

HARD & SOFT WATER



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This factsheet was written for primary school students aged 9-11 as part of the BBC 'Terrific Scientific' schools initiative. A factsheet for teachers and a general audience is also available on the website:

www.geolsoc.org.uk/waterhardness



Left: Soap bubbles in soft water
Right: Limescale in a kettle after boiling hard water
© Henna / Wikimedia

Have you ever noticed that tap water tastes different depending on where you are? Have you ever seen a white coating inside your kettle or the shower head, or found that the shower gel won't lather up? All these effects are caused by differences in the 'hardness' of the water.



Hard water: good or bad?

The good:

- Some minerals in hard water contain **calcium**, which is good for healthy bones and teeth.
- Some people think it tastes better.

Hard and soft water

Hard water is water that contains dissolved **minerals**. Minerals are the materials that make up rocks. Water containing less minerals (for example rainwater) is known as **soft water**. In the UK, both hard and soft tap water is safe to drink.



The bad:

- When some hard water is boiled, the dissolved minerals become solid again and form a hard white layer called '**limescale**'. This blocks pipes and stops kettles working so well.
- Hard water forms '**soap scum**' instead of bubbles when detergent or shower gel is added. This makes washing more difficult, and uses more soap.

How does hard water form?

When rainwater falls it soaks into the ground and flows slowly down through the soil and eventually into the rocks beneath us. Some of the minerals in these rocks mix with rainwater in the same way that sugar mixes with tea, by separating into particles too small to see. This process of **dissolving** in the water forms a **solution**. Minerals which do this are called '**soluble**' minerals. Other minerals that don't dissolve are '**insoluble**'.



Cracks in the rocks grow as soluble minerals dissolve, and after many years may form caves big enough to walk around in. As the water evaporates, the newly solid minerals form beautiful shapes.

Photo: Marble Arch Caves, County Fermanagh, Northern Ireland © Robert Mulraney

DID YOU KNOW?



Calcium is found in the skeletons of animals (including humans) and is essential for strong bones and teeth. When animals die, all that usually remains are their skeletons. Some rocks contain calcium minerals because they are formed from the **fossils** of ancient animals (find out how on the next page). Hard water found in these rocks often contains lots of dissolved calcium.

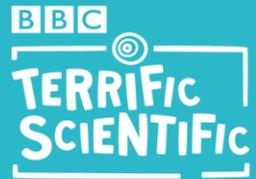
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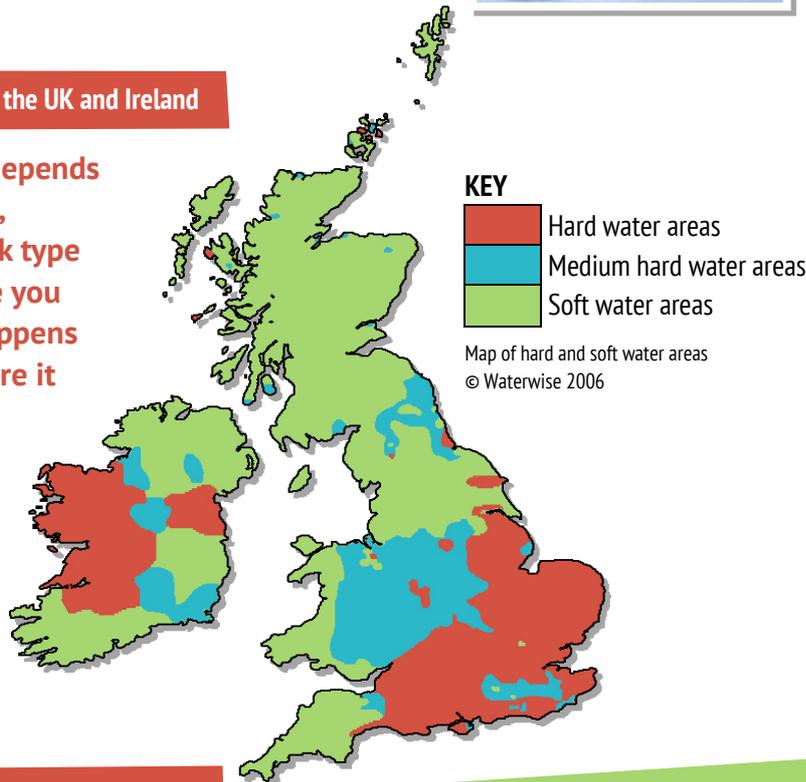
Testing for hard water

- A simple way to test your water hardness is by adding soap. The more soap needed to make bubbles the harder the water.
- You can also use test kits to measure the dissolved calcium. The map below shows how water hardness varies across the UK and Ireland.



Hard and soft water in the UK and Ireland

Water hardness depends on several things, including the rock type in the area where you live, and what happens to the water before it reaches your tap.



Hard water areas

In much of England and Ireland, tap water is pumped out of underground **aquifers** (rocks storing water in cracks and gaps). This is known as **'groundwater'**.

The rocks in some areas are **chalk** (south east England) and **limestone** (Yorkshire), which are made up of soluble minerals. The water is soft when it falls as rain, but often stays underground for long enough for minerals to dissolve from the chalk or limestone, forming hard water.

Soft water areas

In other areas, such as much of Scotland and Wales, most of our drinking water comes from rivers, lakes and reservoirs. This is known as **'surface water'**. This water is **soft** because it has not been in contact with rocks for long enough for the minerals to dissolve.

Some rock types are **less soluble**, so even where drinking water comes from groundwater it may be softer because less minerals have dissolved. For example, the groundwater is often softer in areas such as Nottingham where the main rock is **sandstone**, which is made up of less soluble mineral grains.

Chalk, limestone and fossils

Hard water areas get groundwater from chalk or limestone rocks.

- **Chalk** is the white rock that forms the 'white cliffs of Dover'. It is soft and can be used to draw on a blackboard.

- **Limestone** is a harder grey rock which can form spectacular caves, some of which are open for the public to explore.



Chalk cliffs at Seven Sisters, Dover, UK

Both these rocks are made of soluble **calcium** minerals, which formed millions of years ago from the skeletons of sea animals. After the animals died they sank to the seabed and the soft parts of their bodies rotted away. Their hard skeletons were buried and eventually turned into **fossils**.



Fossil Ichthyosaur (marine reptile) skull found on the Jurassic Coast, UK

Why was part of the UK underwater?

Millions of years ago, the Earth's climate was warmer than it is today. Ice at the north and south poles had melted, so the sea level was higher. Chalk and limestone formed when parts of the UK were at the bottom of a shallow sea that covered much of Europe!



Sometimes it's not that simple!

Why you might get unexpected results if you test your water...

The water in your tap could have come from underground water nearby, or a reservoir further away. So even if you live in a 'hard water area', your water might be softer than you expect. One example is Birmingham, where water comes from reservoirs in Wales!