

Down to Earth

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Freeze and thaw

In the Pleistocene period the world's continents were in the same places they are today, but Devon's landscape looked very different.

During the ice ages, hard frosts shattered the granite outcrops on Dartmoor creating the split rock of the tors. In the warmer periods between ice ages, low scrub or grass covered the land. To the north, ice sheets melted releasing massive amounts of water into the sea. You can see the remains of ancient beaches high above the shore at Hope's Nose, Torquay. They show that sea levels were much higher than they are today.

The limestone country south of Dartmoor has many caves containing the fossils of carnivorous mammals and their prey.

About 500,000 years ago the first humans arrived in Devon. The only traces of their lives are hand axes made from flint. Many of these simple tools have been found around Broom Gravel Pits, near Axminster. These early people did not settle. They moved across Europe following the migrating mammals.

Pottery with a mysterious past

Pottery has been produced in North Devon since the 13th century. By the early 17th century the potteries of Barnstaple and Bideford were exporting their wares to Europe and the Americas. Popular types of Victorian pottery included Barum Ware from Barnstaple and the products of the Fishley Pottery at Fremington. This industry relied on local clay deposits that had formed during the ice ages.

Some clays began as sediment on lake beds. Boulder clay was created by glaciers. As the glaciers travelled across older rocks they rubbed off tiny particles. When the ice melted these were deposited as clay. The colour of the clay varies according to the type of rock. Sandstone clays are red, chalk clays are whitish.

Devon's boulder clays contain pebbles and even large stones. Were these stones carried by glaciers? Most geologists think that ice age glaciers did not reach as far south as Devon. So the origins of the local boulder clay that was used by Devon potteries remain a mystery.

Shaped by wind and rain

Bovey Basin and Lundy are two very different kinds of landscape that began to take shape about 65 mya.

As the Atlantic Ocean opened up, fractures in the Earth's crust allowed molten rock, or magma, to rise. When the magma cooled it formed masses of hard granite rock, like Lundy. In other places the land subsided creating lowland areas like Bovey Basin.

Small lakes and huge river systems formed in the basins. Fine particles of rock were washed down from the exposed outcrops on Dartmoor. These particles settled on lower ground. In the humid climate they hardened into clay. The warm, wet weather eroded the soft Cretaceous chalk leaving behind lumps of flint. Dead leaves and plants carried into the lakes created layers of sediment. These solidified into lignite, a kind of coal.

Tobacco pipes and teacups

In the Tertiary period a fine white clay formed in Devon's lowlands. This clay has been used for centuries to make many different products. It was cut from the ground in cubes. After the cubes had been stored and handled, they became rounded like footballs, so the clay was called 'ball clay'.

Devon is one of the best sources of ball clay. In the 17th century it was used to make clay pipes for the new fashion of smoking tobacco. Clay from North Devon was shipped from Bideford to pipe-makers in Bristol.

Ball clay was also one of the ingredients in an artificial stone called Coade Stone. This was first produced in 1770. It was used for architectural features in buildings such as Buckingham Palace and statues, like the lion on Westminster Bridge, London. Today ball clay is used in industry to make tiles and toilet bowls, china jugs, teacups, plates and electrical insulators.

Sea life turned to stone

Why are the cliffs of East Devon so full of fossils? These fossils come from a time between about 208 to 146 mya. Sea levels rose. The area that is now East Devon was covered by warm waters. This is known as the Jurassic period.

Animals evolved rapidly to take advantage of new habitats. Sea creatures like ammonites flourished.

The top predators in the sea were big reptiles such as plesiosaurs and ichthyosaurs. The dolphin-like ichthyosaurs had large eyes for hunting in the dim light of deep water. Dinosaurs roamed the land.

Between about 146 to 65 mya movements of the Earth's crust tilted the Jurassic rocks. You can see these slanting layers in cliffs along the Jurassic Coast World Heritage Site.

During this phase of the Earth's formation, which is known as the Cretaceous period, the sea advanced westwards. Dartmoor became an island and sandy beaches covered parts of Devon. In well-lit, shallow water lived sea urchins, ammonites and many millions of tiny creatures. As they died their shells carpeted the sea bed in thousands of thin layers. These layers became the pale chalk cliffs at Beer.

Churches and carving knives

The rocks that formed in Devon on the Jurassic and Cretaceous sea floor have been used for different purposes, from building churches to sharpening knives.

Beer stone is a creamy white limestone named after the village of Beer. It has been quarried here since Roman times. When first extracted, Beer stone is easy to carve, but it hardens when exposed to air.

Parts of Exeter Cathedral, St Nicholas Priory and many medieval churches in Devon are built from Beer stone. It was also used in St Paul's Cathedral and Westminster Abbey in London.

Greensand was quarried in the Blackdown Hills. It has porous and abrasive qualities that make it perfect for whetstones. Whetstones are used for sharpening tools like knives, scythes and sickles.

Large lumps of hard greensand were dug from the hillside. They were roughly shaped with a 'basing axe' then ground to a smooth surface. Known as 'Devonshire Batts', these whetstones were shipped in large quantities to other parts of England.

Red is the colour

What gave the cliffs of South Devon their deep red colour? Their story begins between 290 and 208 mya when the climate was hot, like the Middle East and North Africa today. Wind, heat and rain eroded granite outcrops and the older rocks around them. The land nearby was buried under layers of sand and gravel. Streams of volcanic lava ran across it. The desert climate changed the iron in the rocks into a red mineral called iron oxide.

