GLACIATION IN SNOWDONIA

by Paul Sheppard

This unit can be used independently or in conjunction with OS 1:50,000 map sheet 115.

THE SNOWDONIA OR ERYRI NATIONAL PARK, established in 1951, was the third National Park to be established in England and Wales following the 1949 National Parks and Access to the Countryside Act (Figure 1). It covers an area of 2,171 km^2 (838 square miles) of North Wales and encompasses the Carneddau and Glyderau mountain ranges. It also includes the highest mountain in England and Wales, with Mount Snowdon (Yr Wyddfa in Welsh) reaching a height of 1,085 metres (3,560 feet). This is one of 14 Welsh peaks exceeding 900 metres (2,800 feet) in height.

A **National Park** is classed as an area of outstanding natural beauty. The aim of this classification is to preserve and enhance such places of beauty and provide access to the public for their enjoyment through recreation and tourism while maintaining these areas' natural beauty. Snowdonia is also a working environment, where 27,500 people work in farming, forestry, quarrying and the tourism industry. Activity in the Park is overseen by The Nature Conservancy Council which operates in conjunction with the Park's inhabitants to preserve the unique environment which tourists come to see. In particular Snowdonia is attractive because of its spectacular upland environment that is the product of its geological past and, more recently, the effects of the last Ice Age.

To understand the effects of ice on the landscape of Snowdonia, it is important to look first at the geological origins of the area, as this provides the foundation upon which ice can act.

Figure 1: **Snowdonia National Park**

A brief geological history of Snowdonia

Snowdonia is an upland area that owes its origin to the geological events that occurred during Cambrian times 500 million years ago through the Ordovician and Silurian eras, between 430 and 395 million years ago. At that time the area experienced volcanic activity and folding as well as sedimentary deposition. At the end of the Silurian period there was major uplift, known as the Caledonian earth movements, which transformed the landscape into the upland area as seen today. Initially this landscape would have been similar to that of the Himalayas. However, a further 395 million years of geological activity, including submergence below the seas of the Carboniferous era between 340 and 280 million years ago, and more recent geological activity which has not left its mark on Snowdonia, have resulted in a much lower, yet still rugged, landscape.

These remnants of formerly much higher mountains have since been eroded into what is seen today. The mountains of Snowdonia have been changed as a result of aerial (climatic) and fluvial (water) erosion that always act upon a landscape, but in more recent geological times the effects of ice have had a major impact upon the actual land surface.

Glaciation

Ice ages have been common in the British Isles and northern Europe, with 40 having been identified by geologists and geomorphologists. The most recent of these saw Snowdonia covered with ice as recently as 10,000 years ago.

For an ice age to develop, all that is needed is a small drop in temperature as a result of which winter snowfall does not fully melt during the following summer. This leads to the accumulation of snow (**firn**). Accumulated snow eventually compresses into ice, known as **nevé**. If temperatures remain low and accumulation continues, this leads to an ice age, with the formation of ice sheets and glaciers. These cover the landscape and flow under the force of gravity from their source to where they either meet the sea or melt in a warmer environment. However, during an ice age, sea level is much lower as the water is stored in a frozen state and is not part of the normal water cycle.

Being an upland area, ice in Snowdonia accumulated on higher, cooler slopes and under gravity flowed down the former river valleys, fundamentally altering the landscape. The Snowdonia ice cap was surrounded by ice originating from the Irish Sea. This led to

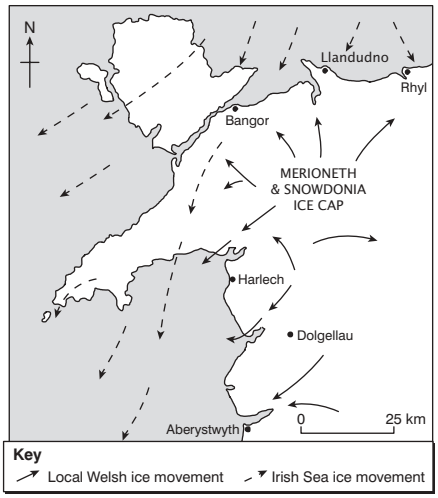

Figure 2: **North Wales at the ice maximum, and conflict between local and Irish ice sheets**

conflict, which meant that some of the Snowdonia ice was blocked in its path to the lowlands while elsewhere it radiated outwards. It flowed eastwards to the Shropshire – Cheshire Plain, north into the Irish Sea and westwards into Cardigan Bay. Its maximum depth has been estimated at over 1,000 metres, covering many of the highest peaks in the Snowdonia area.

