A Geological Guide to St. Patrick's College, Maynooth

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MAYNOOTH COLLEGE
1795 – 1995

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Front cover: bust of St. Patrick sculpted from Carboniferous limestone showing numerous fossils in the base.
Back cover: close-up of base showing fossil shell and crinoidal fragments.

Introduction

Welcome to St. Patrick's College, Maynooth. This area of Co. Kildare is steeped in history. The College itself was built in 1795 while the Castle in front of the College was initiated in the late 12th century though the remains that can be seen today date from the early 15th century. However, St. Patrick's College can also tell a much older story, a story going back hundreds of millions of years. We encounter rocks and minerals every day of our lives but seldom do we give them a second thought. However, different rocks form under different circumstances and in particular environments which give us an insight into the conditions that existed in Ireland in the geological past. For example, rocks quite close to Maynooth show that at certain times in the past volcanoes were erupting, while at other times Maynooth was covered by glaciers or even submerged beneath the ocean!

This guide is divided into a number of sections. Initially there is a brief discussion about rocks and minerals in order that you may better understand some of the features that can be observed. Next a short section considers fossils because many are preserved in some of the rocks that you will be examining at the different stops. The guide concludes with a number of sections which are of general interest. One part looks at geological time while another section deals with some geological activities that can be employed with children. Some references are also included which you might wish to read if you have found your first adventure in geology interesting. So proceed to Stop 1 which is the gate lodge at the main entrance to the Old Campus (see enclosed map in the centre of the booklet for the location of the different stops) and as you walk around the College remember that you are also walking back through time, to a time before even the dinosaurs walked the Earth.

Rock Types

Rocks are formed of aggregates of particles or different minerals. Although there are hundreds of different rock types geologists conventionally categorize them into three different types which reflect their mode of origin. Igneous rocks form from a molten fluid called a magma. Most people have seen molten magma coming out of volcanoes on their television. As this magma cools, small crystals with different mineral compositions start to form and eventually form a rock composed of interlocking crystals. Basalt would be a typical rock that formed in this fashion. Not so well known is the fact that magma can also cool far beneath the earth's surface to form a different igneous rock such as granite. Granite differs from basalt in a number of ways. Firstly it is composed of different types of mineral and secondly it is a coarse-grained rock because the magma took a long time to cool down and consequently the crystals had time to grow large.

The second type of rock is known as a sedimentary rock. which can form in a number of different ways.When rocks are exposed at the surface they become weathered and the rock can slowly disintegrate. The fragments can then be transported by water and deposited in a river, delta, ocean, beach etc. The fragments become compacted as more material is brought down and cemented by fluids trickling through the sediments which bind them together again to form a sedimentary rock such as sandstone.

The last category comprises metamorphic rocks. These form from pre-existing rocks that have been subjected to high pressure, high temperature or both. These extreme conditions often cause the minerals in the initial rock to change into minerals that are more stable under the new pressure and temperature conditions.

Fossils

A fossil represents an object of biological origin which is preserved in rock. Fossils only occur in sedimentary rocks and to be preserved the object must have been covered by sediment quickly after it died. The fossils that occur in the rocks from which St. Patrick's College is made of represent sea creatures that lived millions of years ago. Often the actual creature has been dissolved away but its imprint has been preserved and turned to stone.

Stop 1- The Gate Lodge

The stone around the doorway of the gate lodge is formed of a pale-coloured, coarse-grained igneous rock called granite which probably came from a quarry in the Wicklow Mountains. Although granite can now be seen at the surface south of Dublin it did not form on the surface. It initially formed from a hot (600°C) magma many kilometres below the surface. That it now can be observed on the surface in the Wicklow Mountains is testament to the large thickness of rock which initially covered it and which has

now been eroded away. The granite is about 400 million years old.

The rock is formed of three major minerals, quartz, feldspar and mica. The most obvious mineral that can be observed is the mica which consists of small flat plates which glint and reflect the sun like miniature mirrors. There are different rocks that go under the general heading of granite. This is because the rock may have different proportions of minerals or even different types of feldspar. Later on you will see other rocks that are generally classified as granite but which look different to this one. Quartz, another very common mineral, is often colourless and is an extremely hard resistant mineral which can exist for hundreds of millions of years without being altered.

