

## Glacial history of the Lake District

### Background reading for the Borrowdale trip by Michael Hambrey

Although the UK experienced several major ice ages during the Quaternary Period (the last 2.54 million years), only the last is recorded in the Lake District and surrounding area; this is because glaciers on land tend to destroy evidence of earlier events, especially in mountainous areas. The last ice age is referred to as the Devensian Glaciation, and we will see evidence for this major phase of glaciation in Borrowdale and around Derwentwater. We also see features belonging to a later relatively short-lived, localised phase of glaciation called the Younger Dryas Stadial (or in Scotland the Loch Lomond Stadial).

The peak of the Devensian Glaciation was around 20 - 30,000 years ago. At this time, most of Britain as far south as north Norfolk, the Midlands and south Wales was covered by a large ice sheet. This combined with an ice mass over Ireland to form what is known as the British-Irish Ice Sheet (Figure 1). This ice sheet was highly dynamic and numerical modelling has shown that it fluctuated like a beating heart. Ice-flow patterns were complex and changed over time. In our area, ice flowed around the Lake District from Scotland producing fields of drumlins, e.g. in the Eden Valley and around Kendal, and also left thick glacial deposits on the coast from St Bees southeastwards (the Irish Sea Till). Ice also covered the Lake District and coalesced with Scottish ice. Thus, the ice over the Lakes District formed a distinct dome within the main ice sheet, covering all the summits. It is also likely that, at times, the area was covered by a "highland icefield" with the highest peaks projecting above the ice as nunataks (Figure 2).

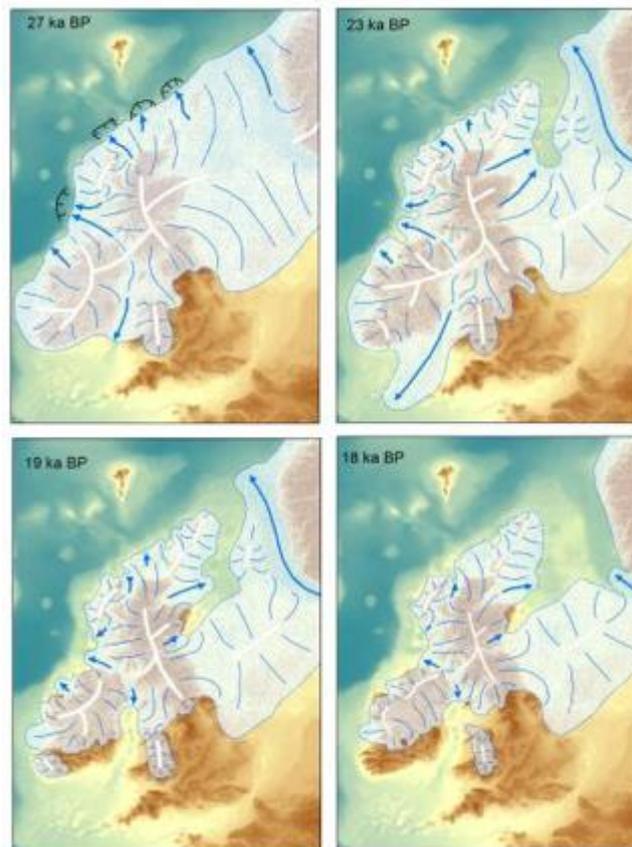


Figure 1. The Late Glacial Maximum of the British-Irish Ice Sheet and its subsequent recession (apart from advance of the Irish Sea lobe at 23 ka). (Clarke et al. 2010).



*Figure 2. How the central Lake District may have looked during the Younger Dryas cold stage, 11,000 years ago: a plateau icefield feeding cirque and valley glaciers on eastern Baffin Island.*

The radial river drainage system, originally developed in Tertiary time, several tens of millions of years ago, was exploited by glaciers in successive ice ages. Fast-flowing ice followed the valleys, steepened the sides and created deep basins in which lakes formed following glacier recession. These are the typical glacial troughs, commonly but inaccurately called U-shaped valleys. A wide range of glacial erosional and depositional features were produced, and these contribute immensely to the landscape quality of our region.

