EXCURSION 2: PORTMARNOCK to MALAHIDE

Jeremy Stone

How to get there: there is a bus stop just north of the Carrickhill Martello Tower which can be reached by bus No. 32A from Lower Abbey Street, or by train to Malahide followed by bus No. 230 to Portmarnock. There is car parking at Sands Hotel (with permission), opposite the Carrickhill Martello Tower, or at various locations along the coast road.
Geological horizon: Lower Carboniferous.
What to see: Lower Carboniferous shelf-sea limestones and fossils (crinoids, corals, gastropod, brachiopods, bryozoans and burrows). Also, small folds, faults, veins, Quaternary deposits and Recent tuffa.
Duration: 2 hours.
Warning and Notes: at extreme high tides much of the section is submerged.

Make your way down to the beach at Portmarnock by the short path just to the south of the Martello Tower, then turn right and walk a few paces down across the rocks towards the sea.

Stop 1. The rocks on which you are now standing were formed on the floor of a warm tropical sea some 340 million years ago, when Ireland was situated just north of the equator (it has been drifting steadily north ever since). These rocks have been dated by the fossils they contain (crinoids and conodonts) and belong to the early part of the Carboniferous Period. At that time, the Wicklow Mountains formed a landmass to the south, and there was also land just to the north of Skerries, such that Portmarnock and Malahide were in a small marine trough running roughly east - west, broadening out into a large open shelf in both directions.

You will notice that some of the rocks here have a rather rubbly appearance, in which there is a fine lime-mud matrix containing subrounded to angular limestone fragments or clasts, ranging in size from approximately 4 cm to 80 cm. These beds formed by bits of rock slumping down from the shelf above, and getting stuck in the lime mud flooring the trough. Nearby you can distinguish a 6 m long, lens-shaped block surrounded by relatively fragmented limestone (breccia), which is conspicuous due to orangy-brown weathering and more intense veining than the surrounding rocks. This whole block has slid down from above, which is why it looks different from its surroundings, and doesn't form part of a more continuous bed.

