# Teachers Fact Sheet No 3
# Speleothems

Geologists refer to cave formations as **speleothems**, derived from the Greek words *spelaion,* meaning 'cave', and *thema,* meaning 'deposit'.

Speleothems are crystalline formations that grow by continual deposition. The composition of a speleothem will depend on which soluble rock the cave is formed in and the chemical processes responsible for its growth.

## Chemical formation

As cold rainwater falls through the atmosphere it absorbs oxygen and carbon dioxide from the air.

When the rain finally reaches the forest floor it begins to seep through leaf litter, absorbing **humic acid**, a complex mixture made up of many different acids, and additional carbon dioxide absorbed from the soil, which forms another weak acid called **carbonic acid,** $H_2CO_3$.

As this continues to make its way into the earth, following small cracks in the dolomite, it dissolves small amounts of dolomite. The dissolved dolomite (**calcium magnesium carbonate**) is added to the solution, now creating **calcium magnesium bicarbonate** and **calcium carbonate**.

In the process of becoming calcium bicarbonate underground, the solution becomes slightly pressurised. When it reaches the open air, the pressure is relieved by releasing the carbon dioxide (the release of the carbon dioxide is similar to what happens to carbonated soft drink when it gets warm and goes flat). In doing so, it can no longer hold the calcium carbonate in solution and must release it as well. Magnesium bicarbonate remains in solution but when the calcium carbonate leaves the solution, it crystallises into calcite (CaCO3) and encases the upper surface of the water drop. There is often still some calcium carbonate left in the water. When it drops and hits the floor, the impact forces most of the carbon dioxide to leave the solution.

Over many thousands of years, layers of calcite deposits build up on the ceilings, walls, and floors of the cavern wherever droplets form or land, creating a variety of formations. The shape of the speleothems is determined by the speed and different ways in which water enters the cave. Dripping water will create formations that are a different shape to those formed from splashing or seeping water.

## Rate of growth

Several factors affect the rate of growth for cave formations. The temperature outside, which affects the rate at which plants decay in the soil (and therefore the amount of carbon dioxide/carbonic acid in the soil), and the amount of rainfall are the two most important factors. From year to year the growth rate may change, even from one formation to another in the same area of a cave. The period of most rapid growth was actually about 130,000 years ago, during a particularly warm and wet period. Today the cave is much drier and growth is commensurately slower. Measured rates range from several millimetres a year to <0.01mm a year.

## Colours

The purest forms of calcite deposits are clear to a translucent white. Most Hastings speleothems have a solid cream/white appearance. When formations have hues of other colours, such as creams and reds, it is mostly due to organic materials in solution resulting from the breakdown of organic matter on the surface, or from other minerals crystallised at the same time as calcite.

## Pollution

The crystalline structure of speleothems can be very porous, making them vulnerable to damage if people touch them. The natural oils in our skin will leave a light coating of oil on the formation. While one touch has only a minimal effect, many deposits of oil over time prevent any further growth. When calcium solution runs over the formation it normally leaves a

layer of calcite behind. However, the human oils create a coating that the calcite cannot cling to. In a sense, the formation is now dead. We can see this same effect when washing a car that is waxed – the water beads up and runs off. Therefore it is very important that people do not touch any surface in a cave.

## Forms of speleothems

### Stalactites (Greek *stalaktos*, 'dripping')

Stalactites are usually formed when straws become blocked at the bottom. Solution enters the cave around the upper rim of the straw and flows down the outside of the straw.

### Stalagmites (Greek *stalagmos*, 'dropping')

Stalagmites are usually left behind by water falling from the ceiling of the cave, as drips hit the floor, carbon dioxide is released and this causes crystal to form where the drip has landed. Over time with the repetition of drips, a mound will build up on the floor, this is a stalagmite. Dripping water will create formations that are a different shape to those formed from splashing or seeping water. The nature of their growth means that a stalactite may possibly grow in length faster than a stalagmite will grow in height. However, a stalagmite that forms from solution dropping from the ceiling will most likely be wider than the stalactite above it.

There are two easy ways to help you **remember** the difference between a stalactite and a stalagmite

- Stalactite is spelt with a '*C*' for ceiling. Stalagmite is spelt with a '*G*' for ground.
- A stalactite holds 'tite' to the ceiling. A stalagmite 'mite' reach the ceiling some day.

### Straws

Straws are the building blocks for the development of stalactites. When droplets of solution enter and are suspended on the cave ceiling, carbon dioxide is realised into the cave's atmosphere. During this process calcite is deposited around the outer rim of the droplet. When the droplet is replaced with another droplet the process continues, eventually building a hollow tube of calcite.

### Column

Usually a stalagmite is directly below a stalactite. Over much time they may finally meet. As calcite runs down the stalactite, it now continues to run down the connected stalagmite, smoothing the connection point. Some columns have been together for so long it is hard to tell where the two formations first joined.

### Flowstones

Flowstones are formed through a similar process to the construction of a stalagmite. However, the area receiving the deposit is sloped; as the water runs down the slope carbon dioxide is released from the solution, depositing calcite as it goes.

### Shawls/drapery/bacon strips

When a water drop emerges on a vertical wall, gravity drags it down the side of the wall depositing calcite in a line.

Each additional deposit builds up this fine line until it looks like hanging material. Draperies with red hues, caused by humic acid and minerals in the calcite solution make them look like bacon strips.

### Rimstone Pool

Depressions in the cave floor may collect saturated water. The calcium in the solution will deposit around the edge of the pool. Eventually the deposits build up so high that more and more water can be held. The calcite deposits act as a dam.

### Helictites

**Helictites** are, perhaps, the most delicate of cave formations. They are usually made of needle-form calcite. They can be easily crushed or broken by the slightest touch. Because of this, helictites are rarely seen within arm's reach in tourist caves!

The growth of helictites is still quite enigmatic. Until now, there has been no satisfactory explanation for how they are formed. Currently, formation by capillary forces is the most likely theory, but another theory based on wind formation is also viable.

A helictite starts its growth as a tiny stalactite. The direction of the end of the straw may wander, twist like a corkscrew, or the main part may form normally while small helictites pop out of its side like rootlets or fishhooks.