The Geology of Dún Laoghaire-Rathdown

Killiney Beach

- the stories in the stones

As you walk along Killiney Beach, take a look at the pebbles and cobbles under your feet, rounded by millennia of rolling around in crashing waves of the Irish Sea.
This booklet will help you discover where they came from and how they formed.

This is one of a series of geology guides to Dún Laoghaire-Rathdown co-funded by Geological Survey Ireland.

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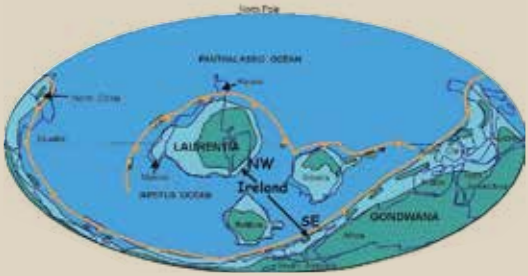
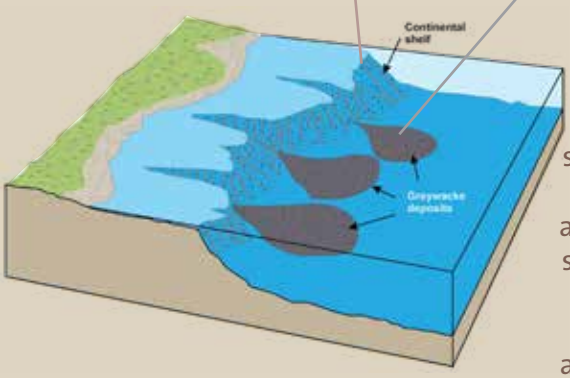
Cambrian (538-485 million years ago)



At the start of what geologists call, the Cambrian Period, some 540 million years ago, what was to become Ireland lay at the bottom of an ocean called the Iapetus. Sediments washed down from ancient continents into the ocean, forming quartz rich sandstone which eventually became metamorphosed into quartzite.

Quartzite

Greywacke



Over time, the continents drifted together, causing earthquakes, which in turn caused vast quantities of sediments to slump down from the continental shelf into deeper water, like an avalanche beneath the sea. As the sediments settle, they form layers of gravels, sands and muds, with the larger grains at the bottom and finest grains at the top. These turned to stone forming greywacke.

Ordovician (485-444 million years ago)

During the Ordovician Period the Iapetus ocean that separated the southeast and northwest halves of the island of Ireland was shrinking as the ancient continents of Laurentia and Avalonia drifted towards each other. This resulted in the formation of a series of mountains as sediments from the sea floor were forced upwards. The remnants of those mountain chains are visible in Ireland in the Wicklow and Dublin mountains, and to the north of Dublin in counties Longford and Down, and in the northwest in the Ox Mountains of counties Sligo and Mayo. In fact, remnants of these mountains extend to the northeast into Scotland and Scandinavia, and to the southwest into the Appalachians of North America. Along with the formation of mountains, the other result of the closing of the Iapetus Ocean was the formation of volcanic islands as the magma from deep in the earth's mantle was forced upwards.

Porphyry

Igneous rocks are classified as extrusive (volcanic) or intrusive (plutonic). Volcanic rock comes to the surface quickly as lava flows and cools and solidifies quickly as it comes into contact with air or water. The resultant rock types, like basalt, have tiny crystals in them, difficult to see with the naked eye. Intrusive rocks, on the other hand, cool very slowly beneath the earth's surface in giant plutons, and so individual crystals have time to grow to considerable size, easily visible to the naked eye, like granite.

Porphyry is a sort of hybrid between these two types of igneous rock. It cools slowly beneath the earth's crust like an intrusive rock, but then gets suddenly thrust upwards to the surface like an extrusive rock, cooling rapidly. The resulting rock type is then composed of large crystals, clearly visible, set in a matrix of fine crystals.

Large crystals of the mineral feldspar

Devonian (419-359 million years ago)

By the Devonian Period, the Iapetus Ocean that separated the southeast and northwest halves of the island of Ireland had closed, and Ireland formed one landmass, connected to North America (then Laurussia) to the northwest and Europe to the southeast (then Gondwana). This resulted in the formation of a huge chain of mountains composed of sea floor sediments being thrust and folded upwards. The remnants of those mountain chains, once possibly larger than the Himalayas, are visible in Ireland in the Wicklow and South Dublin mountains.

