

Glaciation – past and present effects.

SNOWDONIA NATIONAL PARK
One of Britain's breathing spaces

Snowdonia has a great diversity of landscape within its boundary from mountains and moorland to its estuaries and beaches. This glaciated landscape from the hanging valleys and pyramidal peaks to the flat valley bottoms has created a diverse environment for the people of Snowdonia to live and work in and for the visitors who are attracted to its dramatic beauty every year.

This resource aims to direct the reader towards the location of a variety of glacial landforms within Snowdonia before studying their impact on human activities and the impact of human activities on the glacial environment.

Glacial Features.

Grid references are taken from the Ordnance Survey Explorer OL 17 – Snowdon and the Conwy Valley; OL18 Harlech, Porthmadog & Bala or OL23 Cadair Idris and Llyn Tegid

Glaciated Plateau

Migneint - This feature is the result of sheet glaciation associated with ice caps such as the Columbian Ice field in the Canadian Rockies. In Snowdonia the ice sheet was probably centred on the Migneint/Arenig area and was at its height around 18,000 years ago. With a depth of 1400m only the highest mountain peaks would have protruded above the ice as 'nunataks'. As ice flowed from this ice sheet glacial breaches occurred that started the creation of major passes that we see today. The main features of the Migneint today are marshy depressions and irregular lakes many of which have been filled with peat deposits with a few rocky outcrops protruding above the ground.

Glacial Troughs and Ribbon Lakes

These features are associated with severely glaciated areas. Many of the glacial troughs, Nant Ffrancon, Llanberis Pass, were formed originally by outlet glaciers from the Migneint/Arenig Ice sheet and then eroded further by local valley ice with contributions from the cirque glaciers above. The creation of ribbon lakes within these valleys was dependant on the rock type and the erosive power of the ice. Some valleys e.g. Nant Ffrancon have seen their ribbon lakes infilled over time and analysis of the deposits give and insight into the changing climate and vegetation

OL23 Llyn Tegid [9133] This is the largest natural lake in Wales with a length of 4½ miles and depth of 43 m. The lake follows the Bala to Tal y Llyn fault line and is close to the origins of the Snowdonia Ice Sheet.

OL17 Llyn Padarn [5761] and Llyn Peris [5959] These lakes are situated in the same valley to the north west of Snowdon. Llyn Peris is 2.1 km long with an average depth of 19.5 m and Llyn Padarn which is 3.2 km long and an average depth of 16 m. The two lakes were once one and became separated by an alluvial fan created by Afon Hwch. Llyn Peris has been modified to create a lower water body for the Llanberis Hydroelectric scheme. Llyn Padarn was changed during the eighteenth century when slate waste was dumped into the lake.

Cwm/Corrie/Cirques and tarn lakes

OL17 Llyn Glaslyn [6154], Llyn Llydaw [6254], Llyn Teyrn [6454]. A series of lakes in the shadow of Snowdon. Glaslyn is the highest at 600 m then Llydaw at 440 m and then Teyrn at 380 m. The water from Llyn Llydaw is used to power the **hydro electric power** station at Cwm Dyli. A further poorly developed Cwm sits above Glaslyn – Pant y Llwchfa (lluwch = snowdrift)

Cwm Idwal [6459] One of the most studied sites in Snowdonia. Excellent moraine features, created due to ice being added from Cwm Cneifion 200m above. The back wall has a good example of a rock fall below it and shows the geology of the area clearly in the syncline.

Cwm Clyd [6359] Cwm Cywion [6360] Cwm Coch [6361] Cwm Bual [6361], Cwm Perfedd [6261] and Cwm Grainaog [6262] form a series of cwms all facing north north east on the western side of Nant Ffrancon. Aspect and lithology both played a role in their formation..

OL23 Llyn Cau [7112] Located at a height of 475m on Cadair Idris and with a lake depth of 50m it is surrounded by cliffs with the back wall reaching 457 m above the lake at Penygadair (892 m). This Cwm follows a line of weakness in the Llyn Cau mudstones.