Interbedded with the rubbly beds are darker, more shaly beds in

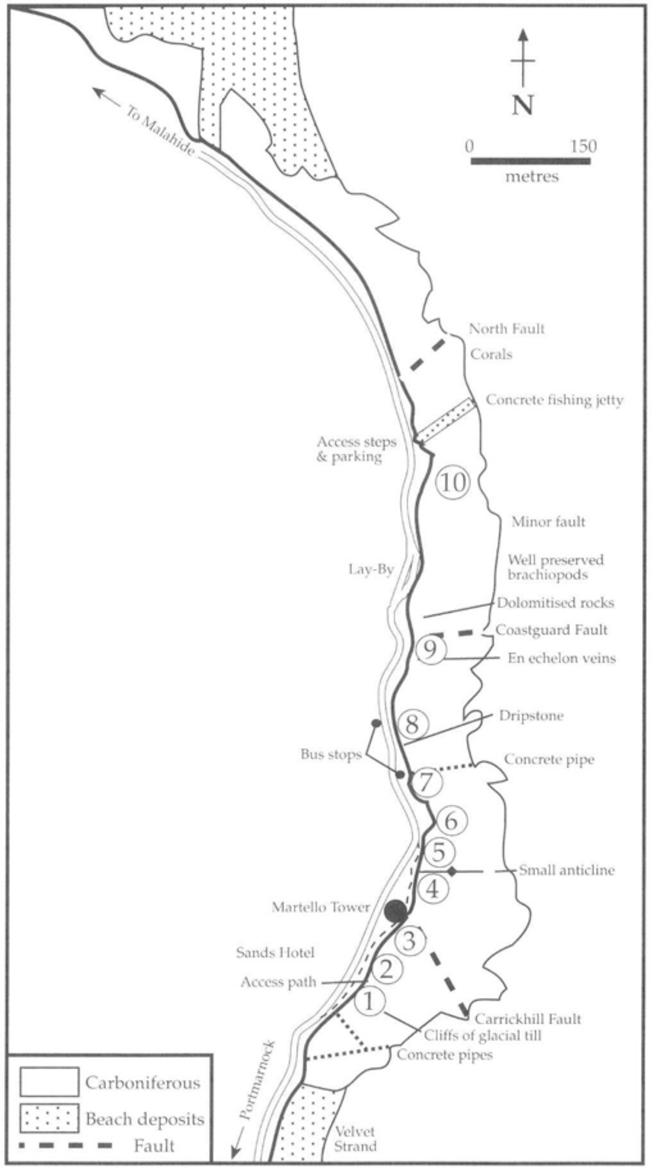


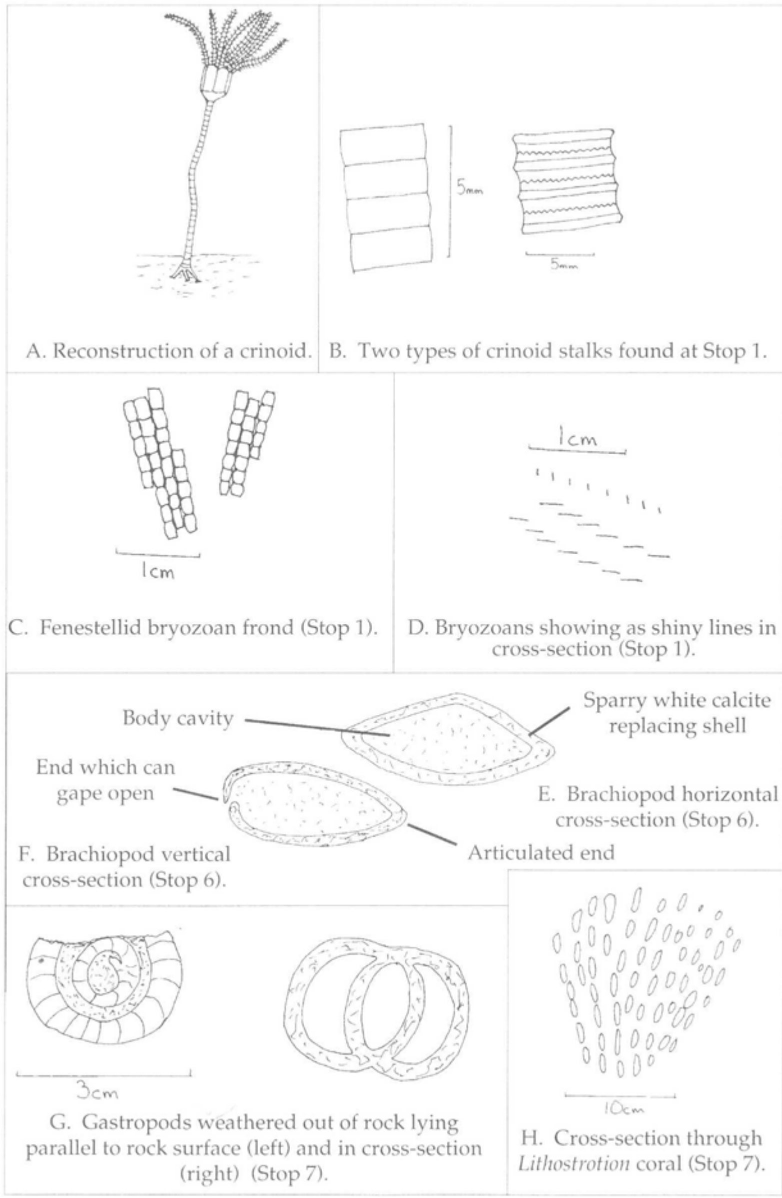
Figure 4. The geology of the coastal section between Portmarnock and Malahide.

which a planar fabric running through the rock is seen (rock cleavage). This developed after the rock's formation, by parallel alignment of platy minerals when the rocks were intensely squeezed during the period of mountain building responsible for amongst others the Harz Mountains in Germany and the Vosges in France (the Hercynian Orogeny). It was also at this time that the beds of rock, originally laid down horizontally on the sea floor, were tilted up to the 45° angle at which they now lie.

Some of these darker, more muddy beds are rich in crinoid debris (the remains of animals called sea-lilies, related to sea urchins and starfish). Crinoids lived anchored to the seafloor by long stems made of many 'Polo-mint' type rings of shell, with soft tissue running down the hole in the middle. The individual rings or ossicles often separated from each other after death and show up in the rocks as little white circles or may be weathered out in three dimensions. On top of the stem was the body-chamber covered in shelly plates, and a series of food gathering arms or tentacles, also covered in shelly ossicles. Although some 80 species of crinoids still exist, they were much more common and diverse in Carboniferous times; with their broken-up skeletons making a sizable contribution to the formation of many limestones. Other common fossils here are bryozoans (sea-mats) which were small animals living in colonies attached to the sea floor or a shell. Each colony consisted of hundreds of individuals (zooids) looking a bit like baby sea anemones, although they were in fact quite different. Each zooid made itself a protective outer casing and these joined together to make quite a large structure, in the form of an upstanding fan or cone (fenestellids), a stick or bush, or an encrusting mat. There are approximately 4,000 living species of bryozoans, and at least 15-20,000 fossil species are known.

