



# Education Service

## Geology Factsheet

All visitors to the Lake District are struck by the beauty, grandeur and variety of the scenery, but few appreciate the extent to which this has been influenced by the underlying rocks and the natural processes shaping their surface. Yet the geology is there for all to see in the form of crags, road cuttings, and rocky knolls in abundance. Evidence of man's exploitation of geological materials is also widespread, with numerous abandoned mines and quarries together with a number of active quarries. The local stone is used in buildings and walls that help to give the landscape its character. Most striking of all, there is the magnificent contrast between fell and dale, the result of glacial action during the last few thousand years.

### Distribution and Origin of the Rocks of the Lake District

The bulk of the National Park is made up of three broad bands of rock trending from SW to NE. The rocks which form the mountains and hills are not necessarily 'harder' than those which form adjacent lower land. The Lake District rocks are 'buoyed up' by sitting 'astride' a 'batholith' or 'raft' of low density granite. The granite underlies the whole area and small protruding parts of it are seen at the surface as the Eskdale, Ennerdale, Skiddaw and Shap granites.

The SKIDDAW GROUP is the oldest group of rocks in the Lake District. They were formed during the ORDOVICIAN period, about 500 million years ago, as black

mud settling on the sea bed in relatively deep water where occasional layers of coarser silt and sand were also deposited.

The Skiddaw Group forms a roughly triangular mountainous zone in the north of the Park, reaching a maximum height of 931m on Skiddaw itself. Despite their slaty appearance, they are not suitable for roofing because they easily break into small pieces. Although there are some rugged areas developed on rocks unaffected by thermal metamorphism, such as on the south face of Blencathra, the mountains developed on SKIDDAW GROUP rocks are more typically smooth in outline.

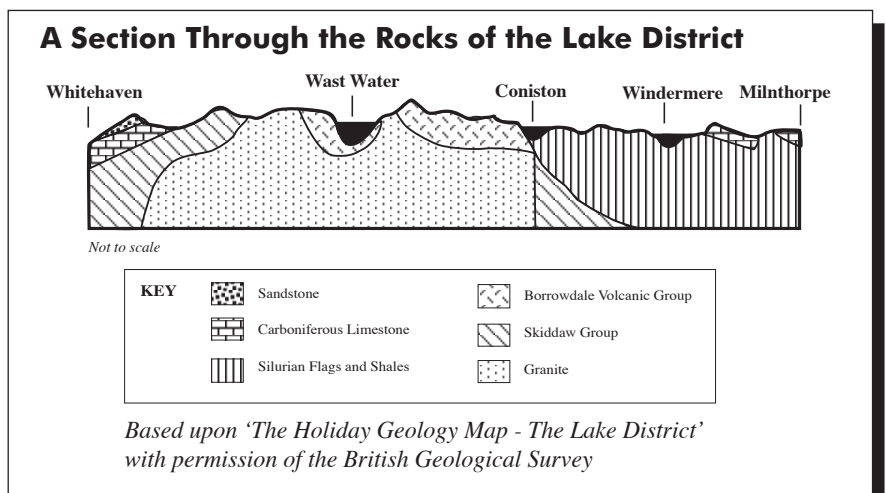
South of the Skiddaw Group lies the BORROWDALE VOLCANIC GROUP (BVG). These rocks are volcanic lavas and ash flows (pyroclastics) erupted during a phase of cataclysmic volcanism 450 million years ago. This volcanism was caused as the Iapetus ocean SUBDUCTED beneath the continent on which present-day England was to form. The BVG lavas are mainly ANDESITES, with some BASALTS and RHYOLITES.

Ash and lava fragments thrown up by the volcano settle out in the encircling waters to form TUFFS and AGGLOMERATES.

The BVG rocks underlie the highest and craggiest central part of the Lake District, including the well known peaks of Scafell (964m) and Scafell Pike (978m), Helvellyn (950m), Conistone Old Man (803m) and the Langdale Pikes (736m). The ruggedness of the terrain makes this the most popular area with fell walkers and rock climbers.

Further south again is a zone of slates, siltstones and sandstones, also formed in the sea, during the SILURIAN period about 420 million years ago. These rocks are known to geologists as THE WINDERMERE GROUP.