Stop 2 - Gateway

Proceed to your left, past St. Mary's Church on your left and stop at the first gateway and examine the grey rocks that form both the gateposts. This rock is totally unlike the granite you looked at earlier. It is a fine-grained sedimentary rock called a limestone. This is the most common rock in Ireland and occurs over 40% of the country. Most of St. Patrick's College is built from limestone. To build the church would have required thousands of tons of rock which would have proven too expensive to have been transported long distances. Consequently, a quarry was opened up in the College grounds in order to provide the necessary stone. The site of this old quarry is now occupied by the reservoir on the location map.

Turn around and look again at St. Mary's Church beside you. Can you guess what rock this is formed of? This too is limestone but it looks nothing like the pillars you are standing beside. This is because the stone in the church has been weathered over hundreds of years and invaded by lichen. Limestone is particularly susceptible to weathering. As rainwater fall it absorbs some sulphur dioxide and nitrogen dioxide gases from the air which makes the rainwater slightly acidic. This weak acid then dissolves the limestone. (A test for limestone is to put a drop of acid onto it. It will be seen to fizz as carbon dioxide is driven off).

The limestone formed in a shallow sea about 345 million years ago when much of Ireland south of Sligo was covered by an ocean. Limestones can form in a variety of ways and range in colour from very pale grey to virtually black. Generally the darker they are the more mud they contain. Limestones are composed of the mineral calcium carbonate and can be formed by chemical precipitation from sea-water or can occur as reef limestone similar to coral reefs found in the Bahamas today.

Stop 3 - Riverstown Lodge

Continue on the main road past the next gateway and Education hall to your left and take the narrow path to your left to the front facade of Riverstown Lodge.

The grey rock that forms the facade of this building is again limestone. Look at the blocks carefully and you can see thin bands of a very fine-grained, black, extremely hard rock. This is known as chert and is composed of the mineral silica. It is very similar to flint which was used by

prehistoric man for cutting purposes. Chert can form by the replacement of limestone and the source of the silica is often microscopic animals and plants.

Stop 4 - Boiler House

Continue in the same direction past the Book Shop and swimming pool, across the road and stop beside the large green door of the Boiler House. Look at the roof of the low building to your left. Here we are able to examine one of the commonest metamorphic rocks that we use - slate. Slate is a fine-grained metamorphic rock formed during burial (or dynamic) metamorphism. Slate initially started out as mud and clay deposited in a sedimentary environment such as an estuary which over a long period of time was compacted to form a sedimentary rock such as mudstone or shale. When this is subjected to very high pressures the rock can be folded and crumpled. Slate often contains the mineral mica which, as we saw for the granite, is a flat mineral like a small plate. As the slate is subjected to intense pressure these plate-like minerals become aligned producing a parallel structure along which the rock is easily split. This weakness in the rock is called cleavage and it is this property of the slate which allows it to be split into thin layers (along the cleavage planes) that have made them so useful for roofing tiles.

Stop 5 - The Junior Garden

Now proceed towards Loftus Hall, the building in front of you surrounded by railings. As you approach the railings you will see an archway with metal gates to your left. Go through the archway and take the second track on your right.

Stop 5 is at the fishpond in the junior garden. If you look around the edge of the pond you will see a large range of small boulders. Some of these you have already seen. There are numerous examples of granite and limestone. The most obvious boulders are pure white and extremely hard. They do not represent rocks but are formed of one single mineral - quartz. Quartz of this dimension often forms as veins in metamorphic or igneous rocks. For example, part of the magma may be silica-rich which, when it cools, can form thick quartz veins.

Stand at the edge of the pond facing the large building. Look carefully at the small rocks and you can see that some of them contain within them lumps of quartz and also pieces of other rocks. This is a sedimentary rock called conglomerate. Conglomerate can form in different environments, for example a beach or a floodplain of a river. The pieces of rock (called clasts) that it contains are quite large and rounded indicating that they have been transported under high energy conditions such as a fast flowing river. The clasts represent the eroded remains of other rocks. This broken-up material is compacted, the intergranular spaces infilled with smaller particles and cemented together to form the conglomerate.

