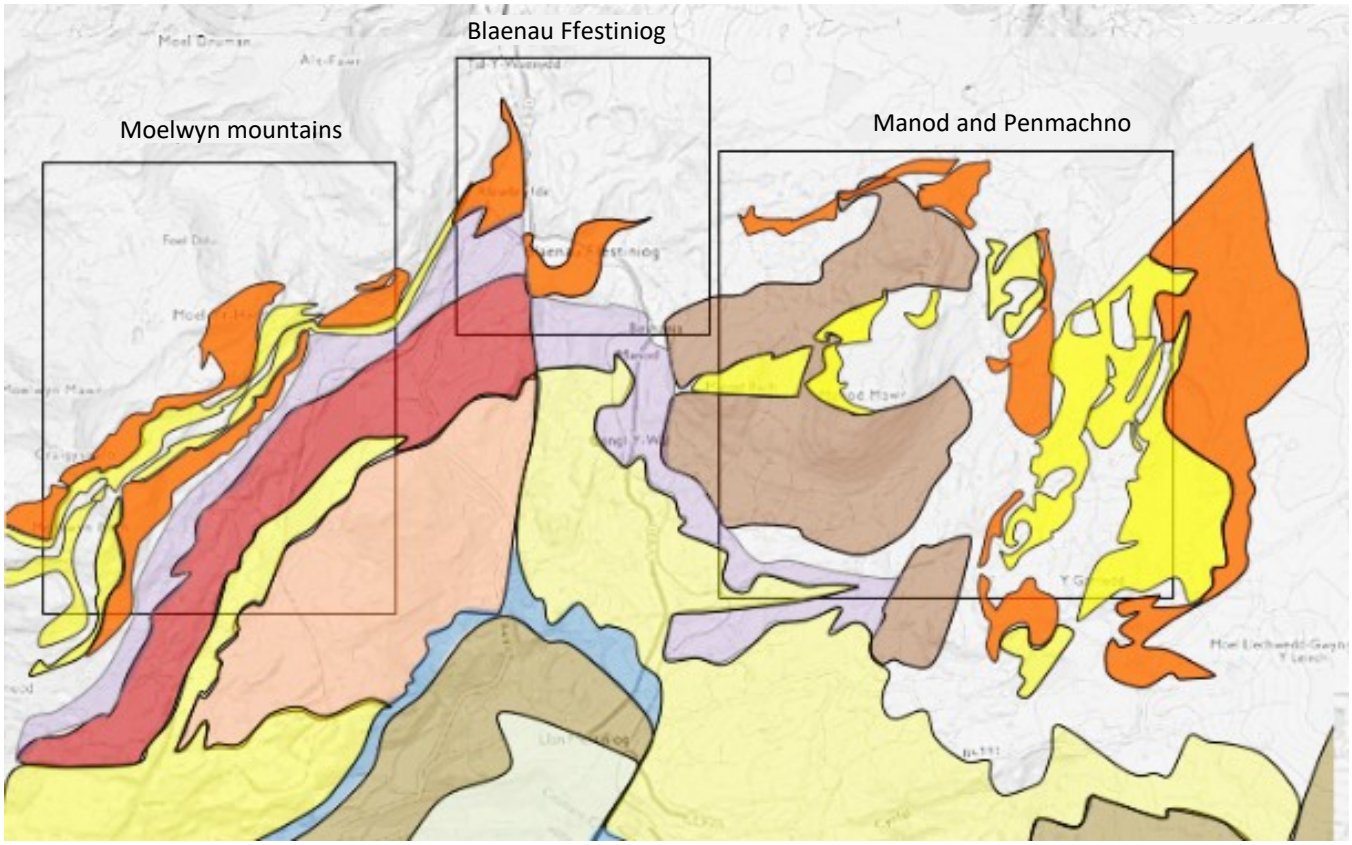


Figure 483: Field excursions.

Blaenau Ffestiniog is well known for its extensive slate quarries which dominate the town. In this chapter we examine the geology of the quarrying area, including the volcanic ashes and intrusions associated with the Moelwyn volcanic centre.

In the mid-Ordovician North Wales lay in the axial region of a large marine basin, well away from bordering land areas. Only fine sediment in suspension in the sea water or carried by bottom currents was deposited, forming the thick sequence of mudstones of the Nant Ffrancon formation. Occasional outbreaks of volcanicity occurred from sea floor vents or produced isolated volcanic islands.

Sedimentation continued in the Welsh Basin through Silurian times, until the region experienced an extensive mountain building episode in the Devonian period. It was at this time that the mudstones of the Nant Ffrancon formation were converted to the economically important slate deposits. Clay minerals recrystallized to platy mica minerals, becoming aligned at right-angles to the direction of maximum pressure. This resulted in the formation of cleavage parallel to the axial planes of folds (fig.484a). The cleavage structure is usually close to vertical and is well displayed in the slate quarries of Llanberis, Nantlle and Corris.

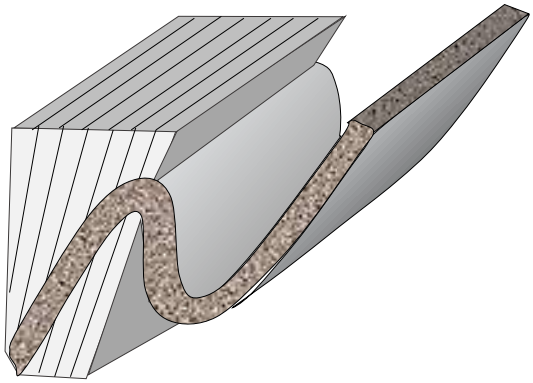


Figure 484a: Axial planar cleavage produced during folding.

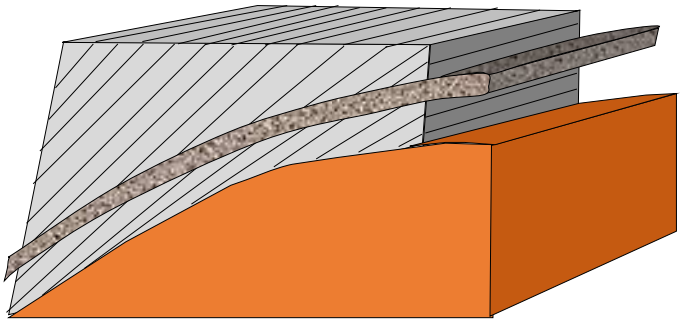


Figure 484b: Cleavage deflected over the Tan y Grisiau microgranite intrusion.

