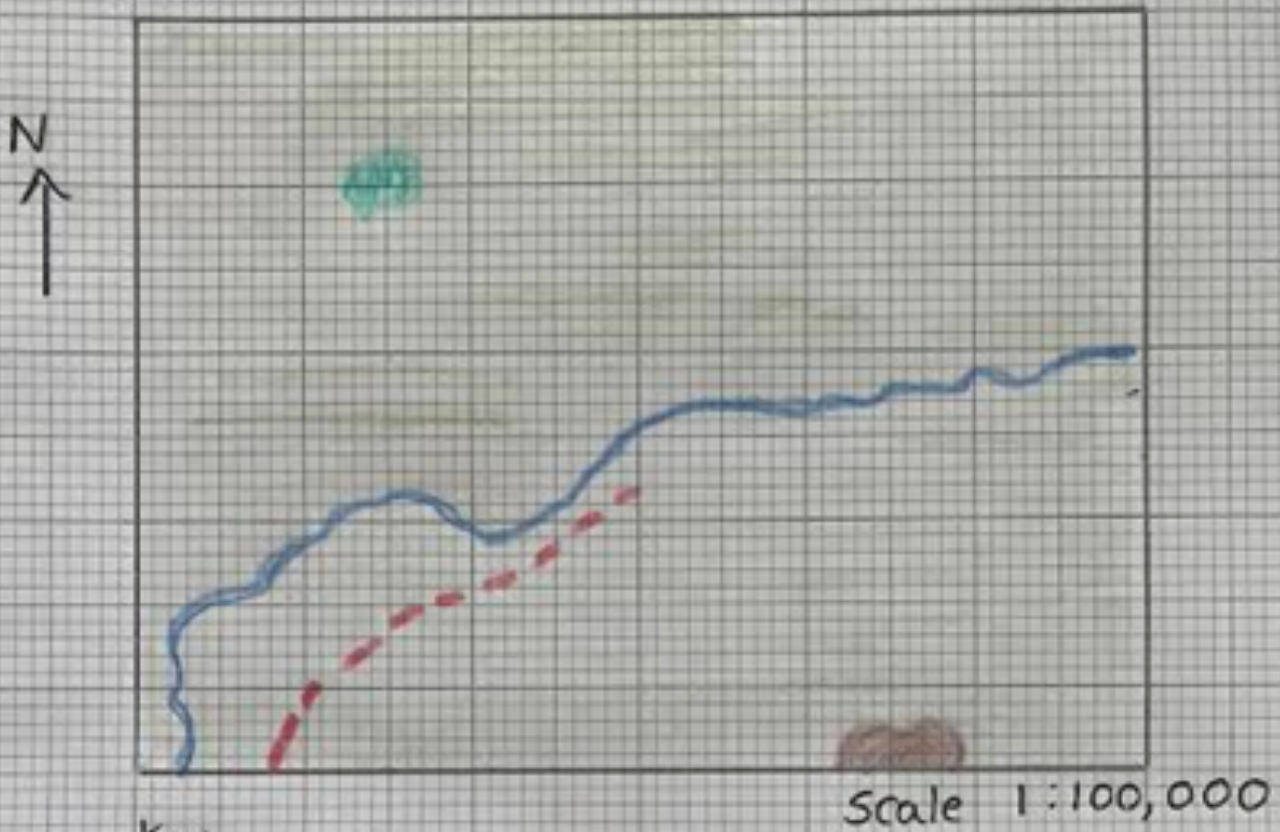






Sketch Map of O.S. Map of Clonmel



Key

-  The entire course of the River Suir
-  An area of land over 400m
-  The Waterford Cycling Trails
-  An area of coniferous plantation

Tectonic activity has influenced the development of the Irish landscape. Although Ireland is no longer located on a plate boundary, the impact of plate tectonics is evident around the country, which suggests that Ireland was once located on a plate boundary. These plates float on the semi-molten asthenosphere. Thermal convection currents in the mantle cause the plates to move. Hot rock rises from deep within the Earth to the surface. As it rises, it cools, flows sideways and sinks. This lateral movement drags the lithosphere (made up of oceanic and continental crust) along with it.

About 850 million years ago, Ireland was divided in two, and Northwest Ireland and Scotland were part of the North American plate and lay south of the Equator. The south-east of Ireland lay south of the Equator. By about 400 million years ago, the ocean between them had closed because of subduction and the two plates had collided. The two parts of Ireland were joined together. The collision of the plates resulted in folding, faulting, metamorphism and volcanic activity. The Caledonian orogeny is associated with the collision of the American and Eurasian plates. The collision was so intense that many of the rocks were faulted during the folding and magma began to intrude into the faults. Ireland's igneous and metamorphic rocks were formed at this time.

These Caledonian mountains include mountains of the West and North-West such as the Maamturk mountains, Twelve Pins, Bluestack Mountains and in the East the Dublin Mountains and Wicklow mountains. The Leinster Batholith is a pluton, which was formed when tectonic plates collided during the Caledonian folds. Molten magma occupied great arched folds in the surrounding sedimentary rocks. The magma cooled very slowly to form the great granite batholith.

About 250 million years ago, the Eurasian and African plates collided. The pressure came from the South as the African plate collided with the Eurasian plate. This resulted in folding, which affected the southern half of Ireland. The 'ridge and valley' landscape of Munster was formed because of the Armorican folding. Ireland was now part of the super continent, Pangaea. Between 200 million years ago and 140 million years ago, Ireland continued to drift northwards as Pangaea broke up. About 65 million years ago, the European and American plates began to split apart creating a constructive plate boundary. The Atlantic Ocean was born. As the rocks were stretched and cracked, volcanic activity, lasting for about 15 million years, resulted. Great cracks or fissures opened. Lava poured out onto the surface, flow upon flow, to form a flat, featureless landscape known as the Antrim Derry Plateau. The individual flows, varying in thickness from 5 metres to 40 metres, cooled to form the igneous, basalt. The Giant's Causeway is the most distinctive part of the plateau. Its 60,000 basalt columns formed when molten magma cooled very slowly after becoming trapped in a river valley. As the lava cooled, it contracted around regularly spaced centres. As seafloor spreading widened the ocean, gradually Ireland moved away from a plate boundary.

