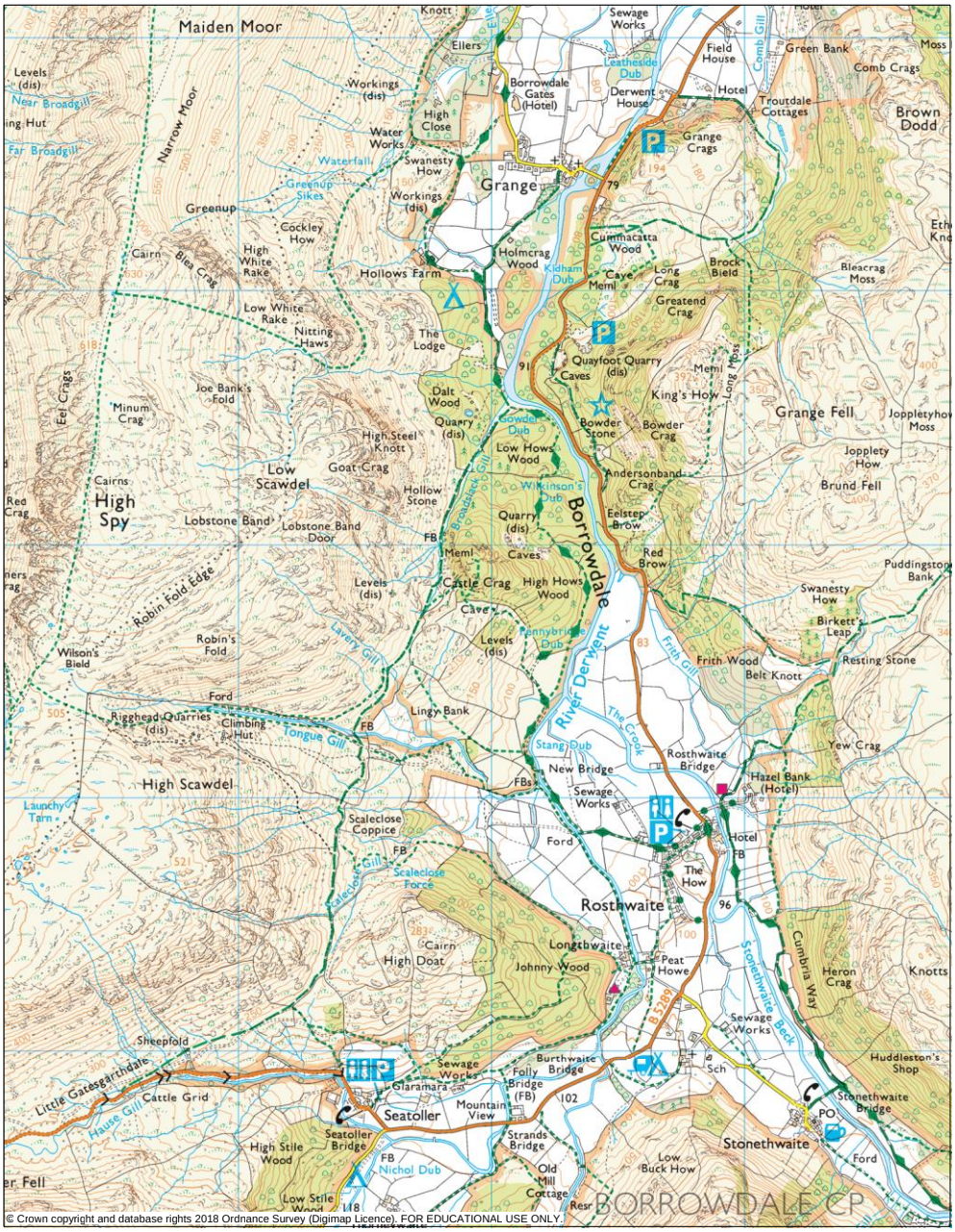
Cumberland Geological Society Excursion
21 July 2018
GLACIATION OF BORROWDALE - ITINERARY