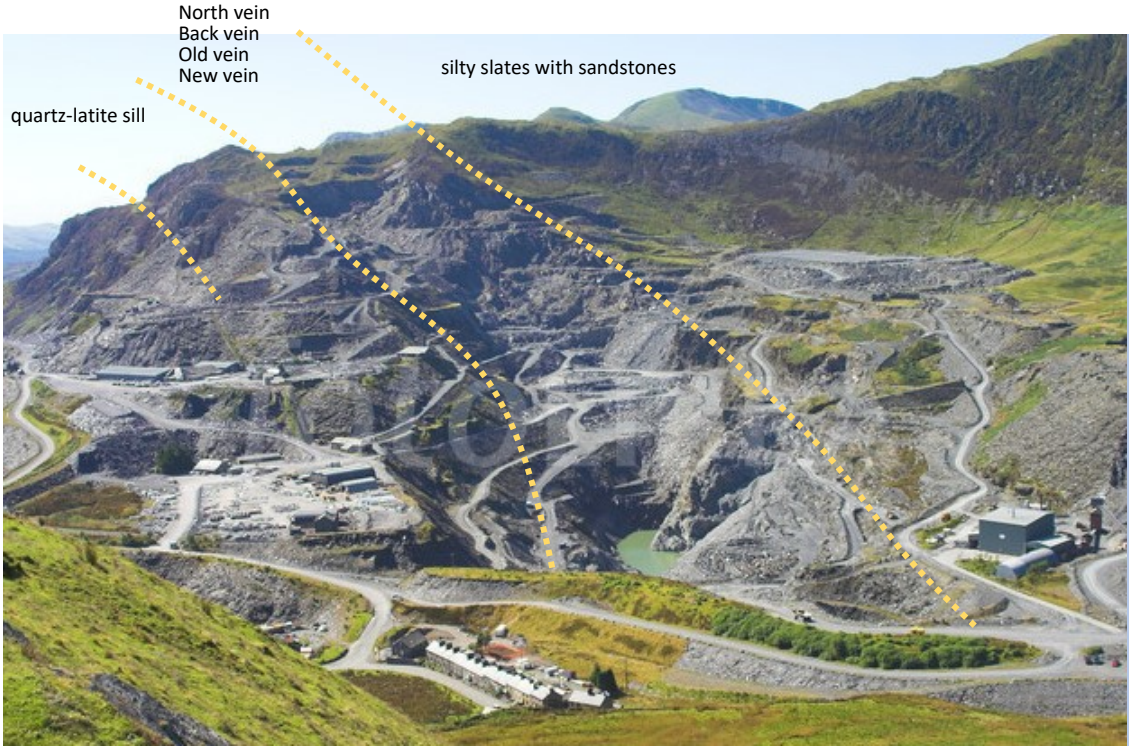
The formation of cleavage in the Blaenau Ffestiniog area, however, has also been affected by the presence at shallow depth of the Tan y Grisiau microgranite intrusion (fig.484b). Stresses were deflected over the top of the massive and solid granite to produce a cleavage at a shallower angle of between 45°and 60°. The dip angle of the cleavage controls the manner in which slate is extracted from the underground chambers of quarries in the Blaenau Ffestiniog area.

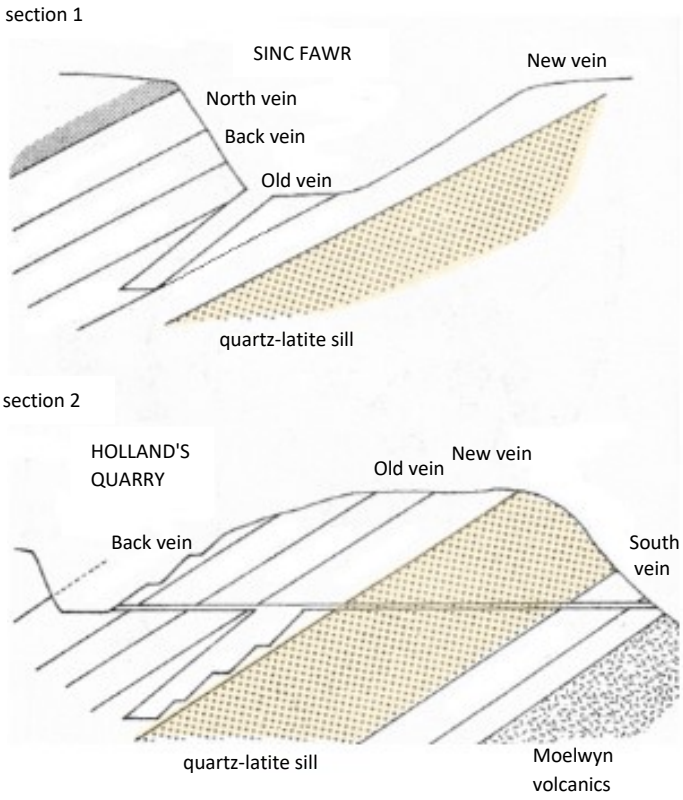
An anticlinal fold around the town of Blaenau Ffestiniog forms a northern continuation of the Dolwen pericline fold structure in the central Harlech Dome. Slates are interbedded with occasional volcanic ashes, and are cut by intrusive rhyolite sills. Explosive air fall and ash flow eruptions occurred from volcanic islands which intermittently appeared in the marine basin. Possible volcanic vents infilled by breccia have been found at Tan y Bwlch near Maentwrog, and at Manod near Blaenau Ffestiniog. The Manod vent lies on a northerly continuation of the Rhobell fracture zone. We find a number of sills related to the eruption of the volcanics. These intrusions are composed of very fine grained rhyolitic rock and were probably intruded into the sea bed sediments at a shallow depth. Some sills solidified rapidly amongst the cold wet sediments and were then broken into fragments as further magma was intruded, producing a rock type known as **autobreccia**.

The geological sequence of the Blaenau slate deposits and the manner in which they were worked are illustrated by the Oakeley quarry (fig.485). Only a small proportion of the mudstone sequence was of a sufficiently pure clay composition to produce the fine cleavage required for roofing slates. Impure silty mudstones contain tiny quartz grains which obstruct the alignment of mica flakes during metamorphism and reduce the quality of the rock. The best workable bands of slate are known by the quarrymen as the New Vein, Old Vein, Back Vein and North Vein. The lower boundary of the workable slate deposits is formed by a thick felsic sill intrusion, and the upper boundary is marked by a transition to silty mudstones.

The Oakeley quarry was initially developed around the 1850's as a series of underground chambers which accessed the slate veins. Pillars of rock were left in place to support the roof. However, in 1882 and 1883, two disastrous collapses of the workings occurred. Fortunately, the quarrymen had sufficient warning of the imminent collapses as cracks appeared through the chamber roofs. A huge open pit was produced which now dominates the quarry.

Field locations visited in this section include: the Moelwyn mountains and the Rhosydd slate quarry; Maen Offeren slate quarry in Blaenau Ffestiniog; and the mountain of Manod with nearby slate quarries at Penmachno.





