SCIENCE AT WORK

Earth Science

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Contents

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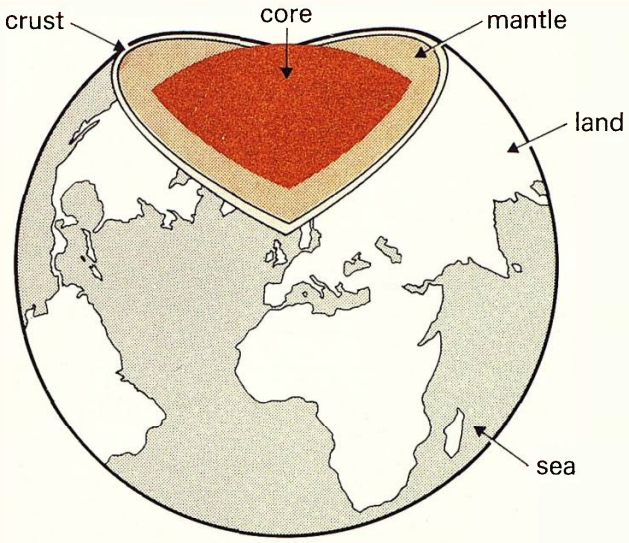
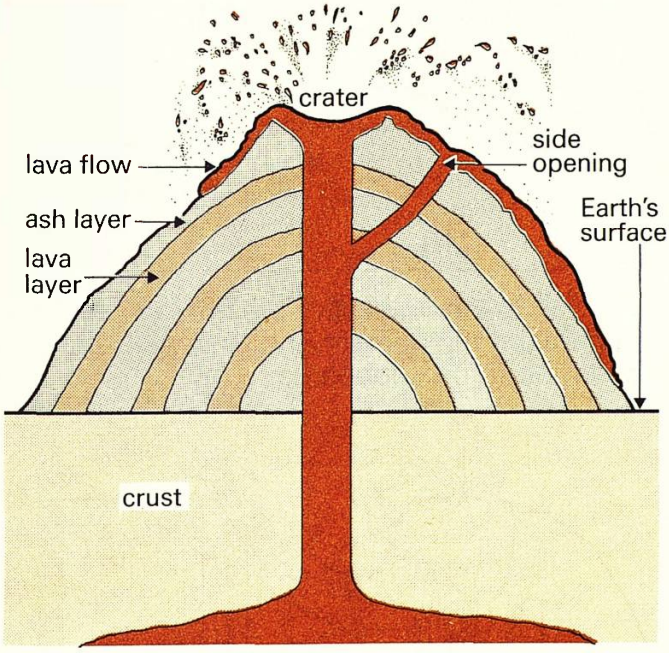
1 Earth structure

Information: The parts of the Earth



People who study the Earth are called **geologists** or earth scientists. They have discovered that the Earth is made up of three layers. At the centre is an extremely hot liquid called the **core**. On the outside there is a solid **crust**. In between there is a semi-liquid layer called the **mantle**.



Some parts of the crust are weaker than others. Materials from inside the Earth sometimes break through these weak parts, as shown above. When this happens a cone-shaped mountain or volcano is formed.

A volcano may be **dormant** (do nothing) for many years. Occasionally it may **erupt** with great force like the volcano above (Mount Hekla in Iceland). During an eruption red hot **lava** or **ash** may be forced out. These are made from the molten (melted) rocks inside the earth.

Q1 What does a geologist do?

Q2 How many layers is the Earth made from?

Q3 Describe the Earth's core.

Q4 What comes out of a volcano?

A model volcano

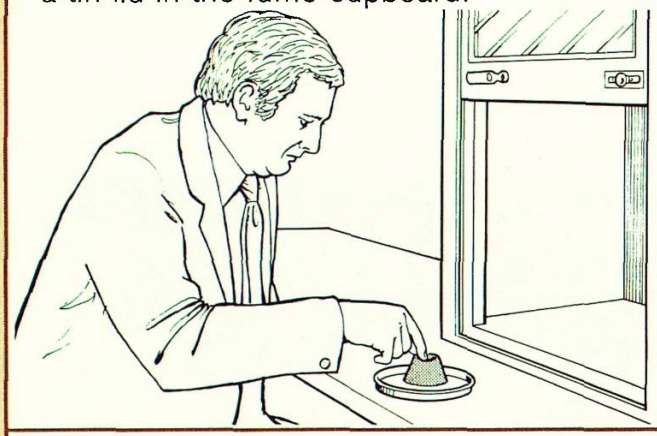
Apparatus

★ Bunsen burner ★ heatproof mat ★ large tin lid ★ plasticine
★ ammonium dichromate ★ spatula ★ safety glasses ★ metal rod
★ tongs ★ fume cupboard

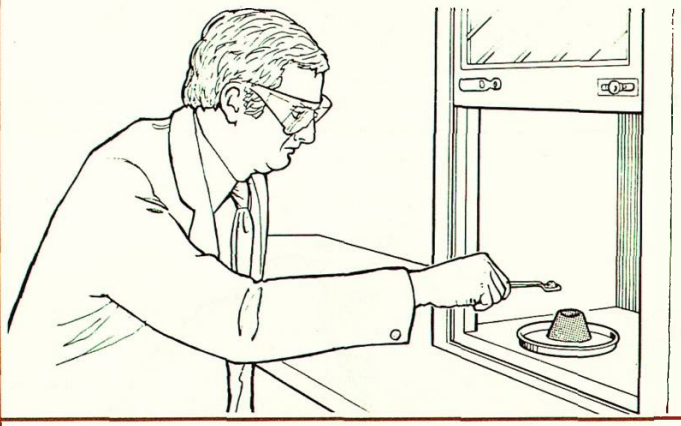
You are going to watch a model **ash** volcano erupting.

Your teacher will do this experiment for you in a fume cupboard.

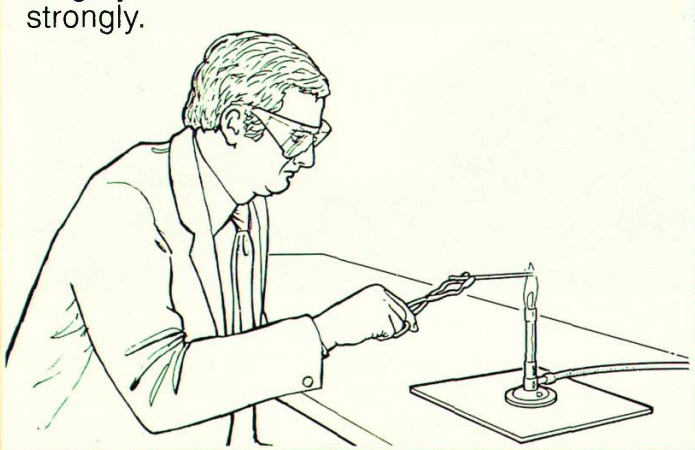
A Your teacher will make a plasticine cone and make a hole in the top. The cone is put on a tin lid in the fume cupboard.



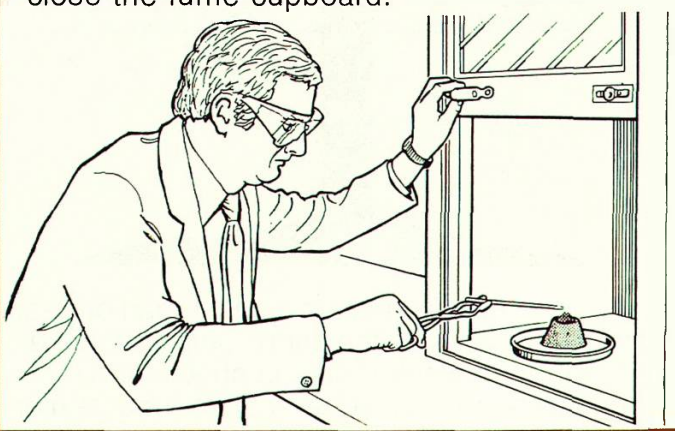
B Using a spatula, your teacher will fill the cone with ammonium dichromate and then put on safety glasses.



C Your teacher will light the burner. Using tongs your teacher will heat a metal rod strongly.



D Your teacher will stick the hot rod into the ammonium dichromate and then quickly close the fume cupboard.



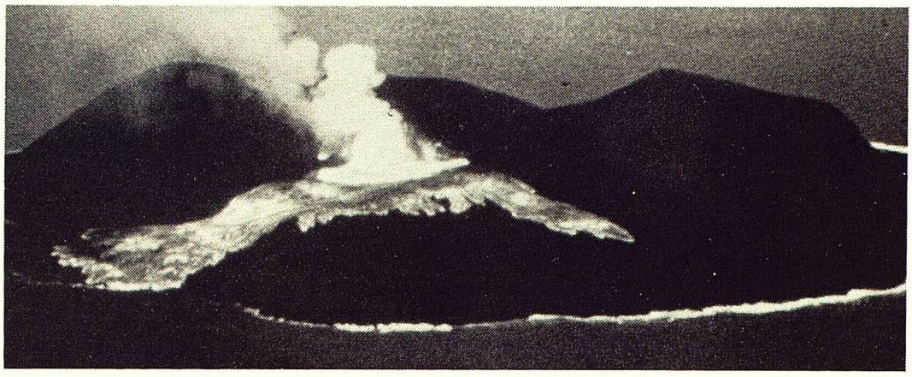
Q5 What happened when the hot rod was stuck in the cone?

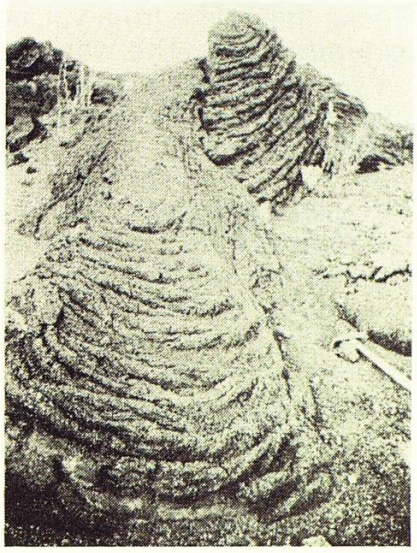
Q6 What type of material erupted from your volcano – ash or lava?

Q7 What was the shape of the volcano at the end?

Information: Liquid rock

Ash or lava may come out of a volcano. Sometimes lava can be a thin, runny liquid as shown below (Mount Helgafjeli in Iceland). At other times it is thick and lumpy like porridge and hardly flows at all. The thick lava is shown on the right (Mount Vesuvius in Italy). When lava cools it becomes solid rock.





Q8 What are the two types of lava?

Q9 What happens to lava when it cools?

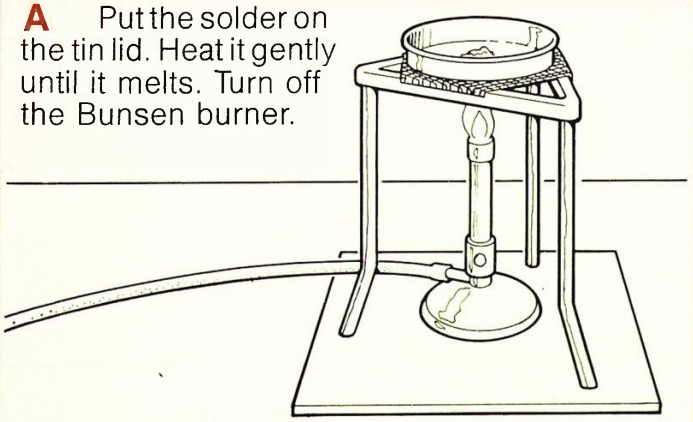
Liquid to solid rock

Apparatus

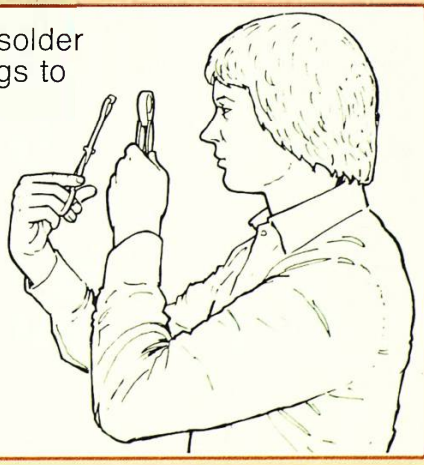
★ Bunsen burner ★ tripod ★ gauze ★ heatproof mat
★ tin lid ★ solder ★ tongs ★ hand lens

You are going to melt a solid, let it cool and examine it.

A Put the solder on the tin lid. Heat it gently until it melts. Turn off the Bunsen burner.



B When the solder is cool, use tongs to take it off the lid. Use a hand lens to examine the solder.



Q10 What happened to the solid when you heated it and let it cool?

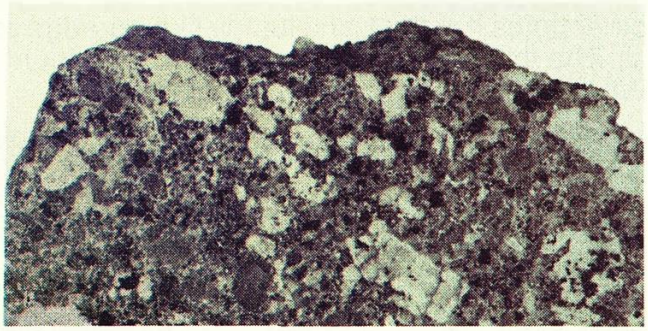
Q11 What could you see when the solder had cooled?

