

Geology: The Carboniferous Period

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Start of the Period: The start of the Carboniferous Period is defined in two ways: by the flooding of the Old Red Sandstone Landmass by the Carboniferous Sea, and by the presence of particular fossils of microscopic plant spores and conodonts. Conodonts are tiny tooth-like structures from an extinct group of worm-like animals. The phosphatic nature of conodonts suggests that the animals that possessed them were vertebrates.

Length, name and examples: The Carboniferous Period lasted 56 million years (354-298 million years ago). In 1822, William Conybeare, an English geologist, gave this geological period its descriptive name 'carboniferous' because of the carbon-rich deposits laid down during it. Coal is the most notable of these carbon deposits. On the South Wexford Coast, rocks formed during the Carboniferous Period occur extensively offshore. Onshore they have been eroded with the passage of time and are now confined to two locations: Hook Head and the Duncormick-Wexford Outlier.



Outlier: An outlier is a limited area of younger rocks surrounded by older rocks. The Duncormick-Wexford Outlier is an elongated band of Carboniferous Period rocks measuring 30 kilometres long by 4 kilometres wide. The band runs on a southwest to northeast axis from Ballyteige Lough to Wexford Harbour along the Rosslare Fault.

The Rosslare Fault: The Duncormick-Wexford Outlier lies between two parallel faults. A fault is a rock fracture along which movement takes place. In this case a major fracture occurred in the Rosslare Complex on the eastern flank of the outlier. The fracture caused the Rosslare Complex rocks on the western side of the fault to drop down 2km. Hinging on the western flank, the band of younger rocks dropped down along the Rosslare Fault as the faulted block sank. The outlier is tilted towards the southeast because of hinging on its western flank. Faulting preserved the Carboniferous rocks that might otherwise have been eroded.

Exposures: With very minor exceptions, rocks in the Duncormick-Wexford Outlier are poorly exposed. However, the structure of the outlier is well known from extensive borehole data collected during exploration for minerals. In addition to giving insights into the structure of the outlier, the borehole data assists in the interpretation of the exposures at Hook Head. Carboniferous Period rocks are continuously exposed at Hook Head from the Tower of Hook lighthouse to Sandeel Bay.

Rock-forming environment: At the start of the Carboniferous Period continental drift continued to carry Wexford northwards towards the equator. The Old Red Sandstone Landmass had been eroded and the sea flooded its surface extending northwards towards the remains of the Caledonian Mountains. The flooding waters are now known the Carboniferous Sea. As the Carboniferous Sea flooded northwards, South Wexford was part of a large island country called The Welsh High. That country extended eastwards from Wexford across the Irish Sea, Britain and the North Sea. As a result, the first two formations dating from the Carboniferous Period are land-based. By the end of the period South Wexford lay north of the equator.

Rock types: Local Carboniferous Period rocks are all sedimentary rocks. Most of these sediments were laid down underwater. Conglomerates, sandstones, siltstones and mudstones occur but the dominant rock type is limestone.

Limestone: Limestone is Ireland's most widespread rock; it underlies 60% of the country's land surface. The lime may be derived from a number of different sources and it may be deposited in freshwater or in seawater of varying depths, but all limestones consist essentially of carbon-based minerals called carbonates. Veins of the mineral calcite are often seen running through limestone rocks.

Rock units: The environment in which Carboniferous Period rocks were formed varied considerably with the passage of time over the 56 million-year time unit. This is reflected by the recognition of eight formations. These are detailed below in order of decreasing age.

1 Oldtown Bay Formation (OB): The Oldtown Bay Formation (OB) is the oldest Carboniferous Period rock type. It lies on top of the Old Red Sandstone association of rocks. The formation derives its name from a small bay on the western side of Hook Head. The formation differs from the Harrylock Formation (HL) immediately below it in that conglomerates are absent and mudstones and siltstones are present. The presence of fine sediments as parent materials of the formation of sedimentary rocks suggests that the deposits were laid down on a coastal plain before the plain was fully flooded by the Carboniferous Sea. The area may have been tidal with extensive mudflats and sand bars. The formation is 32 metres thick and is composed of grey sandstones with siltstones and minor mudstones.

2 Duncormick Formation (DC): The Duncormick Formation (DC) developed from a land-based deposit. Red and grey pebbly conglomerates with subordinate siltstones and sandstones were deposited on land down appreciable slopes. Deposits near Duncormick on the western flank of the Duncormick-Wexford Outlier vary in true thickness from 26 metres to 83 metres. Evidence regarding the thickness of the formation comes from borehole data: apart from the remains of former quarries, there are no exposures of the Duncormick Formation (DC) in the outlier and it is not represented at all at Hook Head. The formation is named after the village of Duncormick. Since they formed under similar environmental conditions and from identical parent

material, the Duncormick Formation conglomerates of Carboniferous Period age look the same as the older Old Red Sandstones of Devonian Period age.