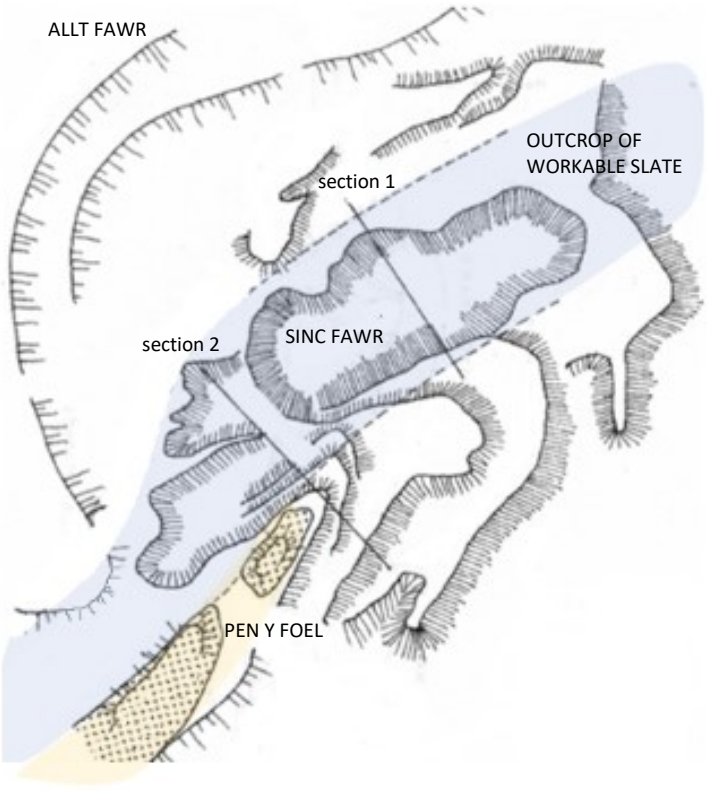
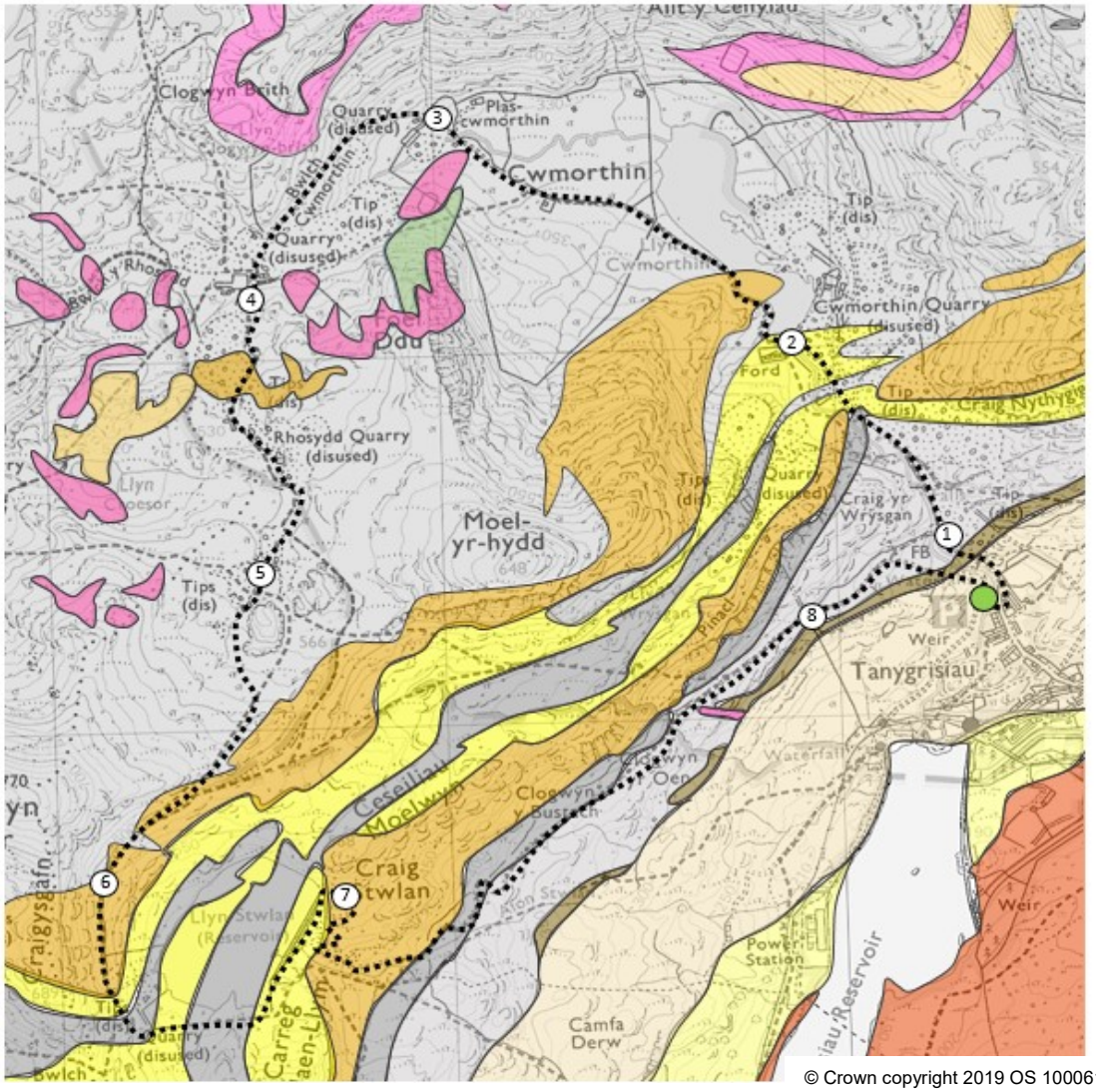


Figure 485: Oakeley slate quarry, Blaenau Ffestiniog.

Moelwyn mountains

6 miles: approximately 3 hours



- Moelwyn tuff
- Nant Ffrancon mudstone
- Allt Lwyd mudstone
- Garth Grit sandstone, conglomerate
- Dol-cyn-afon sandstone
- Dol-cyn-afon mudstone, siltstone
- Microgranite
- Microgabbro
- Felsite
- Lower Rhyolitic Tuff breccia
- Nant Ffrancon siltstone
- Intrusive rhyolite

Figure 486: Field excursion.

During this excursion, we examine the geological sequence from the Upper Cambrian, up through the Ordovician Moelwyn Volcanics, to the slate deposits of the Nant Ffrancon formation. We visit the large slate quarries of Cwmorthin and Rhosydd, viewing disused buildings and machinery, then return past the upper reservoir of the Ffestiniog pumped storage hydroelectric scheme.

Start: A small car park is provided alongside the road above Tan y Grisiau [SH683453].

1: Follow the road up the hill, immediately turning right to cross the bridge over the river. Take the quarry road uphill towards Cwmorthin alongside waste tips of slate.

After a short distance, a prominent waterfall is reached (fig.487). The massive grey rock is the Arenig basal grit member of the Dol-cyn-afon formation. This represents deltaic deposits formed as the Welsh Basin subsided after uplift and emergence in earth movements at the end of Cambrian times. Above the basal grit are layered sandstones and siltstones formed on a coastal shelf. There is evidence of bioturbation by burrowing marine animals.

2: Continue up the quarry road past the sites of the slate processing mills to reach Cwmorthin lake. Cross the stone slab bridge at the outlet of the lake and walk up to the now derelict houses of quarry workers (fig.488). The ice-smoothed outcrops around the houses are composed of pyroclastic ashes of the Moelwyn Volcanic formation.