The movement of plate tectonics has greatly impacted on the development of the Irish landscape. The Ireland of today did not exist until about 400 million years ago.

4.6 billion years ago the earth comprised one super landmass – Pangaea. Overtime Pangaea up into two super continents, Laurasia and Gondwanaland. Laurasia travelled northwards and Gondwanaland travelled southwards.

Ireland as we know it formed part of the Laurasian landmass. Ireland through its geological past has witnessed converging and diverging, undergoing the processes of subduction and sea floor spreading respectively. Ireland has moved from its early location south of the equator to its present location at 53°N. It has moved very slowly over this time, at the rate of 1cm to 2cm per year due to the theory of thermal convection, the engine behind the theory of continental drift/plate tectonics.

About 850m years ago North West Ireland was part of the North American plate which was lying close to the equator. Southern Ireland lay beyond an ocean, several thousand miles to the south, close to the tropic of Capricorn.

Between 440 million and 400 million years ago the two parts of Ireland merged when the separating ocean closed and the two plates collided. The collision took place in a line running from Galway to Dundalk. The impact of this collision can be seen in Ireland today in the form of the Caledonian Fold Mountains.

The Caledonian Fold Mountains of NW Ireland and the granites of Donegal and Wicklow were formed due to this collision. The Caledonian Foldings occurred 450m years ago when the North American and Eurasian plates converged during the Silurian geological period. This was an example of continental-to-continental convergence. These same fold mountains form the mountainous backbone of Norway, Sweden, Scotland and the Appalachian Mountains of NE USA.

During the Caledonian folding period the Leinster Batholith was formed. During the foldings magma intruded into the upfolds to form granite forming the Leinster Batholith. A batholith is a dome shaped mass of igneous rocks, mainly granite, formed by the intrusion of magma into cavities as it forces its way upwards into the crust. It extends for 120kms from Killiney in Co. Dublin to Thomastown in Co. Kilkenny.

About 320 million years ago Ireland lay beneath a warm shallow tropical sea near the equator. This period witnessed the formation of limestone on the bed of these seas. The limestone formed from the remains of compressed sea creatures which were laid down in layers.

Approximately 270 million years ago the Eurasian Plate and the African Plate converged during the Permian geological period. This was a period of continental-to-continental convergence. This convergence resulted in the Armorican Foldings. The Armorican Folding formed the Munster Ridge & Valley landscape comprising anticlines of sandstones and synclines of limestone. The Munster Ridge and Valley runs east to west from the Comeragh Mountains in Waterford to the Caha Mountains in Cork and the Magillicuddy's Reeks in Co. Kerry.

The Armorican Foldings also uplifted the karst landscape of the Burren. The Burren is a very distinctive landscape comprising unique surface features such as limestone pavements and underground features such as dripstone formations.

Between 200 million years ago and 140 million years ago Ireland continued to drift northwards. Marine sediments, rich in organic matter were deposited. Overtime these deposits became oil and gas. The gas in the Corrib gas field, 70 kms off the NW Mayo coast was starting to form around now. The gas in the field was trapped in geological formations called anticlines and fault traps.

65 million years ago the European and American Plates diverged. Ireland experienced sea floor spreading. Ireland was located in an equatorial region. Ireland was undergoing an intensive period of igneous activity i.e. volcanic activity in the NE corner of Ireland which formed the Giant's Causeway. Very fluid molten rock was ejected through fissures in the overlying chalk bed forming an extensive lava plateau – the Antrim Derry Plateau.

By 25 million years ago Ireland was close to assuming its present location. The intervening period of erosion resulted in soil formation and most of the rocks were covered in soil. Brown earth soils started to form in areas covered with deciduous forests with good drainage while in poorly drained areas gleys and podzols were formed. By about 3 million years ago the present-day landscape of Ireland had more or less formed.

My answer proves that continental drift/plate tectonics has affected Ireland. Over millions of years Ireland, once in two parts, has moved from south of the equator to its present location, 53°N. Our climate is no longer tropical, but instead is a Cool Temperate Oceanic climate.

Also, we are no longer close to a plate boundary so volcanic activity and plate movement do not affect Ireland anymore. There is evidence of an extinct volcano at Slemish, Co. Armagh and a fault line in Leannan Co. Donegal. The most recent earthquakes in Ireland proved that earthquakes continue to occur in the interior of plates.

Humans interact with the rock cycle in many ways. This answer will discuss human interaction with rocks as a source of **geothermal energy** in Iceland.

Geothermal energy uses heat from igneous rocks to heat water, produce steam and generate electricity. This occurs mainly in Iceland due to the high level of volcanic activity in this region as the country lies on a constructive plate boundary. Magma rising from the mantle heats the ground to over 200 °C just 1 km below the surface.

To use the geothermal energy, the rocks must be drilled to capture the hot water. Wells are drilled into the rock, and boiling water is collected through large pipes that are placed almost 200 km down into the mantle. The water is superheated but remains liquid due to the great pressure being exerted on it from rocks above. If there is a shortage of groundwater, large pipes of cold water at 10 °C are pumped into the rock via another series of wells. When the superheated water reaches the surface, it decompresses and turns into steam. The steam is then used to drive turbines and generate electricity. The production of geothermal energy has many economic advantages for Iceland. Geothermal energy is responsible for the production of 26% of the electricity produced in Iceland. Geothermal energy provides 89% of the electricity used in homes/industry in the capital city of Iceland.

One of Iceland's most important usages of geothermal energy is for heating greenhouses. For years, the naturally warm soil has been used for growing potatoes and other vegetables. Horticulture has benefitted considerably from geothermal resources, as the heating of greenhouses has increased production and lengthened the growing season.

Geothermal energy has also helped increase the level of tourism in Iceland. Many tourists come to the mineral rich 'blue lagoon' spa complex to relax in the outdoor heated pools. Tourists also visit the many geysers and geothermal springs, which also help attract tourists. Tourism has contributed millions of euro to the country's economy in terms of tax revenue.

