Geological Influences on the Landscape of the Ullswater Valley

John Rodgers

This article is an abbreviated version of a Zoom presentation to the Friends of the Ullswater Way in April 2021. The aim was to show how the landscape around the Ullswater valley was influenced by the geology i.e. the rock formations, the structure and relatively recent surface processes such as erosion and deposition. The audience was anticipated to be mainly people with limited geological knowledge so at the risk of over-complicating matters technical terminology was kept to a minimum. It was also pointed out that a good way to appreciate the various geological influences on the landscape would be by taking a boat journey from Pooley Bridge to Glenridding.

The Rock Formations

Ullswater is somewhat unusual compared to other lakes in that it is surrounded by rock formations from four main divisions (Figure 1):

Carboniferous Limestone

Devonian Mell Fell Conglomerate

Ordovician Borrowdale Volcanic Group

Ordovician Skiddaw Group

The Skiddaw Group

Most of the lake basin is underlain by rocks of this group, dark grey mainly fine-grained sediments deposited in deep sea. At over 450 million years they are the oldest rocks in the Lake District with the main outcrop area forming the northern fells. In the Ullswater area later mountain-building earth movements have raised a large tract which would previously have been covered with volcanic rock. Once this protective cover was eroded away the softer and less resistant Skiddaw Group material was gouged out by glacial action to leave the over-deepened basin of the lake. There are several areas around Ullswater where the low-lying gently sloping land indicates underlying Skiddaw Group e.g. much of Watermillock, Swinburn's Park and Glencoyne Park on the western side and the fields below Barton Fell on the eastern side. These areas are hidden below a mantle of glacial deposits and so there are few exposed outcrops. However, the typical dark beds can be seen in situ where streams have cut deep valleys into the bedrock e.g. high up in Aik Beck (Barton Park) (Figure 2) and below Pencilmill Bridge, Watermillock.

The Borrowdale Volcanic Group (BVG)

In stark contrast to the rather subdued landforms of the Skiddaw Group, the volcanic rocks of the BVG form the rugged, craggy landscape of the fells stretching southwards from Barton Fell on the eastern side of Ullswater and Priest's Crag, Watermillock on the

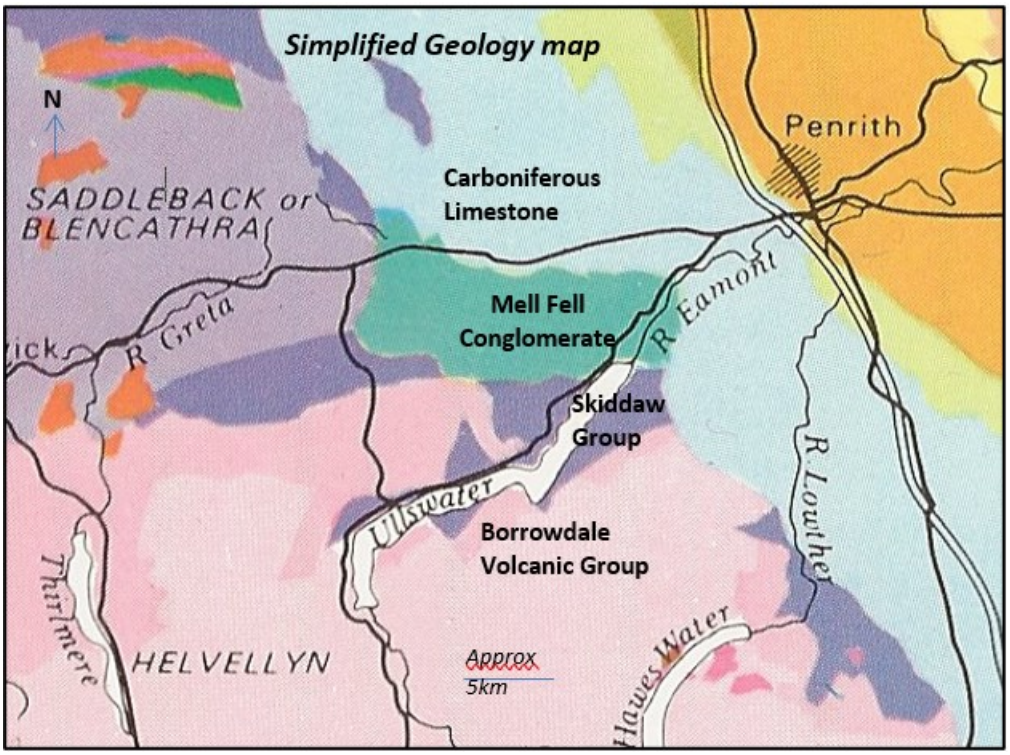


Figure 1. Simplified map showing the four main geological formations around Ullswater.

