Am Muidhe

Teacher's Sheet

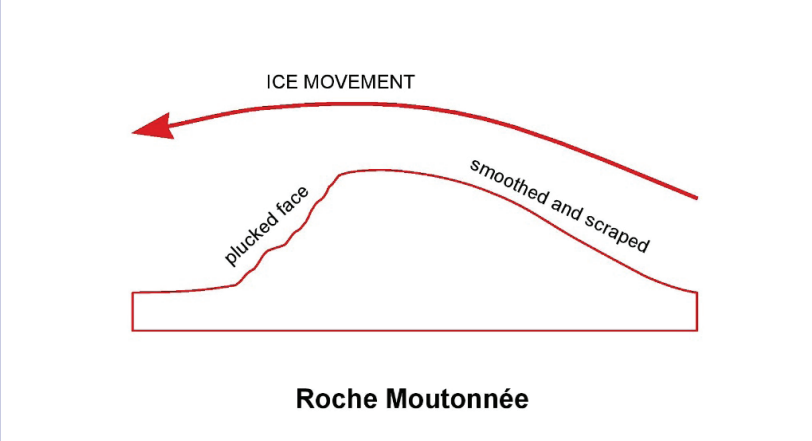


This is a safe location to learn about the Moine Supergroup which is a sequence of metamorphic rocks that form the dominant rock type of the Scottish Highlands between the Moine Thrust Belt to the northwest and the Great Glen Fault to the southeast.

The site is easy to access, being located just off the A82 Road to the Isles, 5km west of Glenfinnan. There is a layby located at NM 8604 8143 where there is space for multiple cars or a coach. The site is located to the north of the layby. Cross the road then walk uphill towards the telecommunications post. Ground is uneven and access is via a steep, often muddy slope, so wellington boots are recommended. The overall shape of the land shows that glaciers moved through the glen from east to west, with a gentle easterly slope and a steep drop-off to the west where care should be taken. Intense folding can be viewed in the exposed pavement, and grooves are seen as a result of glacial scraping.

Location Map

Teacher's Notes

SUGGESTED STOPS	POINTS TO NOTE
Access:	Parking is available at the layby on the A82, grid ref NM 8604 8143. Once parked walk east along the road toward the 'rockfall' signpost. At the signpost, turn north and follow the trodden path for about 10 metres before it turns west, uphill, toward the telecommunication post and the highest point of the Am Muidhe site. As you head up the hill, you will see the interesting exposures of rock poking through the peat and grass. Explore the area from here.
1	**Glacial Striations** The exposure at this location is a metamorphic rock known as schist. In this instance, it has been folded and dates from the Precambrian period. It is part of the Moine Supergroup, as are most of the exposures at Am Muidhe. The exposure at this location is notably smooth and is known as a glacial pavement. This surface formed as fine sediments at the base of a moving glacier, scoured and polished the surface below. There are linear parallel grooves on this surface known as glacial striations. They have been carved by rock fragments at the base of the moving ice. The steep edge at the western side of the exposure indicates that the ice was moving from east to west. This asymmetrical shape is called a 'rôche moutonée' (see diagram below). The last major glaciation in this area reached its maximum thickness 20,000 years ago and declined rapidly over the following 7,000 years. Between 12,500 and 11,500 years ago there was a brief return to cold conditions affecting western Scotland. This is often called the 'Loch Lomond re-advance'. Around Fort William the ice-sheet was more than a kilometre thick and only the tops of the highest mountains, such as Ben Nevis, poked through as Nunataks. The ice-sheet extended to the western coastline of Lochaber so Am Muidhe was not far from its western edge.  **Roche Moutonnée** Glacial striations are visible on many of the rock exposures at Am Muidhe. 

Folds

Most of the metamorphic rocks exposed at Am Muidhe had sedimentary origins. This exposure is of intensely folded, medium-grained mica-schist. Before folding and metamorphism the rocks here began as a thick series of sandstones and shales deposited in a shallow basin in the sea on the edge of the super-continent of Rodinia. This was later to break up and form the continent of Laurentia, modern North America. The time of their deposition is not well known, but the best estimate is the period 1000 – 870 million years ago. The banding which can be seen is due to alternating layers of sands and mud in the original sedimentary rock.