Information: Crystals and minerals

Rocks that come from volcanoes are called **igneous** rocks. The word igneous means that they 'come from fire' and were once molten. The photos show two igneous rocks – **granite** and **basalt**.

All rocks are made up of crystals. Crystals take a long time to form. If a rock cools down slowly, its crystals will be large. If a rock cools down very quickly, its crystals will be very small. The crystals may be so small that you cannot see them – even with a lens.

Granite



Basalt

Crystals can also 'grow' in very hot **solutions** of chemicals. The **quartz** crystals on the left were formed in this way.

In Earth Science the crystals that make up a rock are called **minerals**. Rocks are made from a mixture of minerals. One mineral found in granite is quartz. Basalt is a different mixture of minerals and does not contain quartz.

Q12 What does igneous mean?

Q13 Name two igneous rocks.

Q14 Which rock cooled more quickly – granite or basalt?

Q15 Name one mineral found in granite.

2 Sedimentary rocks

Breaking rocks

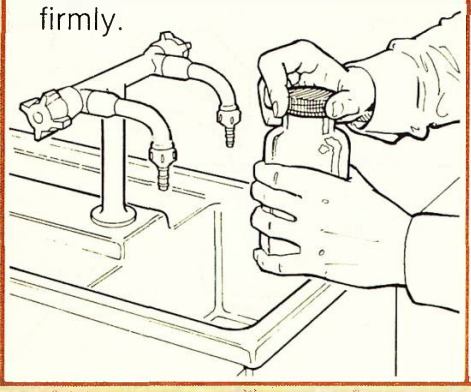
Apparatus

★ small glass bottle with screw top ★ plastic bag ★ wire tie ★ freezer
★ Bunsen burner ★ glass rod ★ tongs ★ safety glasses ★ safety screen
★ beaker of ice cold water

You are going to find out how rocks can be broken up by changes in temperature. You will use glass instead of rock.

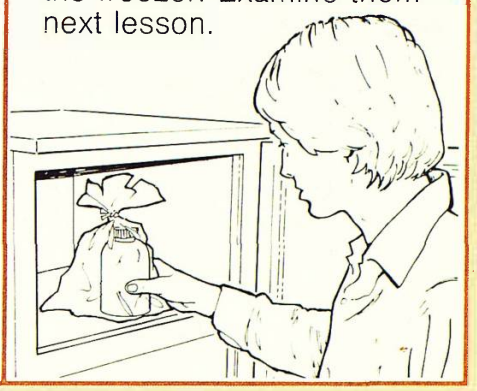
Freezing water inside a rock

A Fill the bottle to the top with water. Screw the lid on firmly.



B Put your bottle in the plastic bag. Tie up the bag.

C Put the bag and bottle in the freezer. Examine them next lesson.

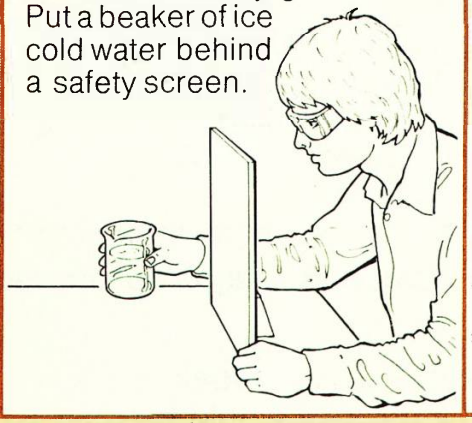


When water freezes it expands or gets bigger.

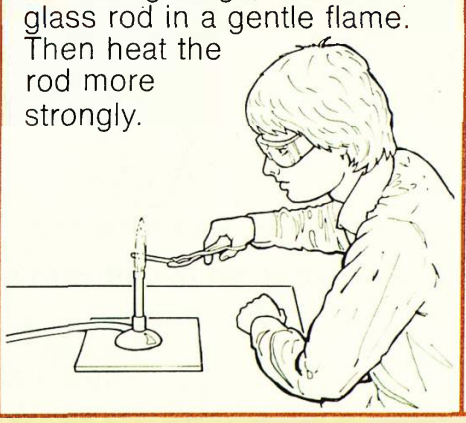
Heating and cooling rocks

Wear safety glasses and use a safety screen.

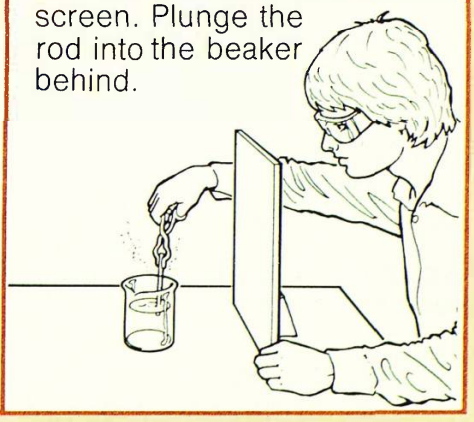
A Put on safety glasses. Put a beaker of ice cold water behind a safety screen.



B Using tongs, hold the glass rod in a gentle flame. Then heat the rod more strongly.



C Stand in front of the screen. Plunge the rod into the beaker behind.



Q1 What happened to the glass rod when it was plunged into cold water?

Q2 What happened to the glass bottle after freezing? Explain why this happened.

Acid on rocks

Apparatus

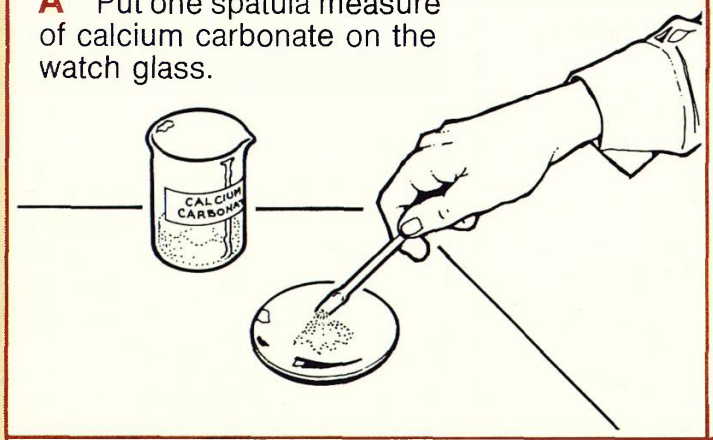
★ watch glass ★ calcium carbonate ★ spatula ★ dropper
★ beaker of acid ★ labelled samples of marble, granite, limestone, chalk, sandstone

You are going to find out how acid affects rocks made from **calcium carbonate.**

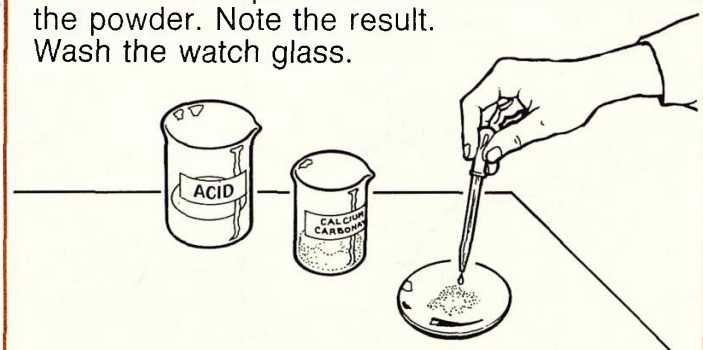
Q3 Copy this table.

Sample	Acid test:	
	fizzes	does not fizz

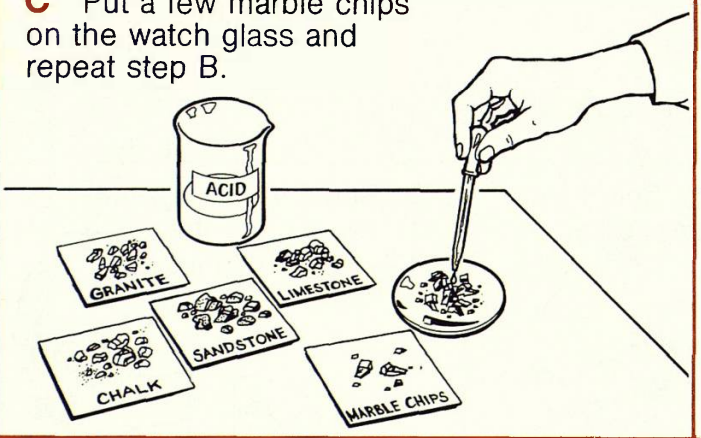
A Put one spatula measure of calcium carbonate on the watch glass.



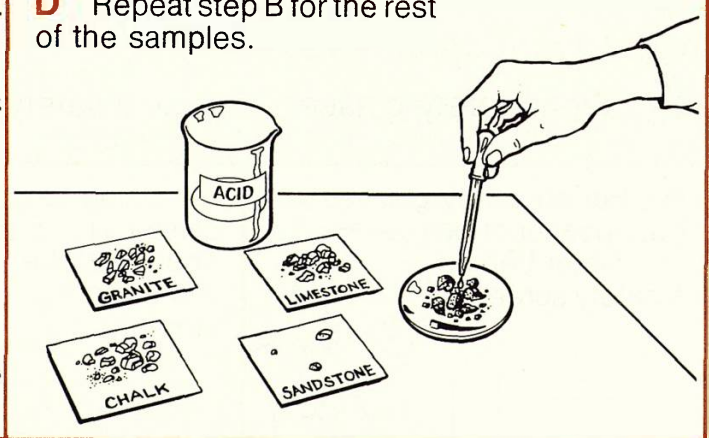
B Put two drops of acid on the powder. Note the result. Wash the watch glass.



C Put a few marble chips on the watch glass and repeat step B.



D Repeat step B for the rest of the samples.



Rocks that contain calcium carbonate fizz when tested with a dilute acid. They are dissolved away by acids.

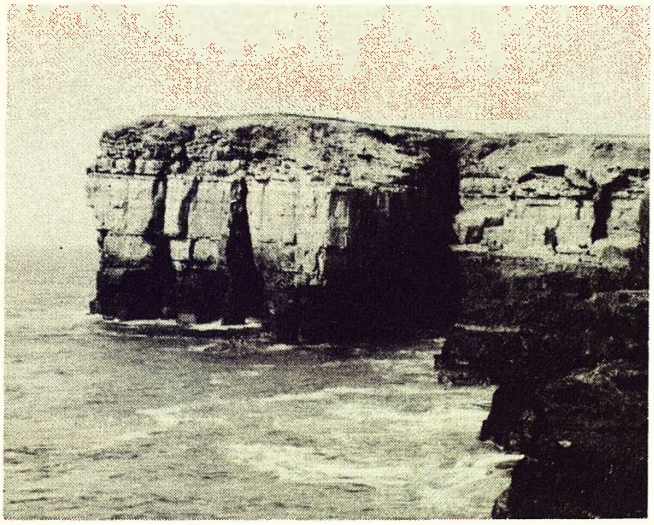
Q4 Which samples:
a) contained calcium carbonate?
b) did not contain calcium carbonate?

Q5 Rainwater is a very weak acid. Which rocks would be dissolved slowly by rainwater?

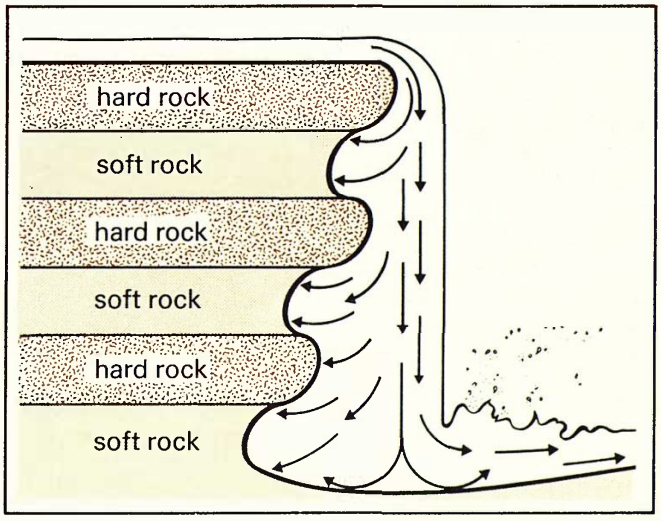
Information: Weathering and erosion

Rocks are being broken up all the time. The weather can break up rock into small **fragments**. Some rocks can be dissolved by chemicals in rain water. One type of **weathering** occurs in cooler countries. Rocks are split when water freezes in the cracks. The ice takes up more space than water and forces the rocks apart. These broken pieces may pile up at the bottom of a cliff and are called **scree**. This photo shows the scree slopes at Wastwater in the Lake District.

Another type of weathering occurs in deserts. The rocks get very hot in the day and cool down quickly at night. The heating and cooling can split the rocks.



Rocks can also be worn away or **eroded** by other things. Breaking waves are powerful. They hurl pebbles at the coast and erode the cliffs.



Erosion also occurs at waterfalls. The diagram shows that soft rock will be worn away more quickly than hard rock.

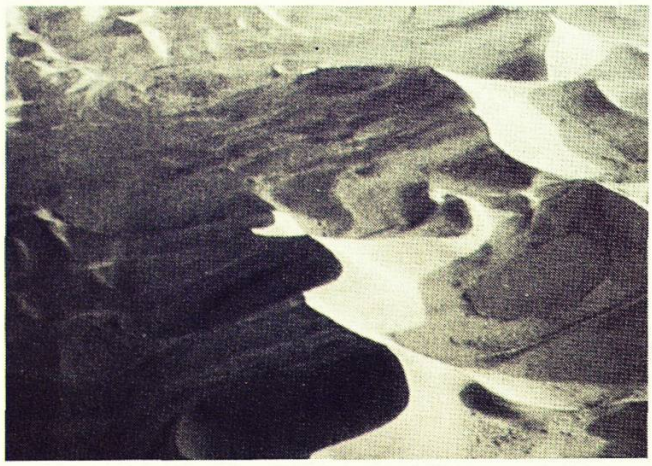
Q6 What is weathering?