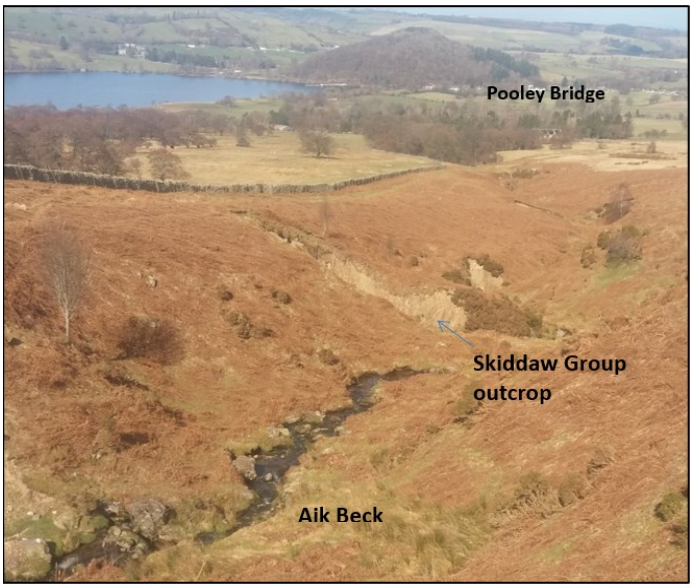


Figure 2. NY 473 223 A rare outcrop of Skiddaw Group bed-rock in Aik Beck where stream erosion has cut through over-lying glacial till.

western side and extend to make up the great bulk of the Central Fells. The thick pile of Skiddaw Group marine sediment was elevated and partially eroded and provided a land surface upon which thousands of metres of volcanic rock accumulated. The earlier phases of activity were dominated by the eruption of lava flows, and a series of these can be seen on Barton Fell. Later activity became more explosive and the southern end of our area consists of a wide variety of lavas and pyroclastics (blown out fragments of ash, bombs and blocks) interbedded with sediments composed of reworked volcanic material eroded and re-deposited between eruptions. Some of the finer ash beds have been transformed into slates and the remains of disused quarries occur around Patterdale. There is no difficulty in distinguishing between the resistant grandeur of the volcanic landscape and that of the gentle slopes of the Skiddaw Group. (Figures 3 and 4)

After the cessation of volcanic activity, subsidence and submergence led to the accumulation of thousands of metres of sediment, mainly in the Silurian Period, which now form the greater part of the Southern Fells around Windermere and Coniston. In the following Devonian Period, mountain building earth movements once more elevated the whole region, part of which was to provide the source material for the formation of the third type of landscape of the Ullswater valley.