Geothermal energy has helped Iceland to reduce the need to purchase oil and has lessened imports, thus improving the country's balance of trade.

An interaction with the rock cycle that I will discuss is the development of geothermal energy in Iceland.

Rocks are constantly being formed and destroyed as part of the rock cycle. The rock cycle summarises the major factors affecting rocks both on the surface and below the crust. It was proposed by James Hutton in the 18th Century that the upper part of the earth was a recycling machine. The cycle comprises 3 stages i.e., creation, modification and destruction.

Geothermal energy has been used for thousands of years for cooking and heating. It is power derived from the earth's internal heat. Geothermal energy is a renewable source of energy. Iceland derives over 30% of its energy requirements from geothermal energy. Iceland has been using geothermal energy since 1929. Five major geothermal plants along with smaller plants account for 30% of Iceland's energy requirements.

Iceland is ideally located to produce geothermal energy. It is located on the Mid-Atlantic ridge. The Mid Atlantic ridge was formed due to the divergence of the North American plate and the Eurasian plate. These two plates are separating at the rate of 2cms per year. This divergence allows magma to reach the surface forming hot igneous rock, mainly basalt, used to produce geothermal energy.

Less than 1km below the surface water, having seeped into the bedrock below, comes into contact with hot igneous rock. Meltwater from Icelandic glaciers guarantees a constant supply of groundwater. The water boils, often reaching temperatures more than 380°C. This surface water then makes its way towards the surface forming hot springs and geysers.

The igneous rocks are drilled to extract the hot water. On reaching the surface the water decompresses and cools turning into steam. The steam is used to turn turbines to produce energy in power stations. If, on rare occasions, there is a shortage of water, water is pumped into the ground where it is heated.

Any surplus hot water is pumped to nearby urban areas where it is used to provide central heating in people's homes. 95% of all homes in Iceland use geothermal energy. In Reykjavik and Akureyri car parks and pavements remain ice free in the winter due to underground heating systems. Both cities enjoy very clean environments because geothermal energy produces very low levels of CO₂.

Cooler water is pumped to greenhouses to help in the production of fruit and vegetables and other horticultural products. Geothermal energy has enabled Icelandic farmers not only to increase output but also to enjoy a longer growing season.

Cheap and environmentally friendly geothermal energy has attracted energy intensive metal smelting industries such as the American MNC Century Aluminium. Aluminium smelting accounts for one-seventh of Icelandic GDP.

Geothermal energy is important to the tourist industry. The Blue Lagoon in Reykjavik, an outdoor swimming pool/spa attracts hundreds of thousands of tourists annually. The spa is an artificial lagoon fed by surplus water from an adjacent geothermal power station. The water in the lagoon contains medical properties which can cure arthritis and some skin diseases. The hot springs and geysers are also major tourist attractions generating huge income for the Icelandic economy.

The Icelandic government have plans to lay over 1300kms of submarine electricity cables from Iceland to Scotland. By 2030 the Icelandic Deep Drilling Project aims to have 50% of all electricity generated by geothermal sources.

Geothermal energy, unlike other renewable sources, is available 365 days a year. It's also relatively inexpensive; savings from direct use can be as much as 80 percent over fossil fuels. Geothermal energy is easy on the local environment because the power plants do not require the clearing of large areas of land, damming of rivers or mining like other energy sources.

Once a geothermal system is installed, the source of energy is free to use and because the plants use very few moving parts, there are generally low maintenance costs involved. It also reduces Iceland's dependence on imported oil improving the country's balance of payments.

Geothermal has some environmental problems. The main concern is the release of hydrogen sulfide, a gas that smells like rotten egg at low concentrations. Another concern is the disposal of some geothermal fluids, which may contain low levels of toxic materials. Although geothermal sites can provide heat for many decades, eventually specific locations may cool down.

(i) A — Floodplain
B — Meander

(ii) C — Incised meanders
D — Paired terraces

(iii) Two coastal landforms that form because of an adjustment to base level are raised cliffs and raised beaches.

(iv) One cause of river rejuvenation is isostatic rebound. When the last ice age finished about 10,000 years ago, a huge weight was lifted off the Europe continent. This caused the earth's crust to rise upwards and sea levels to fall. When land rises out of the sea because of a great weight being lifted from the land, the river will flow down a steeper slope, which gives it extra energy i.e., the river increases its ability to erode. The river has been rejuvenated.

(v) A peneplain is a low relief plain (land has been eroded to base level) that was formed by fluvial erosion. A peneplain (an almost plain) is a low relief plain formed as a result of river erosion. Over time the processes of river erosion reduce the land to base level which is sea level. At sea level there is no more land for the river to erode.

In my answer I will discuss the formation of a waterfall, often called a cascade. A waterfall is a vertical or a near vertical fall of water on the bed of a river. A waterfall/cascade occurs in the youthful stage of a river where there is a vertical drop in the river's course. Waterfalls are formed by the processes of river erosion.

Assleagh Falls near Killary Harbour in Co Mayo and Pollaphuca Falls on the Liffey are Irish examples of waterfalls. Victoria Falls, Zimbabwe is an international example. The highest waterfall in the world is Angel Falls in Venezuela at a height of over 3000 feet.

Waterfalls/cascades form because of gravity, vertical erosion, namely hydraulic action, abrasion, attrition, and solution in the upper course of a river. They can also be found in the river's lower course where rejuvenation creates potential energy for vertical erosion to recommence closer to the mouth of a river.

The rate of erosion is determined by the type of rock the river flows over, the discharge of the river and the height of the vertical drop.

Waterfalls form when a layer of hard rock e.g., granite, lies across a band of soft rock e.g., limestone, on the riverbed. Gravity gives water the power and speed as it forces the river to flow down the mountain. The process of hydraulic action which is the power of the moving water erodes the softer rock faster than the harder rock. This is termed differential erosion.

When the water approaches the fall, it increases in speed because the water in front of it is free falling, making hydraulic action more effective. Hydraulic action is the process whereby the weight and speed of the river opens cracks and loosens rocks from the sides and bed of the valley. The underlying rock is worn away as the water drops onto it.