Stop 6 - The Cemetery

Return to the archway through which you entered the garden and take the road through the gateway to your left alongside the orchard. Continue round to your right,

through another gateway, past the basketball posts and take the first path to the left and follow this to the cemetery which is again first left.

Enter the cemetery; turn to the left; proceed to the end of the path and examine the rocks that make up the headstone nearest to you. The coarse crystalline nature of the red polished rock is very evident. This is a form of granite, but it has a different mineral composition to that at stop 1. The most prominent minerals are large pink crystals of feldspar. Smaller clear crystals can also be observed which are quartz. The dark crystals are mica. However, whereas the mica at Stop 1 was pale (muscovite mica), the mica in this rock is black and is called biotite mica. Examine the granite carefully. Can you see anything that is obviously strange looking and appears to be out of place? Towards the back corner of the granite is an oval patch of dark rock (6 x 3cm). This feature is known as an xenolith which comes from the Greek and means "strange rock". In order to understand how it got to be in the granite we have to tell the story of a process known as granitisation, Figure 1.

As the magma from which the granite will be formed slowly rises towards the surface, pieces of the country rock into which the magma is intruded can be detached and engulfed by the magma. These pieces will be melted and their minerals assimilated into the granite. However, if the granite solidifies before all the rock pieces are melted some pieces are "frozen" into the granite where they remain as very distinctive blobs. Carefully examine the granite again and you can see another xenolith. This time the xenolith is pink and looks very like the granite. In this instance the granitisation process has progressed further. Other types of granite also occur in the cemetery, examine them and see if they are different from this one.

Now, go over to the large central cross and examine it closely. It is formed of grey limestone. However, start at the bottom and slowly examine it vertically. You will come to a layer where there is a concentration of white features, some up to 5cm long. This layer can be followed all around the cross. If you continue to look higher you will come to another concentration of white features. These are fossils and represent some of the creatures that lived in the ocean around 340 million years ago. Most of the creatures that can be seen are known as crinoids. When they lived they consisted of a stem on top of which there was a small cup with arms. The crinoid used these arms to collect food which passed nearby which was then transferred to its mouth in the centre of the cup. The fossil remains that you can see mainly represent the broken up stems of the crinoids after they died. The long parts represent a cross-section along the length of the stems (which allows you to see their internal structure) while the circular polo-mint shape is because you are looking at the bottom of the stem, Figure 2. Why do you think most of the crinoid fragments tend to be concentrated into layers? These layers probably represent storm deposits when the violent waves caused large numbers of the crinoids to be broken up and laid down on the seabed. These were then covered by carbonate particles which were deposited in much quieter conditions and have fewer fossils.