Stop 2. As you walk across the beach towards the Martello Tower, you will pass the 3 m to 4 m high cliffs of glacial till deposited on the underlying Carboniferous shales and mudstones during the last Ice Age (in Pleistocene times, between 2 million and 11,000 years ago). Contained in the rather muddy matrix there are several types of angular to sub angular clasts, ranging in size from 5 mm to 40 cm. Towards the base, the clasts tend to be coarser and include several fragments of the underlying mudstone. Close examination will also reveal, amongst others: clasts of red sandstone, green volcanics, black mudstone, dark chert and white vein quartz. The jumbled and angular nature of the included fragments is typical of sediments deposited by ice.

Stop 3. In the rocks beneath the Martello Tower there are spectacular white veins of the mineral calcite. If you look closely you can see that the little (1



A. Reconstruction of a crinoid.
B. Two types of crinoid stalks found at Stop 1.
C. Fenestellid bryozoan frond (Stop 1).
D. Bryozoans showing as shiny lines in cross-section (Stop 1).
E. Brachiopod horizontal cross-section (Stop 6).
F. Brachiopod vertical cross-section (Stop 6).
G. Gastropods weathered out of rock lying parallel to rock surface (left) and in cross-section (right) (Stop 7).
H. Cross-section through *Lithostrotion* coral (Stop 7).

Figure 5. Various Carboniferous fossils from Portmarnock - Malahide.

mm to 2 mm) fragments breaking off from the veins are rhomb-shaped (fragments breaking off from quartz veins have an irregular shape). Veins form later than the rocks themselves, when tectonic squeezing produces cracks in the rocks. Hot liquids containing dissolved calcite then flow up through the cracks, and the calcite crystallises out of the fluid onto the walls of the crack gradually filling up all the available space - as happens in areas of hard water when a kettle gets furred up with limescale. Intense veining often marks the site of a fault, and that is the case here. A fault, which is hard to make out on the beach but passes inland through the grounds of Malahide Castle, has caused slightly older Carboniferous rocks to lie at the surface next to the rocks you first examined (Stop 1). From now on, as you walk along the section, the rocks get progressively younger (although the sequence is disturbed by smallscale faulting and folding).

Stop 4. Approximately 40 m north of the Martello Tower the dark limestone is made up of finely laminated micrites (rocks made of very fine crystals of calcite), and 1 mm scale ripples of alternating light and dark grey are particularly clear on wetted surfaces. Also infilled animal burrows (possibly of marine worms) can be seen preserved as lighter grey ovals and circles (2 cm to 3 cm) standing slightly proud of the rock surface. It seems that these rocks were deposited in a rather shallow, possibly tidal, environment. Occasional crinoid ossicles and locally abundant bryozoans, appearing as delicate wriggly white lines, are also seen here.

Stop 5. A short way further on, the beds of rock stop dipping away to the SE and dip instead to the NE; this is because you have crossed a fold in the rocks (such convex-upwards folds are called anticlines, folds the other way up are synclines).

Stop 6. Roughly 20 m further north along the beach from the fold axis, just before a small headland where there are boulders placed on the foreshore to prevent erosion, a single bed rich in brachiopods is crossed. These show up as 4 cm to 2 cm white structures in the rocks. Brachiopods (commonly called lamp shells because of a resemblance to Roman oil lamps) were animals which grew a two-valved shell. At first sight they look similar to modern day molluscan bivalves such as cockles, but their internal soft tissue was markedly different and the two valves were of different sizes; unlike molluscan bivalves. Most brachiopods lived attached to the sea floor by a stalk called a pedicle. The two parts of the shell were hinged at the end with the stalk and the back of the shell could be gaped open to allow sea water to waft inside so that it could be sifted for food particles. Brachiopods were extremely common in the past and well over 2,500 fossil genera are known,

although there are only about 70 genera living today.

Stop 7. As the concrete outlet-pipe, which runs across the beach to the sea, is approached, the number of different types of fossil increases, and this may be a reflection of steadily deepening water conditions through the time of these rocks deposition. Corals of the genus Lithostrotion become more common and appear as 20 cm (or so) clumps of lighter coloured spheres and ovals (marking the tops of individual coral pipes), many of which stand slightly proud of the bedding plane surfaces, due to a greater resistance to erosion. It now becomes much easier to envisage that you are walking across the bottom of an ancient coral sea, and individual coral clumps can be found in vertical cross -section where beds are broken off suitably, showing that the corals are preserved in life position. Large gastropods (snails) appear as 3 cm to 4 cm lighter coloured spirals, or three chambered geometric shapes if preserved in cross-section. Also there are patches of relatively fine crinoid debris.

