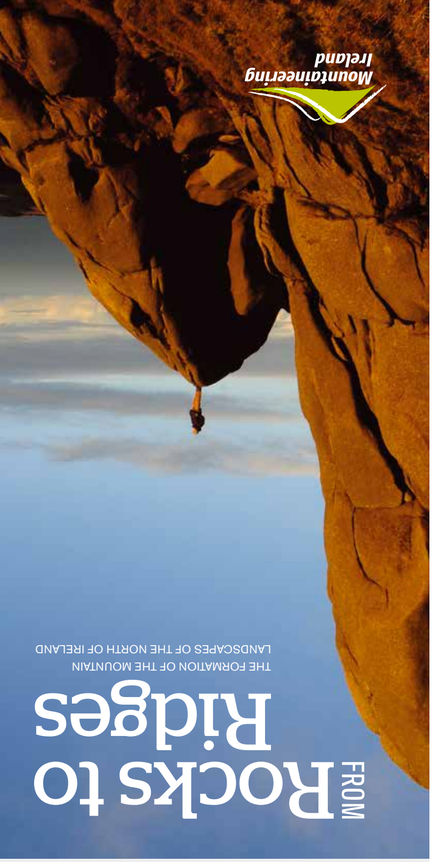


Rocks to Ridges

FROM THE FORMATION OF THE MOUNTAIN LANDSCAPES OF THE NORTH OF IRELAND

Mountaineering Ireland

Origins of Rocks, Soils and Landforms

From the imposing Mourne Mountains, to the prominent peaks of Donegal and the rolling Sperrin Mountains, the north of Ireland is home to a remarkable variety of upland areas. This guide is a companion for walkers and climbers that provides a 'base-camp' introduction to the rocks, soils and landforms of this most dramatically picturesque part of Ireland.

The guide features a geological map with accompanying text and photographs that explore linkages between rocks, soils and landforms. It is intended to aid identification of key rock types, soils and landscape features that can be seen in the uplands of the north of Ireland and in other upland areas around the world.

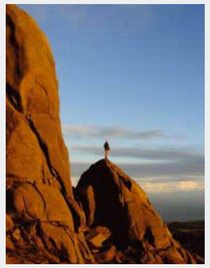
The small island of Inishtrahull located off the north coast of Donegal is the oldest place in Ireland, with rocks that have been scientifically dated as 1,778 million years old. However, most of the rocks forming the north of Ireland range in age from 650–30 million years old and include representatives from all but one of the geological time periods. This staggering variety of bedrock geology is almost unheard of worldwide for the size of area. In addition the area has experienced repeated episodes of glaciation over the last 2.6 million years (known as the Quaternary time period) that have sculpted the landscape we see today. The youngest materials blanketing the landscape are the soils; these have formed since the last ice melted about 12,000 years ago.

By studying rocks, soils and landforms in upland regions we discover how the Earth works. We see how continents have formed and moved, how they have collided and consumed each other, how they have been worn down by ice sheets and glaciers, and what processes result in soil formation. The mountains provide windows into the past. So even on a misty day you can look down at your feet and see hundreds, thousands and even millions of years back into Earth history.

Cover Image: Tors

Masses of bedrock that stand conspicuously above the surrounding ground surface are known as tors.

Tors are more resistant to weathering processes than the adjacent areas either because they consist of harder rock types, or because they have wider cracks. Various theories have been invoked to explain the origin of these enigmatic landforms, including action by frost, ice, water and wind. While it may not be clear how these formed, there's little argument that they provide some of the most attractive features on our mountains.



North Tors, Slieve Binnian, Mourne Mountains, photo by Craig Hiller

Bedrock Geology of the North of Ireland

The landscape of the north of Ireland is strikingly varied and is a reflection of the diverse geology on which it has been shaped. The rocks here were formed from about 650 up to 30 million years ago and include all three geological groupings of sedimentary, metamorphic and igneous.

Igneous rocks display a fine to very coarse-grained crystalline texture. They form when molten rock cools and solidifies underground, where it is called magma, and on the land surface where it is called lava. Rapid cooling above ground produces fine-grained rocks such as basalt and slow cooling underground leads to the formation of coarser rocks like granite and gabbro (see basalt and granite in key below map).