These rocks are less resistant than the BVG and form a belt of foothills stretching from the Duddon estuary to Kendal. They are possibly the most familiar part of the Lake District to many visitors as they lie across the A591, the main tourist route into the National Park, and include the lakes of Windermere and Conistone Water.



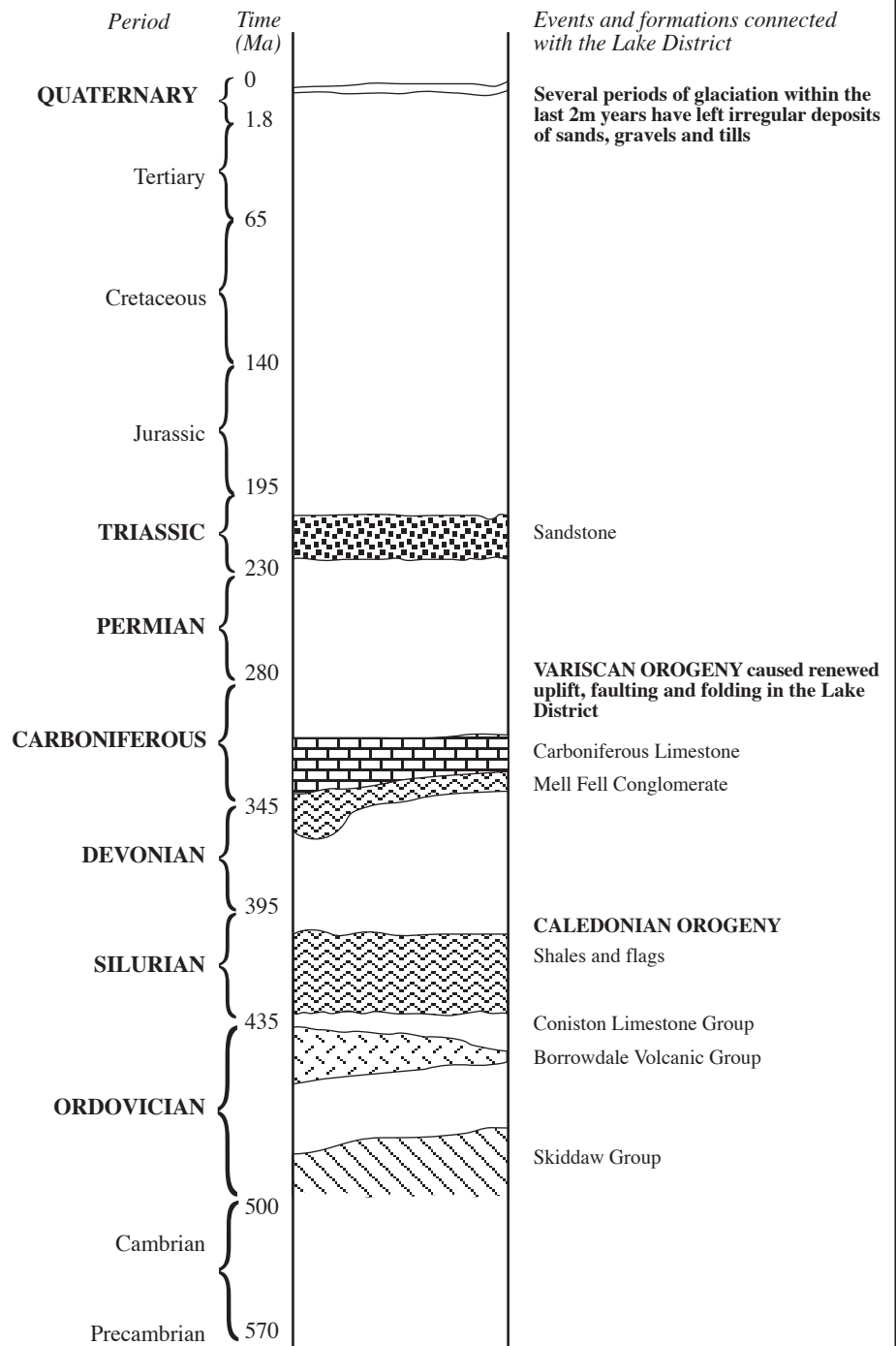
About 400 million years ago all these rocks were folded, faulted, intruded by molten magma and pushed up to form a very high mountain range. These events are known as the CALEDONIAN OROGENY (mountain building episode) and they were caused by the collision of two continents. 400 million years ago the Lake District mountains looked something like the Himalayas today. The Himalayas are still being formed by India colliding with Asia to build a high mountain range. The Caledonian orogeny compressed many of the BVG tuffs and turned them into the famous Westmorland green slates.