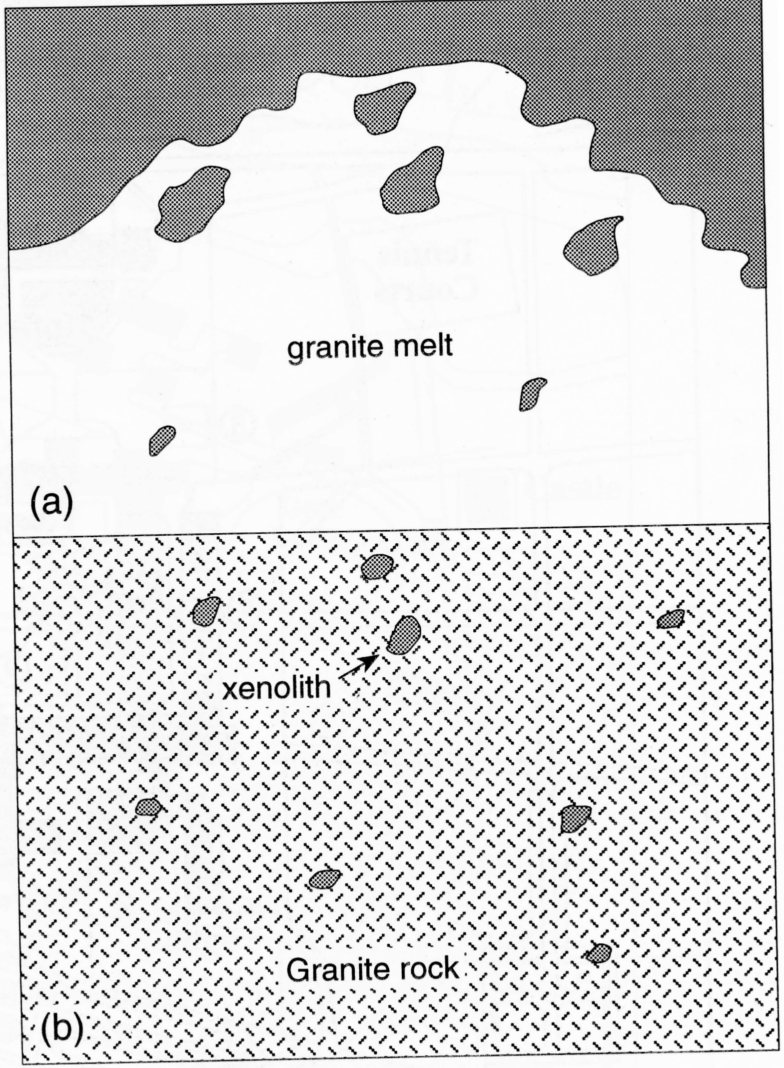
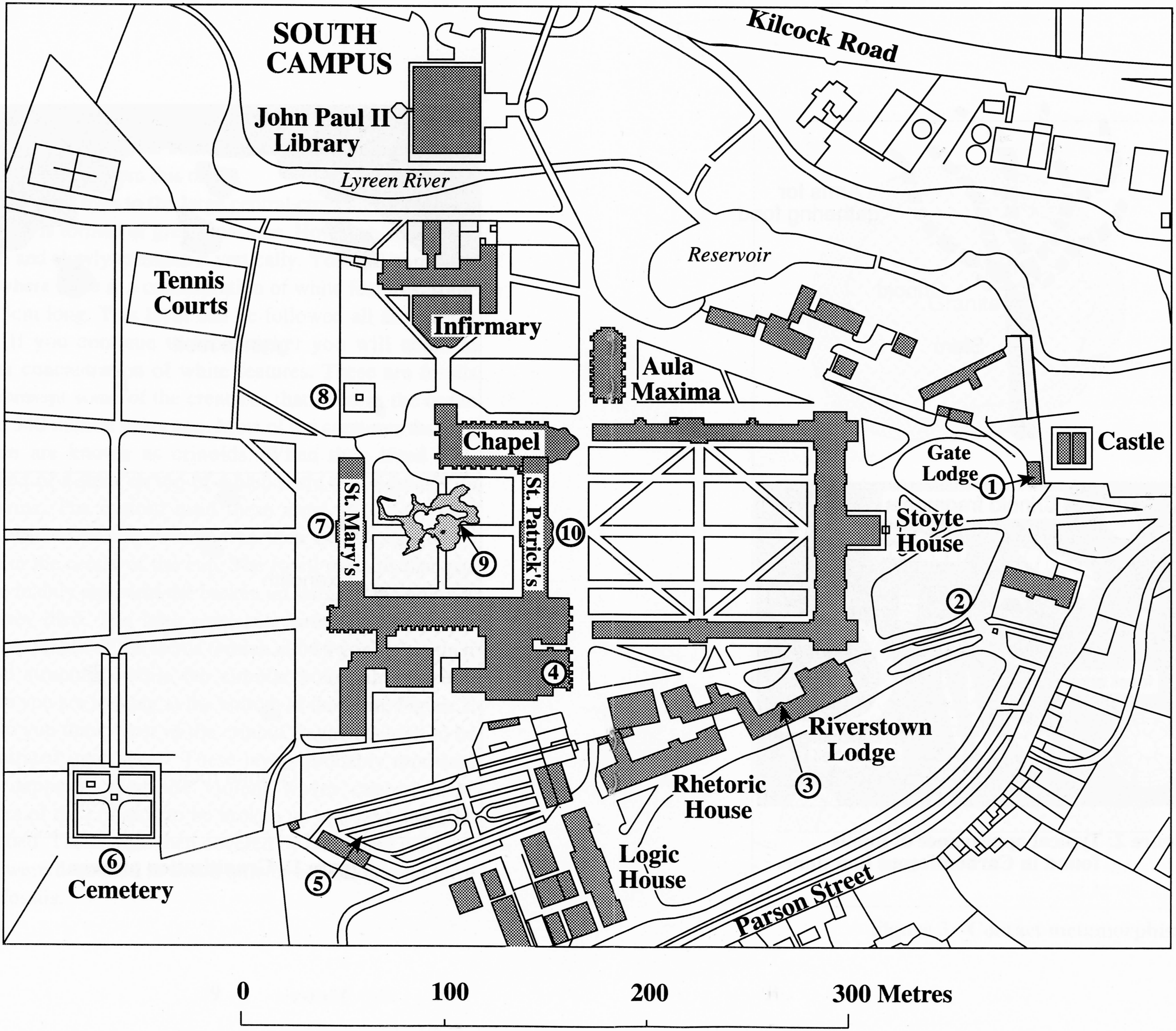