Over time, the hard rock is undercut, becomes unstable and collapses, forming an overhang. The rock that has collapsed to the bottom of the fall is swirled around in an eddying action and uses abrasion to widen and deepen the foot of the waterfall. Abrasion is the wearing away of the bed and sides by the scouring action of the load i.e., material carried by the river.

The force of falling water increases the size and depth of the hollow at the bottom of the fall. Also, the falling water is unhindered by friction and therefore its velocity and hence the power to erode are increased. This carves out a deep hollow called a plunge pool. The plunge pool continues to be deepened by the process of hydraulic action and abrasion.

The falling water splashes against the back of the waterfall dissolving some of it by solution. The splash back creates a cave behind the waterfall, leaving an overhang of hard rock above it. This hard rock is termed the cap rock. As the underlying rock erodes, the overhang collapses.

This process of undercutting and collapse are repeated many times, causing the waterfall to retreat upstream in a process called headward erosion, leaving a steep sided gorge downstream from the waterfall.

Sometimes waterfalls can form because of glaciation. Glaciers move down pre-existing valleys eroding them and making them much deeper and wider. As a result, smaller valleys flowing into the main glacier valley are left hanging above the main valley. Rivers from these valleys enter the main valley creating a waterfall. Pollanass, Co. Wicklow is an example of a hanging valley waterfall.

Waterfalls can also form where a river enters the sea over a cliff. Waterfalls, called knickpoints, are also formed by the process of river rejuvenation. Knickpoints mark the point where the river used to enter the sea before rejuvenation.

Waterfalls are temporary features and eventually they become rapids and disappear from the landscape. For example, the Niagara Falls retreats by 1 meter per year.

Metamorphic rocks were once igneous or sedimentary rocks which were changed both physically and chemically by great heat or pressure. There are 3 types of metamorphism, thermal metamorphism, regional metamorphism, and dynamic metamorphism.

Thermal Metamorphism occurs when the change in rock type is due to intense heat due to volcanic activity. Marble is formed due to the thermal metamorphism of limestone at convergent plate boundaries.

When the plates collide, limestone is subducted and on entering the mantle it melts forming magma. Its well stratified structure and marine fossils are both destroyed. It now becomes a non-foliated rock. Most of Ireland's metamorphic rocks were formed in this way 450 million years ago during the Caledonian fold mountain building period when the North American and European plates collided.

Due to the high temperatures and pressure the limestone minerals are compressed until all the space between the crystal grains is squeezed out, forming large crystals. The magma then rises cooling the surrounding limestone changing it into a hard, smooth rock, marble. During this process calcite minerals in limestone are re-crystallised creating a denser rock comprising interlocking calcite crystals.

Often the limestone contains impurities and so marble comes in different colours – the presence of serpentine (copper ore) results in the green marble of Connemara while the presence of iron oxides results in a red or pink marble. The presence of carbon results in a black marble as in Co. Kilkenny. Pure white marble is quarried at Carrara in Tuscany, Italy. White marble is also found in Rathlin Island, Co. Antrim.

Marble is a highly valued rock with a smooth texture, ideal for building (pillars and floor tiles) and sculpture (statues and headstones) but it may be damaged by acid rain. The Taj Mahal in India was built of white marble. It is used in warm countries as it can reflect light cooling the interior of buildings.

Regional Metamorphism occurs when the change in rock type is due to pressure due to folding over a large area or region. Regional metamorphism formed the majority of Ireland's 450m years ago when the North American and Eurasian plates converged during the Caledonian fold mountain building period.

Gneiss a common metamorphic rock was formed by regional metamorphic processes more than 20kms below the surface, from pre-existing formations that were either igneous (granite) or sedimentary rock (shale).

For metamorphism to occur, temperatures of 650° C are required. It can also form through metamorphism of schist. Gneiss forms part of the earth's lower crust. It is a tough hard rock comprising feldspar, quartz and mica and is found in Belmullet, Co. Mayo. It is used in flooring, ornamental stones, gravestones, buildings and work surfaces.

Dynamic Metamorphism occurs when pieces of crust slip past each other in opposite directions or when plates collide. Slate forms due to the dynamic metamorphism of shale. It is black in colour due to carbon in organic matter present in sediments.

At converging plate boundaries shale is put under immense pressure. This pressure compresses the shale into different layers or strata, forming slate. Temperatures of 300° C are required for metamorphism to occur.

Slate is waterproof and it splits easily into thin sheets making it ideal for roofing but trade in slate has declined due to the greater use of tiles. Slate is found in Valentia, Co. Kerry and Kilaloe, Co. Clare. It is also used in blackboards and billiard tables.

(i) **A:** North American Plate
B: Eurasian Plate

(ii) **C:** Iceland

(iii) **Age range at D:** 23-66 million years old
Age range at E: 145-180 million years old

(iv) **Basalt** is the most commonly formed igneous rock along mid-ocean ridges.

(v) The ocean crust at E is older than the ocean crust at D as new crust is being formed at D because of the process of sea floor spreading introduced by Harry H. Hess in 1960. The North American & Eurasian Plates are diverging due to convection currents in the mantle. As the plates diverge, basaltic magma rises from the mantle to fill this gap. The cooling and hardening of the magma over time form a new ocean floor crust at D. As more new oceanic crust continues to be formed at D, the older oceanic floor crust at E is pushed away from the plate boundary.

(vi) The *Moho line* also known as the *Mohorovicic* discontinuity marks the transition between the upper mantle and the Earth's crust.

Weathering is the breaking down or wearing away of landforms on the spot (in situ). Weathering does not involve the removal of the material that results.

There are three types of weathering:

- a) Mechanical or Physical Weathering
- b) Chemical and
- c) Biological.

In my answer I will discuss three types of mechanical weathering, namely freeze thaw, exfoliation and salt crystallisation. Mechanical Weathering or physical weathering refers to the physical disintegration of rocks brought about by sun and frost. It causes rocks to crumble. It does not alter the chemical composition of rocks. These 3 types of physical weathering occur because of a temperature change. Another type of mechanical weathering is pressure release.

Mechanical weathering occurs in areas that have little or no vegetation cover such as deserts and mountains and in areas of extreme climate. Mechanical weathering is very prevalent in sedimentary rocks which possess joints, strata and bedding planes.