Sedimentary rocks are typically composed of sand grains eroded from other rocks (igneous, metamorphic or sedimentary) or minerals precipitated from water. Animals and plants can also contribute to sediment as fossils. Grains are often transported, for example by water or wind, and then deposited in discrete layers known as beds. As beds of soft sediment are buried they are transformed into rock, for instance sand to sandstone and lime-rich mud to limestone (see examples in key).

Sandstones are made up of grains, most commonly of quartz, that are naturally bound together by minerals such as calcite. However, the term sandstone covers a wide variety of rock types. Greywacke sandstones have a range of grain sizes and minerals, while other sandstones can range in texture and colour depending on the size and mix of grains and binding cements.

Composed mainly of calcite, limestones are often white (chalk), pale grey or cream coloured. Impurities such as iron oxide can change the colour to brown, yellow, or purplish red, while organic material or fine mud can give a blue, grey or black colouration. Many limestones contain fossils.

Metamorphic rocks form when other rock is subjected to intense heat and pressure within the earth, for example limestone turns to marble, sandstone to quartzite, and mudstone to slate. During metamorphism, minerals may be re-aligned and recrystallized perpendicular to the dominant pressure producing thin layers in, for example gneiss and schist (see example in key).

Ice Sheets

Ice sheets and glaciers are powerful agents that shape the landscape through their ability to erode rock, and to transport and deposit the resulting sediment. The surface of Ireland has been modified by the growth, flow and decay of several large ice sheets during the last 2.6 million years in response to marked changes in climate. The last Ice Age was from approximately 29,000–12,000 years ago and the majority of glacial features relate to this period. At its maximum extent the ice sheet covered the whole of Ireland and concealed the highest mountains. It also extended as far as 100km across the western continental shelf into what is now the Atlantic Ocean. Certain landforms were created at the time of maximum ice extent, others as the ice thinned and wasted away into the mountain valleys. All these features - drumlins, moraines, cirques and troughs contribute to the rich tapestry that is our glacial heritage.

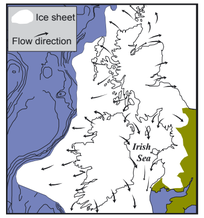


Image to the left shows the maximum extent of the ice sheet that covered Britain and Ireland during the last glaciation.

Landforms

Landforms are a major aspect of the upland landscape and they vary enormously in size, shape and origin. Some were created by the weathering and erosion of rock, while others resulted from the deposition of sediments. Recognising different features and understanding how they were created enables us to appreciate how the landscape has changed through time. Many upland landforms were fashioned by repeated glaciations, whilst others were only formed during the final phase of glaciation. Since the last ice disappeared the landscape has remained dynamic as frost-related processes, mass movements, river action, peat and soil development have been superimposed on the glacial legacy.