Figure 487: Waterfall in Dol-cyn-afon sandstone.

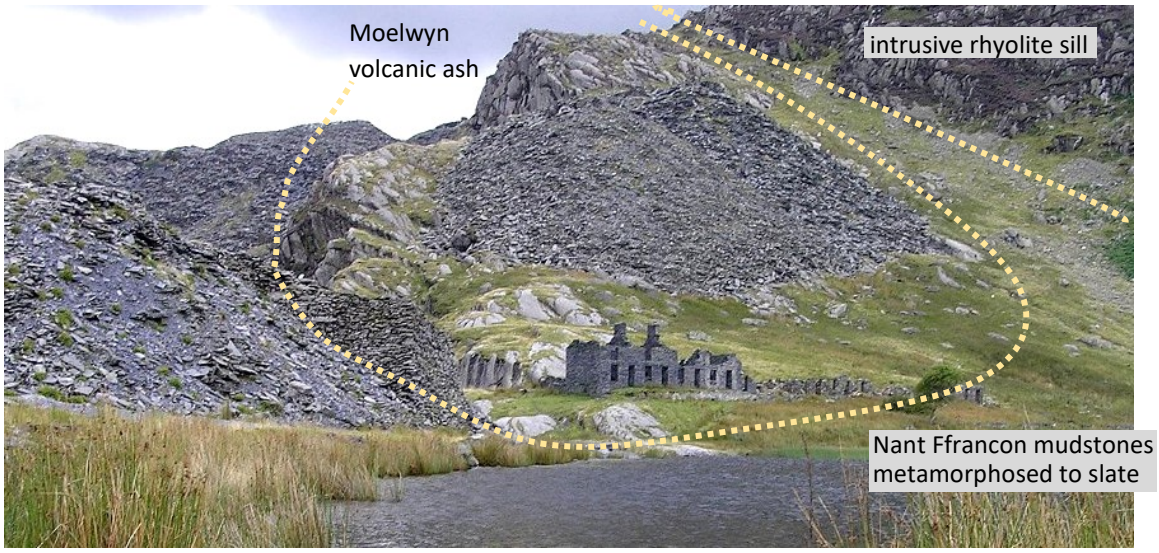


Figure 488:
Llyn Cwmorthin.

Opposite you on the eastern side of the lake is the large Cwmorthin slate quarry. Quarrying at Cwmorthin started in 1810, and in 1860 the site was connected to the Ffestiniog Railway by a series of inclines leading down past Tan y Grisiau village. In 1900 the Cwmorthin quarry was taken over by the Oakeley quarry which was working the same veins of slate on the other side of the mountain, and a connection was made underground. Quarrying continued on a declining scale until the 1990's when the quarry closed. In the later years, opencast working took place on the hillside above the lake. Heavy machinery was used to expose pillars of good quality slate which remained between old underground chambers.

For safety reasons, there is a locked gate at the entrance to Cwmorthin quarry. However, it is possible for organised parties with a qualified leader to explore the underground workings. In the following description, we will outline the underground features of Cwmorthin, which are typical of the Blaenau Ffestiniog quarries.

Beds of workable slate at Cwmorthin have a dip of approximately 30°and may be 50 metres in thickness. Quarrying often begin by opencast working of surface outcrops. However, the shallow dip of the slate requires the removal of excessive amounts of overburden in order to reach deeper sections of the vein. The preferred method of quarrying was therefore to develop underground chambers (fig.489).

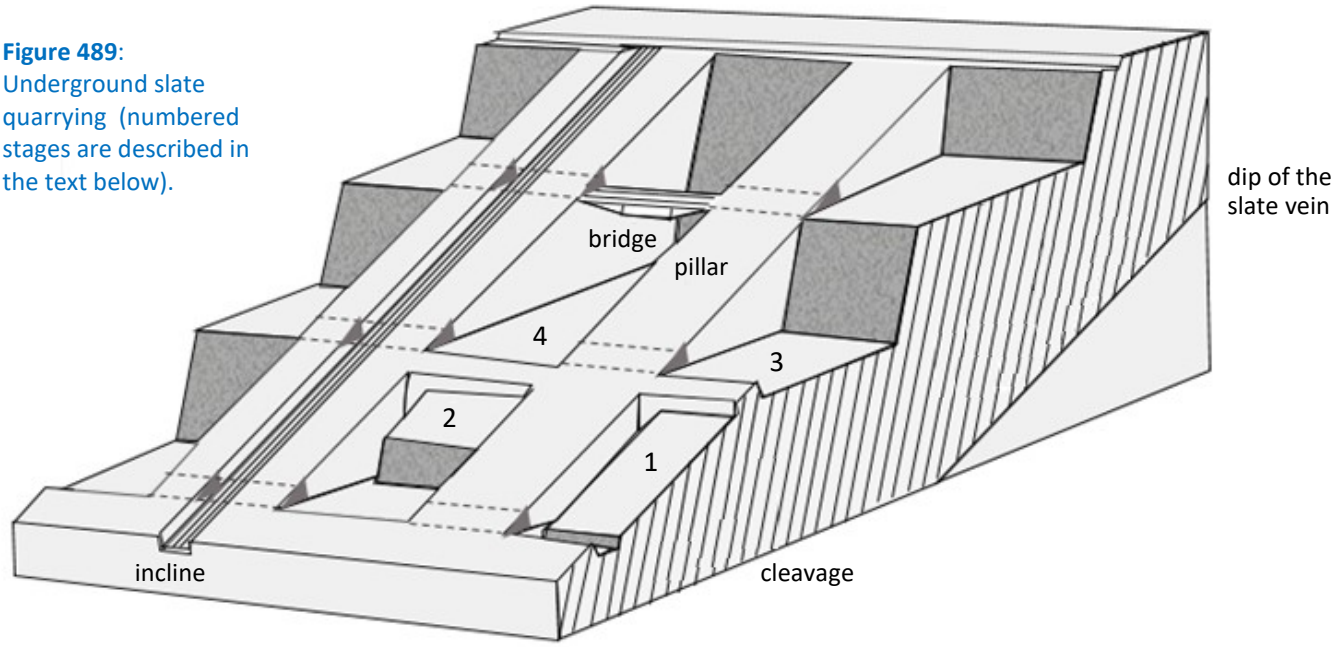


Figure 489: Underground slate quarrying (numbered stages are described in the text below).

An access tunnel or **adit** was driven from the valley side to reach the slate vein. From this point, an incline could be cut below the roof of the vein to provide a transport route for the removal of slate (fig. 490).

At depth intervals of about 10m, horizontal tunnels were cut sideways below the roof of the slate vein. These tunnels marked the 'floors' of the underground workings. At intervals along the tunnel, chambers could now be developed. Pillars of rock would be left in place between chambers to support the overlying rock.