Freeze – thaw Action/Frost Wedging

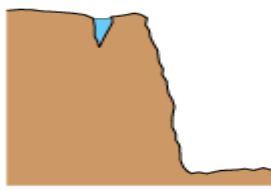
Freeze-thaw action often called frost shattering or frost wedging occurs in mountainous areas where the temperature fluctuates above and below freezing. It is the most common type of mechanical weathering.

Rain enters cracks (fissures/joints) in rocks. When this rainwater freezes due to temperatures falling below freezing, its volume expands by 10% and the cracks are widened. The ice operates as a wedge widening the cracks and splitting the rock. When temperatures rise the following day the water thaws and flows deeper into the cracks and joints of the rock.

Rain falls again and this process of freeze thaw action continues until the rock is completely broken-down producing rock fragments, which can be seen on mountain sides. These rock fragments are termed regolith.

These rock fragments move downslope due to gravity. This process is termed mass movement. These rock fragments are called talus or scree. Scree particles are often angular indicating that they formed due to sudden splitting. Scree accumulations can be seen on Croagh Patrick, Co. Mayo and on The Great Sugarloaf, Co. Wicklow.

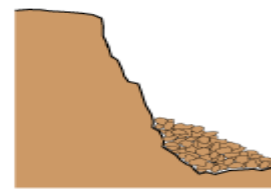
Freeze - thaw also occurs in the Burren. Many of the cliffs and terraces in the Burren have boulders at their bases formed due to the temperature fluctuating in and around freezing.



Rainwater collects in a crack.



The temperature falls below 0°C. The water freezes and expands, making the crack bigger



Eventually after repeated freezing and thawing, the rock breaks off.

Freeze thaw action.

Exfoliation/Onion Weathering

Exfoliation is due to temperature changes. In cloudless regions such as deserts, for example the Sahara or Death Valley where the daily range of temperature is great, rocks expand during the day and contract at night due to the absence of cloud cover when temperatures fall (0°C to 50°C). The process is accelerated if the rocks are well jointed and well stratified.

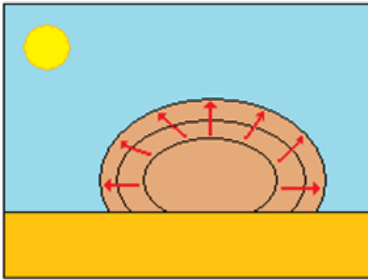
This expansion and contraction cause the rock to weaken leading to its eventual destruction. If the rock breaks down into large rectangular pieces, it is termed block disintegration e.g. Monument Valley Arizona.

Heating and cooling do not occur equally. The outer layer or skin of rock absorbs more heat than the inner layer. Dark coloured rocks absorb more heat than light coloured rocks. Some minerals heat faster than others, for example, quartz expands three times as much as feldspar.

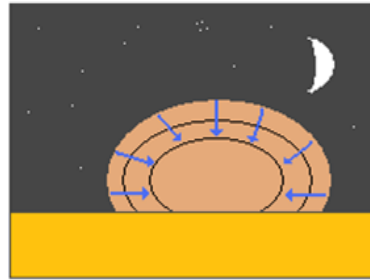
The outer layer will expand more than the inner one, causing it to peel off. This process is called exfoliation or onion weathering. It is very common in the Atacama Desert in Chile.

Exfoliation requires the presence of moisture. Moisture manifests itself in the form of heavy dews (the rapid loss of temperature at night produces dews), showers or capillary action – the process by which water is drawn up from the bedrock pores due to high temperatures. Isolated masses of rock, e.g., the Devil's Marbles, in Central Australia, or the Half Dome in Yosemite National Park may be rounded off to form an exfoliation dome.

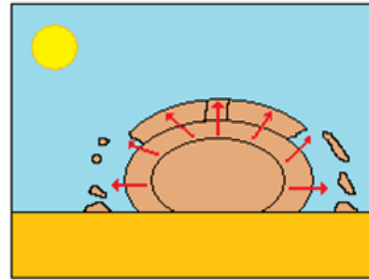
In deserts such as the Sahara there is a great diurnal (daily) range of temperature from 35 degrees C during the day to about 10 degrees C at night. This is a range of 25 degrees C.



During the day the sun heats up the surface layers of the rock and they expand which forces them outwards.



At night the rock cools down and the surface layers contract and are pulled inwards.



After many daily cycles of expansion and contraction the surface layer eventually breaks up and thin layers of rock 'peel off'.

Salt Crystallisation

This process is associated with hot arid climates and salt solutions such as a Mediterranean Climate where evaporation rates are high. Water containing salt enters cracks and joints in the rock.

Overtime, the water evaporates leaving salt deposits behind. When salt is heated it expands exerting huge pressure on the rock causing the rock to disintegrate. The process can produce honeycombs on sea walls composed of sandstone, granite, and limestone. Salt crystallisation occurs in Corsica, France.

In conclusion I have explained the role of temperature in the process of physical/mechanical weathering.

In this answer I will discuss how humans have impacted on river processes by the building of dams, namely the Three Gorges Dam on the Yangtze River in China.

Dams are walls built across rivers in their upper course regulating the flow of water by forcing the water to flow through tunnels in the dam wall. Dams interfere with a river's natural processes of erosion, transportation and deposition.

In China the Three Gorges Dam which was completed in 2011 at a cost of \$25b has interfered with the natural processes on the Yangtze River. It is located in the middle of the three gorges on the Yangtze River in the Hubei Province of China.

This dam was intended

- a) to end centuries of floods along the basin of the Yangtze which have claimed over 1m lives over the past 100 years. Construction of dam will reduce the frequency of flooding from once every ten years to once every onehundred years.
- b) to provide energy to fuel the country's economic boom, reducing the country's dependence on coal, reducing greenhouse gas emissions.
- c) to improve navigation along the Yangtze.
- d) to provide irrigation waters to drought affected areas.

It was designed to supply 10% of China's electricity needs but will only supply 3% of the country's energy requirements when completed because of China's increasing demand for energy. The project also aims to alleviate poverty in China by attracting investment to soak up surplus agricultural labour.