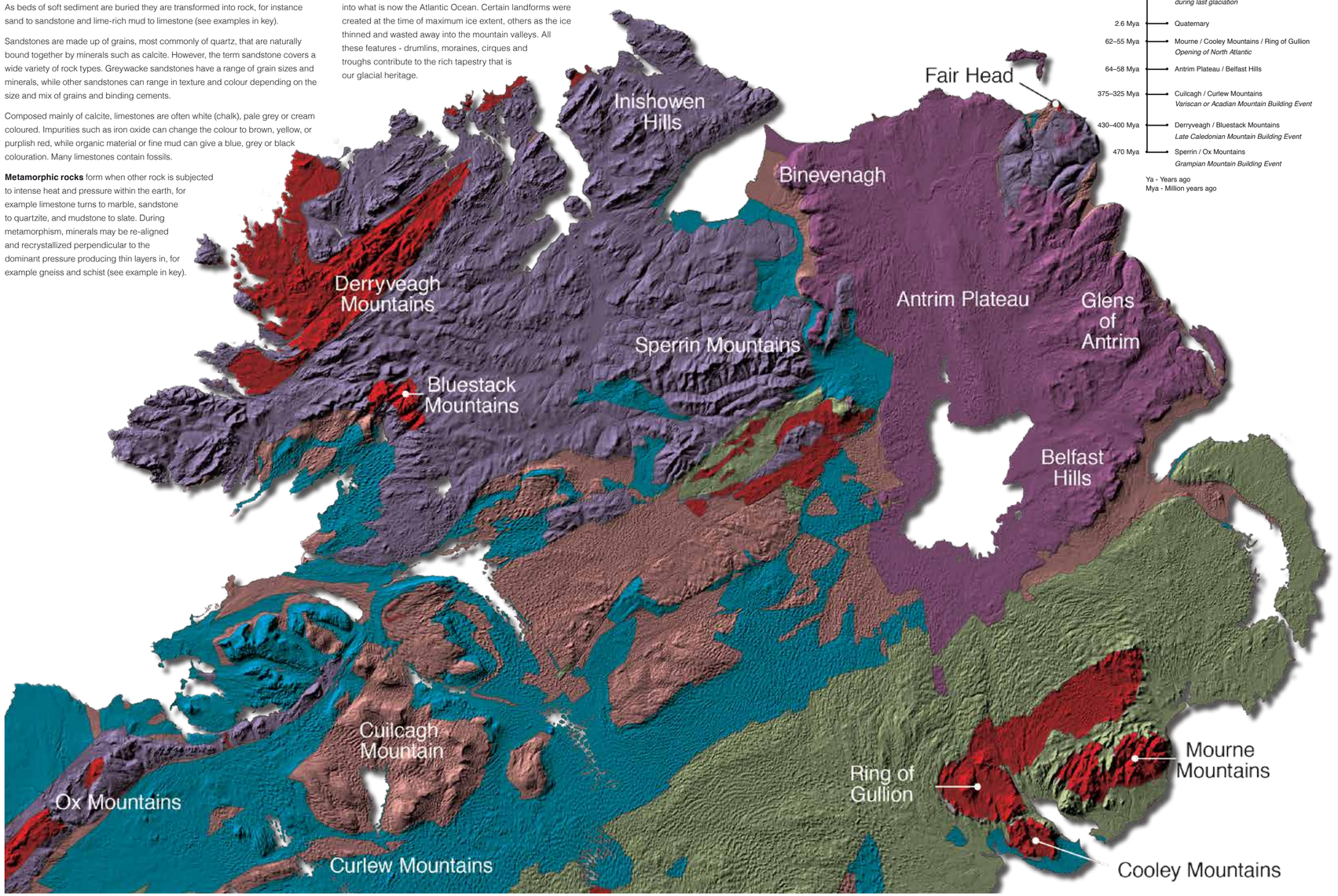
Soils

Soil has been described as 'the vital skin of the Earth' because it sustains food production on which society is dependent. The variety of soils in a region relates to several factors namely: geological parent materials, climate, topography, plants and animals (including humans) and time. Most soils are mixtures of organic and mineral (rock) materials in which a soil profile has developed. In upland areas soils are generally less productive than in the lowlands because of altitude and more adverse climate. Upland soils are normally leached and acidic, or waterlogged and acidic, and have large amounts of organic matter. Nevertheless, they are not without variety and interest.

Key Geological Events

Present day	*Soil formation*
12,000 Ya	*Last ice retreat*
29,000 Ya	*Maximal extent of ice sheet during last glaciation*
2.6 Mya	Quaternary
62–55 Mya	Mourne / Cooley Mountains / Ring of Gullion *Opening of North Atlantic*
64–58 Mya	Antrim Plateau / Belfast Hills
375–325 Mya	Cuilcagh / Curlew Mountains *Variscan or Acadian Mountain Building Event*
430–400 Mya	Derryveagh / Bluestack Mountains *Late Caledonian Mountain Building Event*
470 Mya	Sperrin / Ox Mountains *Grampian Mountain Building Event*

Ya - Years ago
Mya - Million years ago



Simplified bedrock geology overlain on a relief map.

KEY

Underlined rock type shown in picture.

Responsible recreation - can others enjoy tomorrow what we enjoy today?