1: The first stage in opening a new chamber was to cut a 'roofing shaft'. This was essentially a slot to separate the workable slate from the overlying rock. At this stage it was important for the quarrymen to carefully inspect the roof and remove any insecure rock, to avoid roof falls later as the chamber was developed.

2: Slate could now be extracted from the chamber, using hand or mechanical drills to make holes for explosive charges to break away large blocks of slate along the cleavage surfaces.

3: The working face would gradually move backwards until the chamber reached a full height of 10m between floors.

4: Where the thickness of the slate vein permitted, a chamber could be developed to a height of more than one floor. This could, however, cut the transport routes to the incline. The problem was solved by constructing a timber bridge to span the gap.

Continue along the course of the old tramway beside Llyn Cwmorthin, passing the ruined chapel, to reach the head of the valley. At this point, waste tips of the Rhosydd quarry can be seen above you on the valley side to the west.

3: Follow the path which ascends to Rhosydd. Near the top of the path you pass a huge stone waterwheel pit on your right, before emerging onto a flat plateau covered by the remains of quarry buildings. The quarrymen's barracks and the foundations of the slate processing mill can be seen.

Rhosydd Quarry was opened in the 1830s, but the remote location caused problems for the transport of finished slates. In 1864, a new tramway was built westwards from the Rhosydd mill to a point high on the cliffs at the head of the Croesor valley. From here, a steep incline carried trucks down to the Croesor tramway for onward transport to the harbour at Porthmadog.

If time permits, follow the tramway as it cuts through a microgabbro intrusion and winds around the valley head to reach the winding drum of the Croesor incline. The peak of Cnicht dominates the head of the Croesor valley, composed mainly of Nant Ffrancon siltstones but strengthened by several large sill intrusions of felsite and microgabbro associated with the Snowdon volcanic centre to the north. Return along the tramway to the Rhosydd mill.

Figure 490: Cwmorthin quarry.

(above left) Incline with track for hauling up trucks of slate.

(above right) Large quarry chamber. A stairway has been constructed up a cleavage surface which formed the working face.

(below right) Cross-cut tunnel through a slate pillar. A timber bridge across a worked-out chamber is visible.

Locate the floor 9 adit and incline which are situated near the old mill building. Ascend the series of inclines, past slate waste tips, to reach the moorland on the higher slopes of the mountain. Two large open pits will be seen, known as the East Twll and the West Twll.

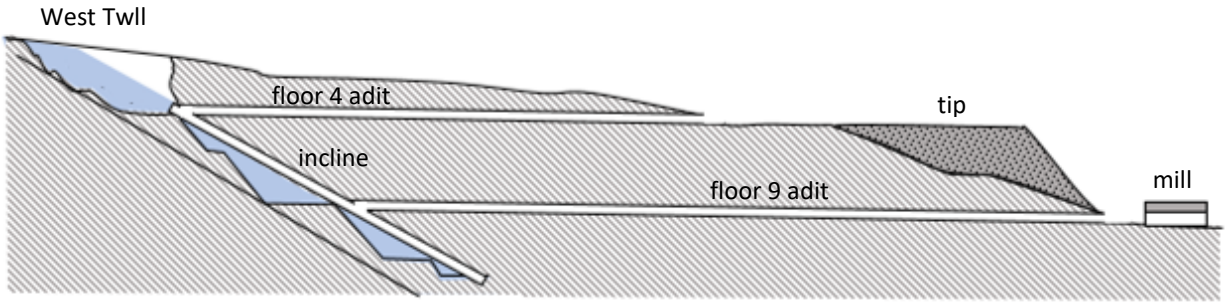


Figure 491: Diagrammatic cross section of the Rhosydd quarry workings. The Old Vein is shown in blue.

The underground layout of the Rhosydd quarry is illustrated in fig.491. The main productive band of slate is the Old Vein which was first worked at the surface in the West Twll, then accessed by adits on floors 4 and 9 as the workings extended below ground. A transport incline was cut, and sequences of chambers were developed on either side in a similar pattern to the Cwmorthin quarry. Pillars were left in place between chambers to support the chambers, but in 1900 a catastrophic collapse took place in the eastern part of the quarry. The resulting roof falls produced the East Twll pit (fig.493). Remnants of original pillars can be seen amongst the jumble of fallen blocks of rock.

Figure 492: Entrance to the floor 9 adit, with an incline alongside.

5: Cross the moorland to the West Twll, taking care not to approach the edge of the pit too closely as sections of rock are overhanging and unstable. Large working chambers can be seen extending underground from the base of the pit, and the transport incline reaches the surface in the north-east corner. The Old Vein is a darker coloured mudstone, overlain by sandy coloured silty mudstone.

Figure 493: (left) Collapsed chambers forming the East Twll. (right) Opencast pit of the West Twll.

6: Continue to the edge of the mountain escarpment where Llyn Stwlan, the upper reservoir of the Ffestiniog pumped storage scheme, comes into view. Contour around the hillside until you are above the lake, then drop down to join an old mine tramway which skirts around the basin.

The tramway passes small slate quarries before reaching outcrops of the Moelwyn Volcanic formation. The volcanics consist of a variety of unwelded felsic ashes and coarser pyroclastics (fig.495). Unbedded agglomerates often pass upwards into roughly bedded ashes with lapilli, then finer laminated ashes. These fining-upwards sequences represent the air-fall products of individual explosive eruptions. In places, the ashes show evidence of slump folds produced whilst the material was unconsolidated. It is likely that the eruptions took place from a volcanic vent on a volcanic island into the shallow water of the surrounding marine basin.

Continuing around the end of the lake, observe the silty slates, siltstones and fine-grained sand-stones which were laid down during a long quiet interval between volcanic episodes. The reservoir dam has been constructed along the outcrop of a thick sill of quartz-latite.

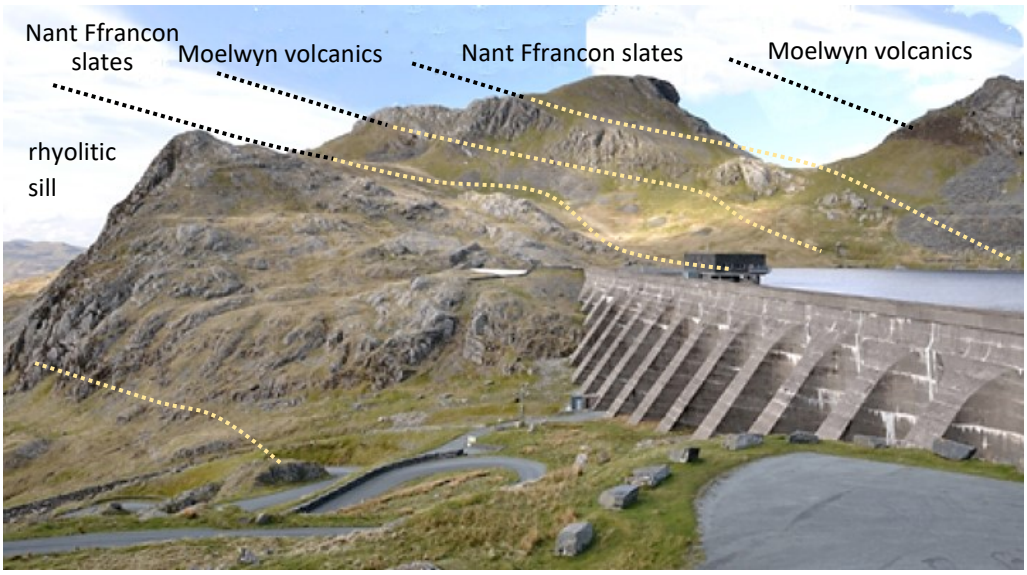


Figure 494:
Outcrops at Llyn Stwlan.