3 Portersgate Formation (PG): As the Carboniferous Sea flooded across the part of the Welsh High that is now known as South Wexford, sands and muds were deposited underwater forming sandstones and mudstones. The first thin limestones also started to appear. These limestones are composed of eroded limy fragments, possibly sourced from coral reefs fringing the Welsh High. These marine sediments were the parent materials of the formation. The formation is the first truly marine-based rock type of Carboniferous Period age in South Wexford and is rich in fossils. The formation is named after the townland of Portersgate, Hook Head. The formation varies eastwards from a thickness of 41.5 metres at Hook Head to 18.4 metres in the Duncormick-Wexford Outlier. The formation is divided into two distinct members.

3a Houseland Member (PGhl): The older Houseland Member (PGhl) of the Portersgate Formation (PG) comprises clean sand and is interpreted as representing a nearshore, wave-worked beach and tidal sandy area.

3b Lyraun Cove Member (PGlc): The overlying and younger Lyraun Cove Member (PGlc) of the Portersgate Formation (PG) is interpreted as representing offshore, quieter conditions with the first shallow-water limestones and muds below the reach of the tides.

4 Ballymartin Formation (BT): Named after an outcrop at Ballymartin Point near Pallaskenry, County Limerick, rocks in the Ballymartin Formation (BT) reflect the gradual deepening on the Carboniferous Sea and the consequent change in its marine life. South Wexford lay on a warm, shallow shelf and conditions were probably not unlike present day conditions experienced in offshore Florida, the Bahamas and throughout the Caribbean. The formation varies in thickness from 70 metres at Hook Head to 25 metres in the Duncormick-Wexford Outlier and comprises alternating beds of pale-grey, clayey limestones rich in fossils of sea lilies and dark-grey limy mudstones.

5 Ballysteen Formation (BA): Named after the village of Ballysteen near Pallaskenry, County Limerick, the 450 metre-thick, dark-grey, fossil-rich limestones that comprise the Ballysteen Formation (BA) are free of mudstone. The sediments — fragments of pre-existing limestones and fossils that gave rise to them — are interpreted as having been laid down in an open, current-swept, underwater shelf environment. The rocks are severely weathered giving examples of caves, blowholes, arches, crevices and stacks. There is an excellent coastal exposure of the Ballysteen Formation (BA) at the lighthouse at Hook Head. The exposure is easily accessible and the site is rated among the best in Europe for fossils of shelled marine animals. The formation has one member.

5a Bullockpark Bay Member (BAbb): The 25 metre-thick Bullockpark Bay Member (BAbb) of the Ballysteen Formation (BA) limestone differs in two ways from the rest of the formation: first, it is composed of sand-sized grains of limestone with an internal concentric structure and, second, the mineral magnesium replaces the mineral calcium. To reflect this change to magnesium carbonate from calcium carbonate, the rock is called dolomite rather than limestone. The concentric structure of the grains is believed to be due to the fact that the

grains were being continually agitated as they grew; this suggests that they formed in a sandbank environment during a period of temporary shallowing of the Carboniferous Sea.

6 Wexford Formation (WX): The Wexford Formation (WX) is named after Wexford town. Limestones that comprise this formation are much paler in colour, much finer in grain size and have often been altered chemically. They are rich in corals and shelled microscopic creatures. These pale, fine-grained limestones are confined to the Duncormick-Wexford Outlier, they do not occur at Hook Head. The formation is estimated to be 500 metres thick.

7 Park Formation (PK): Late in Carboniferous times the warm shallow sea silted up. Rocks reflecting the transition from a deep clear sea to a shallow muddy sea comprise the Park Formation (PK). The formation is entirely concealed and is known only from boreholes in the Duncormick-Wexford Outlier. About 32 metres thick, the rocks are mainly dark-grey to greyish-black silty mudrocks rich in sulphide minerals indicating that they were deposited under oxygen-poor, delta conditions. As the Carboniferous Sea continued to silt up it transformed the delta to coastal swamp. The swamps supported lush forests.

8 Richfield Formation (RF): Debris from the swamp forest became fossilised and formed coal. The formation is also entirely concealed and is known only from borehole information. It is believed that the formation, which is about 38 metres thick, was deposited in a typical coal swamp environment away from any area of marked relief. The sequence of rocks in order of age are 4.5 metres of black and greyish-black, carbon-rich mudrock, 0.2 metres of bituminous coal, silty mudrock, yellowish to greenish-grey sandstones, grey mudrocks and siltstones and thin sandstones. Rocks in this formation represent the last stage in the evolution and silting of the Carboniferous Sea.

Variscan upheaval: At the end of the Carboniferous Period the Variscan Upheaval occurred in Germany. The impact of the upheaval was not severe in South Wexford but it was strong enough to gently buckle the beds of rocks at Hook Head. The parent sediment materials that formed these rocks were, of course, laid down horizontally but the beds of rocks we see today at Hook Head are uplifted and tilted at an angle. The deformation of the rocks was so slight that the rocks generally lack any evidence of cleavage.

End of the period: The combination of the gradual silting of the Carboniferous Sea and uplifting due to the Variscan Upheaval caused South Wexford to emerge from the sea. The return of dry land conditions marked the end of the Carboniferous Period and the beginning of the next period of geological time.

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