Leader: Michael Hambrey (Emeritus Professor, Aberystwyth University)

Grange - Rosthwaite



Digimap®
Ordnance Survey

Scale 1:20000
0 100 200 300 400 500 600 700 800 900 1000 m

Projection: British National Grid

Apr 13, 2018 08:42
Michael Hambrey
Aberystwyth University

Summary

Start: Rosthwaite Village Hall, 10 a.m.
Finish: Rosthwaite, 5 p.m. or Grange 5.30 p.m. (or earlier)
Recommended buses: 77 at 9.20 a.m. or 77A at 9.30 a.m. from Keswick
Route: Rosthwaite – YHA - Seatoller – Little Gatesgarthdale (below Honister) – Tongue Gill – Castle Crag – Rosthwaite/Grange (see map)

1. Rosthwaite

The village sits on and around a prominent wooded, rocky knoll named The How, which formed a partial barrier to over-riding ice. This feature is a *roche moutonnée.* Adjacent are three ridges of glacial debris, which represent end-moraines of a glacier entering Borrowdale from Stonethwaite and Langstrath (Figures 1 and 2). We will examine the morphology of these features.



Figure 1. Borrowdale viewed from King's How. The route of our excursion starts at Rosthwaite, centre-left, heads up towards Little Gatesgarthdale to the right and then traverses the hillside on the right. At left is the Stonethwaite valley; its glacier produced the moraines at Rosthwaite. Beyond is Glaramara and the hanging valley of Coombe Gill. The Scafells are just visible beyond the rays of sunshine, below which is Seathwaite at the head of Borrowdale, and Great Gable is on the right. The valley floor, left of the River Derwent, was formerly occupied by a moraine-dammed lake.

The Stonethwaite Glacier completely blocked the valley when these moraines were formed, creating an ice-dammed lake that extended up valley to the position of Seatoller. The age of these moraines is uncertain. The previously inferred Younger Dryas age is now discounted. Attempts have been made to date the moraines using cosmogenic nuclide dating methods on exposed boulders, but results are ambiguous with ranges of 16-36 ka obtained. At least these numbers suggest that the moraines are older than Younger Dryas.

Downstream (north) of Rosthwaite is a flat plain that is often flooded. It represents the floor of a moraine-dammed lake, the dam being located near the Jaws of Borrowdale (Figure1).

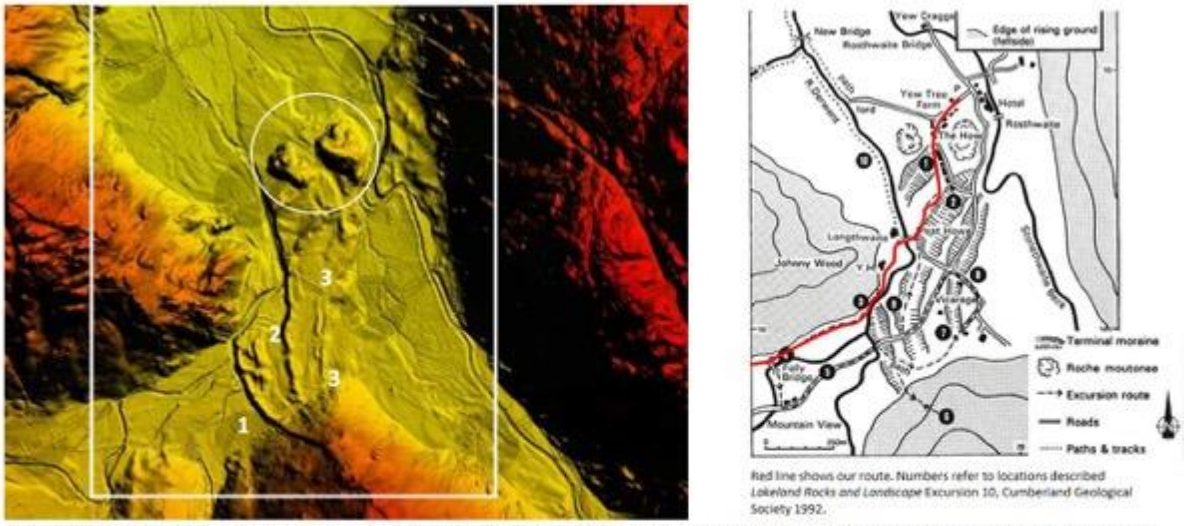
A.