Figure 495: Rocks of the Moelwyn Volcanic formation.

Figure 496: Auto-brecciated quartz-latite sill, Llyn Stwlan.

7: Cross the reservoir dam to reach the road which descends towards the lower reservoir at Tan y Grisiau.

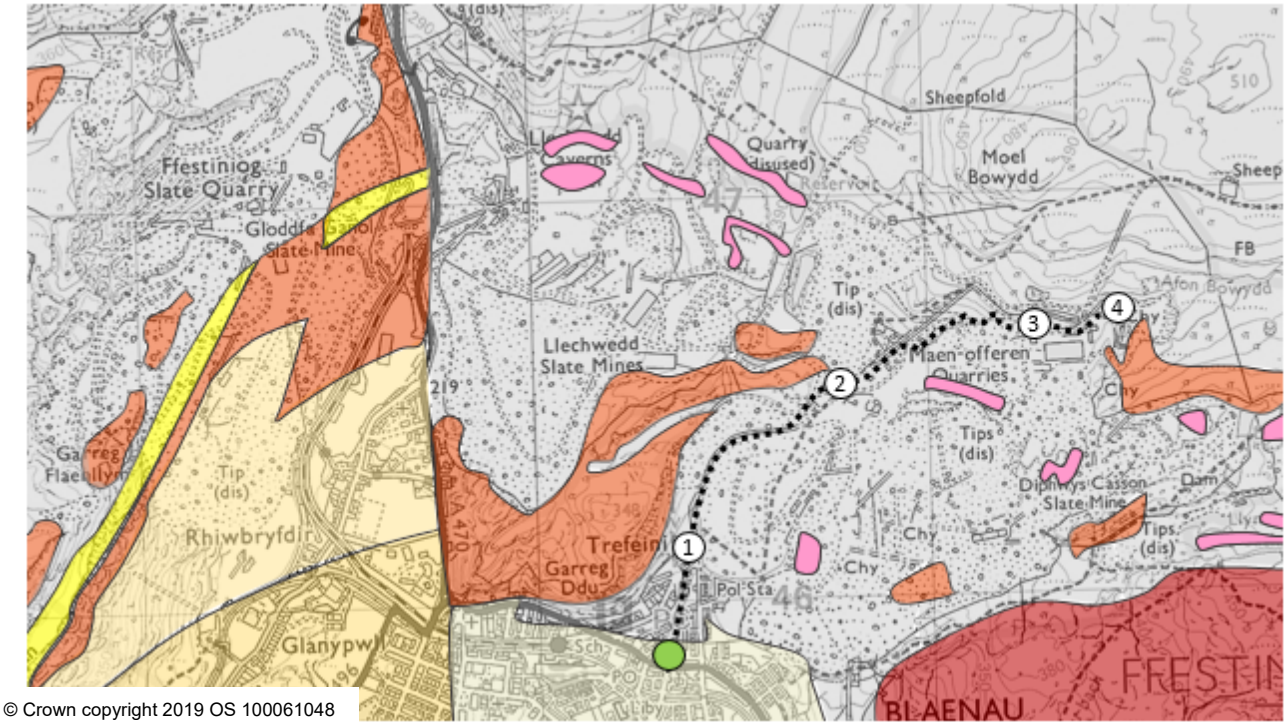
Outcrops next to the reservoir and along the series of hairpin bends below the dam are quartz latite. The intrusion is made up of alternating zones of autobreccia and flow-banded and flow-folded material. The felsic magma was intruded at shallow depth below the sea bed and was clearly very viscous. At times, glassy solidified chunks of rock were caught up in the flow to produce the autobreccia. It is likely that the intrusion is magmatically related to the Moelwyn Volcanic formation, and both have links to the nearby volcanic centre at Manod.

8: Continue down the road to reach the parking area in Tan y Grisiau. Near the point where a long quarry incline descends across the road, observe current bedded sandstones of the Allt Lwyd formation. These sediments were deposited in a deltaic environment as the Welsh Basin deepened at the start of Ordovician times.

Figure 497: Cross-bedded sandstone of the Allt Lwyd formation.

Blaenau Ffestiniog

2 miles: approximately 2 hours



- Penmaen tuff
- Nant Ffrancon siltstone
- Moelwyn tuff
- Allt Lwyd mudstone
- Dol-cyn-afon sandstone
- Allt Lwyd sandstone, siltstone
- Quartz-latite
- Microgabbro
- Intrusive rhyolite

Figure 498: Field excursion.

A group of major quarries is situated around the town of Blaenau Ffestiniog. These quarries are currently producing slate or have been active in recent years. Visitor activities are also being developed: zip wire and mountain bike descents, and interesting and informative tours of the surface and underground workings are available. The quarries are therefore still very active sites.

This excursion describes Maenofferen quarry which is within a short walking distance of the central car park and railway station in Blaenau Ffestiniog. At the time of writing, Maenofferen is being worked on a small scale to produce slate from opencast areas. It may be possible, with permission from workers on site, to walk up the quarry roadway to view the disused mill buildings and incline winding house. If access on foot is not possible, similar locations can be visited as part of a lorry tour operated from the nearby Llechwedd quarry visitor centre.

Start: Park in the central car park in Blaenau Ffestiniog near the railway station [702459].

1: Walk up through the town to reach the entrance to Maenofferen quarry.

2: If access is possible, continue up the quarry road past opencast workings to reach the upper mill area. Within the slate succession can be seen the rocky outcrops of several rhyolitic sills (fig.499). These very fine grained intrusions are associated with the Manod and Moelwyn volcanic centre, and were probably emplaced at shallow depth within the seabed muds.

Figure 499:

Quarry road to the Maenofferen upper mill area.

3: View the disused mill and workshop buildings (fig.501). Great care should be taken due to the unsafe state of the roofs.

Maenofferen was first worked in the early 1800's as an opencast quarry on the hillside immediately to the east of the current mill buildings. A tunnel, which is now blocked, led from the base of the open pit to the mill. By the mid-1850's, slate began to be extracted from underground chambers in the slate vein which dips northwards beneath the hillside at about 30°. A large incline equipped with three sets of railway tracks was constructed from the base of the open pit to access the underground workings.

The winding house for the incline was initially powered by a steam engine, and the chimney flue from the boiler can be seen climbing the side of the pit. In the later days of the quarry, the incline was converted to electric power.