This ice met further sheets of ice that had accumulated and which flowed away from the Lake District and southern Scotland, causing major erosion (Figure 2). Later there was deposition in the area of Llandudno on the northern edge of Snowdonia. This has been verified by the presence of erratics in this area. An **erratic** is a rock of a different geological origin from the area in which it is currently found. The erratics in this area have been identified as originating in the Lake District and the Firth of Clyde.

The easiest path for the Snowdonia ice to take was to follow the routes cut by rivers. However, as ice is relatively solid and is far bulkier than particles of water, as it moves it can significantly alter the landscape over which it flows. Consequently, classic glacial features have developed in Snowdonia.

There are distinct features of both ice erosion (Figure 3) and deposition.

Frost shattering	Mechanical erosion occurring in rocks with crevasses and joints. Water enters joints and on freezing expands by 9%; daily freeze and thaw widens and weakens joints, causing pieces of rock to shatter from the main body of rock.
Abrasion	Rocks become embedded in the ice. Moving under gravity the rock-laden ice acts like sandpaper as it rubs against the floor or side of the valley or its floor.
Plucking	Ice freezes onto bare rock, and then ice movement pulls away the bedrock. It is likely that this rock has already been loosened by earlier erosional activity, such as freeze – thaw (see *Frost shattering* above).
Rotational movement	Downhill movement of ice pivoting around a point and overdeepening at that point (see *cwm* in Figure 4).

Figure 3: **Types of glacial erosion**

Feature	Example (+ OS grid reference)
Pyramidal peak	Mount Snowdon (GR 6056)
Arête	Tryfan (GR 665595)
Cwm (also known as a **corrie** or **cirque**)	Cwm Idwal (GR 6459)
U-shaped valley/glacial trough	Nant Ffrancon (GR 6460)
Ribbon lake	Llyn Ogwen (GR 6560 / 6660)
Hanging valley	Nant Ffrancon (GR 635625)
Truncated spurs	Nant Ffrancon (GR 630610)
Roche moutonnée	Nant Ffrancon (GR 639627)

Figure 4: **Features of a glaciated landscape**

Features of erosion

These four erosional processes led to the formation of a classic glaciated upland landscape, whose features are listed in Figure 4. To help you locate these using the six-figure grid references supplied, you will find it useful to refer to a copy of the OS 1:50,000 map sheet 115 of Snowdonia.

- **Cwms** (corries or cirques), **arêtes** and **pyramidal peaks** are all formed at the source of the glacier. A cwm is an armchair-shaped hollow that is usually found on sheltered north-facing slopes, at angles between 310 and 120 degrees, where ice accumulated and freeze–thaw and possibly chemical weathering acted at the base of the ice. Rotational movement and frost shattering aided this process and scoured out a deeper floor. A higher rock lip also formed in front of this hollow, where deposition occurred as the ice flowed away and lost its erosional power (Figure 5). An arête occurs where two corries form, one on each side of a mountain or ridge. A pyramidal peak forms where three corries form on all sides of one mountain and are separated by three ridges (Figure 6).
- The classic **U-shaped valley** associated with upland glaciated areas is perfectly displayed in the **Nant Ffrancon Valley** (GR 6460 to 6363 and see Figure 8), which has steep sides and a flat valley floor. Its sides are marked by **truncated spurs** (GR 640611) which are the remnants of the interlocking spurs of the original river valley. These were eroded as the ice forced a straighter, more efficient path to the Irish Sea. Along the sides of Nant Ffrancon there are also **hanging valleys** (eg GR 637627) which mark the old upper courses of rivers which were either not affected by ice, or only by smaller glaciers which did not have the ability to erode to the depth of the main glacial valley or trough (Figure 7). On the valley floor (GR 639627) is a **roche moutonnée** which was formed where a hard volcanic dyke protrudes from the floor of the valley. This was smoothed on the upstream side, but made rugged by plucking and abrasion of the rock on the downstream side. This feature therefore displays the area's varied geology and the effects of ice both plucking and abrading the rock.
- Llyn Ogwen is a **ribbon lake**, which occupies a glacial valley floor and follows the shape of the valley. It extends from the lip of the Ogwen Falls in the glacial hollow created by the Irish Sea ice sheet. The lake itself is a post-glacial feature but indicates the effect the ice had in creating a hollow as it flowed over the landscape.