B.



Figure 2. The two outer of the three Rosthwaite moraines, looking down-valley. They are evident from the humps in the stone walls



The white rectangle on the LiDAR image shows the location of the map above included in the field trip hand-out. The three moraine ridges shown on the map are clearly shown on the LiDAR image. There are two smaller ridges immediately to the east of ridge 1, and another to the west of ridge 3. Ridge 1 extends up the side of Low Buck How to above the 200 m contour level. The steep southern sides of two hills in Rosthwaite village within the white circle do not appear to be rôche moutonnée* on the LiDAR image but look more like crag and tail* features. * see Appendix for explanation of these terms.

Figure 3. The Rosthwaite moraines in a LiDAR image (prepared by Chris Wilson), and CGS map from 1992.

2. Track from YHA to Seatoller

On route from Rosthwaite to the River Derwent, we will examine the composition of the stone walls. They are made of boulders transported at the base of the glacier, and are typically subrounded in shape.



Figure 4. Boulders (including the very large one) were extracted from till in the moraine. They indicate basal glacial transport.

On a bend in the River Derwent there is a good section through the outermost of the three Rosthwaite moraine. The poorly sorted texture is typical of a deposit that has been derived from basal glacier ice.



Figure 5. The outermost (oldest) moraine is cut into by the River Derwent, giving a clear view of the texture of the glacial deposits.

At this location, on the near bank, the bedrock bears potholes up to several metres above the river. These were produced when meltwater from glaciers at the head of Borrowdale (Seathwaite branch) were actively incising the blocking moraine.

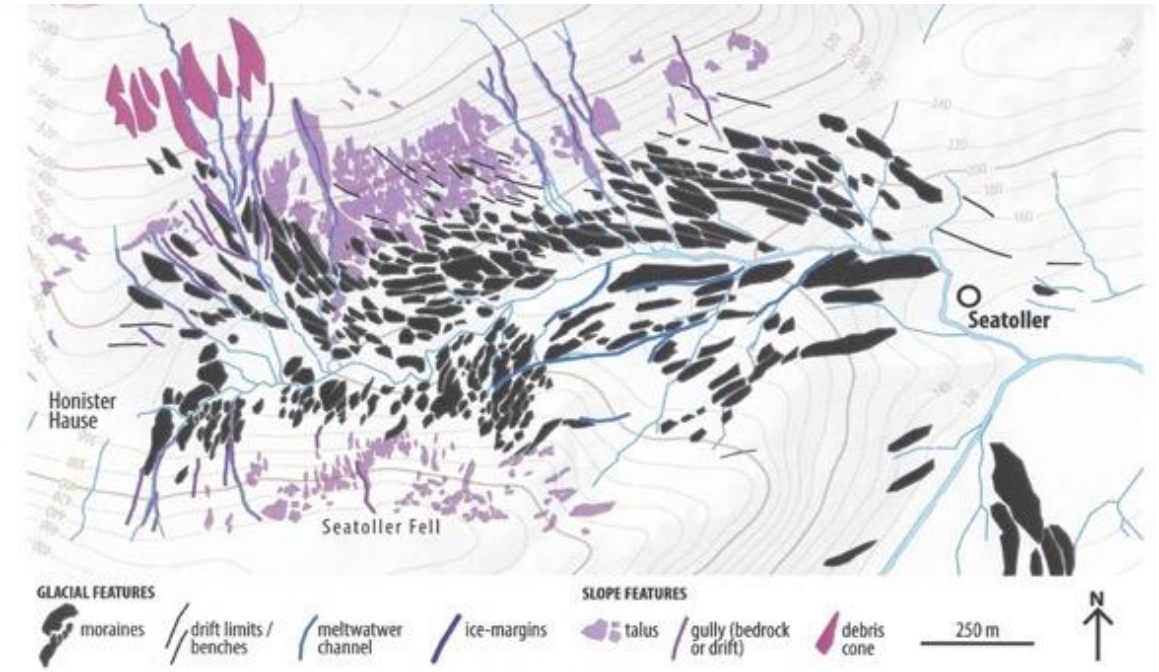
After passing through woodland, a stretch of fields gives open views across the valley of hanging valleys.