Millions of years of erosion have worn down these mountains to their present size, but the folds and faults can still be seen and the igneous intrusions, which cooled and crystallised hundreds of metres below the surface, are now exposed around Eskdale, Ennerdale, Shap, Skiddaw and Carrock Fell. They all form part of a very large granite 'batholith' at depth (as already mentioned) and this tends to 'buoy up' the whole area.

During the DEVONIAN period the high mountains were eroded to low hills and about 350 million years ago most of the land sank beneath a tropical sea. This teemed with life and the sea floor became covered with a thick layer of sediment, made up of the broken remains of shells, to form the pale grey Carboniferous Limestone. Some shells survived intact and so fossil corals, brachiopods and snails are sometimes found in the limestone.

During the latter part of the CARBONIFEROUS period this sea was eventually filled in with mud and sand and was colonised by swampy forests whose remains now form coal. Most of these rocks lie on or just outside the National Park boundary.

## The Geological Succession in the Lake District



Note: Geological periods represented in the region are shown in bold capitals. Time is shown in millions of years before present.

About 280 million years ago the Carboniferous rocks were uplifted and folded into a broad dome by another orogeny, the VARISCAN OROGENY (its most severe effects were felt in what is now Devon, Cornwall, South Wales and South West Ireland). After the Hercynian mountain building episode the Carboniferous Limestone was left as a broken rim girdling the higher mountainous core. The limestone takes the form of a long curved cuesta around the northern edge of the National Park and a more broken zone in the south, lying only partly within the National Park. It contains two very prominent west facing scarps, Whitbarrow Scar and Scout Scar, both situated to the west of Kendal.

Since the formation of the Skiddaw Slates Group during the Ordovician period, the part of the Earth's crust we now call the Lake District has been slowly drifting north, starting from a position well south of the equator. During the late Devonian, or early Carboniferous, it crossed the equator and by about 250 million years ago it reached the latitude of the present day Sahara Desert.

A landscape of sand dunes and salt lakes developed, with seasonal downpours of rain washing rock debris from nearby uplands onto stony plains. These conditions persisted throughout the PERMIAN and TRIASSIC periods and ended about 190 million years ago.

The St. Bees and Kirklington Sandstones to the west and north of the National Park were formed at this time and are thought to be the result of 'flash floods', whereby a mass of sand or larger debris is deposited in a sudden downpour or storm.

By contrast, the Penrith and Lazonby Sandstones of the Eden Valley (east of the National Park), although deposited in the same eras, are desert sandstones of aeolian origin showing dune bedding and rounded grains. Since the formation of the Triassic rocks, many more rocks have formed in what is now the British Isles, but none of them are now found in the Lake District. The drift northwards, however, continued, bringing us to our present latitude.

About 2 million years ago the Earth's climate cooled, allowing the development of glaciers and ice sheets which, at their maximum covered most of mainland Britain. These cold episodes were called GLACIALS and were separated by warmer INTERGLACIALS supporting broadleaved forests. It is believed that there may have been as many as 10 such climatic oscillations.

It is the action of glaciers and meltwater, frost conditions and slope action during this period which have shaped most of the surface detail of the Lake District and made the area a text book example of such landforms. (See Panel)

Following the last glacial episode the HOLOCENE commenced. This is typified by sea level changes and the development of soils. In the Lake District, grey-brown forest soils developed beneath mature oak forest at lower levels, whilst at higher altitudes MONTANE soils were formed - known locally as RANKERS. Many of the lake and estuarine basins became filled with peat. Tree clearance in the 11th Century led to soil erosion and further activity on the alluvial fans and lake deltas of the central Lake District. Since then the land surface has remained virtually unchanged.

