Salt

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GCSE key words
Ions
Uses of sodium chloride
Electrolysis

Charles D. Winter/SPL

Salt crystals

The lowest freezing temperature of water which can be obtained by dissolving salt in water is called the eutectic point and is –21 °C. (This is the basis of zero on the Fahrenheit temperature scale.)

We need salt (sodium chloride) in our diets to survive, but too much can be toxic. Where does it come from, and what is it used for?

Deep under the Cheshire countryside there are vast deposits of solid sodium chloride (salt). These were laid down on the beds of ancient shallow seas which used to cover this area of Britain 225 million years ago. The salt deposits stretch for many kilometres and are at least 24 metres thick and up to 150 metres underground.

Mining in Cheshire

Shafts are sunk into these salt beds from the surface so that the salt can be mined. The salt is a dense solid which is slightly orange-coloured (due to traces of iron oxides). The salt is structurally very strong so it can be dug out without the need for too many supports to keep the roof up.

The salt is mined by blasting areas of it with explosive and then cutting out the remaining pieces with huge cutting machines (which resemble large hedge trimmers). The large lumps are crushed underground before being raised to the surface using lifts.

The impure salt mined in this way is spread on roads in cold weather to prevent any water from freezing. Remember that impurities, such as salt, dissolved in water reduce its freezing point, hopefully below the temperature of the surrounding air and road surface, and so the water on the road will not freeze.

TopFoto

Cutting rock salt at a mine in Cheshire

Right: *Mine buildings at Boulby in North Yorkshire*

James King-Holmes/SPL

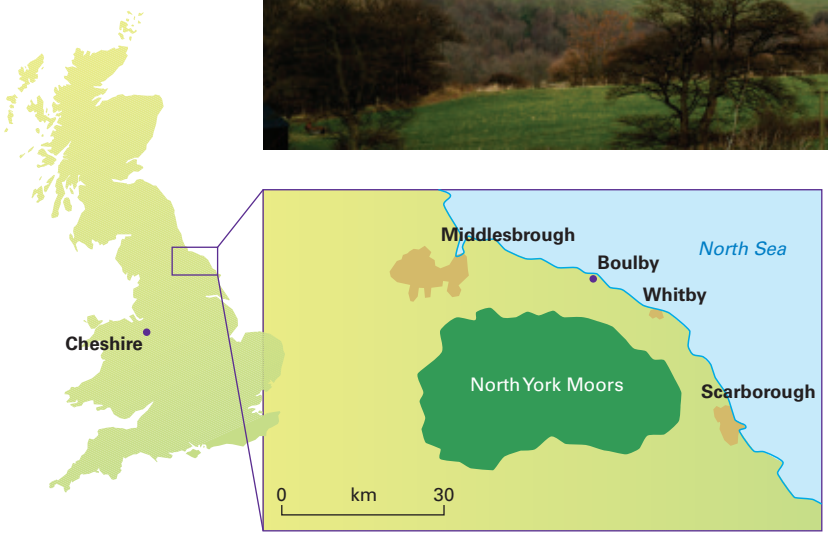

Figure 1 *Map showing the locations of Cheshire and Boulby*

Over the years many areas of Cheshire have been subject to subsidence. Ancient underground salt workings have collapsed resulting in the land above them slumping into the hole that is formed. Newer methods of mining are designed to prevent this from happening.

Mining at Boulby

The preserved bodies of prehistoric salt miners who met with accidents have been found in Austria. Salt prevents bacterial decay so the bodies still have flesh, hair and clothes.

Salt is also mined at Boulby, near Whitby, in North Yorkshire. Boulby is the site of one of the deepest mineshafts in Europe. Sodium and potassium chloride are brought up from beds 1100 metres below the surface. Mining is continuous and about 60 000 tonnes of potassium chloride and 12 000 tonnes of sodium chloride are dug out each week.

Potassium chloride is mostly used in the manufacture of fertilisers, although a small amount is used for making television and computer screens.