Stop 8. Approximately 50 m beyond the concrete pipe, there is a spot in the cliff where the boundary between the till and the underlying limestone is particularly clear. This contact is termed an unconformity, that is to say a point in a geological sequence representing a major break in time. The interval between deposition of the limestone and the glacial till is something like 340 million years. Also at this point there is water rich in dissolved calcium carbonate dripping down on to the beach. Once in contact with the air, much of the calcium carbonate comes out of solution and crystallises on whatever the water happens to be dripping over at the time. The lime deposit produced is called tuffa or dripstone, and is what makes up the spectacular stalactites and organ pipe sheets seen in some caves. In the past, such places as this were termed dropping wells, and many were thought to have mystic significance because by placing an object (such as a leaf) under the drips, a stone replica could be produced, often within a couple of weeks in very lime-rich waters. There is a case of someone on a recent caving expedition finding a petrified pair of gloves formed in this way!

Stop 9. As the the little headland marking the northern end of the bay is approached there are spectacular vein systems developed - some en echelon patterns probably marking the outcropping of the top of a particularly thick vein. Once the headland is rounded, the so called Coastguard Fault dipping steeply southwards, is seen in the cliffs. There is a well-defined wall of rock the southern edge of the fault plane as it runs down across the beach, this is termed the hanging wall as it is on the upper side. Faults such as this mark a point where there been considerable movement along a fracture, and when the two rock masses rubbed past each other, their surfaces got broken up and crushed into small pieces to form fault breccia and fault gouge (or rock flour) respectively, and both of these are seen in the cliff. On the north side there is also disrupted bedding, typical of faults. The normal limestone distinctive orangy brown colour. This alteration involves magnesium being substituted into the limestone and is related to hot fluids coming up from depth and reacting chemically with the surrounding rocks. Faults are often mineralised by hot fluids, and lead ore (galena), tin ore (sphalerite) and a coppery type of fools' gold (chalcopyrite) occur in small amounts here and are associated with two small faults (marked by a rust-stained breccia) just beyond the next small headland.

Stop 10. A short way beyond the Coastguard Fault, where a path descends from a lay by at the cliff top, well-preserved brachiopods of several species are seen in the rocks at the foot of the cliff. Between here and the concrete fishing jetty (where steps lead up to the road marking the end of this excursion) the rocks contain beautifully preserved bryozoans of at least four species, which weather out clearly on bedding surfaces. These are particularly clear on the lichen -covered rocks near the water's edge. Whole brachiopods and large fragments of crinoid columns can be seen in the darker, more shaly beds of the cliff.

EXCURSION 3: BALSCADDEN & HOWTH

Ian Sanders

How to get there: DART to Howth station, then 10 minutes walk eastwards past the yacht club in the direction of the Martello tower. When you reach the King Sitric restaurant at the landward end of the East Pier turn right up a steep road (Balscadden Road) past a modern apartment block on the left, and a high, poorly vegetated embankment (supporting the Martello tower) on the right. Bus No. 31 (direct to Howth village) or 31B (scenic route via Howth Summit). Car parking is available beside the East Pier (below the Martello tower).
Geological horizon: Cambrian, Lower Carboniferous, & Quaternary.
What to see: Faulted rocks, limestone, glacial deposits.
Duration: 1 hour or a little more.
Notes: Access is possible at any state of the tide, though half tide allows more to be seen in Balscadden Bay.

The Howth peninsula is composed of rocks of two ages. To the south, Cambrian quartzites, sandstones and mudrocks form the higher ground and can be seen in the cliffs and rocky foreshores. To the north, Carboniferous limestones lie beneath the lower ground and crop out in a few coastal and inland exposures. The two groups of rocks are separated by a fault the eastern end of which is exposed in Balscadden Bay, immediately to the east of Howth village. The western end emerges on the coast just south of Sutton Dinghy Club. Quaternary boulder clay, sand and gravel form deposits up to several metres thick resting on the older Carboniferous and Cambrian rocks in many places.

Balscadden Bay makes an excellent 'first geological visit'. In one small area it is possible to examine all three main groups of rock, Quaternary, Carboniferous, and Cambrian, that occur on the Howth peninsula.

Stop 1. The embankment opposite the Balscadden Road apartments. Observe that the embankment consists of buff-coloured sandy and pebbly material. These pebbly sands are believed to have been deposited towards the end of the last ice age. At that time Howth (and much of the rest of Ireland and Britain) was buried under a thick sheet of slowly moving ice, much as Greenland is today. The ice engulfed the original soil, stones and loose rocks in its path and carried them forward. With climatic warming, about 14,000 years ago, the ice sheet melted and the stony and muddy the