OLD RED SANDSTONE

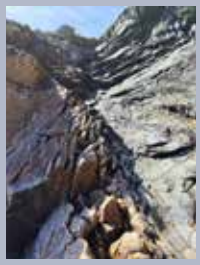
The Old Red Sandstone (ORS) does exactly what it says on the tin! There is quite a range of rock types within this group, but they share these three characteristics – old, red, and composed of sand that has turned to stone! They were deposited when a series of rivers carved through the mountain chain that formed when the Iapetus Ocean closed, forming, in parts, deep river valleys as they eroded the landscape. They are red in colour due to the presence of iron oxide in the sediments. They can be fine- (muddy), medium- (sandy) or coarse- (gravelly) grained, or as in this pebble, form conglomerates – water rolled pebbles in a matrix of sand. To understand these rocks, think of a river flowing from a mountain through a rocky landscape. Heavier material

including cobbles and gravel are dropped by the river on the upper slopes, closer to the mountain, while the finer sand and muds are carried further to the lower, gentler slopes. These rocks are most common in Ireland in the south and southwest in Waterford, Cork and Kerry, but there are outcrops in other parts of Ireland. The ORS on Killiney beach is more likely to have come from smaller outcrops further north on the Island of Ireland or from the UK on the east cost of the Irish Sea.

THE LEINSTER GRANITE

Granite is an igneous rock formed from magma (molten rock) deep beneath the ground. It is characterised by large crystals of three distinctive minerals, quartz, feldspar and mica, which are visible to the naked eye. Most of the granite we see on Killiney beach is from the northeastern extent of a huge mass of rock that extends south-westward through south county Dublin and Wicklow and into county Carlow. Stretch your imagination and think of two continents colliding over 400 million years ago, the collision causing a huge mountain chain to fold upwards. Now stretch your imagination even further and think of this molten rock deep beneath the rising mountain chain, cooling slowly over millions of years to form the Leinster Granite we see here in the rock formations, and in the walls and buildings of this part of Dublin.

MICASCHIST



As the molten Leinster granite rose with the forming mountain chain caused by the closing of the Ocean, they exerted extreme temperatures (greater than 500 degrees Celsius) and pressures on the rocks through which they pushed (known as ‘country rock’). These rocks were the sediments (sandstones and mudstones) laid down in the Iapetus Ocean over hundreds of millions of years in the Cambrian and Ordovician Periods. The result was the alteration of these rocks through metamorphosis (heat and pressure), changing them into the micaschist we see today. You can see this bedrock once the tide is out at the northern end of Killiney Beach.

Carboniferous (359-299 million years ago)

350 million years ago, our planet looked entirely different. The continents as we know them were in vastly different places and alignments. Ireland was located in a shallow tropical sea off the supercontinent called Pangaea. The sea was teeming with life: crinoids (sea lilies), sea-urchins, brachiopods, bivalves, corals, nautiloids and trilobites, the remains of these organisms formed into limestone. Later, sea level changes meant the development of coal in Co. Roscommon and Co. Kilkenny.

Carboniferous bedrock accounts for over half the island of Ireland. This carboniferous limestone bedrock is found in every county apart from Wicklow.

Types of Limestone

CHERTY LIMESTONE

Chert

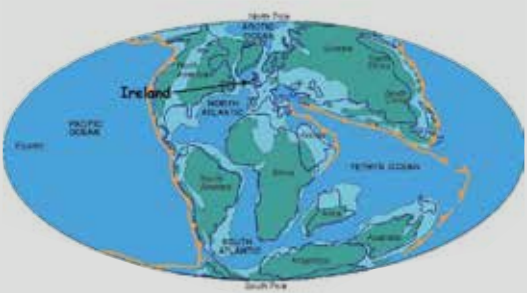
Have you noticed layers of darker stone in the grey limestone? This is chert, which is the mineral form of silicon dioxide (SiO_2). Unlike the relatively soft limestone, chert is harder than steel. The best-known form of chert is flint, which occurs in chalk – a pure form of limestone.

FOSSILIFEROUS LIMESTONE

These rocks were formed in a shallow ocean that was teeming with life. The fossilised remains of the animals that lived in that sea, over 300 million years ago, can be seen if you look closely (on the left, crinoids; on the right, coral).

Keep an eye out for holey limestone that looks like a stone sponge. This surface feature was created long after the limestone was formed, when small animals that lived just under the water line, burrowed their way into the limestone, creating shelters. If you look carefully, you can sometimes see the remains of these organisms.

Cretaceous (145-66 million years ago)



During the Cretaceous Period, most of Ireland was covered by a shallow warm sea and the resulting rocks are a white limestone (or chalk) rich in fine marine fossils. These rocks are well known to be exposed on the island of Ireland along the Antrim coast but are also known to be present beneath the Irish sea. The most famous example of these rocks however is the white Cliffs of Dover in southern England. These rocks do not occur in Killiney, but there is evidence of them if you look closely.

Chalk is a very soft rock and often weathers away when transported by water or ice, but within the chalk limestones occurs bands and nodules of flint (silica), which is much harder and can survive being transported great distances by natural forces.

The flint found on the beach was transported here by ice sheets during the last glaciation. Some of these ice sheets moved along the Celtic Sea between the island of Ireland and Britain, scouring rocks along the way and depositing them as they moved.

If you do find some, you can congratulate yourself as you would have been a valuable member of the hunter gatherer societies that lived here some 9,000 years ago, as flint is an important resource for making sharp tools, and for lighting fires.