Q7 What is scree?

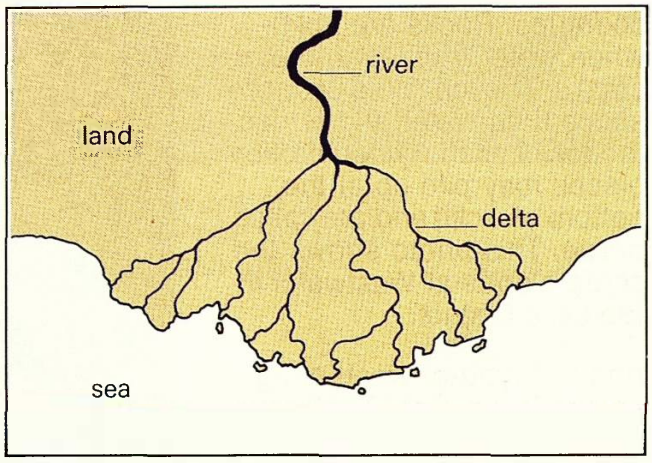
Q8 How do waves erode rocks?

Information: Rocks and sediment

Fragments of broken up rock may be carried from place to place by wind, water or ice. The fragments are called **sediment**. This sediment is usually dropped in layers making **sedimentary rocks**. One layer of sediment settles on top of another. Gradually the fragments are cemented together forming hard rock. After many millions of years there may be several layers in one place.



Sand can be carried by wind to make sand **dunes**. These are in the Kalahari desert.



A river **delta** may form where a river flows into the sea. The delta is built up from sediment carried by the river water.

A **glacier** is a slow moving river of ice. The moving ice erodes the rock and carries the sediment away.

The Grand Canyon in the U.S.A. shows the layers of sedimentary rocks.

Q 9 Name three ways in which sediment can be moved.

Q 10 How does sediment become hard rock?

Q 11 How is a river delta formed?

Q 12 Are layers of sedimentary rocks made slowly or quickly?

Rock layers

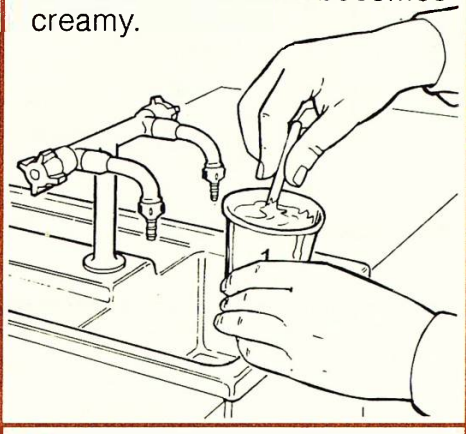
Apparatus

★ 2 plastic cups ★ Polyfilla ★ sand ★ grease ★ colouring agent
★ object (such as sea shell, leaf, tooth or piece of bone) ★ scissors

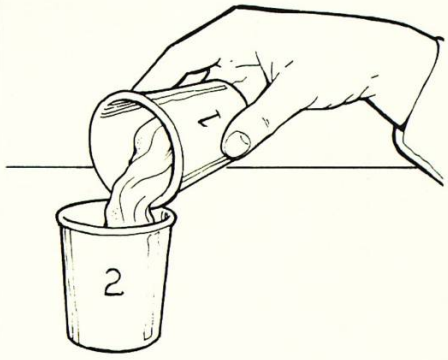
You are going to make layers of **sedimentary rocks**.

A Smear a very thin layer of grease all over the object.

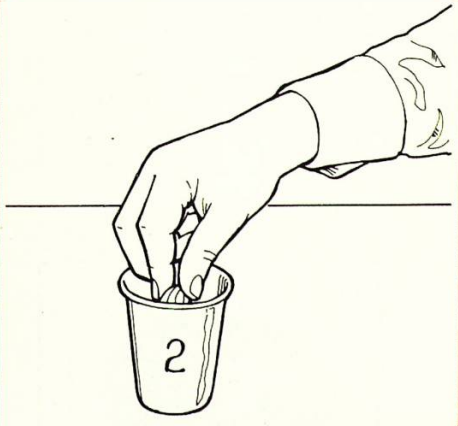
B Put some Polyfilla in one cup. Slowly add water and stir until the mixture becomes creamy.



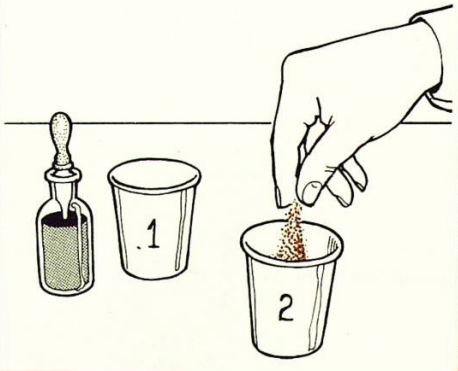
C Pour the mixture into a second cup until two-thirds full.



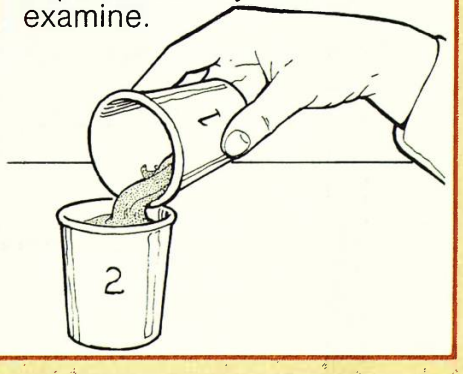
D Press the object into the surface of the mixture.



E Cover with a ½ cm layer of sand. Mix 3 drops of colouring with the first cup of mixture.



F Pour the coloured mixture over the sand. Leave to set until the next lesson. Then cut away the cup, separate the layers and examine.



Sedimentary rocks are made from small, loose fragments cemented together. Remains of living things may get trapped in the layers leaving marks called fossils.

Q13 What did you use to make your fossil?

Q14 Why were sand and grease used?

Q15 What type of rock have you made?

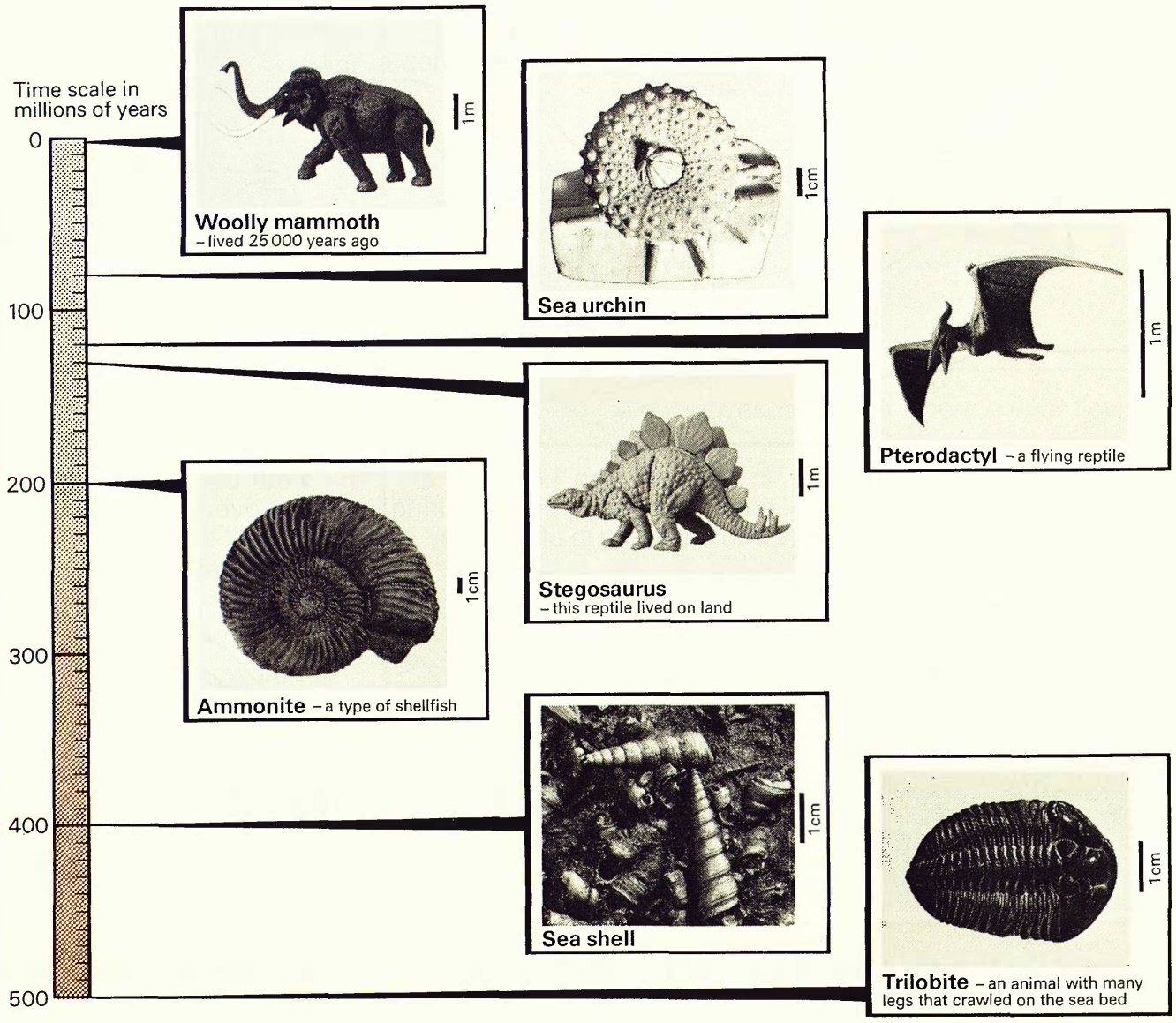
Q16 In sedimentary rocks, is the oldest layer at the top or at the bottom?

3 Fossils and coal

Information: Fossils

Millions of years ago strange animals and plants lived on Earth. When they died the remains of some of them were buried in sediment. This might have happened on the bottom of the sea or a river. Chemicals from the water soaked into the hard parts of these remains such as bones, shells and the tough parts of plants.

The chemicals preserved these, while the soft parts rotted away. These preserved remains or traces of living things from the past are **fossils.** Geologists have learnt about the animals below by studying their fossilised remains. Look at the pictures and the time scale to find out how long ago they lived.



Q1 What are fossils?

Q2 How are fossils formed?

Q3 Which is the oldest fossil shown above?

Q4 Which fossils shown above did not live in water?

Making a fossil cast

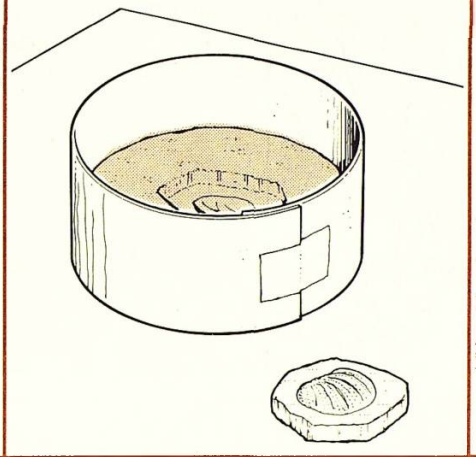
Apparatus

★ plasticine ★ fossil (or shell or leaf) ★ plastic cup ★ sheet of paper
★ Polyfilla ★ stirrer ★ card

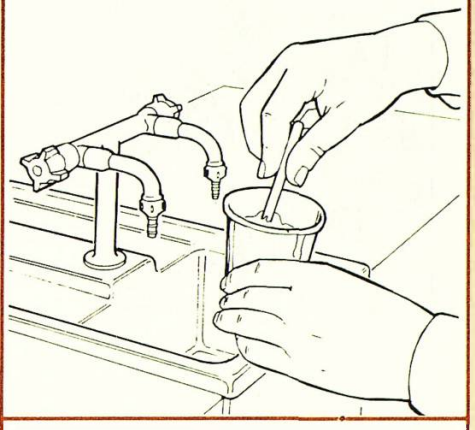
You are going to make a **mould** of a fossil and use the mould to make a copy (**cast**) of the fossil.

A Work the plasticine in your hands until soft. Flatten on a sheet of paper until 3 cm thick. Push the fossil into the surface.

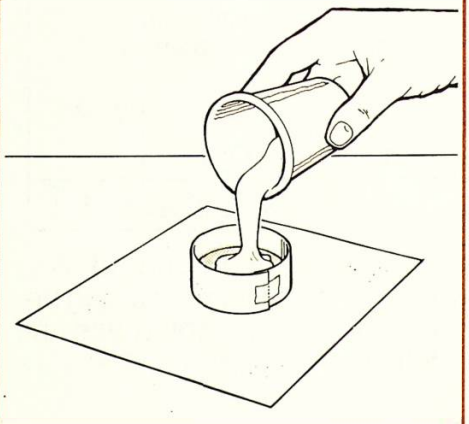
B Carefully remove the fossil. Using the card, make a cylinder around the plasticine.