OL18 Llyn Stwlan [6644] Nestling in the Moelwyn mountains, this Cwm was enlarged by a dam wall to increase its capacity. It is used as a header dam for the Stwlan pump storage hydro electric scheme. A pipe links Tanygrisiau reservoir with this modified lake providing a drop of 300 metres.

Arêtes (Crib)

An arête is a narrow, serrated ridge between two glaciated slopes or cwms positioned back to back. Walks along such outcrops can be fascinating but great care should be taken.

OL17 Crib Goch [6255] and Crib-y-Ddysgl [6155]. This is part of the Snowdon Horseshoe which provides us with one of the most spectacular examples of arêtes in the country. The slope on Crib y Ddysgl (1065m) falls off to the north east to Llyn Bach and Llyn Glas (a drop of 300m) and to the south to Llyn Glaslyn a 600m drop. Crib Coch rises dramatically to a height of 923m with falls of 300m on either side.

OL23 Aran Fawddwy. [8622] This ridge is called Drws Bach and runs from Aran Fawddwy in a south east direction to the Drysgol at a height of 745 metres. The two cwms are located to the north and south of this ridge.

Pyramidal Peaks

These are the result of three or more glaciers located around a mountain. The plucking on each back wall creates a pronounced peak, with very steep sides. One of the finest examples in the world is the Matterhorn (4,478 m.) in Switzerland.

OL17 Snowdon (6054) This has three main Cwms which affected its creation, namely Glaslyn, Cwm Tregalan and Cwm Clogwyn. However the resultant peak viewed from the north is not prominent as a gradual slope leads to Clogwyn Coch and Clogwyn Du'r Arddu. Viewed from the south however, the back wall from Glaslyn to the summit shows a true pyramidal shape.

Cnicht [6446] Often called the Welsh Matterhorn this peak has been created mainly due to the over deepened Croesor valley and the very resistant rock formations within the peak. When this peak is viewed from the north it looks very rounded however when looking from the south west at Porthmadog the peak is very pronounced.

Roches Moutonne

These are rocky outcrops which are more resistant than the surrounding bed rock. Ice deforms around the obstruction eroding (abrading) the up side creating a smooth outcrop (similar to a sheep's back). Friction produces a sheen of melt water which freezes to the leeward side which is then plucked away producing a jagged surface. They can vary in size and shape; however the average size is 10 - 15 metres.

OL17 Maes Caradoc [6362] This is one of the classical examples which are often quoted in the geographical textbooks. Located in the centre of the Ogwen valley (and once covered by a ribbon lake which was quickly in filled with glaciated outwash from the surrounding streams) unlike all the other glacial features, this one can't be located on a map. The valley runs from Cwm Idwal in a NNW direction towards Bethesda.