Many walkers and climbers would agree that the integrity of the upland landscape is central to the quality of our recreation experience. If so, the component parts of that landscape are surely worthy of attention. Mountaineering Ireland hopes that this leaflet will open your eyes to the diversity of our upland landforms and the complexity of the processes that formed them.

Understanding the landscapes we enjoy can empower us to be a voice to stand up for and celebrate these special places. Of course our own recreation activities impact on the physical environment, but by making good choices we can show a positive example to others. Every day we're out in the hills we make countless decisions, such as where to park, what gear to use or where to place our feet; with each choice resulting in a greater or lesser impact on the natural environment.

Those individual choices may seem inconsequential, however the cumulative impact of poor decisions can damage the natural environment. The Leave No Trace approach relies on good information being at hand to inform our choices. We hope the knowledge in this leaflet will enhance your outdoor experiences and help you to make decisions that protect our upland areas.

If we compress the 650 million years since the formation of the oldest rocks in Northern Ireland to one year, the Mournes would be 30 days old, the ice would have melted an hour and a half ago, and we would have been enjoying recreation in the uplands for just one minute. Let's see what positive differences we can make for the uplands in the next minute.

To find out more visit **www.leavenotraceireland.org**.

Find out more

Enhance your understanding of our mountains and the rocks that form them by visiting the websites below, or go to **www.mountaineering.ie/accessandenvironment/Geology** for a more comprehensive list of online resources.

Belfast Hills
www.belfasthills.org

Causeway Coast & Glens
www.ccght.org

Cuilcagh Mountain
www.marblearchcavesgeopark.com

Mourne Mountains
www.mournelive.com
www.mournecooleygullion.com

Ring of Gullion
www.ringofgullion.org

Sperrin Mountains
www.sperrinsgateway.com

Geological Survey of Northern Ireland
www.bgs.ac.uk/gsni

Geological Survey of Ireland
www.gsi.ie

Mountaineering Ireland

Mountaineering Ireland is the representative body working on behalf of all walkers and climbers on the island of Ireland. Membership is open to clubs and individuals. In addition to providing a comprehensive range of services to members, Mountaineering Ireland's work includes: protecting the mountain environment; improving and securing access; providing opportunities for young people to experience our sport and supporting skills development amongst all walkers and climbers.

For more information on Mountaineering Ireland visit **www.mountaineering.ie**

Follow us on Facebook: www.facebook.com/mountaineeringireland

Mountaineering Ireland invites feedback on this leaflet to info@mountaineering.ie.

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Geological Survey of Northern Ireland

Ulster University

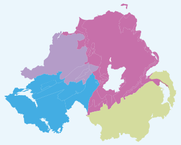
leave no trace

THE CHALLENGE FUND

Beautiful mountains - fragile environment - a special experience

Mountaineering Ireland

Rocks



The bedrock geology of the north of Ireland can be considered in four geographical quarters. The Sperrin Mountains, located in the **north-west** of Northern Ireland, include the main Sperrins Ridge and the highest peak of Sawel Mountain. Ranging in age from 650–570 million years they are the oldest metamorphic rocks in Northern Ireland. The rocks originally accumulated as layers of sand and mud in an ancient ocean called Iapetus. Lava flows were also erupted onto the ocean floor and form part of the stack of layers. As the ocean closed adjacent continents collided and the rocks underwent deep burial and contortion under high temperatures and pressures which metamorphosed the entire rock package into rock types such as schist and gneiss. Similar rocks are present in north-east Co. Antrim where they form the spectacular Torr Head, and in Co. Donegal where they form the conical peak of Errigal Mountain.

The classic quartzite peak of Errigal Mountain, Co. Donegal

Rocks in the **south-east** are greywacke sandstone and slaty mudstones that range in age from 460–430 million years old. These rocks were also laid down as sediments in the Iapetus Ocean that ultimately closed some 425 million years ago. As the ocean narrowed sediments were scraped off the ocean floor and were contorted (folded) and heated causing mild metamorphism.