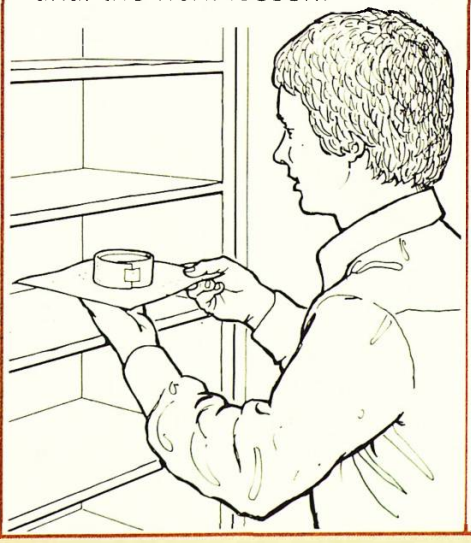
C Put some Polyfilla in the cup. Slowly add water and stir until you have ½ cup of smooth, creamy mixture.



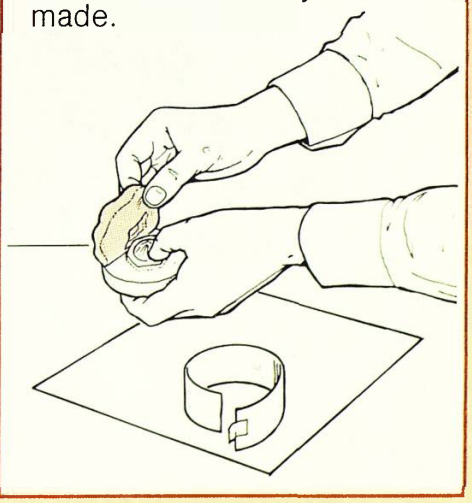
D Pour the mixture quickly into the paper cylinder. The mixture should be about 2 cm thick.



E Leave the mixture to set until the next lesson.



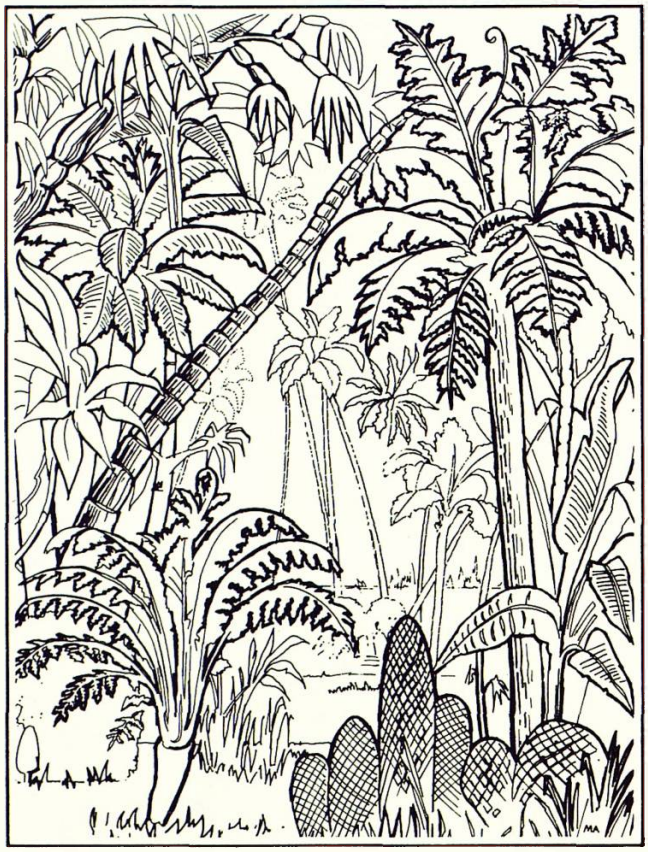
F Very carefully peel off the plasticine mould. Examine the fossil cast that you have made.



Q 5 What type of animal or plant did you use to make the mould?

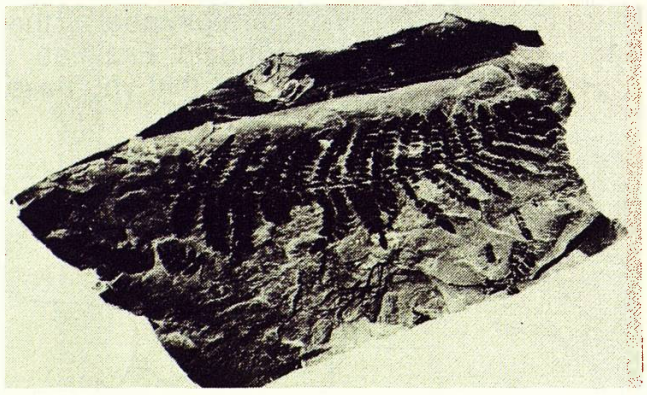
Q 6 How could you make a cast of the other side of your fossil?

Information: Coal

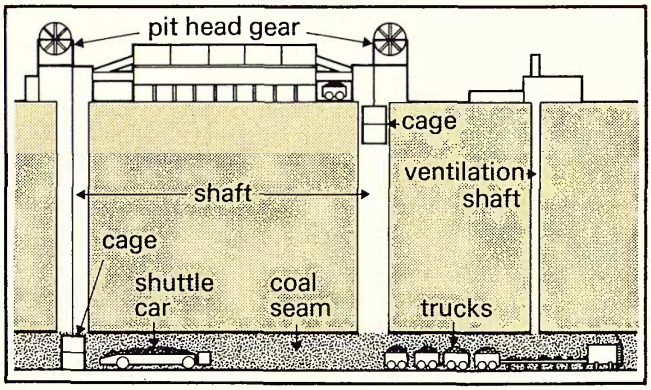


The story of coal starts millions of years ago. Much of the land was covered by forests and swamps. The plants were different from those of today. Some trees had soft trunks, hollow stems or were like giant ferns. The weather then was hot and damp. When the trees died they began rotting away and new ones grew quickly. Dead trees piled up in a thick layer.

When the bottom of the swamp sank rivers brought in sediment. The layer of dead trees was buried and squashed and gradually turned into **coal**. A layer of coal is called a **seam**. Coal seams are always found in sedimentary rocks. As coal is made from plants that lived millions of years ago, it can be called a **fossil fuel**.



Above is a plant fossil in a piece of coal. When the plant was alive it trapped energy from the sun to make its food. When we burn coal this energy is released as heat and light. Coal is an important fuel.



Coal seams are often deep underground. A deep hole or **shaft** is dug so that the coal can be **mined**. Coal can be used to make **town gas** and other chemicals which are used in industry today.

Q7 What is coal made from?

Q8 What is a layer of coal called?

Q9 What is the main use of coal?

Q10 How is coal obtained from underground?

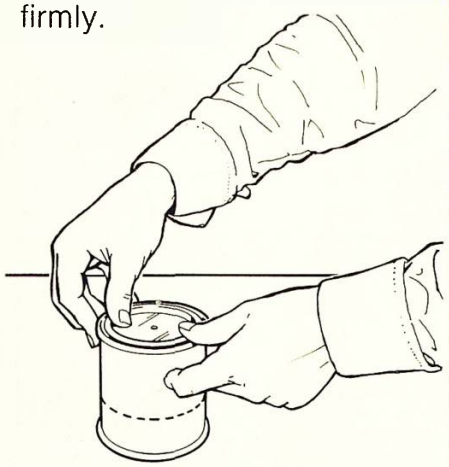
Making gas from coal

Apparatus

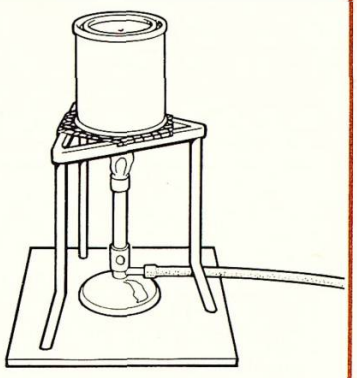
★ small pieces of coal ★ empty tin ★ tin lid with hole ★ Bunsen burner
★ gauze ★ tripod ★ heatproof mat ★ stop clock ★ splint

You are going to make gas from coal.

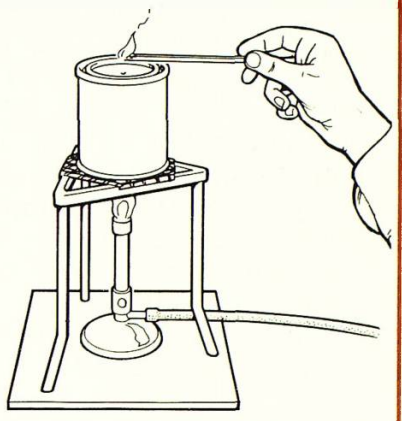
A Put coal into the tin until it is one third full. Put the lid on firmly.



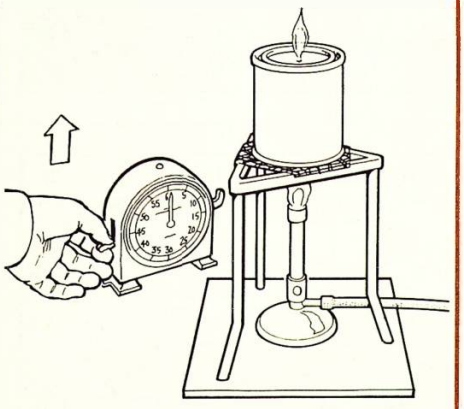
B Heat the coal for 15-20 minutes.



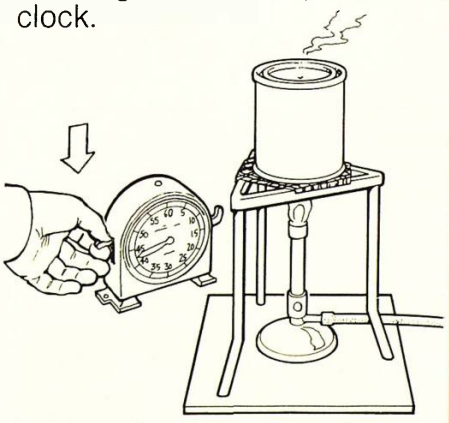
C Put a lighted splint by the hole.



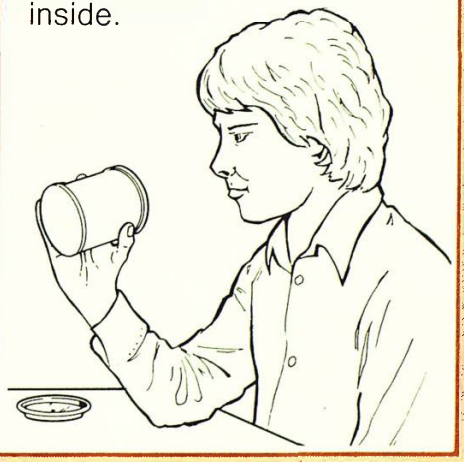
D When the gas coming from the tin lights, start the stop clock.



E Carry on heating the coal. When the flame from the tin goes out, stop the clock.



F Turn off the Bunsen burner. Let the tin cool and then examine what is left inside.



Heating coal in this way produces town gas.

Q11 When coal is heated what is made?

Q12 For how long did your flame burn?

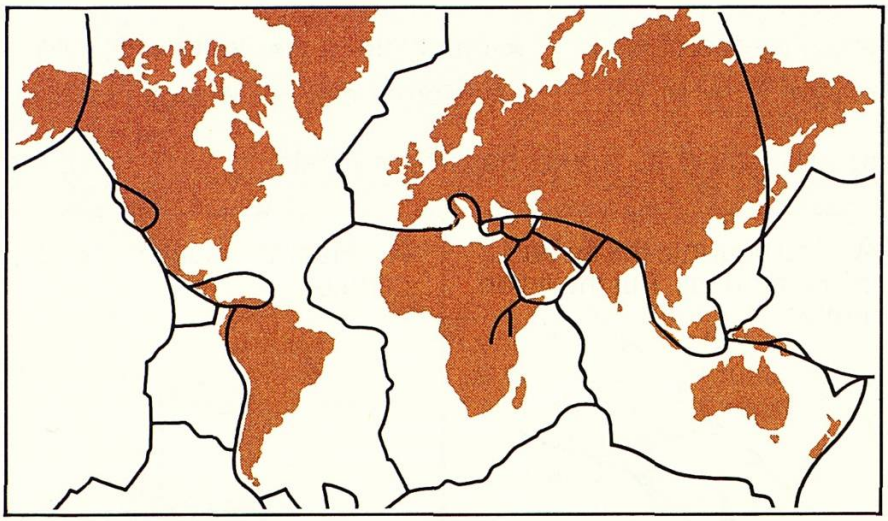
Q13 Why do you think the flame goes out?

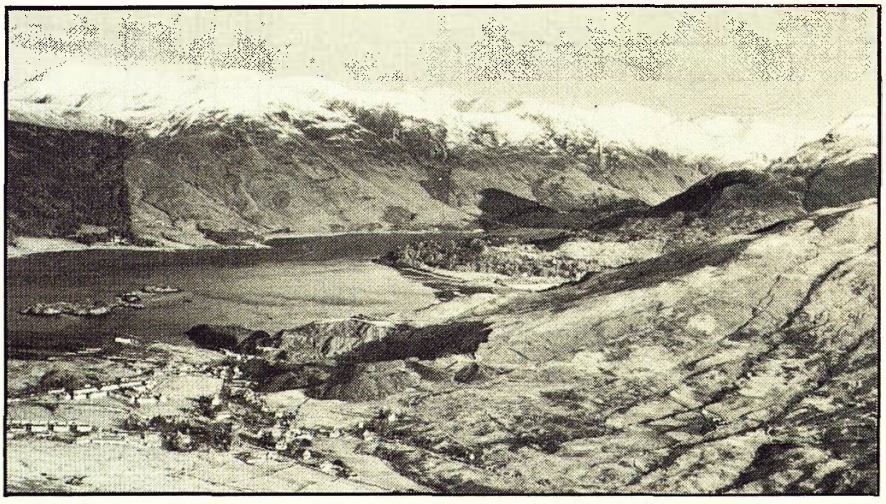
Q14 What is left at the end of the experiment?