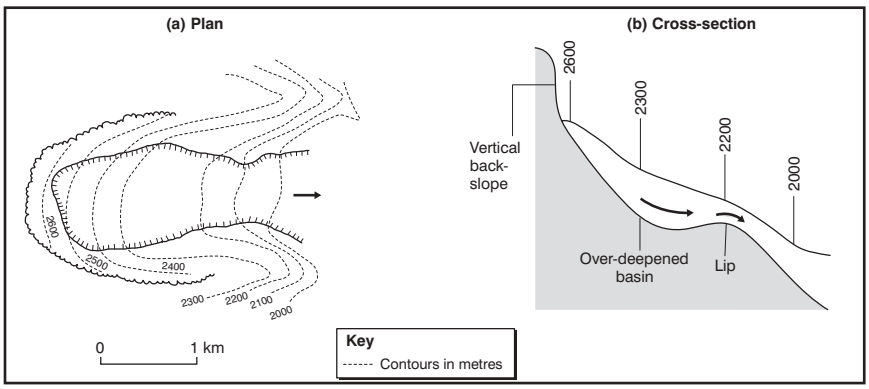

Figure 5: **Formation of a cwm**

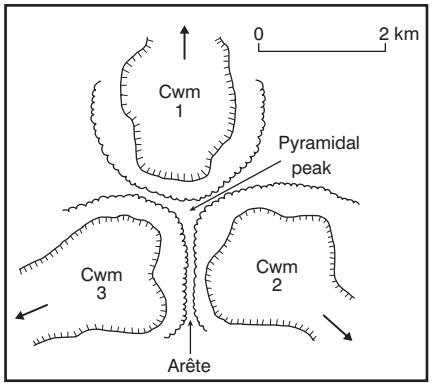

Figure 6: **Formation of a pyramidal peak**

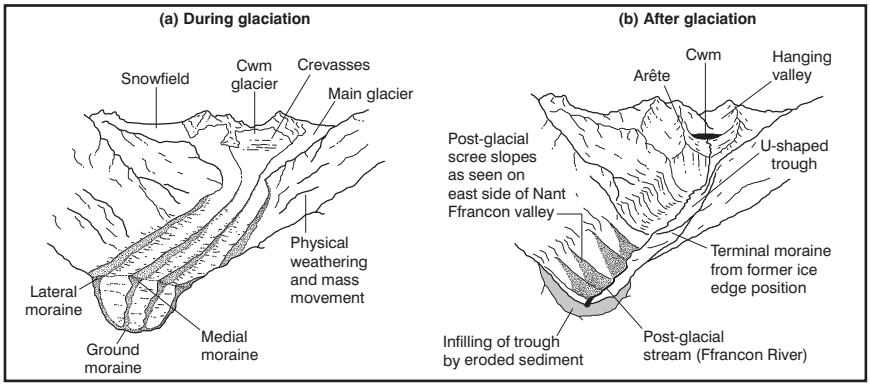

Figure 7: **Erosion of a U-shaped valley by a valley glacier**

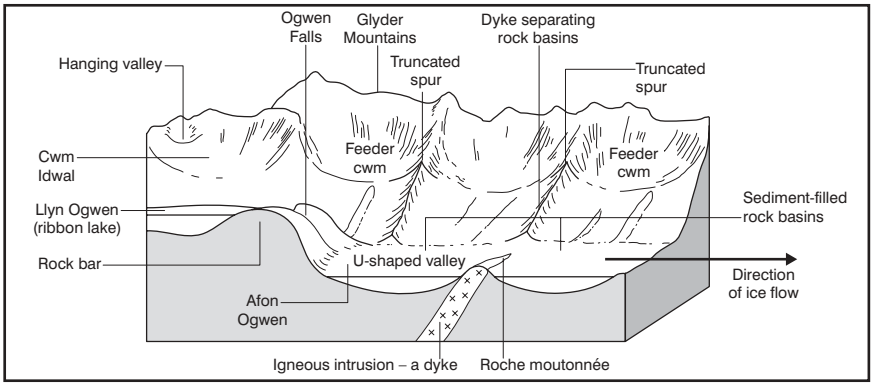

Figure 8: **Block diagram of the Nant Ffrancon valley**

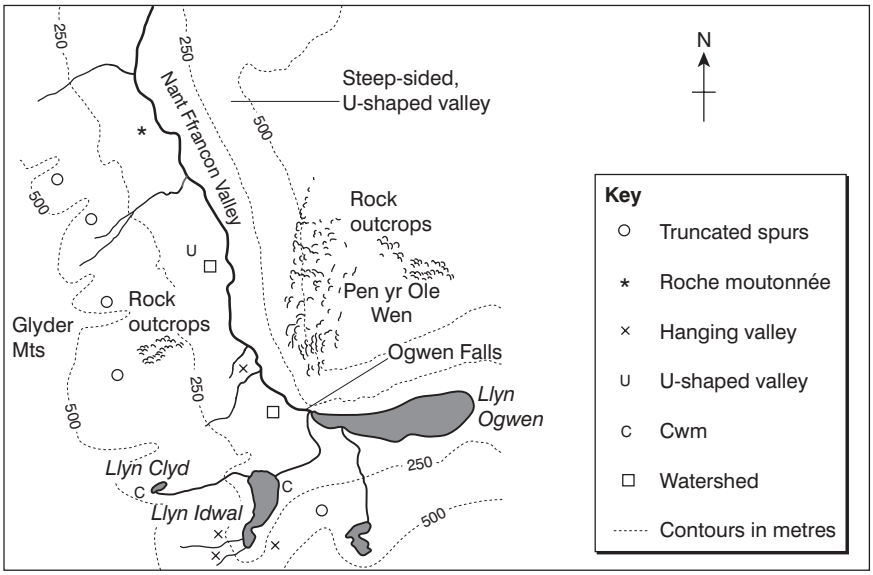

Figure 9: **Sketch of the Nant Ffrancon Valley**

- Linking Cwm Idwal with the Nant Ffrancon valley is the **Ogwen Falls** (Figures 8 and 9) which marks the watershed or division between two river basins. Normally this would be marked by high land between the Ogwen and Ffrancon valleys. The ice should have flowed down the Ogwen valley but its route was blocked by the Irish Sea ice sheet. The ice therefore diverted towards the north-west and flowed over the Ogwen watershed and entered the Ffrancon Valley instead. Its breach from one former river system into another is marked by a steep waterfall at Ogwen Falls.

Features of deposition

Features of deposition seen in Snowdonia include **glacial till** and **moraines**. Till refers to the unsorted mix of rocks, stones and boulders found on most valley floors. These have largely been washed away by post-glacial river activity but remnants can still be seen on the lower slopes. These contain a mixture of unsorted materials, both angular and rounded in shape, indicating the effects of both ice and water.

Snowdonia today

Figure 10 on page 4 shows the Mount Snowdon area, which displays the features associated with a glacial landscape. Note the shapes of the features on the sketch and match these with the features on the OS map.

Snowdonia is a dynamic landscape. This means that it is constantly changing. Climatic conditions may return which see the whole landscape once again covered with ice.

Activities

1 (a) How does an ice age develop?
(b) Using the internet, find out how many ice ages have been experienced in the UK, and their impact on North Wales.

2 Why is this area of North Wales now a National Park?

3 Explain how Snowdonia's geological past affected the way in which ice acted upon the landscape.

4 What 'classic' glacial features can be found in Snowdonia? Select two, and explain how they were formed.

5 Describe the patterns of ice shown on Figure 2.

6 Use the information in this unit and in textbooks to draw simple labelled diagrams to show how the following features are formed:

- cwm
- arête
- pyramidal peak
- U-shaped valley
- hanging valley.

You should be able to reproduce these diagrams under examination conditions if necessary.