3. Little Gatescarthdale

A footpath leads up the hillside above Seatoller to Little Gatescarthdale. This is the name given to the broad open valley through which is routed the B5289 between Seatoller and Honister Pass. It is one of several sites in the Lake District where the effects of extensive glacial deposition during the Younger Dryas can be viewed.

The area was originally mapped by Sissons from aerial photography, and he proposed a small glacier enclosed by the valley which produced hummocky moraine through ice-stagnation (Sissons, 1980). Following subsequent research on plateau icefields, e.g. in Norway, McDougall (2001) remapped the area and proposed icefields over Dale Head and Grey Knotts, the fells on either side of the valley. Recently, McDougall 2015) has used more detailed and accurate imagery (LIDAR) to refine his mapping (Figure 5A). His map shows a series of moraines roughly aligned so that successive ice margins are definable, with ice extending almost to Seatoller (Figure 5B). This mapping demonstrates the preference for "dynamic retreat", rather than ice-stagnation. One might consider whether there is a role for ice-thrusting in moraine formation, a mechanism that has been proposed for similar moraines in Ennerdale and in the High-Arctic (Svalbard).

A.



B.

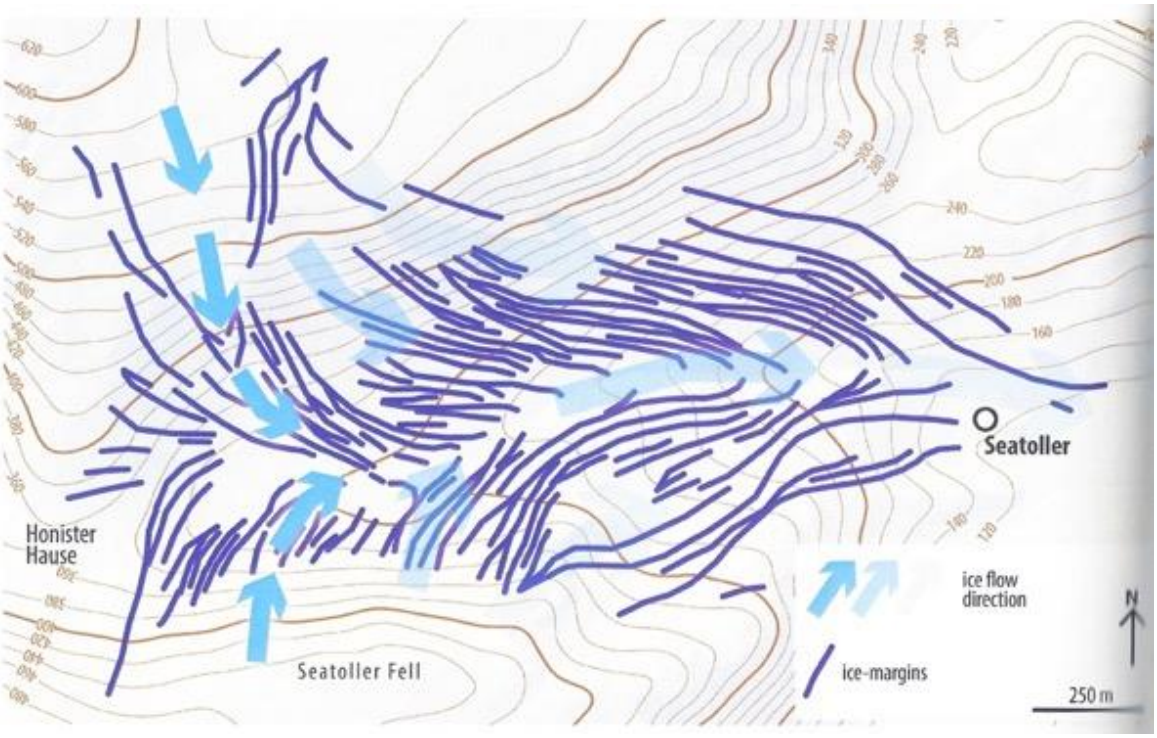


Figure 6. Little Gatesgarthdale from Honister to Seatoller, showing landforms associated with the Younger Dryas stadial. A. Geormorphological map. B. Ice margin reconstruction. (McDougall and Pearce in McDougall & Evans, 2015).

As elsewhere in the Lake District, McDougall's work resolved the riddle as to why Sissons' valley and cirque glaciers were too small and too low to be explained by known palaeoclimatic data. With his plateau icefields supplying the valley glacier extensions, the terrain was deemed high enough to generate the required quantities of snow to sustain the large glaciers

4. Rosthwaite overview

We retrace our steps, onto a higher level track that traverses around the hillside northwards, on the west side of Borrowdale. This provided an opportunity to observe the context of the glacial features around Rosthwaite (using binoculars) and its three moraine ridges and roches moutonnées (Figure 7).



Figure 7. Telephoto of Rosthwaite from the NE. The wooded knolls are roches moutonnées, and the prominent ridge is one of the moraines produced by a glacier from Stonethwaite.

5. Castle Crag summit