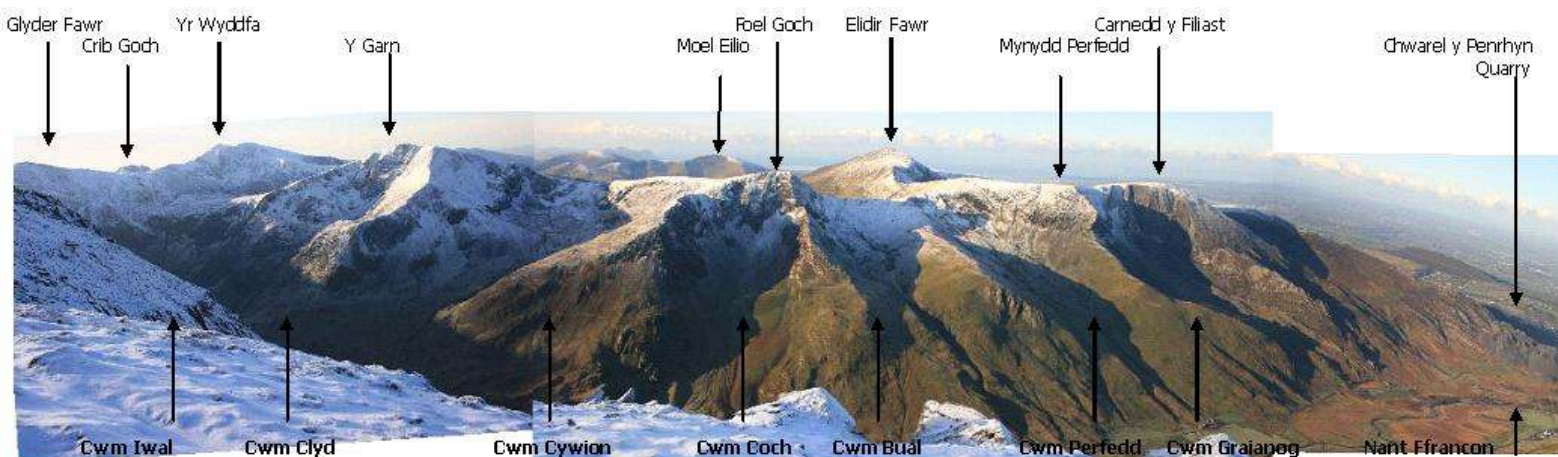
Hanging Valleys and Waterfalls

These occur where the main valley has been eroded at a much higher rate than the tributary valleys. After glaciation the latter are left at a higher altitude 'hanging' above the main valley. Streams that flow from such tributary valleys fall steeply creating water falls.

OL23 Cwm Amarch [7111] This valley begins on the southern flank of Cadair Idris where a dry cwm exists. As it flows into the Tal y Llyn valley it falls over a very steep drop, creating a waterfall. The change in height from the bottom of the main valley to the hanging valley is 315m.

Nant Graig Wen [8317] The hanging valley in this example is small but the waterfalls are one of the best examples in the whole of the Park. The falls are best viewed from the main A470 and surrounded by the coniferous forest

Nant Ffrancon from Pen yr Ole Wen



Ecosystems

As the Ice retreated, plant succession started with lichen and mosses. Alpine plants established on the craggy slopes and some of these – the 'Snowdon Lilly', tufted saxifrage, moss campion, mountain sorrel and alpine meadow rue survive in remote corners of northern Snowdonia.

As the corries and valley became warmer, woodland appeared with Oak, Elm and Birch migrating northwards from Europe and the alpine plants withdrew to the higher slopes. The woodland ecosystem reached its climax 5000 years ago, when it reached a height of 600m in Snowdonia. From then on the woodland decreased due to climatic variations and the introduction of grazing by early farmers. Their remnants can be seen in Cwm Idwal in peat deposits which reflect the abundance of vegetation once here, the remains of trees remain fossilised within this layer and the pollen record within the peat attests to the transition which occurred over time.

Agriculture and ecosystems

The landscape that we see today, the unhindered view over rolling mountains, is down to human activity. What most visitors see as a 'natural environment' is actually part of a never ending 'environment impacted by humans'.

Human remains dating from 5000 B.C. can be seen in a Neolithic dolmen (burial mounds) at Capel Garmon. Around 2000BC early Bronze Age people started to use the abundant metals they found to make tools and Pen y Gogarth in Llandudno was one of the main production centres in Europe. These tools replaced the stone tools of the Neolithic and their production led to the decline of the forests. Gradually, the wooded valley floors were cut to produce firewood and building materials. With people now settled, farming became the main livelihood and land was needed for the animals to graze. Originally animals roamed wild within the wooded landscape, grazing on saplings and reducing the woodlands ability to regenerate naturally. The threat of wild animals led the farmers to enclose their land, using the stones that riddled the landscape – stones and till material deposited by ice. Thus the landscape that we know today developed – that of stone wall enclosures that covered the valley floors and the steep valley sides. Until the 16th Century, approximately 65% of Snowdonia was covered in broad leafed trees. Today, the area covered by native woodland is less than 3%.