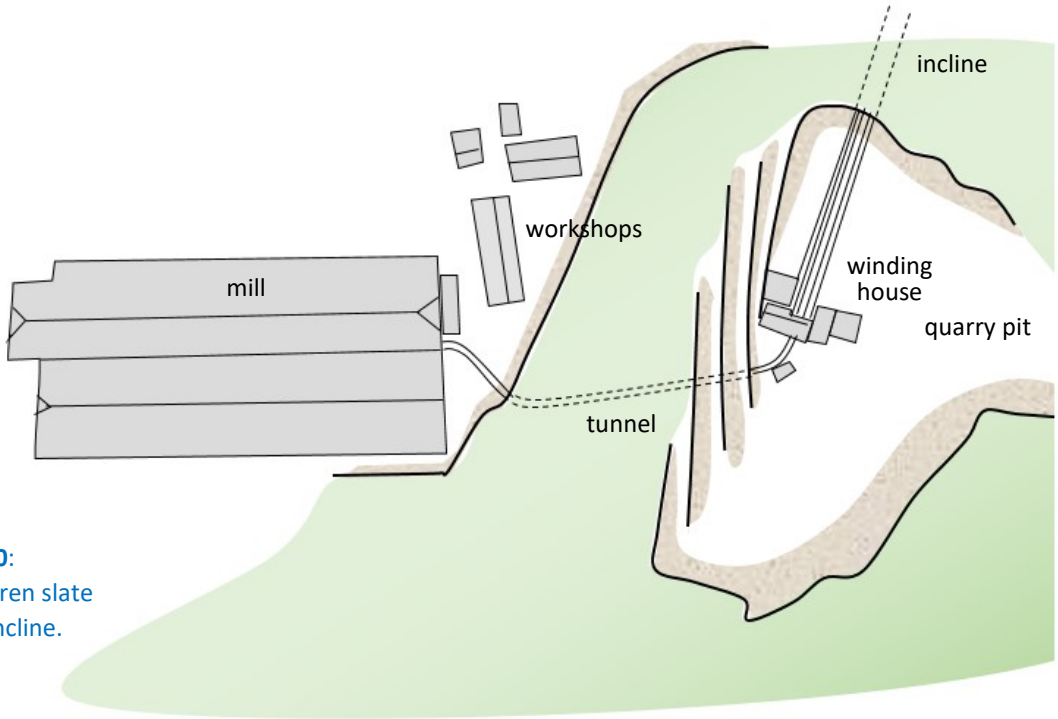


Figure 500:
Maenofferen slate mill and incline.

Figure 501: (top) Maenofferen slate mill and workshops.
(bottom) Quarry pit, incline and winding house. Photo by Ben Garratt.

4: Walk up to the hillside to a point above the quarry pit to view the winding house and incline.

Return down the quarry road to Blaenau Ffestiniog.

Manod and Penmachno

6 miles: approximately 3 hours

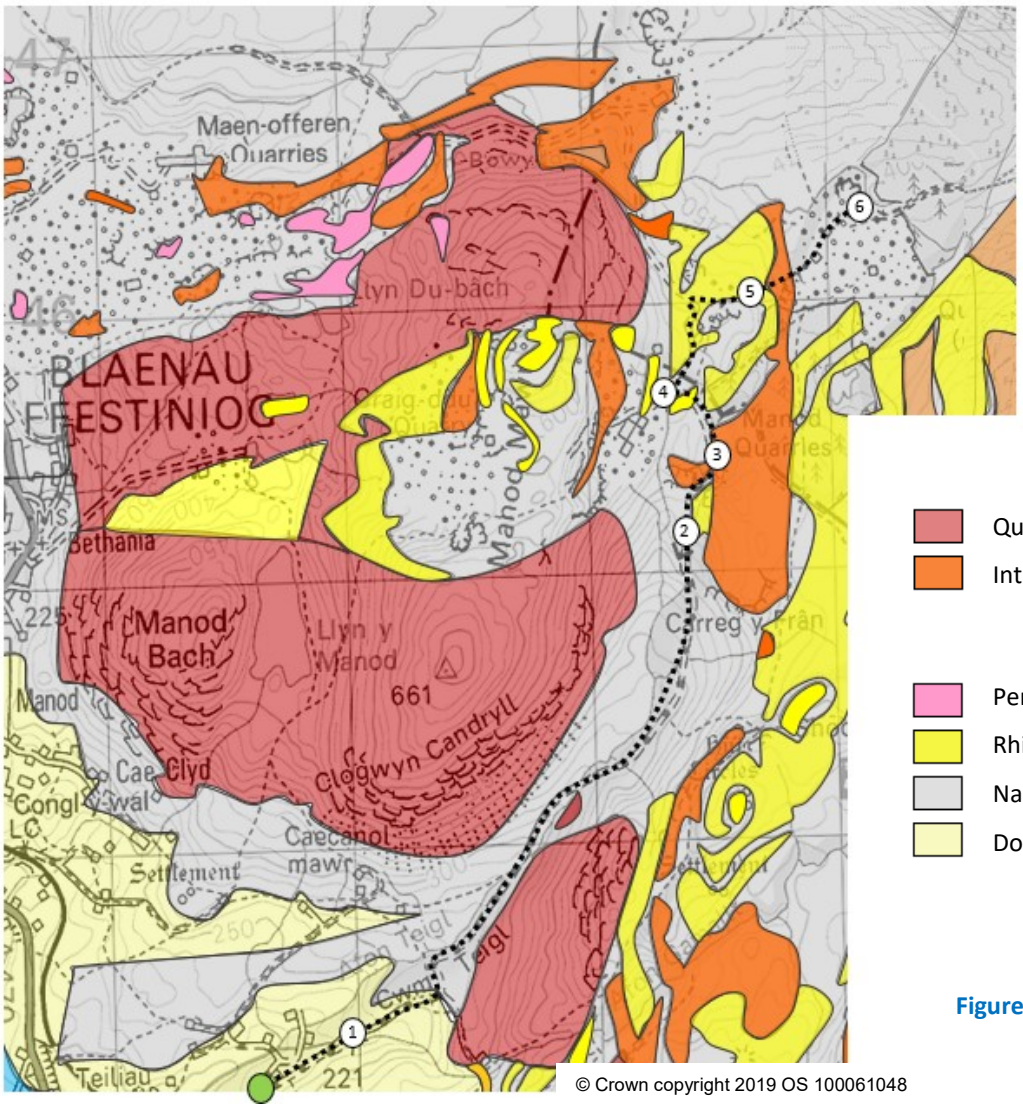


Figure 502: Field excursion.