Folded greywacke sandstone, Co. Down

There are three generations of intrusive igneous rocks present across the north of Ireland. The oldest (485–465 million year old) occur in Co. Tyrone in the foothills of the Sperrin Mountains east of Omagh. They include granites and gabbros that formed during an early stage of Iapetus closure. Much greater volumes of granite were formed later (430–400 million year old) during the final stages of Iapetus closure and include rocks of the Derryveagh and Bluestack Mountains and those north-east of Slieve Gullion and Newry in Co. Down. The youngest granites and gabbros of Slieve Gullion, the Cooley and Mourne Mountains are 62–55 million years old and were formed as the North Atlantic Ocean opened.

The **south-western** part of the north of Ireland is known for its many tranquil loughs, sheer cliffs, mountains and extensive cave systems. The area is underlain by a mixture of sedimentary rocks including limestone, sandstone and mudstone that formed between 360–300 million years ago in a variety of tropical environments such as shallow seas, swamps, rivers and deltas. The rock sequence can be divided into an upper sandstone part that is represented in the Cuilcagh Mountains, and a lower limestone part seen in cliffs above Glencar Lough, west of Sligo, and in the cave systems of Marble Arch south-west of Enniskillen.

Cuilcagh Mountain, Co. Fermanagh

In the **north-east**, the contrasting, uppermost layers of bedrock can be viewed around the margins of the Antrim Plateau. Black basalt, that erupted as lava flows from fissures as the North Atlantic Ocean began to open about 64 million years ago, can be viewed above white chalk that was laid down in an ocean about 80 million years ago. These rocks can be seen along the Causeway Coast Road and in the deeply incised Glens of Antrim whilst at the Giant's Causeway the famous columns and causeway form part of a UNESCO World Heritage Site. Similar columnar structures can be seen in the sill at Fair Head west of Ballycastle.

Columnar dolerite of Fair Head, Co. Antrim

Beneath the chalk the rocks are 200 million year old mudstones and limestones that formed in warm shallow seas that existed at a time when dinosaurs roamed the Earth. Because of their position below the harder chalk and basalt some of the mudstone layers are responsible for often spectacular landslips that are seen for example at Binevenagh and Garron Point. Deeper still lie red mudstones and sandstones laid down between 300–200 million years ago by rivers, lakes and sand dunes, evidence for which can be viewed in the Scrabo Country Park south of Belfast.

Basalt sitting on top of white chalk, Garron Point, Co. Antrim

Subglacial Landforms

Landforms that have been shaped at the base of an ice sheet by actively flowing ice are known as subglacial bedforms and are the most common glacial features in Ireland.

Drumlins

Drumlins are streamlined hills that form beneath fast flowing ice. Their name comes from the Gaelic *druim* meaning a small rounded hill. They are made mainly of glacial till and can range from tens of metres up to a few kilometres in length with a height of up to 50m. Classic descriptions say they resemble a half buried egg, having a steep blunt face on one side, called the 'stoss', and a gentle sloping tail on the other 'lee' side. Recent research has however shown drumlins to be more symmetrical with slopes of similar gradient on either side and with a summit near their centre. Drumlins form in swarms consisting of hundreds or thousands of landforms that are grouped closely together. Within a swarm they tend to have similar long-axis orientations that point in the direction of former ice flow and are used to establish where the fastest flowing corridors of ice were located during the last Ice Age.

Streamlined drumlin, Katesbridge, Co. Down

Ribbed moraine

Ribbed moraines are one of the most abundant landforms in Ireland and are found mainly at lower elevations. Despite having 'moraine' in their title, ribbed moraines are unrelated to moraines that are deposited at the margins of ice. They are subglacial ridges that form beneath an ice sheet, close to the interior, and are created by ice flowing over accumulations of soft sediment. They form perpendicular to ice flow and have regularly spaced ridges, which gives them their characteristic 'ribbed' appearance resembling giant ripples on the landscape. Typically they range in size from 300–1200m long, 150–300m wide and 10–30m in height. However, Ireland boasts 'mega-scale ribbed moraines' in Co. Monaghan that are the largest in the world at up to 16km long, 1km wide and 60m in height. In upland terraine, ribbed moraines are found on the southeast facing slopes of Cuilcagh Mountain, Co. Fermanagh and on the east facing slopes of Bencroy and Knockacullion just east of Lough Allen in Co. Leitrim.