A short, sharp, ascent *via* a rough path leads to the war memorial on top (290 m; 950 ft), past abandoned slate workings with abundant spoil heaps. This rock, being well-cleaved tuff, was used primarily for roofing slate. The view from the summit is magnificent on a clear day. It is thought that the top was an ancient hill-fort, but the quarrying has destroyed much of it.

NB for those wishing to avoid this ascent, there is an opportunity to return to Rosthwaite independently.

Borrowdale morphology

Before reaching the top we will pause at a level platform, where we gain a fine view of Borrowdale and its glacial features. The rugged nature of the landscape is the consequence of the tough Borrowdale Volcanic Group bedrock, and the valleys and surrounded mountains have been fashioned by ice (Figure 1). The flat-bottomed valley is typical of a glacial trough, and its floor contained a proglacial lake downstream of Rosthwaite, possibly dammed by a moraine at the Jaws of Borrowdale. The mountains support cirques and hanging valleys, e.g. Coombe Gill on Glaramara, Gillercomb near Seathwaite, and Styhead

Beck and Taylorgill Force above Seathwaite. At least some of these cirques have fresh-looking moraines that date from the Younger Dryas, but they may have been sculpted by ice over several ice ages. The Central Fells, including the Scafells and Great Gable, supported a plateau icefield that fed glaciers in these upland valleys.

We can imagine what the landscape would have looked like during times when these moraines formed, by comparing with today's Arctic landscapes (Figure 8).



Figure 8. A large valley glacier on Bylot Island in the Canadian Arctic: Sermilik Glacier. The overall morphology is similar to that in Borrowdale, albeit on a larger scale.

Morphology around Derwentwater

The summit is a good place to view the contrasting landscapes of Skiddaw Slate Group strata (smooth) and the Borrowdale Volcanic Group (rough and craggy). Looking north (Figure 8) we see evidence of ice sheet-scale glaciation from the Late Glacial Maximum and earlier. The over-deepened basin containing Derwentwater was formerly contiguous with Bassenthwaite Lake, but the contemporary alluvial fan between was created by the River Greta from an abundant supply of glacial sediment. The glacial sediment, which drapes the lower slopes of Skiddaw and the Vale of Threlkeld, was deposited when ice from St John's-in-the-Vale, Thirlmere and Helvellyn, joined the Borrowdale glacier and flowed out of the mountains to the NW and then west past Cockermouth, before joining Scottish ice flowing through the Irish Sea southwards.