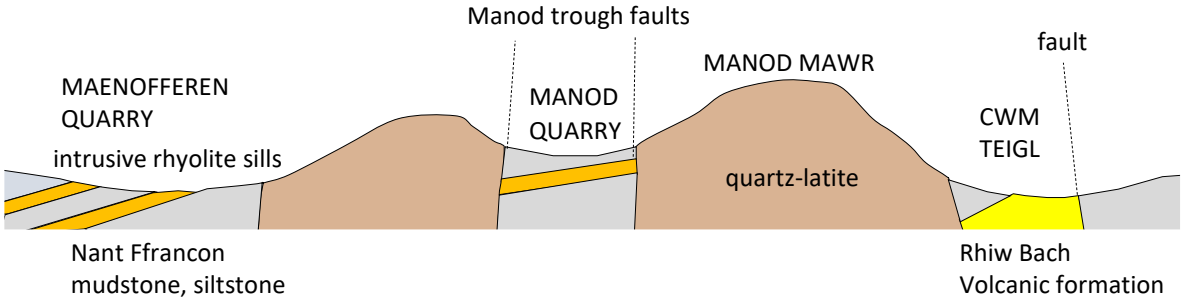


Figure 503: (above) Manod, viewed from the road between Trawsfynydd and Ffestiniog (below) Geological cross section with approximately the same orientation.

In this excursion we visit the isolated hill of Manod Mawr which forms a prominent landscape feature at the head of the Vale of Ffestiniog. Manod is principally a large felsic intrusion, flow foliated and brecciated in its upper parts. It is likely that this intrusion provided a volcanic vent from which the felsic ashes of the Moelwyn and Rhiw Bach Volcanic groups were erupted.

Start: From Llan Ffestiniog, take minor roads to Cwm Teigl. Park by the roadside at the road junction beyond the old chapel [SH716431].

1: Begin the walk up Cwm Teigl past outcrops of Upper Cambrian Dol-cyn-afon mudstones and siltstones in a small river gorge.

2: Continue up Cwm Teigl with the crags and scree of Manod Mawr to your left. Ahead in the distance is the thick felsic sill intrusion of Carreg y Frân (fig.505).

As Carreg y Frân is approached, outcrops of felsic ashes of the Rhiw Bach Volcanic formation are seen at the side of the road. These are very similar to the Moelwyn volcanic ashes outcropping above Tan y Grisiau, and may have been erupted from the same vent. The Rhiw Bach ashes are unwelded and laminated, and were probably deposited by underwater flows from a nearby volcanic vent.

Figure 504: Felsic ash of the Rhiw Bach Volcanic formation.

Figure 505:

(above) Carreg y Frân.

(below) Flow foliated and brecciated rhyolite of the Carreg y Frân intrusion.

3: On reaching the point where the road starts to ascend steeply past Carreg y Frân, outcrops and large fallen boulders of intrusive rhyolite can be seen. Flow foliation and brecciation is present.

To the left of the road, slates of the Nant Ffrancon formation are seen in the walls of the ravine of a small stream. The bedded sequence of Cwm Teigl is separated from the Manod intrusion by faulting, which may represent a reactivation of the Rhobell fracture zone which runs along the eastern side of the Harlech Dome crustal block.

4: At the head of the Cwm Teigl we reach Manod quarry. (In recent years this has been renamed as Cwt y Bugail quarry although confusingly another quarry of the same name already exists, several miles to the north.)

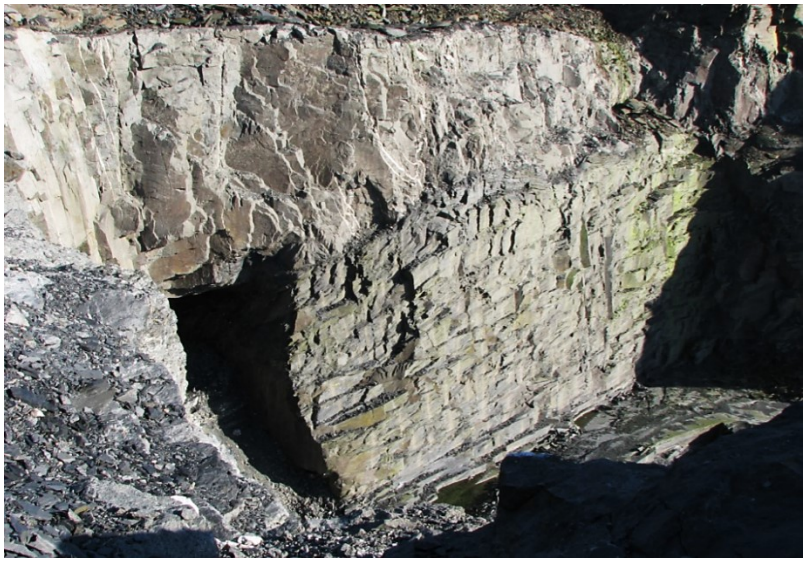


Figure 506:

Manod quarry.

(above) Opencast pit, with slate overlain by bedded ashes of the Rhiw Bach formation.

(right) A thick sill of intrusive rhyolite overlying slates in the opencast workings.

Manod quarry was first developed around 1850. Despite its remote location, the economic operation of the quarry was made possible by the construction of the Rhiwbach tramway. This tramway carried slate from Manod and a number of other quarries. It ran around the mountainside to Maenofferen, down a series of inclines to reach the Ffestiniog Railway, then onwards to the harbour at Porthmadog. Manod quarry is perhaps most famous for its role during World War II in safely storing the valuable art collection of the National Gallery in London in its underground chambers.

At the time of writing, Manod quarry is in operation and access is not possible. However, photographs of the opencast workings were taken a few years ago during a period that the quarry was inactive (fig.506).

Manod was from its early days an underground quarry. Slate was extracted from a large downfaulted area of the Nant Ffrancon mudstones, bordered to the north and south by upfaulted blocks of the Manod quartz-latite intrusion. Chambers were developed within a slate vein overlain by intrusive rhyolite and bedded felsic ashes. Quarrying since the 1980's has focussed on opencast working, removing overburden to reach the valuable slate left in pillars between the underground chambers. A large pit has developed during this work. Many of the vertical rock faces seen in fig.506 are the exposed walls of the old chambers.

5: Alongside the entrance to Manod quarry is the start of the Rhiwbach tramway. Follow this around the hillside, past a deep opencast pit and a derelict television relay station, to reach a junction leading to the Rhiw-bach quarry. Continue towards Rhiw-bach, then descend the incline to reach the quarry mill area.

6: At the foot of the incline we find the remains of the steam engine house which operated the incline, and also hauled slate from the workings. Walk through the old mill to reach the open pit where an incline leads downwards to a number of levels of underground chambers. Access is restricted by a metal gate across the incline, but visits can be arranged for groups with an experienced leader.

The remote location of the Rhiw Bach quarry made it necessary to provide accommodation for the quarrymen on-site. Descend the path around the waste tip to reach the ruins of the quarry village which at one time housed complete families, with a shop and school.

Return along the Rhiwbach tramway, then down the road through Cwm Teigl.

Figure 507:

Rhiw bach quarry.

(above) View from the mill area towards the Rhiwbach tramway. The incline to the tramway begins behind the chimney of the engine house.

(below) The opencast quarry, with the gate at the head of the underground incline. Workable slates in the lower section of the rock face are overlain by bedded siltstones of the Nant Ffrancon formation.