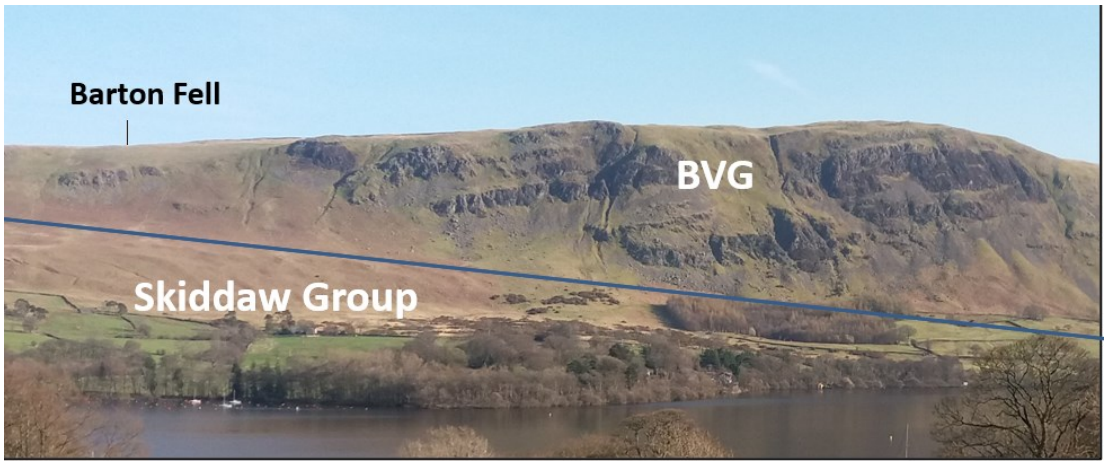


Figure 3. Rugged crags formed by lava flows (Borrowdale Volcanic Group - BVG) overlie more gentle slopes of less resistant Skiddaw Group rocks.









Figure 4. Place Fell, Stybarrow Crag NY 387 179, Glenridding roadside NY 387 168, Patterdale Common slate quarry NY 399 167 are examples of Borrowdale Volcanic Group (BVG) craggy outcrops which are abundant around the south end of Ullswater, in stark contrast to the less resistant and concealed Skiddaw Group at the north end of the lake.

The Mell Fell Conglomerate

This third type of landscape is to be found to the north west of Ullswater where a series of rounded hills extends from Dunmallard above Pooley Bridge westward through Soulby Fell and Little Mell Fell to terminate at the western edge of Great Mell Fell. The area is underlain by the conglomerate rock which originated as thick spreads of gravel and sand eroded from the recently-formed mountains and transported in flash floods and debris flows onto the low lying land. The conglomerate varies from very coarse in which boulders and cobbles predominate to a much finer type of pebbles and sandstone. In contrast to the widespread outcrops of volcanic rock there are relatively few places where the conglomerate is exposed. However, a very coarse variety can be seen in roadside sections just to the west of the boat pier near Pooley Bridge and in the shoreline just opposite. Finer grained examples occur in the stream bed just below Dacre Low Bridge. (Figures 5 and 6)

Carboniferous Limestone

This is the fourth component of the landscape attributable to a major rock formation. Looking directly east from Pooley Bridge up to Heughscar Hill, a line of pale grey limestone crags can be seen. Although only a minor component of the Ullswater valley area, these near horizontal limestone beds are the major feature of Askham Fell and Heughscar Hill where patches of limestone pavement are clearly exposed. There are also numerous sinkholes (Figures 7 and 8).

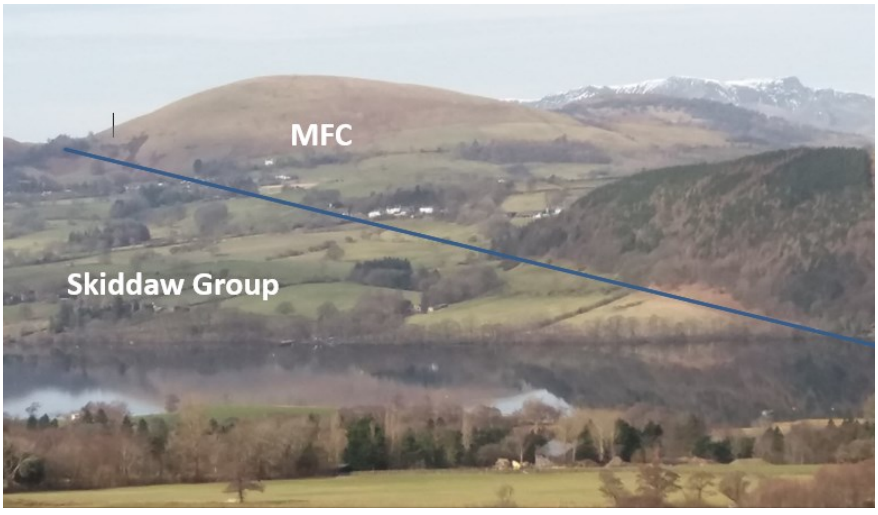


Figure 5. Rounded hills of Mell Fell Conglomerate (MFC) overlie less resistant Skiddaw Group rocks which are concealed below glacial deposits at the north end of Ullswater.

Figure 6. Mell Fell Conglomerate (MFC) in road cut below Dunmallard, Pooley Bridge.