While the dam has prevented the river from flooding by reducing the flow of water, it has interfered with the process of deposition along the Yangtze. Alluvium that should have been deposited further downstream is now being deposited in the 600km long artificial reservoir that was built behind the dam.

As the fertile alluvium it trapped behind the dam and deposited in the reservoir, it interferes with the natural process of transportation along the Yangtze, (traction, suspension, saltation, and solution). There is now less material to be transported. The dam interferes with the flow of the river. It changes the size of the sediment transported downstream. The reservoir is also silting up requiring regular and expensive dredging.

While flooding of farmland may have been reduced farmland is now deprived of fertile alluvium that would have been transported by the river and deposited during times of flooding. Farmers now must use artificial fertilizers to fertilise farmland along the banks of the Yangtze that used to have a rich supply of fertile alluvium.

Building the dam also interferes with the natural processes of erosion (HAAS) along the Yangtze as downstream from the river vertical erosion increases, negatively affecting the Yangtze delta system. The sediment transported by the river is reduced as most is now trapped behind the dam which combined with greater speeds increases the river's ability to erode.

Erosion of the reservoir and erosion of downstream riverbanks is causing landslides along the banks of the Yangtze and threatening one of the world's biggest fisheries in the East China Sea. Annual catches may be reduced by one million tons due to the decline in freshwater and sediment reaching the sea. This may lead to food shortages, unemployment, and poverty.

Marine life, such as fish and the Yangtze River dolphin, in the delta is also under threat. The sea water in the delta is more saline as there is a smaller volume of fresh water in the delta. The future of the Siberian Crane is threatened. Its winter wetland has been destroyed by the Three Gorges Dam.

The dam has set records for the number of people forced to leave their homes. 1.4 million people have been displaced by the project. Thirteen cities have been flooded along with 140 towns and over 1300 villages.





On the positive side farmers no longer suffer from flooding in winter. Water is now stored in the reservoir behind the dam which can be used for irrigation purposes during the summer. Air quality has also improved because the consumption of coal has fallen by one-third since the completion of the project reducing CO₂ emissions into the atmosphere.

Sketch Map of Ireland showing
Western Region



NOT TO scale

key

-  The outline of the Western Region
-  The outline of the Partry Mountains
-  Galway city
-  The River Moy

The development of the transport infrastructure in the **Paris Basin** has greatly aided the development of economic activities in this region. The Paris Basin has one of the most advanced transport networks in Europe. The development of its transport network has been helped by the flat, low-lying or gently undulating landscape as well as the river Seine and its tributaries. The transport infrastructure has greatly aided the development of a successful agricultural sector in the region. The Paris basin is known as the 'granary of France' as 60% of French cereal production occurs there. The Paris basin produces 54 million tonnes of cereal each year. In Beauce, intensive cultivation of cereals, wheat and barley occurs.

Dairying is very important in Brie, producing milk and dairy produce for the urban population of Paris and other markets. The transport infrastructure allows for fast, efficient transport of perishable agricultural produce such as milk, fresh fruits and vegetables and non-perishable agricultural produce such as cereals to other areas in France and Europe. The well-developed transport infrastructure also allows for the efficient movement of raw materials to manufacturing plants, leading to a highly developed food processing sector in the region.

The transport network radiates out from Paris. The Paris Basin boasts one of the best rail networks in the world. Paris is the centre of a high-speed rail network — the TGV connects the city to Lyon, Marseilles, Strasbourg, Lille and London via the Channel Tunnel. Travelling at speeds of over 250 km/h, the trains from Paris can reach Marseille in under three and a half hours. Within Paris three million commuters travel to the city daily using both the Metro and the SNCF. The Eurostar connects the Paris Basin to Britain, which means that industry does not need to rely solely on air and sea transport to export goods. Two motorways travel in a ring road around the city, e.g., the Boulevard Périphérique. Although Paris is 160 km from the sea, the river Seine is navigable. Ports have developed at Le Harve, Paris and Rouen, which facilitates the direct importation of bulky raw materials to the industrial heartland of Paris, which runs parallel to the river Seine. Industrial products include locomotive and rolling stock manufacture. The deep-water port at Le Havre provides links with markets in Britain and the United States.

Factories in Paris produce a wide variety of products. Paris is known for luxury products such as jewellery (Cartier) and perfume. Some of the most famous fashion houses in the world are also located in Paris. Heavy steel manufacturing is located further out from the city along the river Seine close to St Denis. Car makers such as Renault and Citroen have large assembly plants in the city and its suburbs. France is a popular tourist destination. This industry is aided by the presence of three airports, Charles De Gaulle, Beauvais and Orly. This has aided the development of a thriving tourist industry with approximately 11% of the population now employed in this sector.

In contrast the development of transport infrastructure in the Mezzogiorno has hindered the development of economic activities in this region. Physical factors have hindered the development of transport in the Mezzogiorno region. Transport in the Mezzogiorno has been underdeveloped due to the mountainous relief and the long distances between the urban centres. Up until the 1950s, the upland relief of the Apennines meant that large areas of the Mezzogiorno were inaccessible, because of a poorly developed road network and this prevented farmers from accessing the lowland urban markets. Perishable crops such as vegetables needed to be delivered quickly to urban markets. Government investment in transport infrastructure meant that local roads were improved to help this process.

New autostrade such as the Autostrada del Sole were built to help connect Southern Italy with major markets in Northern Italy, Germany and beyond. Despite government and EU investment in the region, agriculture remains generally unproductive and subsistent in nature. This important road link between the North and South of Italy reduced transport costs and helped encourage industry to locate in the Mezzogiorno. It helped the development of the food processing industry, which depended on getting fresh food to the factories in a short time. Most industrial development has occurred in coastal areas, where the more well-developed road network allows for more efficient transport of goods to markets.

Deep water ports were constructed at Taranto and Siracusa. These attracted the steel and oil refining industries to the region and encouraged further development. Government investment also saw a new airport being developed at Calabria, which has further helped economic development in the region. As a result of both government policy and investment in transport infrastructure, secondary economic activity has improved considerably since the 1960s.