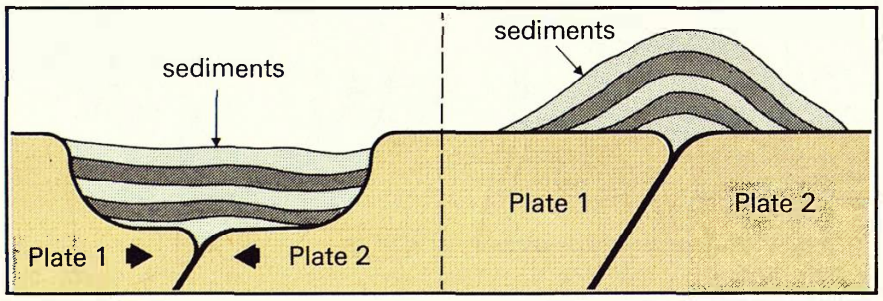
4 Moving rocks

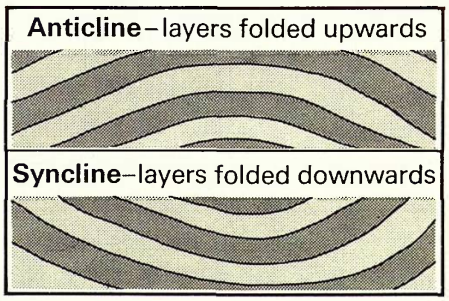
Information: Mountain building

The Earth's crust is broken into several pieces called **plates**. These are shown on the map. Huge forces from deep inside the Earth may push two plates towards each other. This movement can make **fold mountains**, like the Grampians in Scotland, shown in the photo. Mount Everest (8848 m), the highest mountain above sea level, may have been made in this way. Fossil sea shells can sometimes be found on top of high mountains. This is because the rock layers may have been under the sea before folding started. The diagrams below show how sedimentary rock can be folded in various ways.









Q1 What is the Earth's crust made up from?

Q2 What may happen when two plates move towards each other?

Q3 What is the highest mountain on the Earth?

Q4 What shape is an anticline fold?

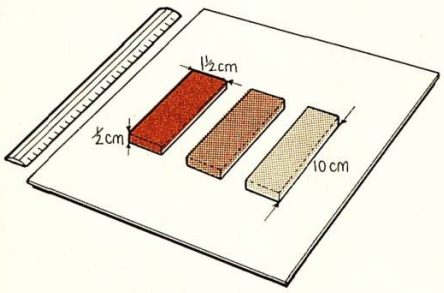
Making mountains

Apparatus

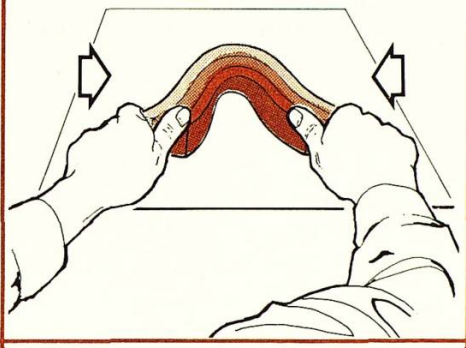
★ 3 different coloured pieces of plasticine ★ sheet of white paper ★ roller
★ ruler ★ knife ★ powder

You are going to find out how rock layers can move to form fold mountains.

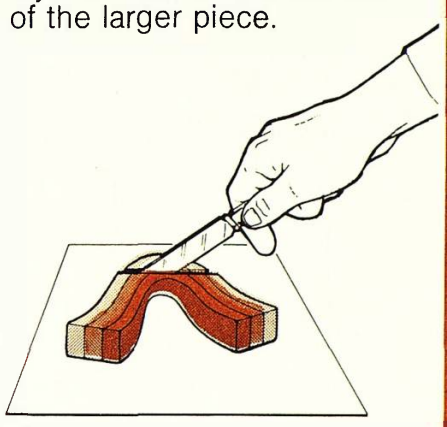
A On a sheet of white paper, roll out each piece of plasticine to form 3 flat strips.



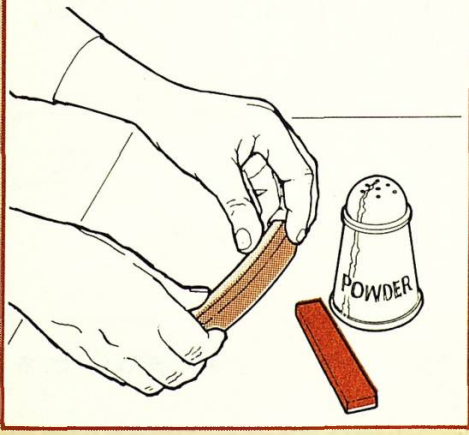
B Gently press the strips on top of each other. Lay the strips on their sides. Push inwards from both ends. Draw your shape.



C Take a knife and cut as shown. Take care not cut the bottom strip off from the other layers. Draw the cut surface of the larger piece.

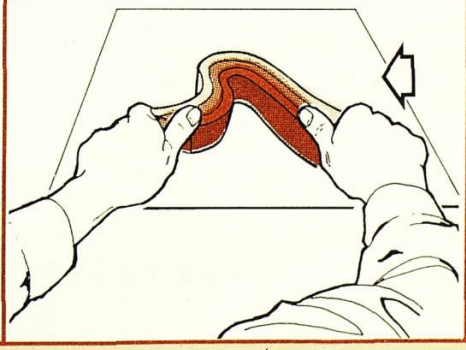


D Repeat step A. Gently press the strips on top of each other. (Use powder between the strips if they begin to stick).

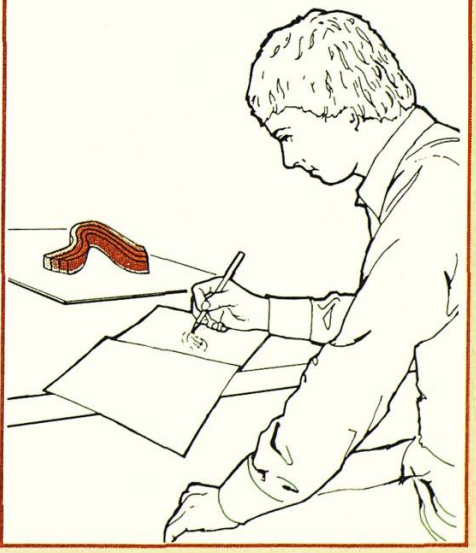


E Lay the strips on their sides on the paper. Hold one end still. Push the other end inwards.

(This shape is an **overfold**.)



F Draw your new shape.



Q5 In which step did you make anticline fold?

Q6 Explain how an overfold is made.

Q7 Try folding your layers to make other mountain shapes and then draw them.

Snapping rocks

Apparatus

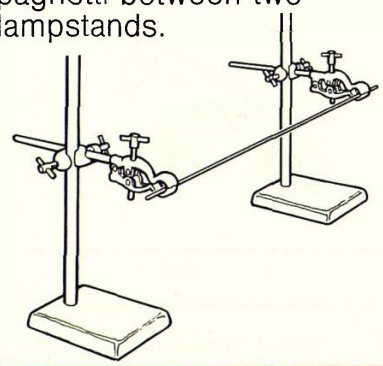
★ 2 pieces of spaghetti ★ 2 clampstands ★ 10 g weight hanger ★ 10 g weights ★ ruler

You are going to find out what makes rocks snap or **fault**. You will use spaghetti instead of rock.

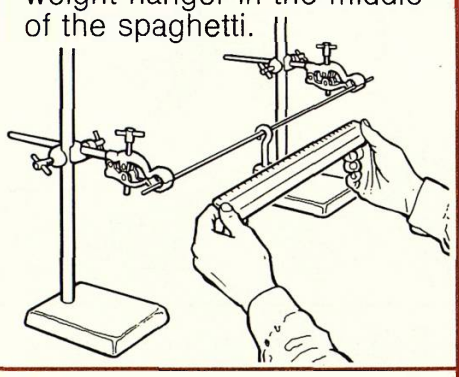
Q8 Copy this table.

Weight (g) needed to snap spaghetti:	
when put in place slowly	when put in place with a swinging movement

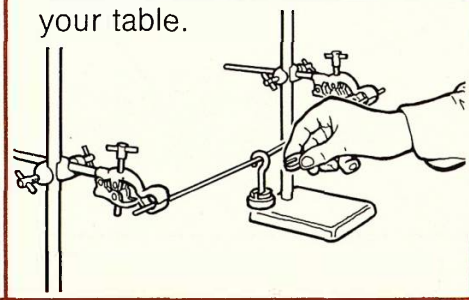
A Carefully fix one piece of spaghetti between two clampstands.



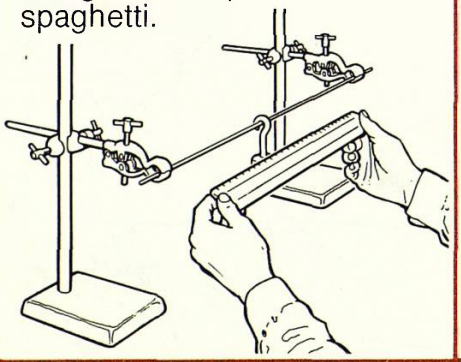
B Gently hang the 10 g weight hanger in the middle of the spaghetti.



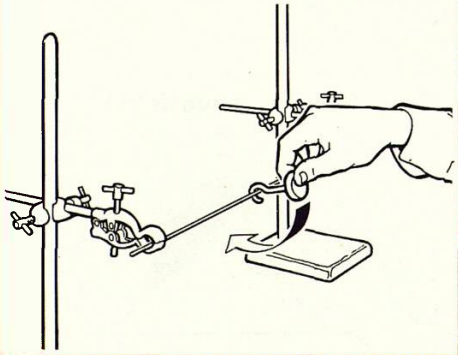
C Gently add the weights, 10 g at a time until the spaghetti snaps. Record the result in the first column of your table.



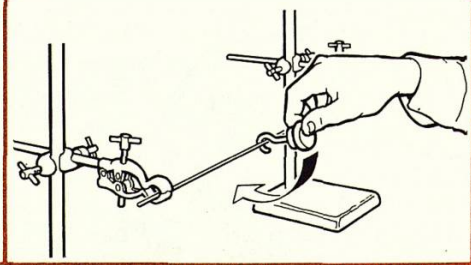
D Repeat steps A and B, using another piece of spaghetti.



E Gently lift the hanger out to one side and then let it fall.



F Add a 10 g weight to the hanger. Repeat step E adding 10 g weights until the spaghetti snaps. Record your result.

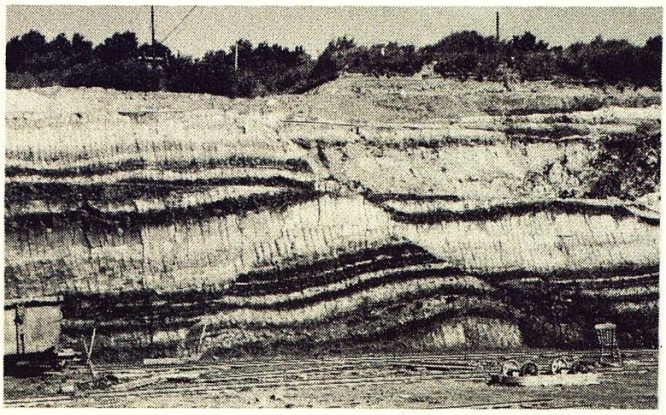


A weight added with a swinging movement gives a more sudden pull on the spaghetti than a weight added slowly.

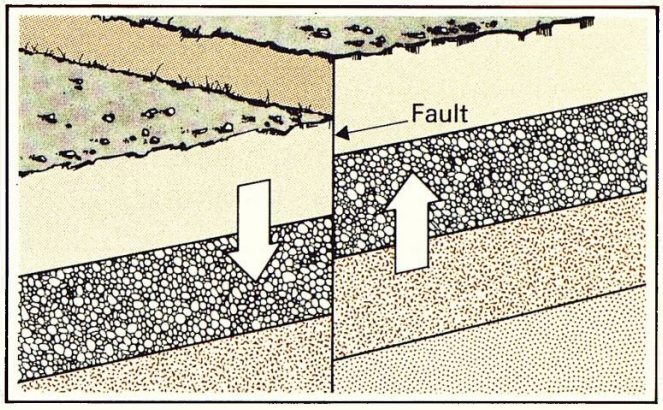
Q9 What weight snapped the spaghetti when weights were added:
a) slowly?
b) with a swinging movement?

Q10 Is spaghetti (rocks) easier to snap when weights are added slowly or suddenly?

