DEVONIAN LIMESTONES

by David Allen

Thatcher Rock, Torquay – a sea stack in Devonian Torquay Limestone, with distant high sea cliffs across Tor Bay at Brixham

CONTENTS

1. BRIEF DESCRIPTION

In south Devon you can find limestone rock which dates from the Devonian geological time period, about 416 to 345 million years ago. These limestone rocks are sedimentary rocks and predominately consist of the mineral calcium carbonate. Sedimentary rocks form when material or sediment is deposited and compacted to form a rock.

Devon was the county where the Devonian rock series was first recognised in the mid nineteenth century and rocks of the same age world-wide are referred to as Devonian. The limestones in Devon were formed mainly in the Middle Devonian.

The calcium carbonate which forms this limestone originates from various sea creatures. These range in size from very small planktonic animals, through corals (small creatures but often living in large colonies), to sometimes quite large organisms with individual shells. The abundant life in warm, clear waters produced carbonate sediments which were deposited at the bottom of relatively shallow seas, often around volcanic islands.

One of the most striking features of the Devonian limestone is the abundance of fossils it contains. Where the rocks have been weathered, or have been polished and used in buildings, the clarity of these fossils can be particularly good.

Around Plymouth at the Hoe, Cattewater and Mount Batten you can see distinctive landforms formed of strong limestone rock. Also, around Torbay and Brixham the spectacular cliffs are formed of limestone. In urban Torquay, inland cliffs both natural and manmade (the result of quarrying) are locally characteristic. Devonian limestones can also be found around Ashburton, Buckfastleigh and near Chudleigh.

2. GEOLOGICAL DETAIL

During the earliest part of the Devonian, conditions around southwest England changed from continental sedimentation in rivers and lakes to deposition in shallow seas with scattered volcanoes. First of all, the Lower Devonian sediments were mainly sands with some volcanic material and only occasional accumulations of fossil debris resulting in only patchy and generally thin limestone beds.

In the Middle Devonian, continental landmasses were present to both the north and south with variable conditions in the sea ranging from coastal to deep water, representing both shallow marine platform and deep basinal deposits. In shallower water areas, possibly around volcanic islands, conditions were probably similar to those in Pacific Ocean margins today, like Indonesia. Life was abundant in the clear warm water producing a regular and abundant supply of animal remains. This allowed accumulation of thick carbonate shell deposits which produced thick limestones. The volcanoes assisted in the formation of the limestones by building shallow sea floors which encouraged colonial organisms. Although periodic emissions of poisonous gases may have killed the organisms, regular re-colonisation developed deposits of substantial thickness.

The term limestone includes three major groups; organic, chemical and detrital or clastic. Organic limestones include accumulations of carbonate animal remains, either complete or broken, which form reef, shelly, coral or algal limestones etc. depending upon composition. Chemical limestones are deposits derived from carbonate minerals originally dissolved in the water. Detrital or clastic limestones are mechanically deposited carbonate rocks made up essentially of fragments of organic carbonate shells or a pre-existing limestone rock. All three types occur in the Devonian Limestones of Devon although chemical limestones form a relatively small proportion.

The organisms which created the limestones include sponge-like stromatoporids which are small colonial organisms that form mounds in shallow water and can build large reefs. The most abundant and most important fossil group in creating the limestones were the corals, in particular the chain like and compound colonial species which formed substantial reefs. There were also solitary corals which provided shelter for other creatures around the reefs and coastlines. These other organisms included trilobites (early segmented animals), brachiopods (marine invertebrates) and crinoids (sea lilies).

The changing depositional conditions and volcanic activity in South West England during the early Devonian period were a reflection of the start of a significant period of mountain building. These processes continued through the Devonian and Carboniferous

periods (about 400 to 300 million years ago) and into the early Permian period. These processes were caused by the collision of moving plates of the Earth's crust – known as 'plate tectonics' or 'continental drift'. Deep troughs (or basins) formed below the narrowing sea and received vast volumes of sediments from the erosion of the nearby continental land masses – Wales and North America to the north and offshoots from the ancient continent of Gondwana to the south. The accumulated carbonate mud sediments were deeply buried and turned into limestones, then folded and contorted and thrust up into mountains by the slow but relentless collision of the continental plates. This long period of earth movements and mountain building is known as the 'Variscan Orogeny'.

As a result the Devonian age rocks in Devon, including the limestones, have a complex structure. In the area which became the southern part of Devon, the sedimentary conditions were particularly complex with sedimentary basins largely controlled by geological faults. The relative movement of fault bounded blocks resulted in both shallow and deep water conditions with further complications arising from the formation of volcanic islands. Formation of limestones, in particular of reefs, was closely related to the shallower water areas or 'highs'. Later ground movements resulted in further disturbance and complex folding, sometimes with blocks of strata overturned and thrust over others and separated into blocks by faulting.