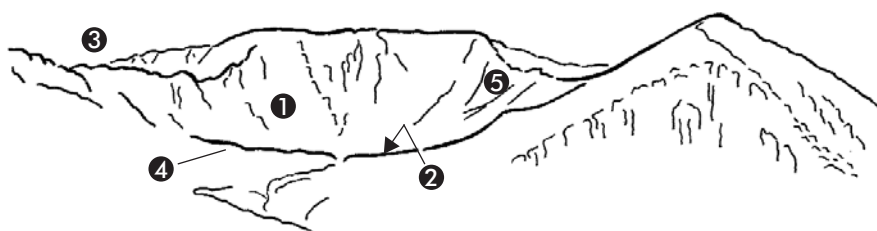
### Quarries and Mines in the Lake District

Many Lake District rocks have been quarried, mostly for use in the construction industry. There are many miles of drystone walls and numerous village buildings made of local stone which came from small local quarries.

The most important rock quarried in the Lake District is slate taken from the BVG. The most famous quarries were around Honister Pass. Various types of Granite were quarried for use as kerb stones and stone setts (cobble). Granite was quarried near Ravenglass, in Eskdale, at Threlkeld (near Keswick) and at Shap.

Mines in the Lake District were created to exploit mineral ores which formed as 'veins'. These mineral veins filled cracks (joints and faults) in between the surrounding rock quarried when mineral-laden groundwater cooled and depressurised as it progressively circulated through the bedrock. Veins are very unpredictable in their thickness and mineral content and, as a result, mining them was always a financial risk. Some of the more famous mines were Greenside lead and silver mine, Borrowdale graphite mines (the graphite from these mines was used to make pencils in Keswick; these were the first of their type in the world) and Coniston copper mines.

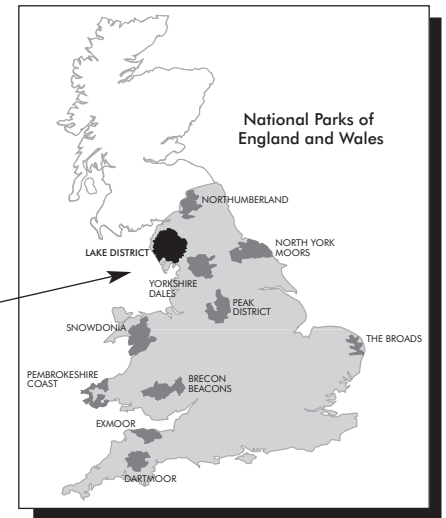
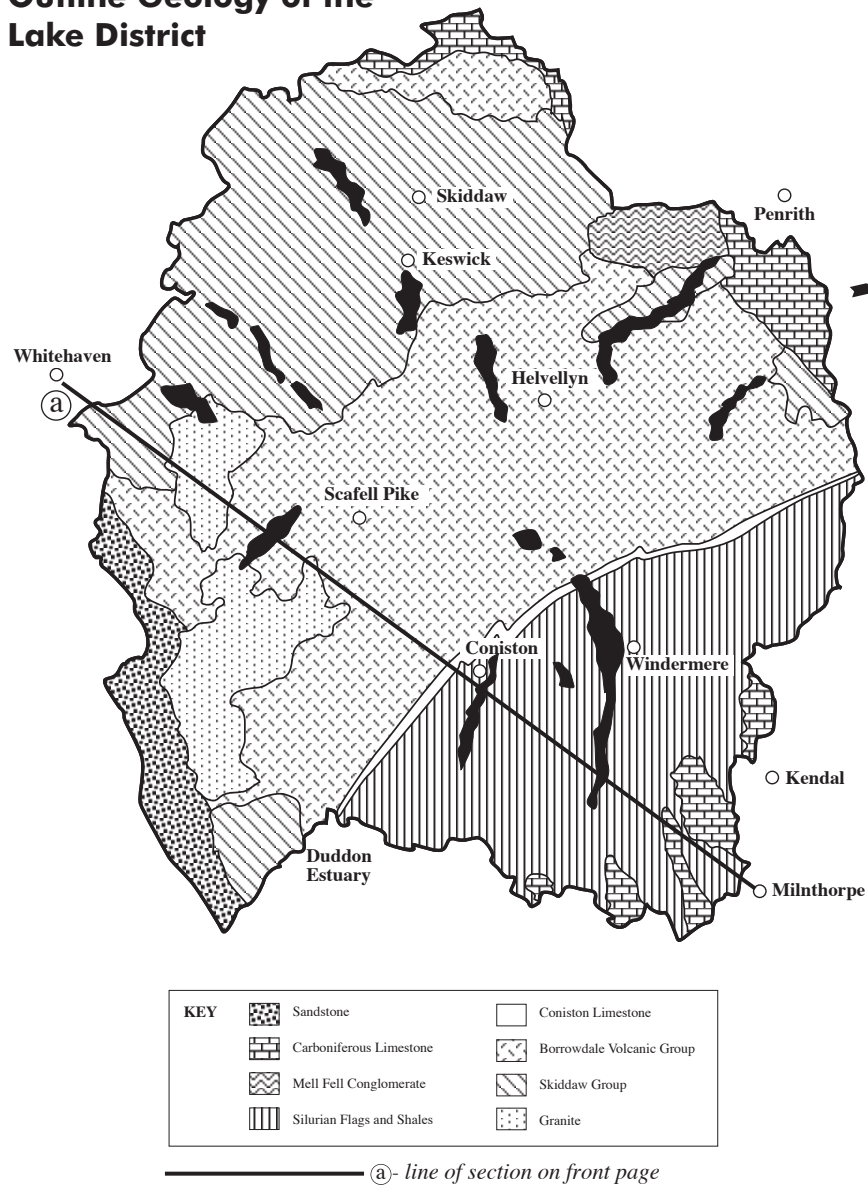
#### Examples of Glacial Features around Helvellyn (NY 343151)