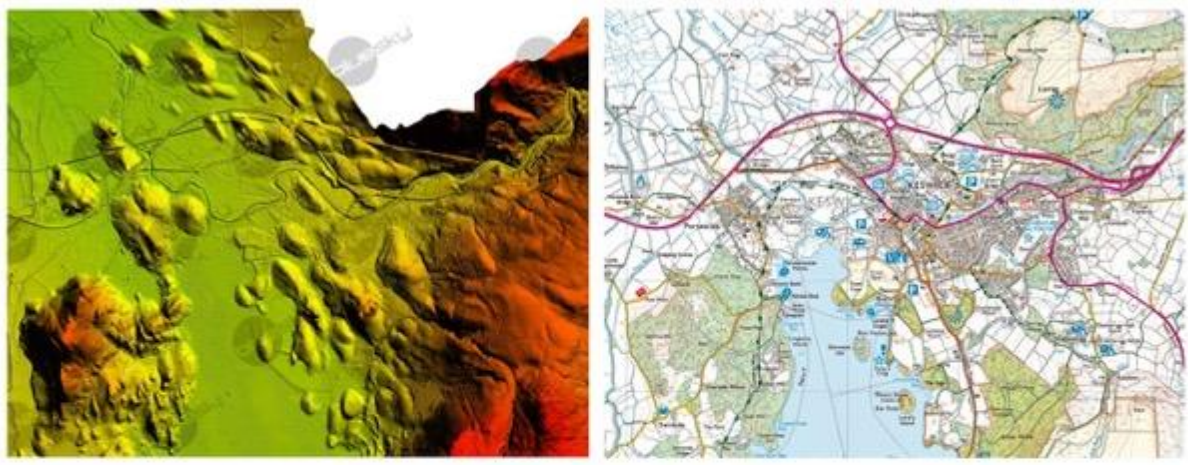
The Keswick area has smooth mounds of glacial sediment or *drumlins*, which belong to a family of *streamlined bedforms* produced under highly dynamic ice. These are represented by the wooded knolls and islands (Figures 9 & 10).

Surprisingly, this aspect of Skiddaw shows few signs of glacial erosion, and even on the north side, there are no well-developed cirques as on the other higher fells.

The flanks of Derwentwater and Borrowdale are over-steepened, especially in volcanic rock on the east side, giving rise to popular climbing crags.



Figure 9. This is not the view from Castle Crag, but from the slopes leading up to King's How opposite, where similar impressions are obtained. The view is towards Derwent Water, Keswick and Skiddaw.



A LiDAR image and extract from OS 1:25 000 map of the area around Keswick

Most of the elongate hills on the LiDAR image are drumlins. Their long axes indicate the trend of ice flow which changes from south-north around Derwentwater to south east-north west to the north of the town.

Figure 10. The drumlins around Keswick: LiDAR images prepared by Chris Wilson.

6. River Derwent

Most of the lower hillsides in the Lake District are draped in till – a poorly sorted glacial deposit. This material is recycled by streams and rivers, resulting in sediment sorting, producing gravel bars in the upland rivers. We will observe the roundness characteristics of the gravel (Figure 11).





Figure 11. A gravel bar in the River Derwent above Grange. Castle Crag, forming the Jaws of Borrowdale, is in the background.

Figure 12. The glacially abraded and striated surface of Borrowdale Volcanic rocks on the roche moutonnée at Grange Bridge.

7. Grange Bridge

We end the excursion by examining detailed erosional features from the Last Glacial Maximum at Grange. Here the bridge straddles a *roche moutonnée*, a small hill produced by glacial abrasion on the upstream side, and rock fracture (or plucking) on the downstream side (Figure 12). Striations are visible, especially if the surface is wet, indicating the sense of ice flow.

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