

## Arctic and Alpine Snowdonia

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The most familiar glaciers are the cirque glaciers as found in the Alps today. These sometimes coalesce and form valley glaciers and it was generally believed that glaciers of this sort excavated the principal features of the Snowdonian mountains. But in the last Ice Age the Snowdonian glaciers extended 80 miles to Wolverhampton, an impossible feat for a valley glacier. Only glaciers extending from large ice fields as found in Alaska could travel such distances.

Looking at accumulation and ablation of ice (growth and decay), we find that in polar systems the rate of accumulation is extremely slow, perhaps 10 metres per sq metre per year. Alpine glaciers accumulate at something like ten times that rate. For glaciers to be in a steady state, obviously the same amount of ice must melt each year as is formed. An important characteristic of this input/output of ice is that the storage element of the glacier is massive – in polar ice in the order of 10 cu km of ice; in alpine glaciers 102 cu km.

The most important characteristic is the thermal system of the glacier. Polar ice sheets are frozen to their base, at least in the central zone, and are not able to move very quickly. Correspondingly alpine glaciers do move quickly because they are poly thermal. That is, they are at pressure melting point throughout their depth and therefore move easily over their base. Polar glaciers therefore move by internal deformation of ice crystals. Alpine glaciers slip along on a water base. Polar systems are relatively stable; some ice is known to have been there for 75,000 years. On the other hand, alpine ice has a life of only about 100 years.

In Europe the last ice age, that is the cold period of the last 100,000 years, is now known as the Devensian. During the last ice maximum, a consequence of the large Scandinavian ice sheet is

that the atmospheric circulation over Britain would have been radically different from now. The ice dome, by reflecting most of the incident radiation, would refrigerate the atmosphere and create a glacial anticyclone bringing very cold air over Britain.

The last advance of the Devensian ice, some 18,000 years ago, did not quite reach Shrewsbury, which was the focus of a pincer movement of Irish Sea ice flowing through the Cheshire Gap and Welsh ice coming due east. Sand and gravel pits around Shrewsbury reveal English ice deposits (sand, chert and other erratics), overlying Welsh deposits 50 or 10 [*sic. ? 100; Ed.*] feet down.

The Welsh ice cap was 1400 metres thick at its centre between Bala and Snowdonia, comparable to the present Greenland ice sheet. So Snowdonia was not the centre of glaciation, but mountains on the periphery. The valleys through them were breached by ice on an enormous scale, as found on the east coast of Greenland today.

Turning to land forms attributable to alpine and arctic glaciers in Snowdonia. In the Carneddau between Ogwen Falls and Conway, most of the cirques are small and don't always cut through to the plateau summits at about 3000 feet. These cirques, although a common landform, were relatively unimportant, being the smallest of the glacial basins. They are also very susceptible to climate change and can advance into valley glaciers in a few decades, or disappear over a similar period.

Seen from a distance, The Carneddau do not show evidence of major glaciation, being subdued, soft landscapes, but there are major troughs excavated through the mountains with a total depth over 2000 feet. Valley glaciers do not do this. Again, a view from the Glyders shows a mountain torn in two. In the valley floor are a

string of lakes as the watershed, a feature not found in river dissected landscapes. The same type of glaciated land forms is seen looking from Snowdon to the Glyders.

Further inland are the more subdued plateaux between Snowdonia and Bala. Here there are excavated troughs without any cirques around them. This is similar to the ice centre regions in Labrador and Scandinavia. So here is evidence of the whole area being buried by a massive ice sheet. Some of the best evidence of ice sheet glaciation in Snowdonia is that it hardly exists! That is, there are no strong land forms, but a rather subdued ice abraded landscape. However when the massive ice sheets melted, the massive quantities of melt water left behind huge deposits of delta material known as kames, such as at Betws-y-Coed.

There is an anomaly between those areas of Snowdonia where there is clear evidence of alpine type glaciation and those areas subjected to ice sheet glaciation. Around the central peak of Snowdon are a number of radiating rock basins. In the passes such as Nant Ffrancon, there is a different pattern. There is no central mountain, instead the entire flanks of the Nant Ffrancon are incised by some 13 rock basins, some of which have joined up. In the Carneddau region, if the area above the assumed snow line is plotted, 3000 feet above sea level, only a relatively small percentage of the mountain area is covered by cirque basins.

A similar landscape in the Glyder range shows that nearly half of the scene, above the snow line, is decimated by a long chain of cirques. These do not radiate out in all directions but are definitely linear, facing north-east and exploiting the fractures formed by the Caledonian Orogeny. Therefore in Snowdonia, where major outlet glaciers from the ice sheet erupted through the mountains, cirque basins collected at a later stage along the opened up flanks. Where the mountains were protected by being more remote from these outlets, they developed an alpine environment.

So what was the chronology of events? The Ice Age began at the base of the Quaternary at 1.6 million years before present. 26,000 years ago the last ice sheets began to develop in Western Europe. At this time the lowlands around Caernarvon for example were clothed in coniferous northern forests. In the mountains,

semi-permanent snow bodies and small glaciers were beginning to form. [*The previous main glaciation had been 100,000 years ago; in between had been warmer periods and periods of intensive, dry cold*]. These cirque glaciers coalesced quite quickly and sent down glaciers to the valleys. This was a period of alpine glaciation but, in a short period of time influenced by the cold anticyclone, the main ice cap formed on the land plateau and began to develop outlet glaciers. At the ice maximum, about 18,000 years before present, the summit of Snowdon would have formed nunataks in the ice sheet.

As ice breached the mountains and moved into the lowlands, a composite outlet glacier formed. As the ice moved, about 13,000 years before present, the cirque glaciers predominated once again. For a brief period there was no ice in Snowdonia, but the Loch Lomond re-advance re-established the cirque glaciers. Even so, by 10,000 years before present the cirques were again ice free.

The Idwal bogs inside the moraines in inner Cwm Idwal filled just after the beginning of the Neolithic period. The valley lake in Nant Ffrancon filled 3000 years ago, coinciding with The Bronze Age.

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