FLINT

Paleogene (66-23 million years ago)

If you ever have the wish to understand plate tectonics, a good place to start is by looking at Europe and Africa as jigsaw pieces that slot into North and South America – it is not too big a leap to envisage a time before the Atlantic Ocean existed!

Whilst the process of the opening of the Atlantic Ocean had started in the south many millions of years previously, by the Paleogene the opening of the North Atlantic Ocean had started.

As plates pulled apart and the ocean formed, the crust thinned, resulting in the generation of volcanic and magmatic rocks. Early Paleogene (known as the Palaeocene) age rocks are mainly found in the northeastern part of the island of Ireland, but evidence of this time can be found in a surprising way on Killiney Beach, if you can train your eye.

There is a lot of granite on the beach, as the Leinster Granite outcrops at the northern end of the beach, but if you can spot it, there are a few rounded cobbles of a lighter coloured, finer grained granite.

This came from Ailsa Craig and was brought here by the glaciers of past ice ages. Ailsa Craig is an island in the outer Firth of Clyde, off the west coast of Scotland. It is the remains of an igneous pluton formed during the Paleogene. The island and the granite are famous as the source of curling stones!

AILSA CRAIG MICROGRANITE

Quaternary (2.6-0 million years ago)

If you stand with your back to the sea along Killiney Bay, you can see the remarkable power of the last ice sheets that covered this area some 20,000 years ago. These glacial sediments were left behind by the ice as it moved back and forth over the landscape. The scale is breathtaking; it extends for over 5km along this stretch of coastline. It's pretty thick here, sitting on top of much older slate and mica-schist rocks from the Ordovician Period.

When you look at the cliff, you can see several layers of glacial sediment. These layers have gravel beds, sand pockets, and clay lenses, with erratic limestone rocks mixed in. You'll also spot big boulders of the Leinster granite and limestone in the section, as well as scattered along the beach. If you look closely, you might even find small pebbles of a special type of microgranite from Ailsa Craig in the Firth of Clyde.

GLACIAL SEDIMENTS

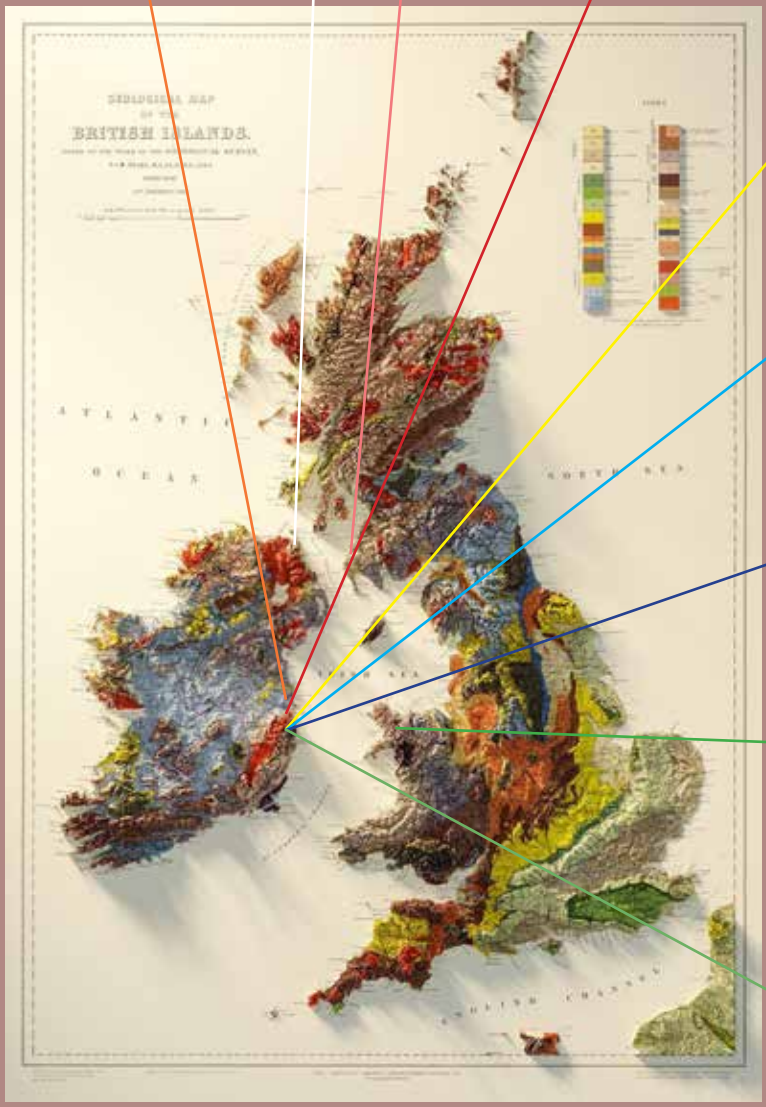
Where did they come from?

LIMESTONE

FLINT

AILSA CRAIG
MICRO-GRANITE

PORPHYRY



QUARTZITE

GREYWACKE

LEINSTER
GRANITE

OLD RED
SANDSTONE

SCHIST

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