Conserving the Alpine environment

Cwm Idwal a National Nature Reserve site since the 50's there are several enclosures within to see what vegetation would return if sheep were kept out. Implemented in 1957 the experiment shows that when left alone, heather grows in abundance on the acidic lip, Rowan trees and bilberries returned as well as cotton grass on the wettest areas. Although these plots showed visibly what could grow there, sheep still grazed around them and occasionally within them. Today, through European legislation and finance with regard to the protection of SSSI's, new boundary walls were built in the Cwm. These run into the lake to stop sheep from entering the cwm in the summer and the area is regularly shepherded. The secondary succession of plants is proceeding within the Cwm as, apart from **wild goats**¹, the area is left alone. Whilst the environmentalists and ecologists look forward to the regeneration, the geologists are uncertain – with further growth, glacial striation marks and the geology of the area will be hidden from view by heather and gorse, and tree roots will make their way into solid rock through fissures, eroding what many come to see and study today. Luckily, ground survey techniques can 'see' further into the rock than the naked eye, and will preserve a record of what was there during the Ice age.

¹ - **Wild Goats** (*Capra domestic*)

The wild goats of Snowdonia are descendants of animals which were once kept as livestock by hill farmers. Problems arise when the goats come down to the valleys, to graze on flower and vegetable gardens, and when they get into plantations of young trees. Goat numbers were low, especially when cold winters kept the death rate high, but a succession of mild winters and extra grazing due to less sheep has seen a dramatic rise.

Conservation and Extermination! - the problem of plants.

Even though the climate in Snowdonia is cold and wet, with rocky slopes and poor, thin, acidic soils, some plants introduced to Britain thrive in the conditions creating problems. Without any natural predators to limit their expansion they spread rapidly, choking out many native plants. Consequently they are termed "invasive".

The 3 plants which pose the most serious threat are the Rhododendron ponticum, Spartina Grass (*Spartina townsendii*) and Japanese Knotweed (*Fallopia japonica*).

Rhododendron ponticum

Native to parts of Turkey and Portugal it was brought into this country during the 18th and 19th centuries and used for landscaping within ornamental gardens and as cover for game. It soon spread into the wild. Rhododendron grows in dense stands and shades out all other plants. It needs moisture and high humidity to germinate – both found within Snowdonia. Each flower head produces between 3 and 7 thousand seeds, which are light and highly airborne, and so the spread of the plants can be quite quick. It can also photosynthesise in 2% daylight, and will eventually shade out and kill the native trees. It kills off competition from other plants by producing a poison from its roots and cyanide is found in its leaves. As a result no animals eat it and it has no natural predators here. As it reproduces by seeding and layering, can resist hot and cold temperatures, wet and dry conditions, the spread of Rhododendron is very hard to stop.

Plants have to be cut and burnt, the stumps treated with herbicide and re growth sprayed, often every 3 or 4 years, before it is killed. This is an expensive and time consuming process. It has been found most effective to clear a whole area at a time, and a lot of successful work has been done around Maentwrog, the Sychnant Pass and Beddgelert.

Spartina Grass (*Spartina anglica*)

Spartina is used in the Netherlands to reclaim land from the sea, owing to its ability to grow on mud flats and sand banks and build up grazing land there.

In the Mawddach estuary, highly valued for its beauty and as a tidal feeding ground for many species of birds, the spread of Spartina is unwelcome.

In the early 90's, an experiment was conducted by the Park Authority to see whether aerial spraying with a herbicide would work against the Spartina, but it was not considered a success.

Japanese Knotweed (*Fallopia japonica*)

Japanese knotweed does not produce fertile seeds but spreads when fragments of root or stem are moved from the parent plant - either by river currents, during construction work or when grass verges are cut. Like Rhododendron, Japanese Knotweed shades out and destroys native plants, and often stops access to badly infested areas, such as river banks. It can be killed by spraying with herbicide although it needs to be meter tall for spraying to be effective. The treated areas will often need to be re sprayed over a three year period, and the National Park Authority, in co-operation with the Environment Agency, has been targeting and clearing particular areas for the past few years. Dry conditions are required otherwise the herbicide is washed into streams impacting on the fish population.