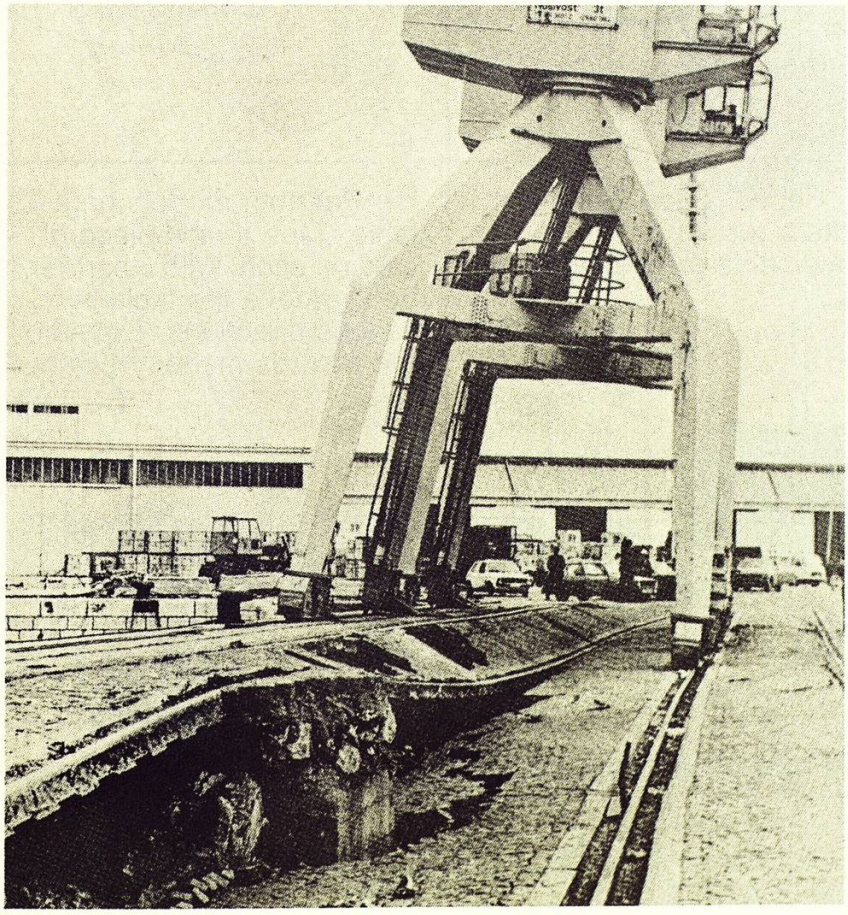
Information: Faults



When the Earth's plates move suddenly they can snap rocks. This can be seen as a **fault** in the rocks as shown above.



This diagram shows the movements that could produce a fault. One side could have moved up or the other side may have moved down. Faults can also happen when there are sideways movements.



When layers of rock snap and move past each other an **earthquake** happens. An earthquake can produce **vibrations** (fast movements to and fro) of the Earth's surface. These vibrations can do great damage. The photo was taken in Yugoslavia after such an earthquake.

Q11 How is a fault made?

Q12 What causes an earthquake?

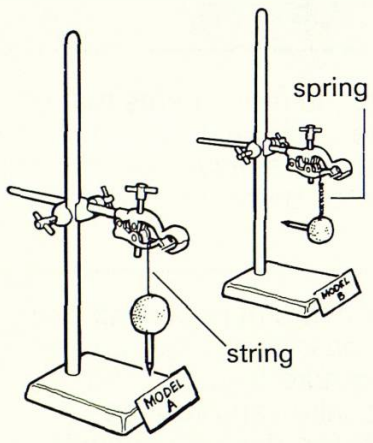
Making seismometers

Apparatus

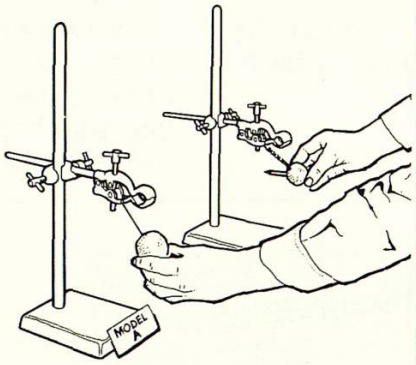
★ 2 clampstands ★ 2 felt tip pens ★ string ★ 2 lumps of plasticine
★ spiral spring ★ 4 pieces of card ★ clear tape

You are going to make two **seismometers**. These instruments detect earthquakes and other movements of the earth's surface.

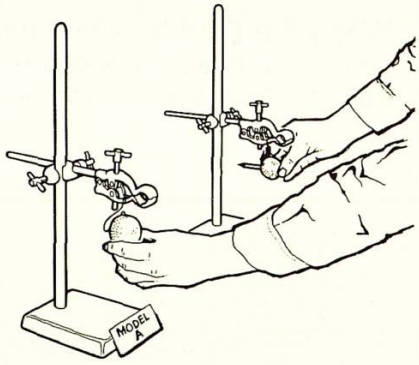
A Set up two sets of apparatus as shown.



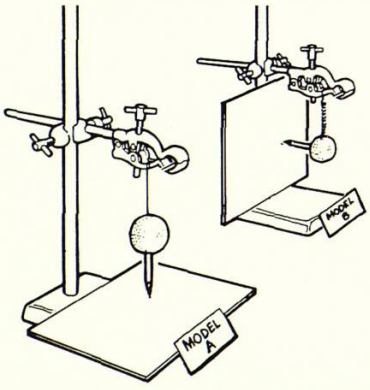
B Gently move both lumps of plasticine sideways and let go. Note which model shows sideways movement best.



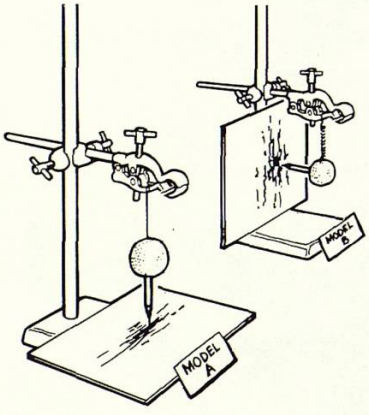
C Gently move both lumps of plasticine up and let go. Note which model shows up and down movement best.



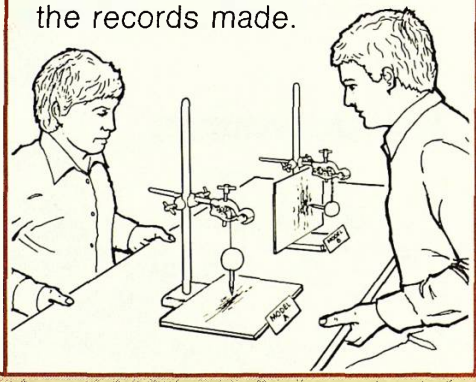
D Tape a piece of card near each pen tip. Adjust your models so each pen tip just touches the card.



E Repeat steps B and C to make a record of the movements on the cards.



F Put both models on a table. Tape a new piece of card on each. With a partner, gently move the table in various directions. Examine the records made.



Earthquakes have two types of movement – horizontal (sideways) and vertical (up and down) vibrations.

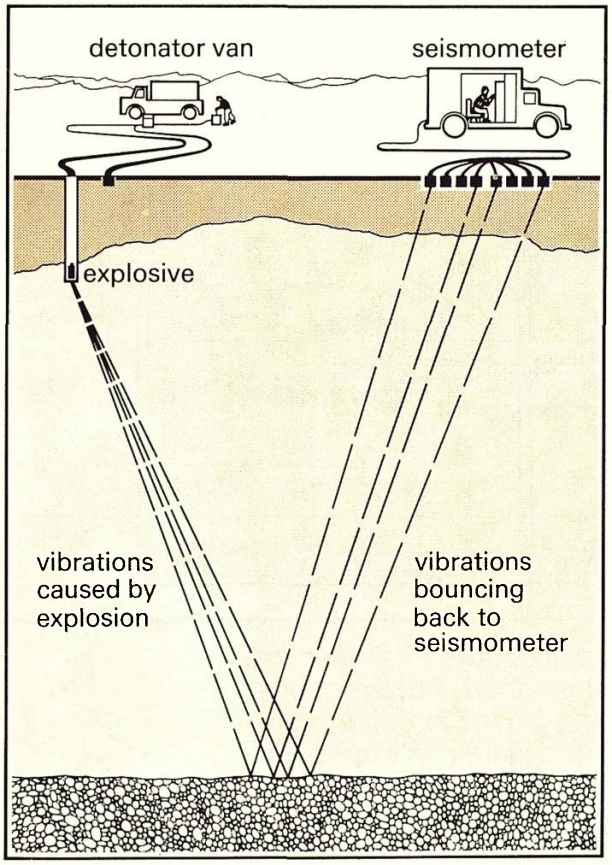
Q13 Which model was best at recording:
a) horizontal movement?
b) vertical movement?

Q14 Think of a place where there may be vibrations. Leave your models to see if they can detect any 'earthquakes'.

5 Oil and gas

Information: Finding oil and natural gas

Geologists use seismometers to find **oil** and **natural gas** underground. They blow up a small amount of explosive buried in the rock. This causes a very small 'earthquake' and vibrations.
The seismometer measures the time taken by the vibrations to travel through the rocks. This is **seismic exploration**.
It gives geologists information about the type and shape of rock layers underground.

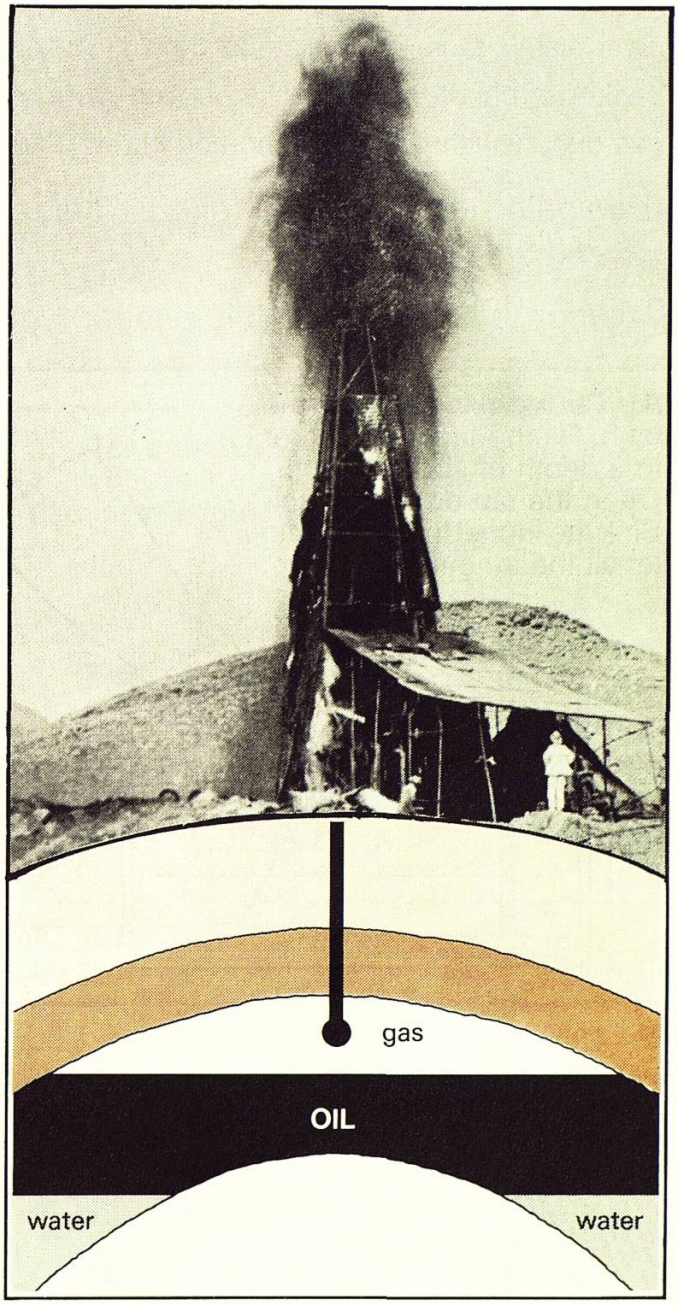


Q1 How does a geologist make his 'earthquakes'?

Q2 Where are oil and gas found?

Q3 What 'stops' the oil or gas escaping to the surface?

Q4 What type of fold acts as an oil trap?



Like coal, oil and natural gas are fossil fuels and were formed in a similar way. They are all found in sedimentary rocks. Oil and gas are usually found in rocks that have been folded into an anticline. The oil and gas try to rise up through the rock layers until they come to a layer that will not let them pass. This layer is known as an **impervious** layer. It may be made of clay or even salt.

A model oil well

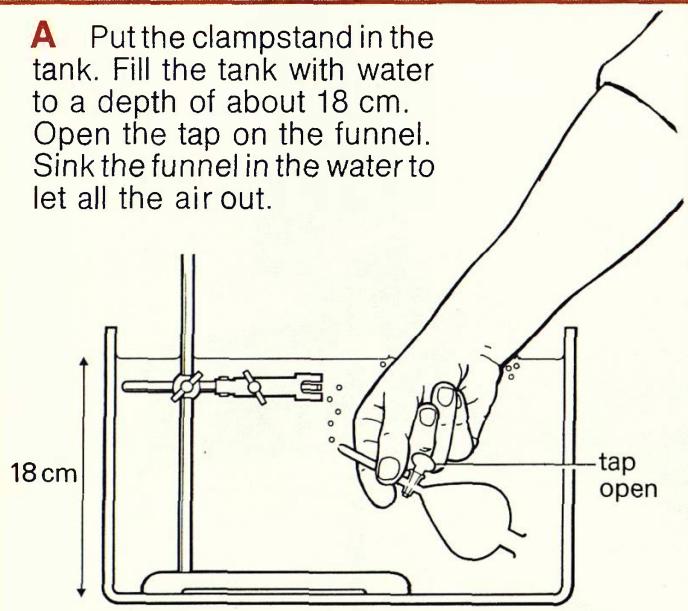
Apparatus

★ clear plastic tank ★ clampstand ★ separating funnel ★ 20 cm³ syringe
★ beaker of paraffin ★ large beaker of water
★ gas supply with rubber tubing and screw clamp ★ splint

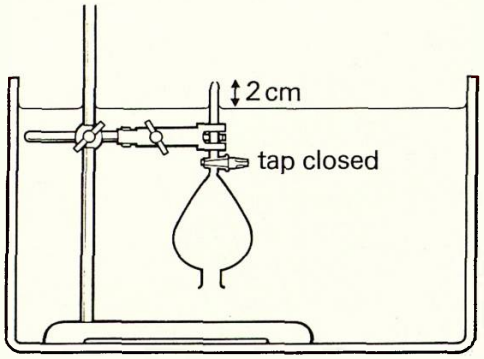
You are going to see a model 'oil well' being made. Paraffin is used instead of crude oil.