Ribbed moraines, Upper Lough Erne, Co. Fermanagh

Landforms of Glacial Erosion

Corries / Cirques

Corries or cirques are large bowl-shaped depressions found in mountainous areas. They are backed by a steep concave slope, known as a headwall, and have a flat or over-deepened bottom that can contain a small lake and a rock lip at the front. The typical cirque shape is the product of two main processes: first, glacial abrasion and quarrying occur as the glacier flows in a rotational manner from the headwall towards the lip; second, frost-action occurs on the upper part of the headwall above the glacier surface which helps to erode the headwall. The Pot of Legawherry below Slieve Commedagh and Slieve Corragh is a good example in the Mourne Mountains.

Pot of Legawherry, Mourne Mountains, Co. Down

Striations

Striations are scratches on rock surfaces that were caused by interaction with other rocks being transported by ice. They are usually only a few millimetres deep but can be several metres in length. They are important because they record the direction of former ice flow. In some locations, it is possible to see striations of different directions cutting across one another. This indicates that the direction of ice flow changed either because the ice retreated and then re-advanced over the area again from a different direction, or because of a shifting ice flow pattern within the glacier itself.

Meltwater channels

An important part of any glacial landscape is water derived from the melting of ice. Water passes over, through and under ice in a connected system that lubricates the flow of ice over the landscape. As it travels it erodes passages within and under the ice, a process that is aided by high water pressures caused by the weight of ice. Numerous forms of meltwater channel are found across the landscape from huge linear tunnel valleys to small notches between drumlins. Meltwater channels are often cut into underlying bedrock which is an indication of the erosive power of such systems. The presence of a stream that is too small to have formed the feature in which it flows, is good evidence for it having acted as a meltwater channel.

Craigagh Hill meltwater channel, Sperrin Mountains

Roches moutonnées

A roche moutonnée is an asymmetric bedrock knoll that has been shaped by ice flow over its surface. They tend to occur in clusters and range in length from several metres to kilometres. On one side they have a smooth gently sloping face formed by abrasion, whilst the other side is steep due to plucking by the ice — a process known as glacial quarrying. Like striations and drumlins, roches moutonnées also indicate former ice flow direction. Good examples can be seen in the Bluestack Mountains and in the Derryveaghs, where they record north-westerly ice movement across the Errigal to Muckish chain.

Roche moutonnée, near Muckish, Co. Donegal

Glacial troughs

Glacial troughs are deep linear valleys with steep walls and a curved base. They are often described as U-shaped and form as glaciers abrade and quarry rock from the sides and floor of the valley. Smaller tributary valleys may have been left hanging above the main trough because the latter was eroded more deeply. Although mainly associated with valley glaciers, glacial troughs can also be carved beneath ice sheets if there is a focussed area of ice flow. Walkers in the Derryveagh Mountains will see a classic example in the main valley of the Glenveagh National Park.

Glacial trough, Annalong Valley, Co. Down

Landforms of Glacial Deposition

Erratics

Erratics are boulders that have been transported by ice to their present location. They are different from the bedrock on which they have come to rest and may have moved a few to several hundred kilometres. For example, granite boulders from the small island of Ailsa Craig in the Firth of Clyde occur all around the Irish Sea coast and were carried by ice sheets that flowed from south-west Scotland. Matching the rock type of an erratic with geological maps allows us to discover where it came from and to reconstruct former flow patterns. When the ice melts erratics become exposed to radiation that continually bombards our planet from outer space. The radiation reacts with minerals in the rock and creates isotopes that increase in concentration with age. The concentration can be measured to establish the time that has elapsed since erratics were deposited. As such, erratics are large timepieces that record the end of the last glacial episode.