'It's always wet and windy here'

Snowdonia is a suitable site for the production of electricity from wind and water. Both are regarded as sustainable methods of producing electricity, but they can create environmental problems.

Hydro Electric Power Stations.

Two environmental problems arise from this type of energy production.

- Often water is piped from a lake or reservoir, or a collecting point in a river, to a turbine downstream, where the kinetic energy of the water is turned into electricity. Owners must ensure that enough water is in the stream/river at all times to protect that habitat which can mean that no electricity is produced in the summer.
- Unburied pipelines and access tracks to hydro-electric stations can be unsightly, and damaging to the landscape. One of the best examples is the Cwm Dyli power station on the south eastern side of Snowdon, although the pipe was used in a James Bond movie. One station which has been built to reduce environmental impact as much as possible is Dinorwig, where the pipeline and turbine house are built inside the mountain itself.

Wind Turbines

The Snowdonia National Park Authority as a planning authority has a planning policy which does not allow the development of any wind farms inside the National Park although the Planning Committee might look favourably at an individual's application for planning permission for a windmill and turbine for personal use. Wind farms such as Moel Mae Logan to the east of Llanrwst and outside the national park can be seen from Snowdon 15km away.

Transport

Ever since people first colonised Snowdonia after the last Ice Age, movement and communication has been very difficult because of the rough and mountainous terrain. Early settlers found it easier to travel by sea.

The Romans, attracted by valuable minerals and oak forests, were the first invaders to try to make the area accessible by land. They built good, straight roads, but these were limited in number and location. A thousand years later, Edward 1st built his famous castles along the coastline and used ships to bring in supplies, showing clearly that this was still the easiest form of transport. The drovers of Wales used the Roman network of routes that led from Wales towards the cattle markets of England. When Thomas Telford was given the brief of designing a 'quick' postal route from London to Holyhead, his route followed the quickest path and led straight through Snowdonia. The A5 was completed by 1830 and was the first time that the area had been fully opened up to the outside world with a modern road that included new bridges and had a gradient of less than 1 in 10 throughout. This road brought the first 'tourists' to Snowdonia. Victorians saw the area as 'wild and imposing', and yet looked in awe at the landscape as they travelled to Ireland. The opening of the railroads in Wales led to further developments of tourism within the National Park. Although many of the lines have since closed, some are operated as tourist attractions. In the 1960's two major and controversial engineering works opened up Snowdonia with new wide roads. The building of the Trawsfynydd Nuclear Power Station and the Celyn Reservoir created the A4212, a convenient road from the Midlands into the heart of the National Park and through to the Llyn Peninsula. Another major change was brought about by the A55 Expressway - a dual carriageway link between Liverpool and Holyhead, which has reduced the travelling time from Liverpool to the Park boundary to one and a half hours.

Traffic – Jams in a Honey pot!

A survey of visitors carried out in 1994 showed that there had been a rise in day visitors to Snowdonia whilst the number of staying visitors fell. Improved transport links with the opening of the A55 expressway was the main cause for this as journey times decreased dramatically.

This had an impact on the local economy. It has been estimated that a staying visitor (tourist) spends about four times as much money per day as a day visitor.

The same Visitor Survey showed that 91% of people visiting the Park came in private motor cars. Increased traffic, especially in the popular northern area of the Park, and particularly around Snowdon itself, was becoming a cause for concern. The problems being;

- **Traffic congestion at busy times** - frustrating and unsafe
- **Roadside Parking** - untidy and unsafe
- **Pollution** - a national and international problem

The first two problems can give rise to pressure for road improvements and/or more car parks. Experience has shown that building and improving roads and car parks only creates more demand, which can never be satisfied. The National Park Authority has a policy of resisting the development of new roads and car parks, and of encouraging the use of public transport wherever possible. For 18 years it has helped to subsidise the "Sherpa" bus service around Snowdon itself, and has done as much as possible to encourage people to leave their cars at home. The National Park authority is a partner in the Green Key Initiative which attempts to improve parking and public transport within the area.

