CAVE GEOLOGY

Limestone and Cave Formation

Limestone

Limestone in South Wales was formed around 330 million years ago in warm, shallow, tropical seas near the equator. The bodies of sea creatures and corals sank to the bottom and were crushed by the weight of both water and the build up of more bony remains. Seas at that time would have been teeming with life.

As the limestone was beginning to form, it would have been laid down continuously over a long period in what are called 'beds'. There would then have been a change in conditions where a different material would have been laid on top of the limestone bed – this might have been organic matter which results in a layer of shale, material washed into the sea from a river delta, volcanic ash or lava from an eruption, or just a period of reduced sea life. In time, conditions returned to normal and the next bed of limestone would have begun to form. The layer between the two beds is called a 'bedding plane'.

Bedding Plane Bed Joint

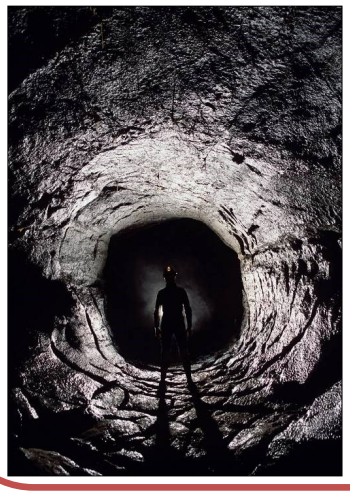
So how did the Limestone get from the Equator to here in Wales ? Tectonic plate movement would have meant that the limestone was carried across the surface of the Earth to end up here. It is still moving incredibly slowly, though we can't tell. During it's journey, it has been uplifted from under the sea to become a part of the land mass, a process called Orogeny, and the stresses created during this journey have caused cracks in the limestone called 'Joints'. These become important later for the formation of the cave in the limestone.

Cave Formation

When it rains, the water collects Carbon Dioxide from the atmosphere and from organic matter in the soil above the limestone, forming a weak Carbonic Acid. This moves quickly down through the Joints until it reaches the bottom of the Joint at the top of the next bed of limestone. It then moves slowly across the top of this limestone bed, dissolving the limestone that it comes into contact with there, forming the first tiny tubes.

The flow may follow the direction of the joint above or may travel 'downhill' along the bedding plane between the beds. Limestone, whilst laid down horizontally, has become tilted during it's journey across the Earth's surface and this tilt, or Dip, allows water to travel 'down-dip'.

As the weak acid continues to dissolve the Limestone, the size of the tubes become larger, forming the first small passages and as the speed of water flowing increases, abrasion begins to add to the process as well as the chemical reaction of the limestone with the carbonic acid. This abrasion is caused by the sand, grit and small stones carried by the water.



Phreatic Passages

These first passages are filled with water and the passage forms all the way round it's diameter, these being called Phreatic Passages

Cave Formation Equation

Carbon Dioxide C02 +
Water H20

↓

Carbonic Acid H2C03 +
Calcium Carbonate CaC03

↓

Calcium BiCarbonate
(dissolved Calcium Carbonate)
Ca2+ + 2HC03-

Vadose Passages

As the water levels fall over time, the passages drain of water leaving it flowing only at the bottom of the passage and the limestone dissolution now occurs there only, forming the classic keyhole shaped Vadose Passages.

Formations within Caves

As water droplets fall from the roof of a passage, they are now carrying dissolved limestone in the form of Calcium Bicarbonate. Each drip of water can leave a deposit of Calcium Carbonate behind, which in time can form Cave Formations such as Straws or Stalactites. As the drip reaches the floor, remaining Calcium Carbonate can be deposited to form Stalagmites. So, as the water drips, the Calcium Carbonate is deposited in a pure mineral form, the Water continues to the floor and Carbon Dioxide is released into the air of the cave.

Speleothem Formation

Calcium BiCarbonate Solution $\longrightarrow$ Carbon Dioxide + Calcite + Water

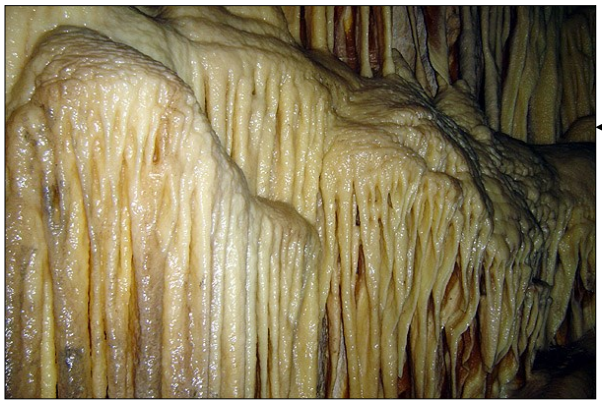
$Ca2 + 2HC03- \longrightarrow C02 + CaC03 + H20$

Stalactites

Stalagmites

Straws

Curtains



Flowstone

Cave Pearls

Gour Pools

Helictites

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Resource prepared by Gary Evans (CIC). Resource production funded by NRW in partnership with the SWOAPG Environmental Charter.
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