Figure 1: Granitisation process.


SOUTH CAMPUS
John Paul II Library
Lyreen River
Kilcock Road
Reservoir
Tennis Courts
Infirmary
Aula Maxima
Chapel
Castle
Gate Lodge
Stoyte House
St. Mary's
St. Patrick's
Riverstown Lodge
Rhetoric House
Logic House
Cemetery
Parson Street
1
2
3
4
5
6
7
8
9
10
0
100
200
300 Metres

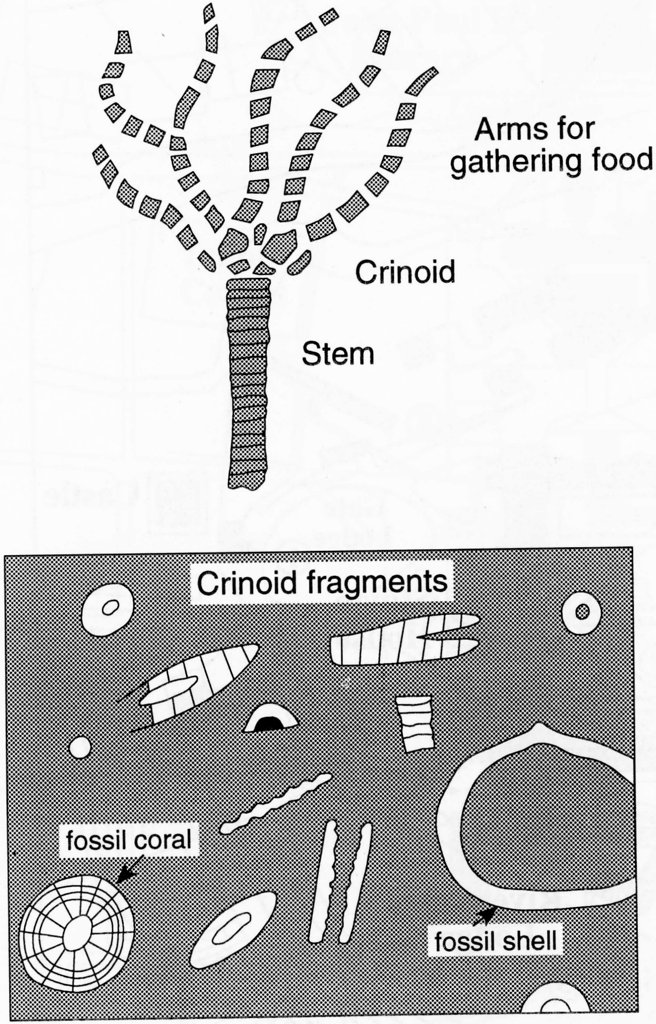


Figure 2: Typical appearance of fossils found in Carboniferous limestone.