The rocks here are part of the Moine Supergroup which form most of Scotland north of the Great Glen. They are named after a region of northern Sutherland call a'Mhoine, 'the peat'. The Moine rocks around Am Muidhe have had an extremely complicated history of metamorphism and folding and have been subjected to many different orogenies. An orogeny is the name given to a large scale structural deformation of the Earth's crust associated with plate tectonic activity. It is sometimes called mountain building. Some rocks were affected by folding between 825 – 725 million years ago, an event that has been called the Knoydartian Orogeny, after the remote region of Knoydart in north-western Lochaber. However, the main deformation of the rocks occurred much later during the Caledonian – Appalachian orogeny which was responsible for most of the mountains of the Highlands. The Caledonian - Appalachian orogeny occurred in two stages, the Grampian and Scandian orogenies. The Grampian orogeny occurred around 470 million years ago, when the edge of Laurentia collided with a subduction zone, and the Scandian orogeny occurred 430 million years ago when the small continent of Avalonia collided with Laurentia. Avalonia carried the rocks that underlie England, so Scotland and England were united at this time.

These collisions, with forces being exerted from varying directions, led to the intense folding you see here. The folds vary from only a few centimetres high to several metres. The larger folds are themselves folded, sometimes in more than one direction. The Gaelic name, Am Muidhe, 'the churn' is very well chosen. The minerals found in metamorphic rocks are often used as indicators of the pressure or temperature conditions in which they formed acting as 'geo-barometers' and 'geo-thermometers'. One such mineral is garnet as seen here. This indicates that these rocks were at one point, buried relatively deeply.

Boudin – signs of stretching

"Boundin" is French for sausage. These structures, looking like a string of sausages, form when beds of rock are stretched.

Some of the original sedimentary layers, such as sandy layers rich in quartz, are more rigid than those formed from muddy layers rich in mica. The rigid layers are said to be more 'competent'. When they are stretched the competent layers break into the lens-shaped 'boudins', the process being called 'boudinage' while the less competent mica rich layers appear to stretch uniformly into thinner layers.

This feature can be seen clearly at grid reference NM 85972 81471.

Intrusions

The white rocks at this ridge (NM 85903 81442) are a very special type of igneous rock called ‘pegmatite’. The name ‘pegmatite’ is given to intrusive igneous rocks with exceptionally large crystal sizes. In the Am Muidhe pegmatites individual crystals may be 10s of centimetres in length, but in the most extreme examples of pegmatites, crystals several metres long can grow. Pegmatites form in magmas containing large amounts of water which cause crystals to grow unusually quickly. The pegmatite cuts through the folded schist and in places contains separated blocks of schist called ‘xenoliths’, meaning ‘foreign rock’. This shows that the episode of folding was over when the pegmatite was intruded. The force of the pegmatite intrusion has broken off pieces of the surrounding schist and these have been included within the intrusion.

The minerals in these pegmatites are mainly feldspar, quartz and mica. The feldspar and quartz are both white in colour but the feldspar has angular surfaces and will break into angular fragments. This is because feldspar has a property called ‘cleavage’ and breaks in special, regular directions. Feldspar is the most abundant mineral in the Earth’s crust.

The quartz is more grey in colour and does not have a cleavage. Quartz is the second most abundant mineral in the Earth’s crust. Together feldspar and quartz are the main minerals of granite and this pegmatite can therefore be described as a ‘granite pegmatite’, the most type pegmatite.

The third mineral is mica, the silvery, colourless variety called muscovite. The crystals may appear black on the rock surface but this is because you are looking at crystals end-on, parallel to the cleavage. The cleavage of mica is in one direction and very perfectly developed. You can prise the sheets of mica apart with your finger-nail, the most distinctive feature of the mica group of minerals. In mica schists (the main rocks of Am Muidhe) the mica crystals grow parallel giving the rock its distinctive lustre.