Figure 7. Heughscar Hill



Figure 8. NY 486 237 Limestone crags and pavement on Heughscar Hill make up the youngest of the four main geological formations around Ullswater. They can be seen high above Pooley Bridge to the north east.

Structural Influences

The two main features to have influenced the position and shape of the valley are the Ullswater Anticline and the Howtown Fault. These are shown in Figures 9 and 10.

The anticline (upfold) is indicated by the volcanic rocks which dip away from the centre on either side of the lake. The crestal region has been preferentially eroded away exposing the less resistant Skiddaw Group below. This would then have allowed river and subsequently glacial erosion to gouge out an over -deepened valley.

The other major component has been the lateral movement along the Howtown Fault which has resulted in the central line of the lake being offset to produce the well-known double bend.

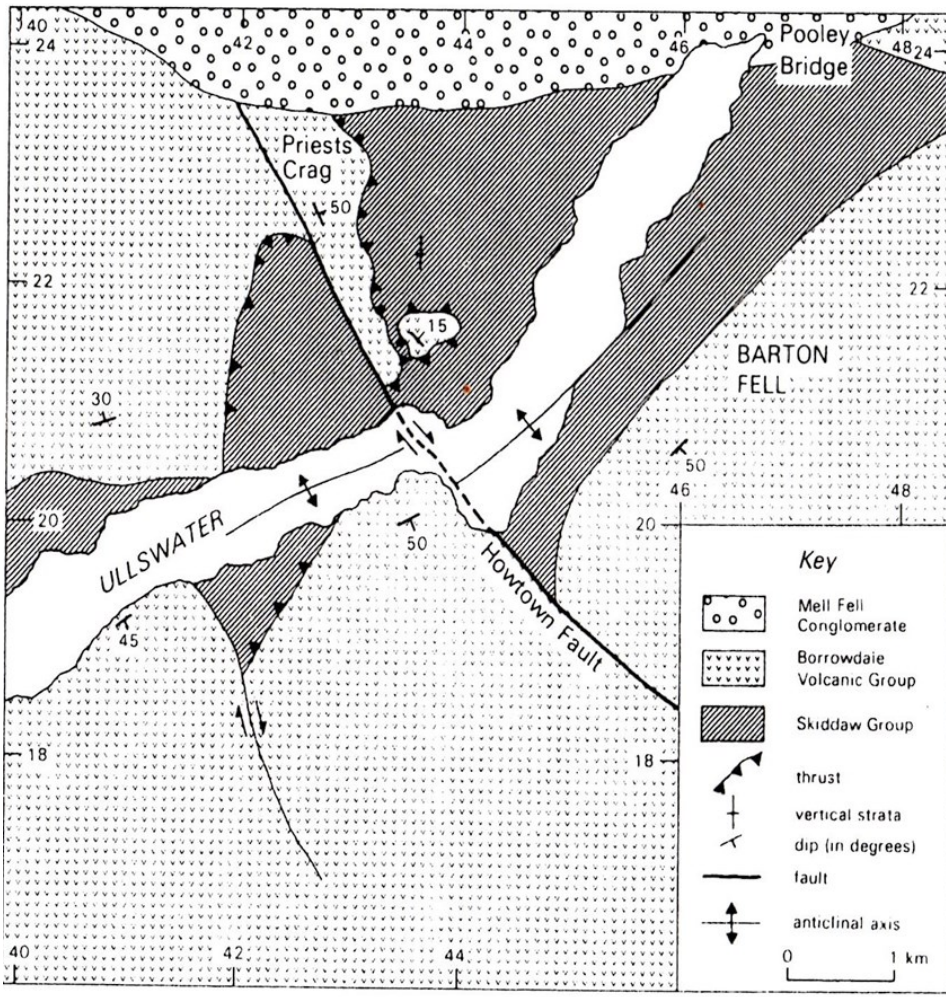


Figure 9. Simplified structural map of the northern portion of Ullswater



Figure 10. View looking north east shows how the Howtown Fault has caused lateral displacement resulting in a bend in the lake.

Surface Processes

The action of weathering and erosion of bedrock and the transport and deposition of sediment has been particularly important in shaping the present topography. A series of glaciations has modified former river valleys by widening and deepening as high mountain glaciers extended from the dozen or so coves. These tributaries eventually joined the main Ullswater valley and produced enough erosive power to scour out the second deepest basin in the Lakes. Glencoynedale was a minor tributary which failed to erode down as much and is now seen as a fine example of a hanging valley.