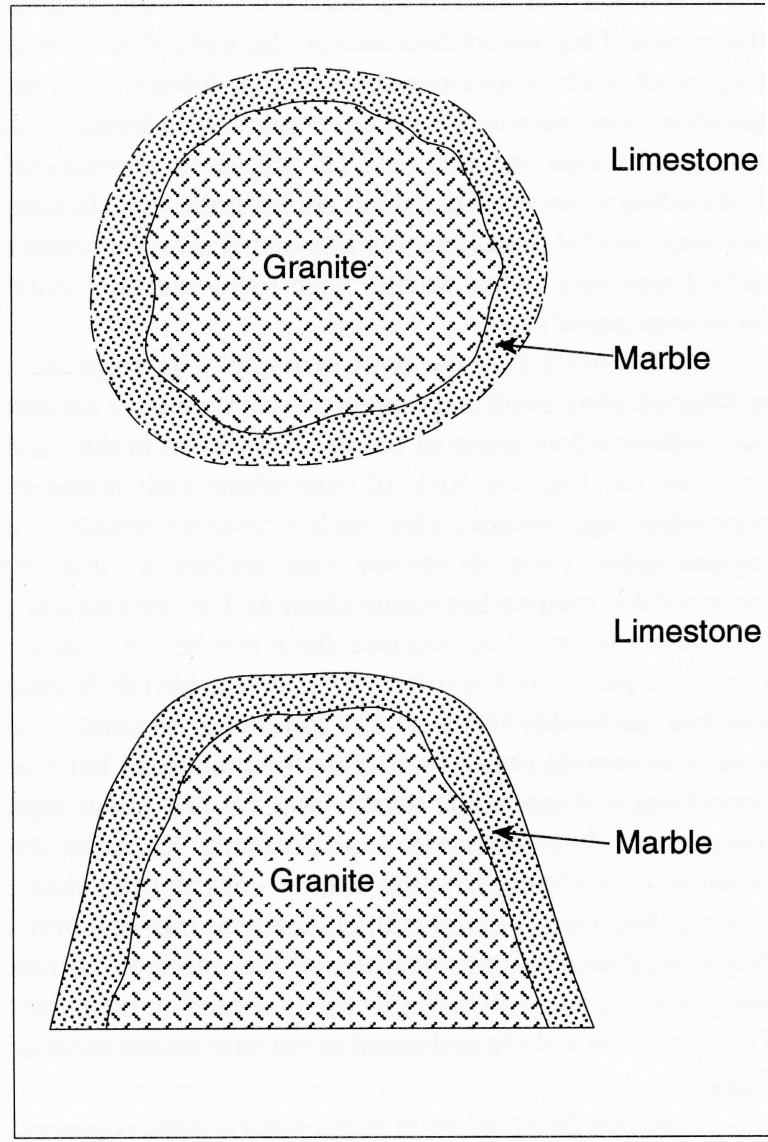


Figure 3: Contact metamorphism.

Today if you want to see coral reefs you have to go to the tropics. They do not form around Ireland today because they need warm water conditions. That brings us to the question, how are we able to find coral reefs in Ireland that are over 300 million years old? The answer is very simple! 300 million years ago Ireland did not lie at the same latitude as today. At that time Ireland was situated near the equator thus it was very much warmer than today and thus coral reefs were plentiful.

If you walk past the large cross, to your right are a number of white headstones made of a rock we have not met yet. Unfortunately some of the headstones are broken and you can see that the rock is pure white with a sugary crystalline appearance. This rock is marble which is a metamorphic rock. However, we looked at another metamorphic rock earlier - slate (Stop 4), but this one has a completely different appearance for a number of reasons. Firstly the parent rock is different. Slate starts off from mud whereas the marble starts off as a limestone. Secondly, the slate was formed under high pressure conditions but low temperatures whereas the marble was formed under high temperature but relatively low pressure. Because the pressure is relatively low the marble does not develop a cleavage like the slate. If a granite magma is intruded into a limestone then the limestone around the intrusion will be baked by the heat, recrystallised and turned into marble. This process is known as thermal or contact metamorphism, Figure 3.

Examine the small vault in the corner of the cemetery. This stone building contains igneous, sedimentary and

metamorphic rocks! Can you spot them? The roof is formed of very distinctive granite slabs and there are some small blocks of granite around the doorway. At the front of the vault you can see some green to blue/grey rocks with an associated cleavage like the slate and they are metamorphic rocks. Dark limestone (a sedimentary rock) can be seen around the sides of the vault. If you examine the sides of the building you can see what appear to be large stains of a whitish substance. This substance is calcite. What appears to have happened is that over time, calcite has been dissolved from the cement or even the limestone by rainwater trickling down the side. When the water evaporated the calcite was precipitated in a thin layer to form a dripstone.