Access for leisure.

There are many different types of paths that people can use within the area as well as access land where people can roam freely.

- **Public Footpaths** – Public Right of Way (PRoW) for walkers only.
- **Bridleways** - are open to walkers, horse riders and cyclists. (Cyclists must give way to walkers and horse riders)
- **Permissive Paths** - are negotiated with landowners and may be subject to special conditions.
- **Access Land** – in the past, the public had no automatic right of access without the owner's permission. The CRoW act created open access land, which entitles people to walk anywhere they like within mapped areas.

Some problems arise from access by the public to land:

Dogs

Dogs can cause harm and distress to farm animals - particularly sheep - resulting in suffering to the animals and financial loss to the farmers involved. A dog may run after sheep, drive them into dangerous places or separate ewes and their lambs. The shock and strain of being chased can cause death, particularly when sheep are pregnant, and disturbance at lambing time can often cause the death of new born lambs.

Dog owners are legally required to keep their dogs "under close control." Many farmers would prefer this to mean "on a lead". A farmer still has the right to shoot a dog that is disturbing its sheep.

Damage to Dry Stone Walls and other boundaries

When a path crosses a boundary wall or fence between two fields or two farms, stiles or 'kissing gates' are provided so that the public can cross without any danger of farm animals straying. When people climb over walls and fences, stones are dislodged, and wire fences slacken and sag. This means extra work and expense for farmers, and the risk of animals straying.

Footpath Erosion

The process of footpath erosion is complicated and depends on a number of inter-related factors, both human and natural.

Briefly, when too many people walk on fragile mountain vegetation it dies, roots are no longer able to hold the soil together, and leaves no longer protect the soil from falling rain. Heavy rain washes the soil away, often turning footpaths into small streams. People then tend to avoid walking on stones or mud and skirt around the problem areas, which makes the path wider.

Mountain Bikes

Over the past 20 years, off road cycling, or "mountain biking" has become a popular pastime. Rugged terrain, steep slopes and amazing views are rarely seen in cities. It is legal to ride on main roads, bridle ways and on designated paths. Pollution free, healthy, and enjoyed by the whole family, this is a sustainable form of transport which new policies aim to encourage within the National Park but at specific sites and under control.

It can, however, cause problems -

1. **Erosion** - Large tyres with deep treads damage vegetation and top soil, which begins the process of path erosion.
2. **Safety** - When cyclists travel quickly downhill in poor visibility and when walkers are present, accidents can happen.

Because of the popularity of mountain biking on the bridleways on Snowdon itself, a voluntary code of practice was established in the early 90's asking cyclists not to use the bridleways on the mountain between 10 a.m. and 5 p.m. from 1st June to 30th September. Other routes in the area have been upgraded to provide activities outside of these hours and there are some wonderful rides to be had out there.

Useful websites

www.eryri-npa.gov.uk for further information about Snowdonia

<http://www.snowdoniagreenkey.co.uk> - all about the Green Key Initiative

<http://www.ccw.gov.uk> for information about access land in Wales and nature reserves

http://www.countrysideaccess.gov.uk/things_to_do/open_access for access land in England

<http://www.mbwales.com/> for mountain biking in Wales

<http://www.natwindpower.co.uk> information about Cwm Dyli HEP

<http://www.fhc.co.uk> for information about the Dinorwig Power Station

www.star-attractions.co.uk for visitor attractions within and surrounding Snowdonia.

Further reading

Classical Glacial Landforms of Snowdonia - Kenneth Addison.

Geographical Association Publications; ISBN 1-899085-24-6

Rock Trails Snowdonia; A hillwalkers guide to the geology and scenery - Paul Gannon

Pesda Press; ISBN 978-1-906095-04-8