Cloghmore Stone erratic, Rostrevor, Co. Down

Moraines

Moraines are ridges of glacial sediment that have been deposited by ice and contain mostly till. Moraines are named on the basis of where they form within the glacial system and can be created by everything from large ice sheets to small valley glaciers. In valleys there are three main types. If they form along the sides of a glacier they are called lateral moraines. When two valley glaciers converge, their lateral moraines combine creating a medial moraine. Moraines formed at the end of a glacier are known as end or terminal moraines and are formed by debris that is dumped by melting or bulldozed when the glacier advances again. Large ice sheets also create moraines along their outer edges, but these are usually considerably larger. As the ice melts it produces a sequence of end moraines that show the pattern of glacier retreat. Moraines can be seen in many of the valleys in the mountains of Donegal, the Sperrins and the Mourne Mountains.

End moraines in Glenaan, Glens of Antrim

Till

Till is a glacial sediment produced by the flow of ice across a landscape. It is typically a mixture of clay, silt and sand with larger angular cobbles and boulders. Its composition is also variable and reflects the range of different bedrock types over which the ice has travelled, though the rock type immediately below a particular till is usually best represented. Cobbles and boulders within till are often striated. Till can be seen along stream and river banks and in tracks that have cut through overlying soil or peat.

Till exposure, Sperrin Mountains

Deltas

Deltas form in water bodies such as lakes where streams of glacial meltwater deliver sediment. Over time, these build into flat-topped landforms that have a steep sloping front called the foreslope. They form in a range of glacial environments including marine settings such as fjords, or in places where meltwater becomes dammed behind a moraine or part of the ice sheet itself. In glacial landscapes the most common deltas are Hjulström deltas which form in shallow water and have gentle foreslopes and Gilbert deltas that form in deep water and have flat tops and steep foreslopes. Any sediment delivered into the lake becomes sorted into layers of sand and gravel as it settles out in the water column or slides down the steep foreslope of the delta. In the north of Ireland deltas are common features in the Sperrin Mountains where they record the presence of former lakes associated with the decay of the last ice sheet.

Gortin deltas, Sperrin Mountains

Periglacial Landforms

Periglacial landforms develop in association with permafrost (permanently frozen ground) and/or intensive frost action. Ireland has experienced such conditions on many occasions, the last being about 13,000–12,000 years ago. At present some frost-related processes are still effective above about 600m on certain mountains, but most periglacial features relate to very cold conditions in the past.

Boulder accumulations

On some mountain summits and upper slopes there are extensive areas of boulders that make for awkward walking. They are arranged chaotically and are products of frost wedging and heaving of the underlying bedrock. Some boulders may have been transported by glaciers but usually they are local to the site. On moderately-sloping hillsides clusters of boulders may have travelled downslope as a result of freeze-thaw of water-saturated debris. Such boulders often form distinct lobes or terraces and give the hillside a 'staircase' appearance. Examples are found on the summits of Muckish and on Slieve Snaght in Inishowen.

Blockfield on Muckish summit, Co. Donegal

Talus

Talus, or scree, is produced when pieces of rock (from gravel to boulder size) fall from crags and accumulate at a gradient of about 30–35° on the slope below. Freezing and thawing of water in rock joints on the crag can cause rock to detach, as can earth tremors. Talus is loose and unstable and tends to shift downslope if walked on. It is usual to find the smaller rock particles close to the top of the talus and larger blocks towards the base. This is due to fall sorting; larger fragments have greater momentum and on hitting the slope below they bounce or roll a greater distance than the smaller fragments which tend to lodge near the foot of the crag. Talus can be seen on most steep mountainsides with cliffs such as the escarpments of the Antrim Plateau.

Talus slope on the south side of Muckish, Co. Donegal

Mass Movement

At the end of the last glacial episode many hillslopes were left in an unstable state. The pressure imposed by the ice sheet had been released and the land surface was able to 'rebound'. These adjustments weakened the slopes resulting in large-scale rock slides and rock avalanches that formed shattered rock masses on the lower slopes. Mass movements of this type are now rare, instead it is the deposits of glacial sediment and peat that are susceptible to downslope movement. These materials may become 'liquified' during intensive rainfall and move as debris flows.