Box 1 Dark matter

Scientists are using Boulby mine to look for 'dark matter'. This matter, which is thought to make up nearly 90% of the total mass of a galaxy, has no detectable radiation or absorption. A 200 tonne tank of water at the bottom of the mine is being used to try to detect this matter as a new type of heavy neutral particle.

Look for salt content guidance information on packet food from major supermarkets.

Solution mining

The technique of **solution mining** is used to obtain pure salt for industrial use. Three concentric tubes (one inside the other) are sunk through the ground into the salt beds. Hot water and high pressure air are passed down two of the tubes and a concentrated solution of salt emerges from the third. Many impurities are left deep underground.

The concentrated solution of salt is pumped to storage ponds before being piped into factories where it is turned into useful chemicals. This method creates large pear-shaped cavities in the salt beds. These are left full of solution in order to stabilise the cavities and prevent them from collapsing.

The salt produced by this technique can be used for cooking and flavouring purposes, but it has to be made especially pure before it can be consumed by humans. To do this the salt is purified by dissolving it and then recrystallising it in specially designed tanks. Different shaped crystals can be obtained by varying the conditions of temperature, pressure and the amount of stirring of the crystallising mixture. The slower the crystals are allowed to grow, the larger the crystals become. Box 2 describes the role of salt in the body.

Box 2 Salt in the body

Salt helps to maintain the correct water balance in the blood. When dissolved, the sodium and chloride ions also play a major part in initiating and transmitting impulses along nerves and in muscle action.

Excess salt in the diet can cause fluid retention (oedema) and may contribute to high blood pressure. Loss of salt from excess sweating due to exercise or hot weather can cause heat exhaustion. The World Health Organization recommends we consume a maximum of 5 g of salt a day, but in the Western world our intake is often up to 15 g a day.

Box 3 Useful websites

- Read about mining salt in Cheshire by logging on to Northwich Salt Museum's website: www.saltmuseum.org.uk
- Boulby mine is described at: www.mining-technology.com/projects/boulby
- The search for dark matter at Boulby mine is illustrated at: http://hepwww.rl.ac.uk/ukdmc/pix/boulby.html and described at: http://news.bbc.co.uk/1/hi/sci/tech/2981837.stm
- You can find out about how salt used to be purified at: www.lionsaltworkstrust.co.uk

Box 4 Modelling the structure of salt

Obtain equal numbers of red and green cocktail cherries. Lay them out in a 3 by 3 grid on a table so that they are alternately red (corresponding to sodium ions) and green (chloride ions). If they are touching, the natural stickiness should keep them together. Enlarge your model by putting a layer of cherries on top of the first layer – still ensuring that opposite colours are on top of each other. A third layer can be added to make a regular cube.

Salt crystals also form in a cube shape – this is because the sodium and chloride ions are approximately the same size and so stack on each other easily. If you look at crystals from a salt pot (or crystals of sea salt) you will see the cubic shape.

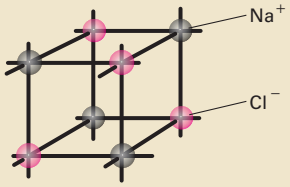

Figure 2 *Structure of salt*

Industrial uses

Salt solution is very important industrially as it can be used to produce a wide variety of chemicals. Electrolysis of the solution allows it to be split into chlorine, sodium hydroxide and hydrogen. These chemicals can then be reacted further to produce other useful chemicals, such as calcium and sodium hypochlorite, sodium chlorate, sodium sulphate and hydrochloric acid.

Molten sodium chloride can be electrolysed to make sodium and chlorine. This is called the **Downs process**. Sodium chloride is also used in metallurgical processes (e.g. for heat treatment baths), as a preservative (e.g. for cheese making and curing food) and in other industrial processes (e.g. for regenerating ion exchange columns, as a dehydrating agent and for glazing tiles).

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A salt is a compound formed by the reaction of an acid with a base. Sodium chloride is often just called 'salt', although it is really a specific example of a salt.

Chemicals made from salt

Puzzle

Match the pictures with the chemicals. Use the internet to find the connections.

Chemicals

1 Hydrogen
2 Sodium
3 Sodium hypochlorite
4 Chlorine
5 Sodium hydroxide

Answers on page 21.