Further modification to the valley is currently taking place as major streams transport in sediment that extend shorelines out into the lake. Notable examples are the deltas of Aira Beck and Glenridding Beck (Figure 11).



Figure 11. The landscape at the south end of the lake has been greatly influenced by glacial erosion forming coves and valleys. More recent fluvial deposition from upland streams and rivers has built deltas which are very gradually infilling the lake.

Lamprophyres: A Short Introduction, with three examples from Cumbria

Duncan Woodcock

Introduction

Lamprophyres are a diverse group of generally porphyritic, mafic or ultramafic rocks that often occur in swarms of dykes. The name, which was introduced by the German petrologist Gumbel in 1874, means "glistening porphyry" (Greek: *lampros*, glistening), and refers to the appearance of a hand specimen when light is reflected off mica phenocrysts that are abundant in some lamprophyres (Figure 1). The name was subsequently used to encompass a wide variety of shallow intrusive rocks that contain mafic phenocrysts (Mitchell, 1994).



Figure 1: A hand specimen (c. 10 cm long) of a mica-lamprophyre from a dyke in Skirwith Quarry, Ingleton, N. Yorkshire. Acadian deformation of the dyke may have imparted a slight foliation to the rock which accentuates the "glistening" of the phenocrysts.

Lamprophyres have a set of characteristics that make them sufficiently distinctive to be considered as a separate group of igneous rocks (Rock, 1987; Le Maitre, 1989):

(i) they are generally porphyritic, with phenocrysts restricted to mafic minerals dominated by biotite or by amphibole (both hydrous minerals),
(ii) felsic minerals, in particular feldspars, are restricted to the groundmass,
(iii) they usually occur as dykes,
(iv) they are often altered, particularly the groundmass, although phenocryst phases may sometimes also be selectively altered.

Traditionally, there was a tendency to regard lamprophyres as petrological curiosities with obscure origins. More recently, lamprophyres have been recognised as petrologically significant (Rock and Hunter, 1987), particularly as there appears to be an association of lamprophyre dykes with certain classes of gold deposits (Rock and Groves, 1988; Yu et al., 2020) and with diamond deposits (de Stefano et al., 2006, Wyman *et al*., 2006)). In this article I aim to provide an introduction to these fascinating and, at times, frustrating rocks.

Classification, occurrence, and UK examples

Older publications usually refer to lamprophyres as "trap dykes" (e.g., Flett, 1900). Teall (1888) has a chapter titled "Mica traps and related rocks" in his "British Petrography" in which he discusses the various attempts to classify these rocks. A systematic study of lamprophyres was carried out by Nick Rock during his doctoral studies (Rock, 1977). Much of this work was adopted by the International Union of Geological Sciences (IUGS) Subcommission on the systematics of igneous rocks, which deliberated in the 1980s (Le Maitre, 1989). The current IUGS classification distinguishes three groups of lamprophyres: calc-alkaline, alkaline and ultramafic.

1 Calc-alkaline lamprophyres

Calc-alkaline lamprophyres have biotite and/or hornblende phenocrysts with feldspar as the principal felsic mineral in the groundmass. Table 1 shows the classification of calc-alkaline lamprophyres. The classification has two "dimensions": the predominant mafic phenocryst mineral and the predominant feldspar in the groundmass. In cases where the groundmass feldspars are altered beyond recognition in thin section the terms "mica lamprophyre" and "hornblende lamprophyre" can be used.

Calc-alkaline lamprophyres are usually associated with granitoid plutons in orogenic belts. Late Caledonian mica lamprophyres are widely distributed in Northern England and Southern Scotland, where they occur as dykes intruding Lower Palaeozoic sediments (principally Ordovician and Silurian greywackes). Many

Calc-alkaline lamprophyres		Predominant mafic mineral	
		Mica (usually biotite)	Hornblende
Predominant feldspar	Alkali (orthoclase)	**Minette**	**Vogesite**
	Plagioclase	**Kersantite**	**Spessartite**

References: Nockolds *et al.* (1978), Le Maitre (1989)

Table 1. Classification of calc-alkaline lamprophyres