The most recent geological maps and descriptions by the British Geological Survey identify the individual successions related to depositional basins and local highs that have been recognised across southwest England. As far as the Devonian Limestones in Devon are concerned these include the Plymouth High and the Brixham and Torquay Highs of Torbay.

Essentially these successions relate to the Plymouth Limestone, the Brixham Limestone and the Torquay Limestone formations in their respective districts. Due to the complex tectonics it is not possible to give thicknesses of the limestone deposits.

The carbonate and other minerals which make up the limestone are commonly recrystallised during diagenisis (the processes, low temperature and pressure, which affect sediments at or near to the earth's surface) which tends to destroy some of the original characteristics of the rock. However, these processes can result in spectacular coloured patterns with veins of white calcite and streaks of red haematite in the various background shades of grey. This is particularly so in some limestones around Newton Abbot, Buckfastleigh and Ashburton, the so-called Ashburton Marble, which are able to take a hard polish. The stone is not a true marble since it has not been subject to the extremes of metamorphic (deep burial) heating and in this case the fossil corals are uniquely preserved.

3. USES

Probably the earliest usage of Devonian Limestone was for building stone. The extensive old quarries around Plymouth and Torquay bear testimony to its past importance. Many of the quarry sites are located close to the shore for ease of shipment such as around the Cattewater in Plymouth, at Hopes Nose and Berry Head around Torbay.

Rough cut stone has been extensively used in vernacular buildings but historically it's most important use has been as dressed and cut stone in public and other important

buildings. It has also seen extensive use in municipal and civil engineering. Slabs of limestone are still to be seen as paving in the streets of Plymouth, Torquay and also to a lesser extent Exeter. It has also been used in retaining walls and harbour works. Much of the mainline railway along the seawall between Teignmouth and Dawlish is faced with blocks of Devonian Limestone brought by sea from Torbay.

The iron oxide minerals, in particular haematite, often gives the stone its distinct pink colouration which can, particularly when polished, appear in many shades through to dark red and maroon. The colouring together with the various greys and almost black, the spectacular fossils and the ability of the stone to take a polish have led to its extensive use for decorative work as ‘Ashburton Marble’. This includes stonework in cladding and flooring as well as in monuments and memorials. The most common destination in the UK has been London where it has been used in the foyer of the Post Office Tower and in the bathrooms of the London Hilton. It is the only ‘marble’ recently produced in Britain and it was an important export, to South Africa, Hong Kong and particularly to the United States where it is seen in public buildings including the President Roosevelt Memorial. Local varieties from Petit Tor near Torquay and Ipplepen near Newton Abbot were also exploited as ‘Torquay Marble. The stone was cut by abrasives drawn by wires to prevent damage and rough handling by extraction with explosives. Polishing of the stone was mainly carried out in Torquay. Sadly, no quarries working the ‘marble’ are active today and the local cutting and polishing industry can supply only imported stone.

In more recent years the bulk of the limestone extracted has been used in the manufacture of cement and for construction aggregates. Unfortunately the tendency for limestone to polish precludes its use for road surfacing but large tonnages are used in the foundations of roads and for drainage and for many other construction uses. Large limestone quarries support the built infrastructure in Devon from Moorcroft Quarry near Plymouth, Linhay Quarry at Ashburton and Stoneycombe Quarry near Newton Abbot.

On a much smaller scale the presence of iron minerals in the limestones, and the weathering products from them, have been of past importance for producing pigments. Umber, a brown form of haematite was formerly worked around Ashburton. It was used in paints, for making brown paper and in earlier times for colouring in woollen cloths. Iron ochre was also important for paint manufacture at Brixham where it was worked in open pits on Rea Hill. Red and brown haematite veins were also worked in the limestone at Sharkham Point, on the eastern side of Brixham; the softer material was used in the paint works whilst the harder mineral was sent to South Wales for smelting.

Although limestones generally form important aquifers the Devonian limestones are generally of low primary permeability due to the recrystallisation which occurred during diagenisis. Groundwater occurs only in joints and fissures and although common rocks around Torbay the limestones are only responsible for around 4 percent of the licensed water abstraction in this area. In Plymouth groundwater from the limestone was utilised in the nineteenth and early twentieth centuries for industrial and brewery use. However, due to pollution and saline intrusion from the sea there are currently no licensed abstractions.

4. PLACES TO VISIT

Please refer to the safety guidance about visiting geological sites on our website before visiting the places listed below.

Triangle Point, Daddyhole, Torquay

Location: A spectacular and accessible location to see the Devonian Limestone southeast of Torquay town centre off Meadfoot Sea Road.
Ordnance Survey 1:50,000 Sheet 202. National Grid Ref: SX 928 628

Description: The limestones around Triangle Point are exposed in cliffs, foreshore and quarry exposures. The limestones are downfaulted to the south by east-west faults. The steep southwest dipping beds form the inverted limb of a major fold which is overturned to the east-northeast. A number of highly fossiliferous horizons are present. The exposures at the northeast end of in the quarry include large bedding surfaces where a rich fauna appears to be in situ. 'Bun-shaped' stromatoporids, frequently intergrown with solitary corals are seen surrounded by branched tabulate corals. The latter appear to have acted as sediment traps for shell debris.