Your teacher will do this experiment for you.

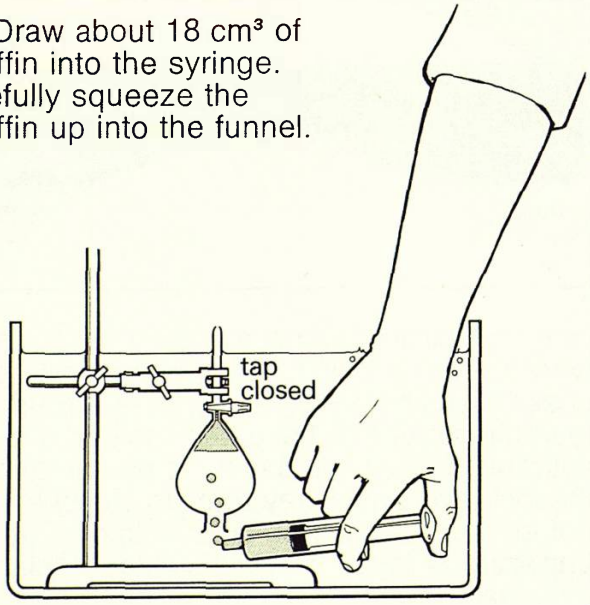
A Put the clampstand in the tank. Fill the tank with water to a depth of about 18 cm. Open the tap on the funnel. Sink the funnel in the water to let all the air out.



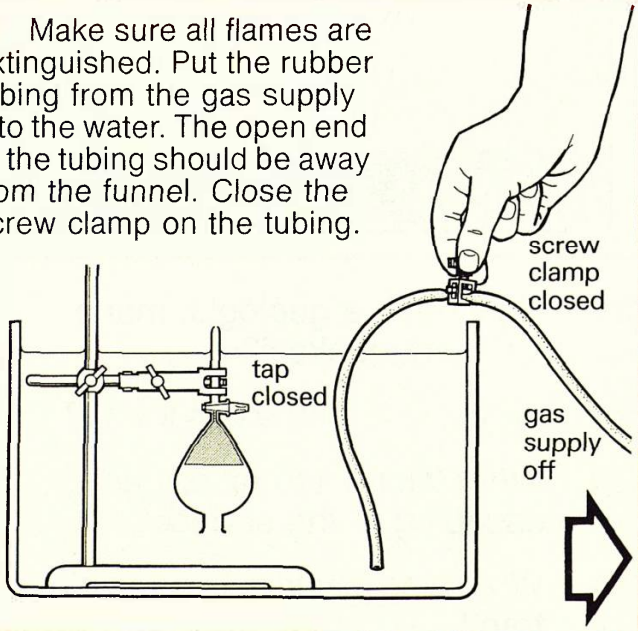
B Clamp the funnel upside down so that the jet is about 2 cm above the surface of the water. Close the tap.



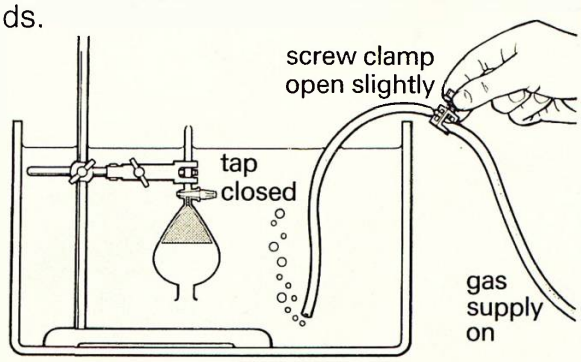
C Draw about 18 cm³ of paraffin into the syringe. Carefully squeeze the paraffin up into the funnel.



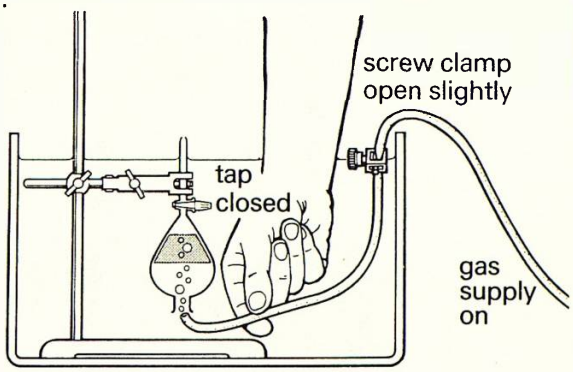
D Make sure all flames are extinguished. Put the rubber tubing from the gas supply into the water. The open end of the tubing should be away from the funnel. Close the screw clamp on the tubing.



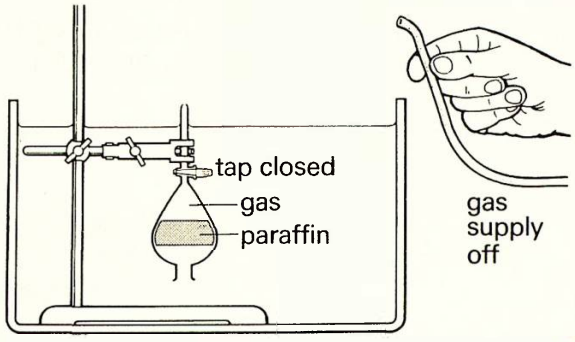
E Open the gas tap slightly. Adjust the screw clamp until gas bubbles are flowing out slowly. Let the bubbles flow out for a few seconds.



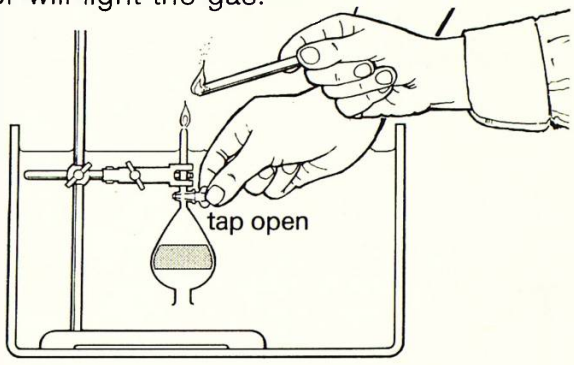
F Hold the end of the tubing under the funnel. Carefully let the gas bubble up into the funnel.



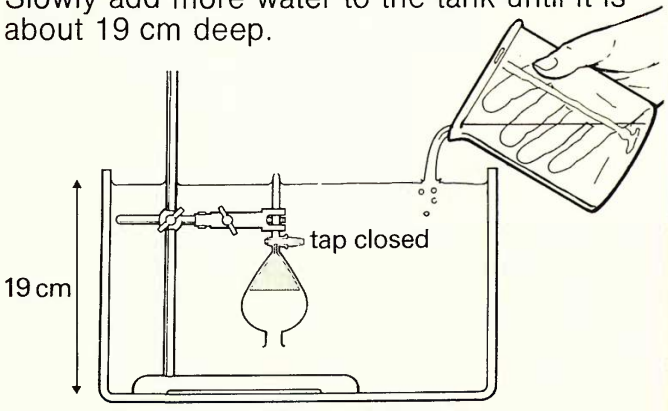
G Continue until the paraffin and gas fill about $\frac{3}{4}$ of the funnel. Turn off the gas supply. Remove the rubber tubing from the tank.



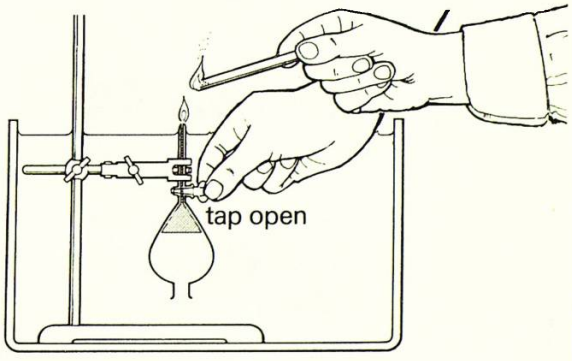
H Ask a partner to hold a lighted splint about 1 cm above the jet. Slowly open the tap. Your partner will light the gas.



I When the gas has burnt off, close the tap. Slowly add more water to the tank until it is about 19 cm deep.



J Ask your partner to hold a lighted splint so the flame is touching the jet. Slowly open the tap. Your partner will light the paraffin.

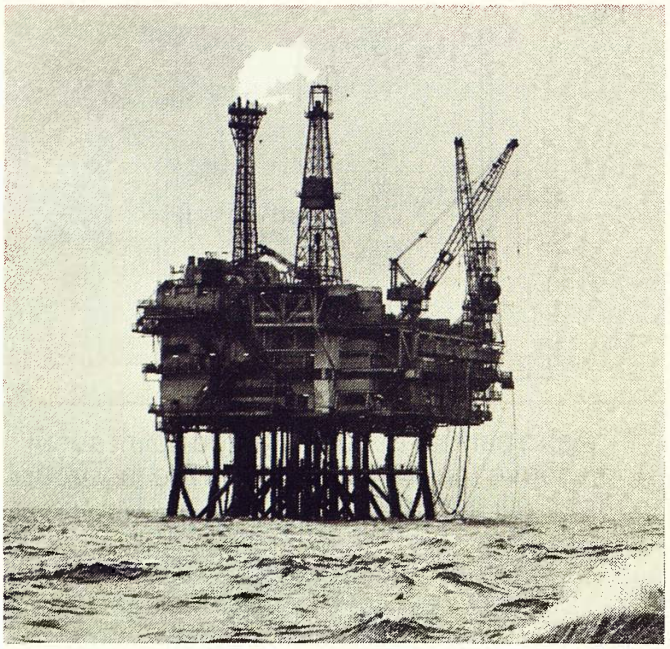


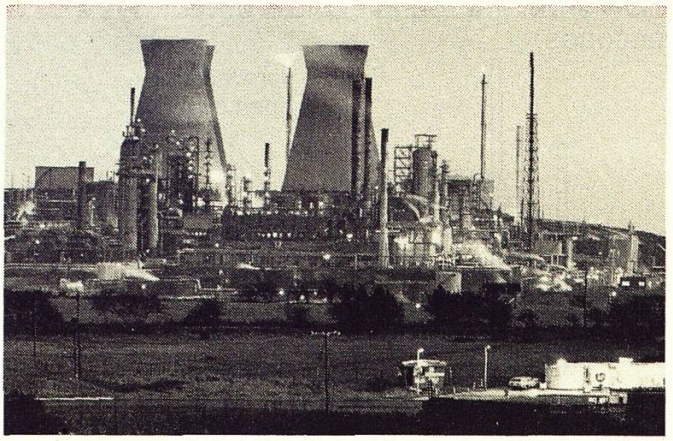
Q5 In step G, which was at the top of the funnel – paraffin, gas or water?

Q6 Why does the gas rise to the top of the funnel?

Q7 In this experiment, the funnel is supposed to be an anticline fold. Why do oil companies drill for oil and gas through anticlines?

Information: North Sea oil and gas





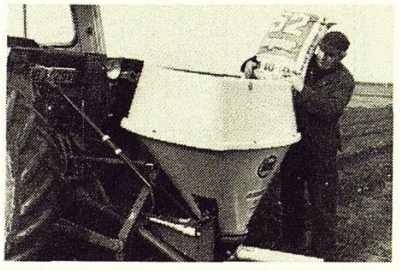
Britain now gets a great deal of oil and gas from underneath the North Sea. The photo on the left shows a drilling rig in the North Sea. The oil refinery above is in South Wales. Here **crude oil** from underground is purified and turned into useful chemicals.

Uses of crude oil and natural gas

Petrol for running motor cars.

Plastics and many other chemicals.

Natural gas is now an important fuel in Britain for industry and the home.



Chemicals from crude oil are used to make fertilizers which are vital for farming.

Q 8 From where does Britain get much oil and gas?

Q 9 What happens at an oil refinery?

Q 10 Name three things made from crude oil.