Feature	Example	Grid Reference
1. Cirque <sup>a</sup> & Headwall	East face of Helvellyn	344152
2. Tarn <sup>b</sup>	Red Tarn	348153
3. Arête	Striding Edge	345149
4. Moraine	Red Tarn lip	351154
5. Scree	South flank of Swirral Edge	344154
6. Glacial Trough	Grisedale	360140 to 390160
7. Ribbon Lake	Ullswater	Impossible to miss!

Notes a) The local Lake District name for cirque is cove.  
b) A tarn is a small upland lake in an ice-fomed hollow.

## Outline Geology of the Lake District



other interesting landscape and geological features without this protection. To help conserve geological sites a Geological Fieldwork Code has been developed. This is available on receipt of a SAE from *The Geologists' Association*, Burlington, Piccadilly, London W1V 9AG. [www.geologist.demon.co.uk](http://www.geologist.demon.co.uk)

The Caldbeck Fells are an important part of the National Park where archaeological, geological and ecological features have been given statutory protection. To protect the important geological and archaeological features of the Caldbeck and Uldale Commons areas special permission and a permit is required for specimen collecting. Permission will be considered for research and educational purposes while commercial collecting is not allowed. Details must be sought from *The Lake District National Park Authority, Blencathra Office, Threlkeld, Keswick, Cumbria CA12 4SG*.

The LDNPA also has policies in the Lake District National Park Management Plan on Mining & Quarrying Sites and Conserving & Enhancing Wildlife (including geological sites). These are available on the LDNPA web site; [www.lake-district.gov.uk](http://www.lake-district.gov.uk)

Cumbria RIGS aims to identify and conserve Regionally Important Geological & Geomorphological Sites. It produces geological guides for areas of Cumbria and information on Geological Education Localities. Their web site is; [www.cumbriarigs.org.uk](http://www.cumbriarigs.org.uk)

## Glossary

**AEOLIAN** - Used to describe environments where wind is the predominant factor in creating the observed features. Deserts are the prime example.

**AGGLOMERATE** - Brecciated volcanic rocks of uncertain origin, (but often containing vent material).

**ANDESITE** - Fine grained igneous rock (extrusive) with intermediate composition. Common minerals are plagioclase feldspar, pyroxene or amphibole and sometimes quartz or biotite.

**BASALT** - Fine grained igneous rock with basic composition. Common minerals are plagioclase, pyroxene and olivine.

**RANKER** - A soil consisting only of the top humus layer.

**RHYOLITE** - Fine grained igneous rock with acidic composition. Common minerals are quartz and alkali feldspar.

**SUBDUCTION** - The term used to describe the forcing of one lithospheric plate beneath another.

**TUFF** - Lithified volcanic ash deposit.

## Conserving Lake District Geology

Some of the sites where the geology can be studied are internationally important or easily damaged by

specimen collecting. The most important sites internationally and for research studies are designated Sites of Special Scientific Interest (SSSIs) which means that they are legally protected from damage. There are