The Mezzogiorno now employs more than 1.4 million people in manufacturing. However, the region continues to be economically disadvantaged compared to the North of Italy. Large state-owned factories, such as the steelworks at Taranto, provided up to 75% of new industrial jobs. However, such big plants are capital intensive rather than labour intensive. This means that the cost of building them is great in comparison with the number of jobs that they provide. They have also been described as 'cathedrals in the sun' because they stimulate little or no spin-off industries. Almost 75% of all new jobs have been in heavy industries such as steel, chemicals and engineering. Because the heavy industries are located along the coast, the inland rural areas have remained depressed. Between 2007 and 2013 €10 billion was spent on developing transport and communication links in the region. Like many other peripheral areas, the Mezzogiorno is also dependent on tourism as a source of revenue; however, its peripheral location has hindered the development of this industry.

Airlines such as Ryanair now fly into Calabria airport, making the region accessible to tourists from other areas in Europe. However, most tourists visit coastal regions with many inland areas remaining inaccessible.

Regions where people share the same language can be defined as cultural regions.

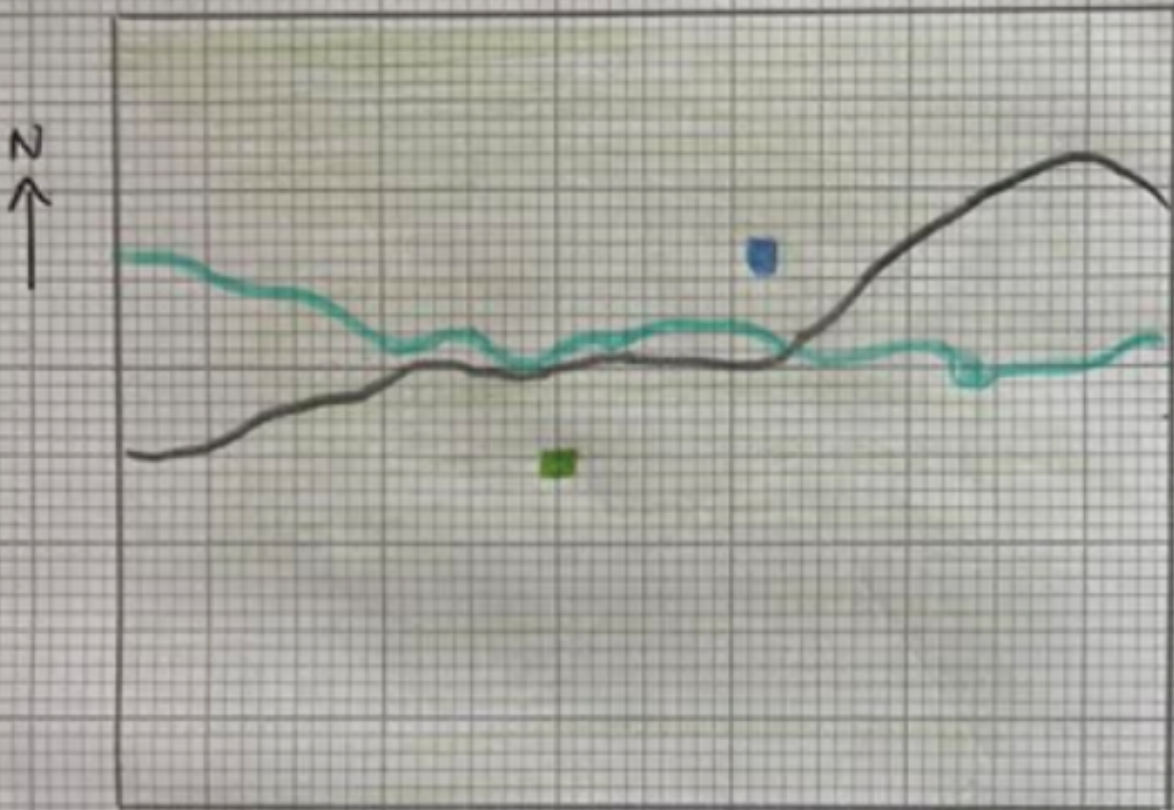
Language is an important cultural factor in defining regions in Ireland. Language plays a major part in defining cultural identity. The Gaeltacht region of Ireland is a unique culture based on language. Gaeltacht regions are areas in Ireland where over 80% of the local population speak Irish as their first language. The Gaeltacht is composed of scattered communities mainly in the West of Ireland. It includes parts of counties Donegal, Mayo, Galway, Kerry, Cork, Waterford and Meath. An example is An Rinn in Co. Waterford. The Gaeltacht regions of Ireland are separated from each other by large English-speaking communities.

The decline of the Gaeltacht regions can be attributed to emigration, which occurred from the West of Ireland since the famine of 1840 and because English was the language of rule until 1921. Outward migration has continued since then because of several factors such as the remoteness of the areas and a lack of funding in these areas. Because the Gaeltacht is a region of distinct Irish culture and tradition, it has received Government funding to try to encourage development and limit de-population. There are strict planning laws in the Gaeltacht areas to try to prevent further decline of the language. Only native speakers or those with a reasonable fluency in Irish can apply to build in these areas.

Language is also an important cultural factor in defining regions in Belgium. A linguistic divide exists in Belgium, which causes great tension between people from each language group. The division of the population by language has led to political, social and economic division of the country. Belgium was established in 1830 when it split from the Netherlands. Prior to the 1830s Belgium was part of the United Kingdom of the Netherlands. The Dutch king favoured the Dutch speakers of the Netherlands. There have been political tensions between the Walloons and Flemings for two hundred years. Wallonia is in south-east Belgium. People from Wallonia are known as Walloons and people in this region speak French. When the French Revolution occurred, the Walloons sought independence from the Netherlands, but they brought Flanders with them. Flanders is in the north of Belgium. People speak Flemish in this region. People from Flanders are known as Flemings. In the eighteenth and nineteenth century Wallonia was the focus of industrial revolution. The presence of coal and iron ore led to the development of heavy industries such as iron and steelmaking. As a result, Wallonia held the balance of power in the country. French was the official language of schools and government. French domination of the economic and industrial life in Belgium between 1830 and 1840 led to increasing resentment amongst the Flemish against the Walloons. The people of Wallonia looked upon themselves as being socially superior to the people in Flanders.