Leave the cemetery and return the way you came, but turn to the left as you approach the basketball posts and go to the back of St. Mary's (see enclosed map).

Stop 7 St. Mary's

Most of St. Mary's is formed of limestone and has many of the features discussed earlier such as fossils and chert bands. Very rare thin shaly layers can be seen. If you examine some of the blocks you will observe that cutting across them are thin white lines. These are calcite veins which originated after the limestone was formed. The limestone would have been subjected to stress which caused it to fracture. Then at a later date fluids migrating through the fractures would have precipitated calcite.

There are a number of darker blocks in this building. Examine one which is located at about head height between the sixth and seven set of windows to the right of the main entrance. (This block is above two small rectangular gratings set into the wall about 1m above the ground). If the sun is shining you will see parts of this rock twinkle with a brassy yellow colour. This block contains some iron pyrites which is known as Fool's Gold because some people mistake it for real gold. Other parts of this block have a red/brown colour which is due to the iron being altered to iron oxide (rust). Just below and to the left of this block is a limestone with patches of white calcite on which very obvious diagonally running grooves can be seen. These are known as slickensides. When this limestone was in the ground, the rock broke under strain and a fault developed which caused one part of the limestone to move past another. This movement caused the calcite layer to be scratched forming the slickensides. Turn to your left and proceed towards the corner of St. Mary's building and proceed to the bronze statue.

Stop 8 Our Lady Queen of Angels Statue

The rock platform around the statue is limestone and contains literally hundreds of fossil crinoids. Also, towards the back some fossil shells can be seen. However, there is one good example of a solitary coral about 2cm across, Figure 2. It is approximately circular and has very distinctive radiating lines. It can be found on the third horizontal slab, approximately 1.5m to the right of the righthand set of steps. Now, turn around and proceed into the garden in St. Mary's Square.

Stop 9 Garden in St. Mary's Square

As you enter this square, walk around the left hand edge until you are standing beside the very large limestone boulder at the back of St. Patrick's. Then proceed out along the walkway (see enclosed map). Most of the rock within this garden is also limestone. However, whereas the limestone from which most of the buildings are constructed is local, a large part of the limestone at this stop has been brought from Adrahan, County Galway and Ballinrobe County Mayo. This limestone has a very attractive weathered appearance incorporating horizontal solutionally-enlarged joints which can be observed at different locations. Some of the large horizontal slabs of limestone contain karren features. These are solution furrows approximately 10cm wide and are formed by rainwater dissolving the limestone as it runs off the surface pavement. To your right (and partially covered by the water) are a number of large slabs of a very pale-coloured rock within which there is very obvious layering. This rock comes from Mountcharles, County Donegal and is called a quartzite. Originally this rock would have been a sedimentary rock called a sandstone which formed by the compaction of sand grains. The sandstone was then subjected to thermal metamorphism which baked it into a very hard metamorphic rock. If you look carefully at one of these slabs you can see a thick dark green rock sandwiched between two thinner layers of pale quartzite. This dark rock is referred to as a metadolerite. Initially the gap between the quartzite layers would have been infilled by very hot (1100°C) magma which would have cooled quite quickly to produce a dark igneous rock (dolerite) composed of the minerals feldspar, pyroxene and olivine. Subsequently, this dolerite was metamorphosed to form a metadolerite. Marble blocks, from Streamstown, County Galway and granite slabs from Ballybrew, County Wicklow can also be found in the garden.