7 Use Figures 8 and 10 to explain the effects that ice has had upon this upland area. If possible, use the OS map sheet 115 to assist in your explanation. Mention all the glacial features seen and describe how they were formed. Also explain how they have modified (altered) the initial landscape.

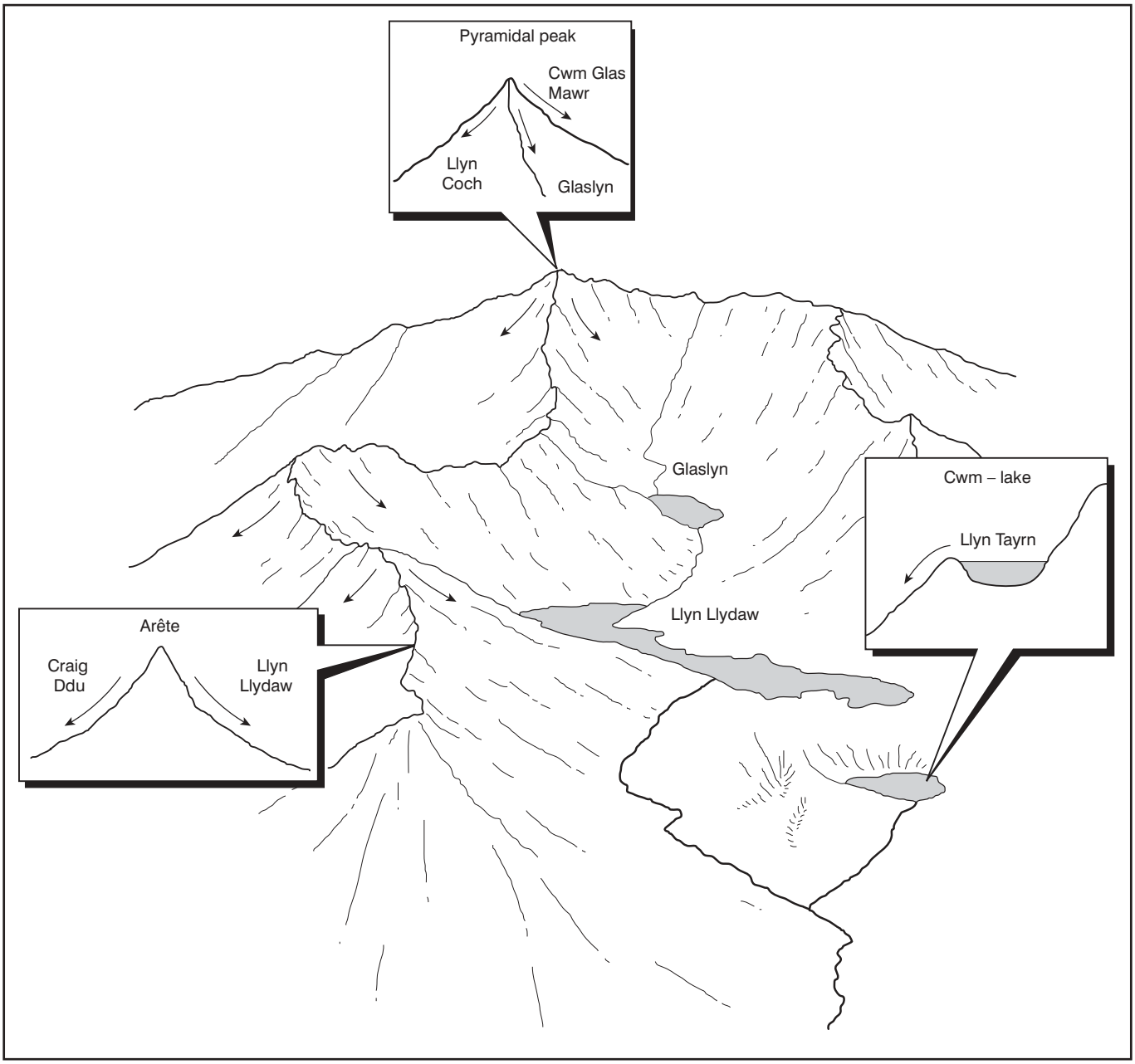

Figure 10: **Glacial features in the Mount Snowdon area**