However, from the 1950s Wallonia went into industrial decline. The mines have closed, and traditional industry has collapsed. Unemployment and out-migration are both high and the region now contains only one third of Belgium's population. Modern industries developed on the cheaper land in Flanders. By the 1960s Flanders was emerging as a wealthy industrial area. Flanders has become an important centre of modern manufacturing industry such as oil refining, chemicals and electronics. Flemings now make up about 58% of Belgium's population. The people of Flanders started to assert their cultural identity. By the 1960s, they defeated government plans to make French the official language of Belgium. Both French and Flemish achieved equal status. A language line was established in 1917, which led to the formation of the two government administrative areas — Wallonia and Flanders — separating the regions that speak French from the regions that speak Flemish. The cultural division of Belgium due to language has many effects on the daily life of the population. Both sides of the language divide rarely visit each other's region. They choose shops, schools and partners based on language. Schools, political parties and culture are all segregated along linguistic lines.

sketch Map of O.S. Map of Clonmel



Scale 1: 100,000

key

-  The entire route of the N24
-  The entire route of the railway line
-  A post office
-  A car park

This answer will describe and explain the sourcing of raw materials and components, and the location of processing units of the American multinational corporation, Dell.

A multinational corporation is a corporation that owns and controls production of goods and services outside its country of origin. Dell is one of the world's most successful manufacturers of computer products, employing more than 100,000 people globally. In 2002 Dell also began to produce other products such as televisions, handheld devices and printers. In 2016 Dell purchased EMC and formed what is now Dell Technologies, which was one of the largest technology mergers in history. Dell delivers computers made to customers' own specifications all over the world. Dell sells its products to consumers through telephone and online sales.

As a multinational company, Dell sources its raw materials from all over the world. Dell manufactures hardware products in which minerals such as gold, tin and tungsten are necessary. These minerals are sourced worldwide; however, since 2017 Dell has insured that all suppliers used conform to the Responsible Minerals Assurance Process (RMAP). In 2018, Dell published a smelter list. Gold is sourced from over 100 suppliers all over the world such as USA, Brazil, Germany, Italy, Japan and China. Similarly, other minerals required in the production process are sourced from global suppliers.

Logistic supplier centres are located close to each Dell factory in the world and these suppliers supply specific parts on a daily basis for custom made computers. This means that Dell only buys raw materials and components once the order is confirmed by the customer. Dell has a policy of manufacturing its products close to its customers.

Dell has located its processing units in three main regions of the world. The first region is the Americas. Dell's world headquarters are in the United States in Round Rock, Texas. This is where the company originated when it was founded by Michael Dell. In 2010, approximately 16,000 people were employed in Dell's headquarters. Dell originally had four processing plants in the United States and Brazil and had regional offices in ten countries. Most of the work that used to take place in Dell's plants in the United States has now been transferred overseas to Mexico and Asia.

The second global region is Europe, The Middle East and Africa. Its regional headquarters are in the United Kingdom. Dell began to expand production globally in 1998 when it moved to Ireland. Dell assembled products for the European, Middle Eastern and African market at its manufacturing plant in Limerick and employed over 4,500 workers. In 2007 Dell opened a new manufacturing plant in Łódź, Poland and in 2009 Dell announced that it would move all manufacturing from its plant in Limerick to Poland in order to be close to its Central and European customers. As a result, jobs were lost at its Limerick operations. Dell is a footloose industry and moves their production to take advantage of grants and low corporation tax. Dell has regional offices in 30 countries in this region.

The third global region is Asia Pacific and Japan. In this region its headquarters are in Singapore. Dell operates manufacturing plants in Malaysia and China to serve the Asian market. Approximately 95% of Dell notebooks are manufactured in these plants. Dell has also invested in a manufacturing plant in Chennai, India to take advantage of the Indian market. Dell operates regional offices in ten countries.

Sustainable development aims to reduce the impact of economic activities on the environment so that resources will be available for future generations. To ensure sustainable development, environmental needs are taken into account when planning economic activities. In Ireland, the Environmental Protection Agency (EPA) was set up in 1993 to protect Ireland's environment and to monitor economic activities that might cause pollution.

The overuse of fossil fuels is economically unsustainable and causing great environmental damage. One of the most sustainable ways of controlling the environmental impact of economic activities is by using renewable energy. Burning fossil fuels such as coal, oil and natural gas are responsible for emissions of harmful gases such as carbon dioxide, nitrogen oxide and sulphur dioxide into the atmosphere, which contribute to global warming. Global temperatures are continuing to rise and scientists suggest that global warming has contributed to extreme weather patterns we are experiencing around the world.

Sustainable energy should be clean and renewable. The main environmental advantage of using renewable energy sources is that they do not pollute the atmosphere. Renewable energy sources include solar power, wind power, geothermal power and biomass. They are clean forms of energy and have no harmful emissions so therefore, do not contribute to greenhouse gas effects. Biofuels such as wood chips and bio-diesel do not release carbon dioxide. Biofuels are derived from biomass, which is dead organic material. Wind power is environmentally clean and renewable and does not use fossil fuels. By using renewable energy we also reduce water consumption, noise pollution and waste. Renewable energy resources do not cause acid rain, which is another environmental problem associated with fossil fuels.

The Paris Agreement was signed in 2015 and has been adopted by 195 countries. This agreement sets out a global action plan to help combat global warming. The Climate Action Bill was signed into law in Ireland in 2021. An important element of this bill is the legally binding carbon emissions reduction, which will see a reduction of 51% in carbon emissions in Ireland by 2030. Currently agriculture is responsible for 35% of emissions in Ireland. Over the next five years measures will be taken to reduce this. Farmers will adopt technologies which will reduce methane. This bill also has consequences for how we heat our homes and by the end of the next decade homes will have to move away from fossil fuels for home heating to more sustainable forms of energy. Environmentally sustainable development is important for the future of the planet and a reduction in the use of fossil fuels for economic activities could contribute to this sustainability.