The wind piled up sand dunes. Rivers fed by floodwater spilled into the desert, creating vast lakes. In the vegetation that grew near the water lived plant-eating reptiles such as rhynchosaurus.

In the cliffs near Budleigh Salterton you can see layers of pebbles. These stones were carried along in strong river currents from northern France.

Part of the cliff face at Coryton's Cove between Dawlish and Teignmouth was once a sand dune 20 metres high.

Stones of Exeter

When you walk around the centre of Exeter you'll see buildings made from purple-red stone. Sometimes the stone is streaked with white veins, sometimes it contains lots of tiny holes. This is a volcanic rock called basalt which is known locally as 'trap'.

As lava from volcanoes cooled and solidified, bubbles of gas formed holes. Veins of minerals later crystallised in thin cracks in the rock.

Trap was quarried in the Exeter area. It was used to build parts of this museum as well as Exeter's city wall and Rougemont Castle.

Breccias are another type of Devon stone that formed in the Permian desert. Breccias consist of bits of rock, sand and gravel washed down from high ground by flash floods. They are found between Paignton and Teignmouth and around Exeter and Crediton.

Breccias were quarried at Heavitree in Exeter. You can see where they were used to repair the city walls, as well as in medieval churches and houses in Cathedral Close and High Street.

Hot rocks

How was Dartmoor granite made?

Between about 300 and 290 mya rocks that had formed on the sea floor from corals, sand and mud were squeezed, folded and fractured. They were gradually lifted high above the water to create mountain chains. At the same time, intense heat and pressure caused by these movements made deeper parts of the Earth's crust melt. This allowed molten rock, or magma, to rise from inside the Earth. The magma baked the surrounding rocks.

As the magma cooled it became solid, forming an enormous mass of hard granite. This is called a batholith, meaning 'deep rock'. A batholith stretches beneath Devon and Cornwall to the Isles of Scilly and beyond. Hot fluids ran along underground fractures carrying elements to the surface like tin, copper, arsenic, gold and silver. As the fluids cooled, these elements formed crystals in the rock. This is why Dartmoor's granite landscape is so rich in the metallic ores which were later important for Devon's economy.

Mineral riches

For centuries Devon's mineral wealth supported a thriving mining industry. Tin was mined in large quantities as well as copper, arsenic and iron.

People found tin in Dartmoor streams more than 2,000 years ago. By the 12th century, miners were digging for metallic ores. These are the rocks from which metals are extracted by crushing and heating.

When all the mineral deposits on the surface were used up, miners dug deep tunnels. You can find the remains of mines and miners' cottages all around Dartmoor. There are ruined engine houses where steam engines once pumped water out of the mines, and blowing houses where furnaces powered by giant bellows heated the ore to melt the metal.

China clay, or kaolin, is produced when granite is slowly weathered by acidic gases and water heated deep inside the Earth's crust. White, powdery china clay has been extracted in Devon since the early 19th century. It is used for manufacturing many products including paper and porcelain, fertilisers, rubber, textiles and toothpaste.

Naming the past

Before the 19th century most people in Europe believed that the Earth was created exactly as described in the Bible, about 6,000 years ago. Then geologists realised that the fossils of plants and animals they discovered in rocks could be hundreds of millions of years old. By studying rocks they were able to work out how and when the Earth was formed.

Geologists gave names to the different stages of the Earth's development. 'Devonian' was the name they gave to the early phase when the reefs flourished. This was because they found so many fossils from this period preserved in the rocks of Devon.

In the 1830s geologists like Adam Sedgwick, Sir Roderick Murchison and Sir Henry De la Beche could not agree how old the Devonian rocks really were. Their arguments made people look more closely at the evidence. Today geologists agree that the Devonian period lasted from around 409 to 359 mya. It was followed by the Carboniferous period between about 359 and 300 mya.

Out of tropical seas

The phase of the Earth's development that began about 409 mya is called the Devonian period. Underwater volcanoes erupted. Mounds of lava grew into islands. On the sides of volcanoes and sand bars in shallower waters, reefs teemed with life. The climate was like the Bahamas today.

The ancient reefs hardened into limestone which you can see in the grey cliffs of Torbay. On the dimly lit sea bed, sand and mud covered the bodies of dead sea creatures, like trilobites. Gradually the shapes of these life forms turned into fossils, becoming part of the rock.

By about 359 mya the Earth's formation was entering a new phase known as the Carboniferous period. Mountains were forced upwards. The sea became deeper. In the cliffs of Hartland Point in North Devon you can see where layers of rock were slowly folded like a concertina.

Rivers ran through swampy woodlands carrying dead plants into the sea. A rock called chert contains the glassy skeletons of tiny creatures that drifted down to the sea bed through clear, deep waters.

Building with ancient mud

Slate is a fine-grained stone. It splits easily into thin plates, like the pages of a book. Overlapping slates are used for roofing and on walls to keep out the rain.

Slate is what geologists call a metamorphic rock. It was formed by heat and pressure inside the Earth's crust. Devon's slate began as mud, washed down from the land into the sea where it piled up on the sea bed.

Scattered through the mud were minerals such as mica, which settled in layers. These layers make slate easy to split, as well as creating beautiful specks of silver in the grey surface.

Slate has been quarried in South Devon for more than 800 years. There were quarries near Plymouth, Tavistock and Ashburton. Not far away in Cornwall is Delabole quarry.

Devon slate was used on many buildings near the South Devon quarries as well as the 'Tudor House' in Exeter. Today old Devon slates, like the examples here, are often replaced by cheaper slates from abroad