From 27,000 years ago onwards, the British ice sheet disintegrated. The rate at which this occurred is currently under detailed investigation. The importance of this work lies in the fact that our ice sheet can be viewed as an analogue for the potential collapse of the West Antarctic Ice Sheet in response to current global warming, along with rising sea levels. This project is called BRITICE-CHRONO and involves eight institutions, led by Sheffield University (<http://britice-chrono.org/>). A vast data-set on glaciation in the British Isles is being assembled, and will provide a unique insight into ice-sheet disintegration.

Glaciologists believe that this Devensian ice sheet disappeared completely, but between 11,500 and 13,000 years ago new glaciers formed over northern and western Britain. The cause of this cooling is thought to be a decline in circulation of currents in the North Atlantic Ocean, which normally transports warm water from the equator towards NW Europe. The decline was triggered by the large influx of fresh water from North America as a large ice-dammed lake collapsed.

A large "highland icefield" developed over western Scotland, centred on Ben Nevis, with glaciers flowing west into the fjords or sea lochs, and south to the lower end of Loch Lomond near Glasgow. In the Lake District, many cirques ("combs") were reoccupied by ice, and from these ice flowed to fill the heads of valleys, including Borrowdale, Langdale and Ennerdale. Similar glaciers developed in the northern and eastern Scottish Highlands, Snowdonia and the Brecon Beacons. In recent years, several authors have suggested that not only were these cirque and

valley glaciers, but that these were fed by plateau ice caps (e.g. McDougall and Evans, 2015), so the extent of ice in the Lake District is now conceived to have been much more extensive than previously thought (Figure 2). A characteristic feature of the Younger Dryas glaciation is the “freshness” of the landforms, particularly the moraines, and it is these that we will focus on in Little Gatescarthdale.

The process of formation of these moraines has been much debated. According to Sissons (1980) they were ice-stagnation phenomena, implying almost instant climatic warming. As we will discuss, other glacial geologists have explained the moraines in terms of “dynamic retreat” under a less rapidly changing climate, or, in our case, by “thrusting” (a type of tectonic process) in glacier ice.

### **Postglacial history**

Lastly, we must not neglect post-glacial changes in the landscape. Following deglaciation, and before thick vegetation became established, rivers transported large amounts of sediment, and many landslips (“rock-slope failures”) took place. One of the UK’s largest rock-slope failures are located above Gatesgarth Farm on Robinson, and at Threlkeld Knotts. “Storm Desmond” in December 2015, extreme though it was, has demonstrated that the Lake District landscape is still evolving. We will look out for evidence of recent stream erosion and deposition.

### **References**

McDougall and Evans, D.J.A. 2015. *The Quaternary of the Lake District Field Guide*. Quaternary Research Association, 269pp.

Sissons, J.B. (1980) The Loch Lomond Advance in the Lake District, northern England, *Transactions of the Royal Society of Edinburgh, Earth Sciences*, 71, 12-27.

Clark, C.D., et al., 2010. Pattern and timing of retreat of the last British-Irish Ice Sheet. *Quaternary Science Reviews*, 35pp.

#### *Also worth a look:*

Smith, Alan. 2008. *The Ice Age in the Lake District (Landscapes of Cumbria)*. Rigg Side Publications. 60pp.

A well interested booklet covering the main features of glaciation in the Lake District.

Hambrey, M.J. and Alean, J.C. 2016. *Colour atlas of glacial phenomena*. CRC Press (Taylor & Francis). A comprehensive illustrated summary of all types of glacial phenomena, with examples from all over the world, including the Lakes District.

Our website: [www.glaciers-online.net](http://www.glaciers-online.net) for illustrations of glaciers and glacial features around the world.