The coast at Daddyhole is dealt with in the 'Geology in Devon' booklet reference 18, page 26. and www.devon.gov.uk/geo-DAD.pdf. See also the Educational Register of Geological Sites; Torbay Site 5 (www.devon.gov.uk/educational_register.htm).

There is car parking on Meadfoot Sea Road, access is via the Promenade at SX 930 630. There is a beach café (seasonal) and toilet facilities.

Hope's Nose Torquay

Location: Devonian Limestone exposed in an abandoned quarry, accessed from Ilsham Marine Drive to the east of Torquay town centre.
Ordnance Survey 1:50,000 Sheet 202. National Grid Ref: SX 947 635 (access point)

Description: The end of Hope's Nose comprises Devonian Limestones and slates. In the former quarry, near sea level, fossils have been etched out by weathering from the abandoned quarry floor. The fossils are generally deformed – a result of their turbulent geological history, and include corals, crinoids, trilobites, bryozoa and brachiopods.

The beds are cut by thrust planes and the structure is picked out by tuff (volcanic ash) bands. Folded limestones can also be seen in the quarry walls.

The locality is famous for the occurrence of native gold although this is no longer visible due to over collecting of specimens.

The coast at Hope's Nose is dealt with in the 'Geology in Devon' booklet reference 20, page 28. www.devon.gov.uk/geo-HWH.pdf. See also the Educational Register of Geological Sites; Torbay Site 6 (www.devon.gov.uk/educational_register.htm).

There is car parking on Ilsham Marine Drive close to the access point with other facilities at Meadfoot Beach.

Both of the above sites are managed by Torbay Coast and Countryside Trust www.countryside-trust.org.uk and are sites with the English Riviera Geopark www.englishrivierageopark.org.uk.

Kents Cavern

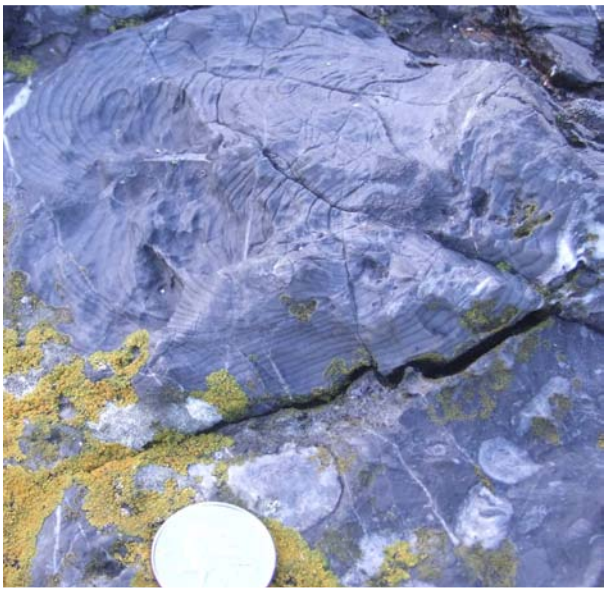
Location: Devonian Limestone exposed in a cave system. In Ilsham Road, Wellswood, to the northeast of Torquay town centre.
Ordnance Survey 1:50,000 Sheet 202. National Grid Ref: SX 934 641

Natural caves formed in Devonian Limestone by water solution. Spectacular geology and cave formations in a location particularly famous for its significant prehistoric human finds as well as associated fossil remains of sabre toothed cat, mammoth and woolly rhinoceros.

The site at Kents cavern is dealt with in the 'Geology in Devon' booklet reference 19, page 27 and www.devon.gov.uk/geo-DAD.pdf. See also the Educational Register of Geological Sites; Torbay Site 7 (www.devon.gov.uk/educational_register.htm).

Kents Cavern is a scheduled Ancient Monument. The site is managed by Kents Cavern Ltd. See www.kents-cavern.co.uk for opening times and admission charges and guided tours. The site includes car parking and visitor facilities including a restaurant, shop and licensed bar.

5. PHOTOGRAPHS



Stomatoporid mound with sections through solitary corals in foreground - old quarry floor at Hopes Nose, Torquay. © DW Allen

Broken corals weathering out from old quarry floor in Torquay Limestone Formation - at Hopes Nose, Torquay. © DW Allen

Cliffs in Torquay Limestone (Daddyhole Member) with steeply dipping limestone beds, at Daddyhole Cove, Torquay. © DW Allen

Moorcroft Quarry in Plymouth Limestone, east of Plymouth at Elburton. City Centre and Plymouth Sound far left. © Aggregate Industries

Sections through solitary corals and occasional brachiopods., at Triangle Point, Torquay. © DW Allen

Ashburton Marble, used as a building stone at County Hall, Topsham Road, Exeter