Stop 10 - Inside St. Patrick's

The last stop is within St. Patrick's. Go in through the main entrance to the church in St. Joseph's square and note in the corridor off to the right the head of St. Patrick sculpted out of a large block of limestone. A plaque in the same vicinity is formed from the mineral onyx which is an extremely fine-grained variety of silica. The onyx originated in Iran. Many people call the rock from which the head of St. Patrick has been sculpted "black marble" but it is not a true marble in the geological sense. Note the many fossils it contains, especially in the base - marble does not contain fossils. Continue along this corridor towards the large picture and turn left through the doors at the end. Along the righthand side of the corridor are a number of small altars. The farthest one along has five different types of marble, giving a range of colours, white; pink; red; green and black. Pure limestone when metamorphosed yields pure marble. However, often the original limestone is impure and these impurities result in a range of colours. For example the famous Connemara marble contains the mineral serpentine giving it a green colour. Marble is also used extensively within the college chapel. The side columns are of a striking red marble which contrasts well with the white marble steps of the altar which originated from the Jura mountains.

Geological time

A brief outline of Ireland's geological history is given in the table. Ireland has not had a simple evolutionary history. There were times when it was much warmer than today but also times when it was extremely cold like the Arctic. There were times when Ireland was not an island and you could walk to France and other times when Ireland did not exist because it was under the ocean. If you want to see a display of the main rocks that can be found in Ireland and the story of its evolution go to the ground floor of Rhetoric House where there is a display cabinet which provides more information.

It is very difficult to comprehend the long periods of time encompassed by millions of years but we can consider the major events in Earth history by compressing the whole of geological time into one year. The Earth is about 4600 million years old and in this hypothetical year the oldest rocks found in Ireland appeared around the beginning of August, while volcanoes in Ireland were spewing out lava at the end of November. Dinosaurs roamed the land on the 19th of December and died out on the 26th. Humans did not make an appearance on the planet until the evening of the last day of the year and finally reached Ireland about one minute before midnight. Maynooth town was covered by glaciers less than 2 minutes ago. Christ walked the Earth 14 seconds before the New Year. And St. Patrick's College? Well it was built less than 2 seconds before midnight on the 31st of December.

MAIN GEOLOGICAL EVENTS IN IRELAND

Quaternary (0-2 Ma): During the early part of this period, Ireland was covered by glaciers. (Ma: million years).

Tertiary (2-65 ma): Volcanoes and lava flows in northeast Ireland. Giant's Causeway formed.

Cretaceous (65-136 Ma): Ireland submerged beneath the sea. Chalk deposited. Dinosaurs died out 65 Ma ago.

Jurassic (135-200 Ma): Ireland still mainly submerged beneath ocean.

Triassic (200-240 Ma): Arid hot conditions with a shallow warm sea in northeast Ireland.

Permian (240-280 Ma): Conditions similar to the Triassic- arid dry conditions.

Carboniferous (280-345 Ma): Ireland mostly covered by shallow sea. Many mineral deposits formed.

Devonian (345-400 Ma): Ireland hot and dry, mountainous landscape similar to the Himalayas.

Silurian (400-435 Ma): Northern and southern parts of Ireland separated by a closing ocean.

Ordovician (435-500 Ma): Many volcanoes, folding and faulting of rocks.

Cambrian (500-570 Ma): Sediments deposited, later folding and metamorphism.

Precambrian (before 570 Ma): Oldest Irish rocks found in Mayo and Wexford, about 1900 Ma old.

Activities

If you have a group of children with you they often enjoy trying to find things for themselves. Below are a few suggestions you can use.

1. Go to the spire and ask them to find:

a. A fossil shell. (Fossil shells can be seen on the window ledge of the window nearest the lightning conductor strip).

b. fossil crinoids. (If you examine the columns at the side of the door you will see hundreds).

2. What is the spire made of? (Limestone). Are there any other rocks on it? (Step back and look high above the door and you will see a granite plaque). Which granite does this look like that you have seen before? (The one in the cemetery with the xenolith).

3. Examine the standing stones in front of the library and the plaques on the Aula Maxima what are they made of? (Different forms of granite).

Suggested further reading

The Irish Geological Association runs regular fieldtrips and holds lectures of a geological interest. If you would like more information about the Irish Geological Association and its various activities, you can contact Dr. Paul Gibson at the Department of Geography, St. Patrick's College, Maynooth. If you want to develop your interest in geology further, the following books might prove useful.

Geology and Ireland by W. E. Nevill.

Fossils by F. A. Middlemiss.

The British Isles through geological time by J. P. B. Lovell.

Acknowledgements

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