Debris flows

Saturation of glacial sediment, soil and peat reduces the friction between particles and if the vegetation cover cannot restrain the soggy mass it will begin to move downslope. Distance and rate of movement depend on the slope gradient and length, and the water content. As the material moves the vegetation cover ruptures and the water gradually 'escapes' leaving behind the debris. The terms 'bog burst' and 'bog flow' are sometimes applied to such features. Recent bog bursts have occurred in the Sperrin and Cuilcagh Mountains, the Inishowen Hills and the Antrim Plateau. Over time vegetation will colonise the exposed surfaces and within a few years sites can become almost unrecognisable.

Debris flow in peat on Crocknalaragagh, Co. Donegal

Rock-slope failures

Rock-slope failures can take different forms depending on the character of the rock, the slope gradient and the height of fall. If the rock has many closely-spaced cracks known as joints it is more likely to fragment into an avalanche type of movement and in doing so can travel some distance. Rock that has fewer joints may remain semi-intact and slide as a more-or-less 'coherent' mass. The north-Sligo to north-Leitrim area provides many examples including the dramatic Eagle's Rock at Glenade.

A back-tilted mass of rock slide material in limestone on Arroo, Co. Leitrim

Soils

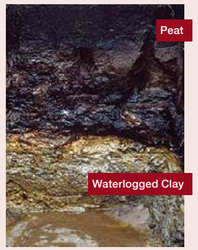
Podzolic soils

Soils developed on sand and gravel deposits usually show evidence of podzolisation because rainwater is able to pass through these materials relatively quickly. In such soils the uppermost horizon is normally peaty, below which, a pale (grey or white) mineral horizon leached of nutrients and iron oxide is found. Below this zone the soil is enriched in iron and organic materials, and has a distinct orange-brown to dark brown colour. In some profiles a thin, undulating, iron accumulation known as an iron pan may be present and acts as a barrier to roots and water. Numerous variants exist but all are acidic soils.

Podzolic soil developed in glacial sand and gravel deposits, Glens of Antrim

Gleyed soils

In low-lying areas close to the water table or in areas of frequent and heavy rainfall, soils with high clay content will generally show evidence of periodic waterlogging. Peat-rich topsoil is common, below which is mineral material whose colour depends on the water content. When saturated, gleyed soils take a bluish-grey colour, when drier they assume a browner hue. This change in colour is brought about by chemical changes and bacterial action associated with iron oxides.



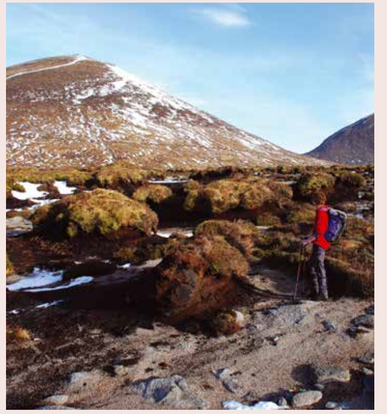
Gleyed soil with a peaty top horizon, Sperrin Mountains

Peat

Peat is found in both upland and lowland areas of Ireland and supports vegetation with a limited range of species. Blanket bog, so-called because it covers the landscape, is a product of slow plant matter decomposition in cool wet conditions, particularly in areas where precipitation exceeds 1,250mm per annum. In the east it is found above about 300m, whilst in the west it occurs right down to sea level in Donegal. Blanket bog began to accumulate at different times in different areas and in some places is several metres thick. Its development has been associated with change to a wetter climate and also the activities of early farmers who, by removing the native tree cover and farming the land, facilitated an increase in ground surface wetness and thus encouraged peat to form.

Today most areas of blanket peat are undergoing erosion. The surfaces resemble a mosaic of islands and channels, or haggs and groughs to give them their correct names. These landscapes are difficult to traverse and make for slow going on foot. The erosion is not necessarily recent; evidence suggests it has been taking place for at least 3,000 years. The terms hagg and grough are of Scandinavian origin, indicating that these features were present and familiar to our Viking forebears.

Most of the erosion is achieved by running water, either beneath the peat mass, where if flows in unseen tunnels, or across the surface where it can exploit breaks in the vegetation cover. Sub-surface flow can lead to collapse and break-up of the overlying peat that can then be gradually carried away by both types of flow. Once the peat becomes exposed, winter frosts may play a role in its further fragmentation.



Peat haggs in the Mourne Mountains, Co. Down