6 Minerals for industry

Identifying minerals

Apparatus

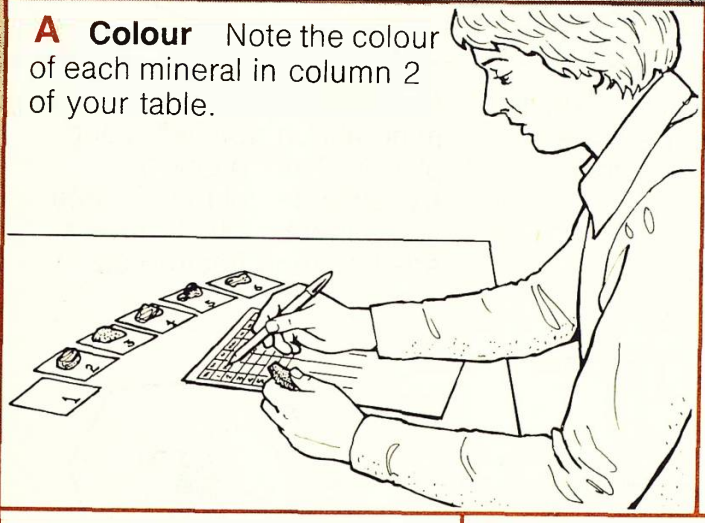
★ six minerals numbered 1 to 6 ★ bathroom tile ★ hand lens

You are going to try to identify six minerals.

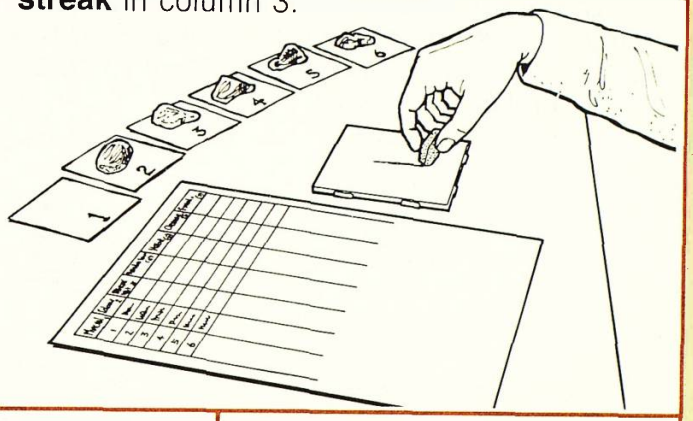
Q1 Copy this table.

Mineral (1)	Colour (2)	Streak test (3)	Hardness Test (4)	Habit (5)	Cleavage (6)	Fracture (7)
1			Hard			
2			Softer than 1			

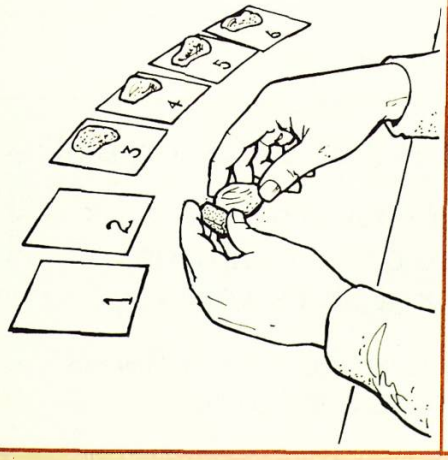
A Colour Note the colour of each mineral in column 2 of your table.



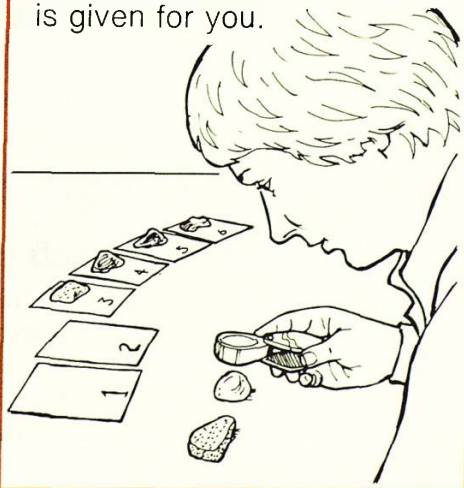
B Streak test Rub each mineral on the back of a bathroom tile. Note the colour of the **streak** in column 3.



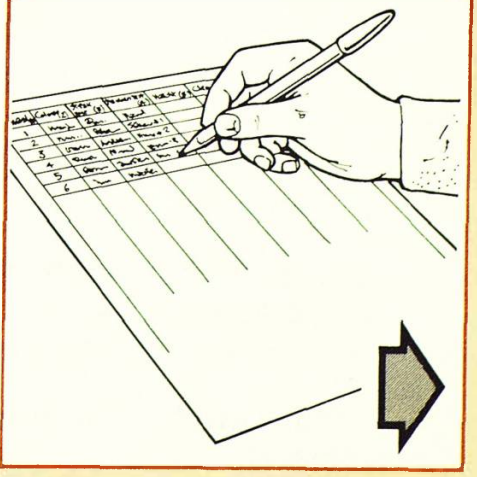
C Hardness test Take mineral 1 and mineral 2. Scratch them against each other. Blow away any dust.



D Use a lens to see which has a scratch. This is the **softer** of the two minerals. In column 4, record which is the softer mineral. The first result is given for you.

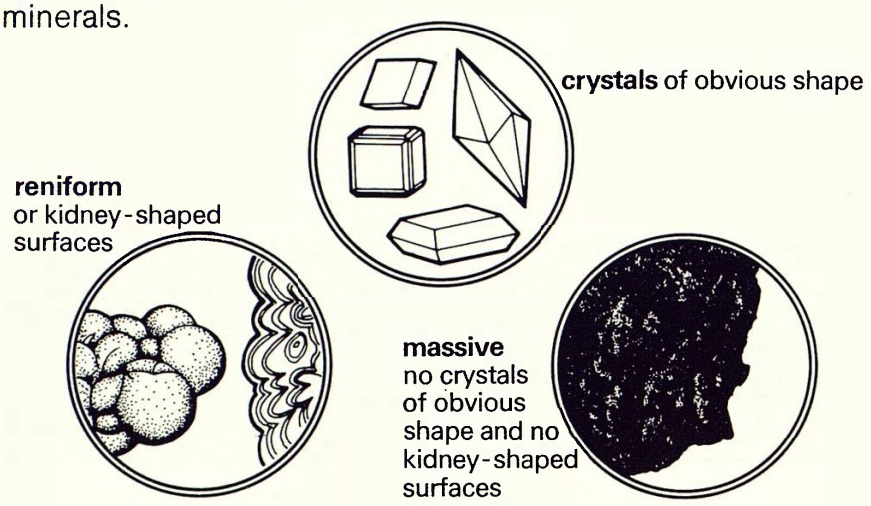


E Repeat steps C and D using minerals 2 and 3, 3 and 4, 4 and 5, 5 and 6. Each time record in column 4 which is the **softer** mineral of the two.

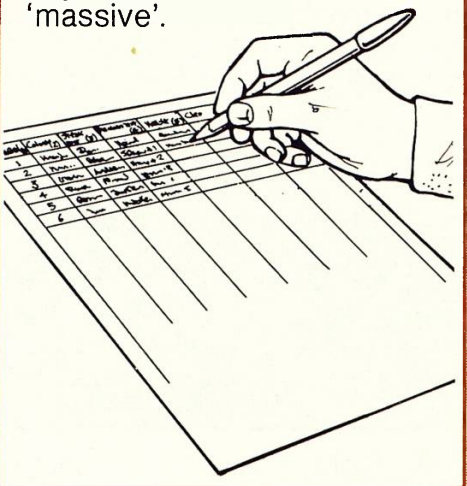


Minerals for industry

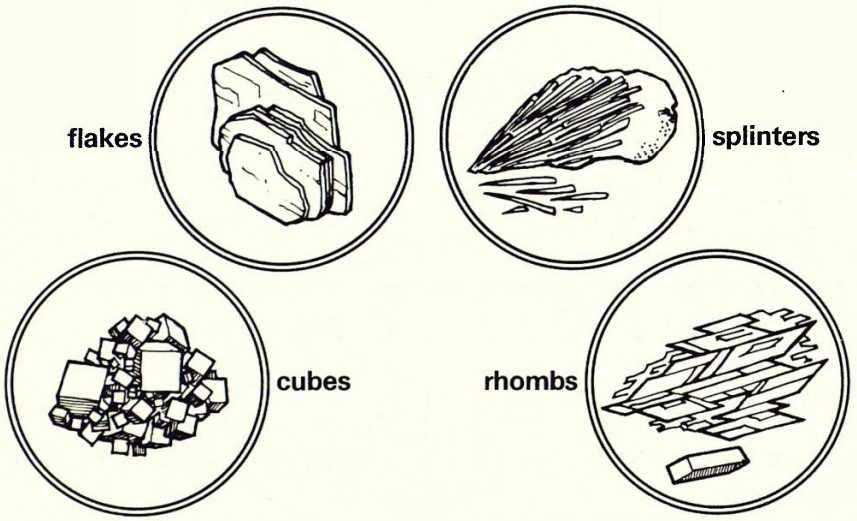
F Habit Minerals can occur in many forms or habits. Three forms are shown below. Use a hand lens to look at all 6 minerals.



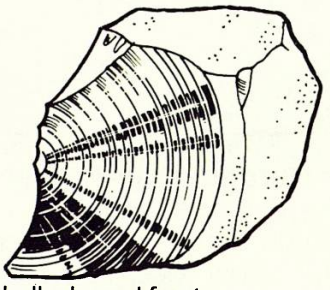
G In column 5, note the habit of each mineral. Write 'crystals', 'reniform' or 'massive'.



H Cleavage Look at any flat, freshly-split surfaces of each mineral. These are **cleavage planes**. Four types are shown below. Note the cleavage type of each mineral in column 6. If a mineral does not show one of these four, write 'none'.



I Fracture Some minerals do not split along planes. They break or **fracture**. In column 7, note any minerals which have a shell-shaped fracture as shown below.



shell-shaped fracture

J Use the key on the next page to try to find the name of each mineral.

Q2 How many minerals gave a white streak?

Q3 Can a mineral be identified by doing just one test? Explain your answer.

Q4 What were the names of your minerals?

Q5 Which was your softest mineral?

Q6 Which of your minerals contained calcium carbonate? (Hint: look at pages 6 and 25).

Q7 Draw pictures of your minerals or the crystals in them.

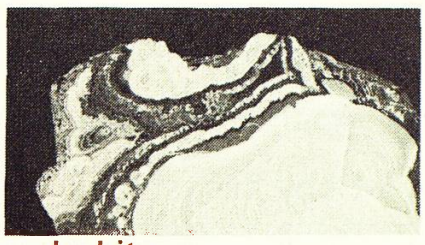
Information: A key for identifying some minerals

Two pieces of the same mineral may not look exactly alike. Several tests are needed to find out the mineral's name.

The photos show spectacular examples of minerals from a museum. Yours probably will not look so good.

haematite
This may have reniform surfaces and shell-shaped fractures.

mica



malachite
This may have reniform surfaces and shell-shaped fractures.

START HERE → Does the mineral look like metal?

- **Yes** → What colour is it?
  - Yellow, like gold: **pyrites**
  - Grey, silver, black or red. → What colour is its streak?
    - Red or brown: **haematite** (shown above)
    - Grey or black: **galena**
- **No** → What colour is it?
  - A colour other than green. → Are there obvious crystals?
    - **Yes** → Do the freshly-split surfaces (cleavage planes) look like sheets?
      - Yes: **mica** (shown above)
      - No → Test for hardness and put in order.
    - **No** → Test for hardness and put in order.
  - Green. → What colour is its streak?
    - Pale green: **malachite** (shown above)
    - White: **fluorite** This mineral can be found in many colours.

Test for hardness and put in order.

Hardest → Softest

diamond	quartz	fluorite	calcite	gypsum	talc
(shown on page 28)	(shown on page 4)	(shown below)	(shown below)	(shown below)	

fluorite
This may have shell-shaped fractures.

calcite
This will fizz when tested with acid.

gypsum

Metals from ores

Apparatus

★ charcoal block ★ Bunsen burner ★ blow pipe ★ heatproof mat ★ tripod ★ gauze
★ cerussite (lead ore) ★ sphalerite (zinc ore) ★ spatula ★ safety glasses ★ tongs

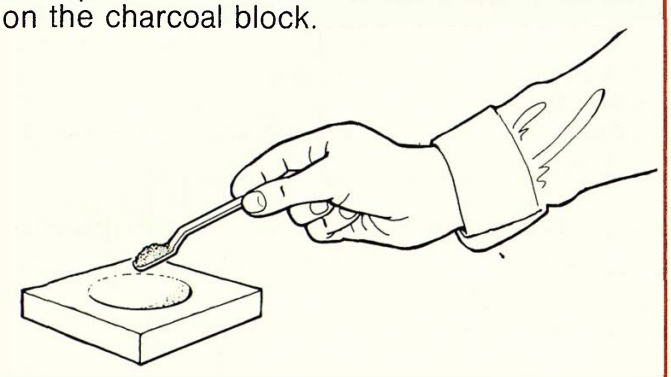
You are going to extract two metals from their ores.

Wear safety glasses. Follow instructions carefully.

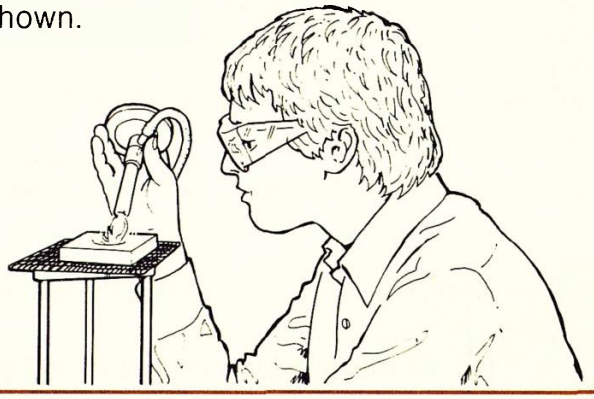
Q 8 Copy this table.

Name of ore	Colour before heating	Colour after heating
cerussite		
sphalerite		

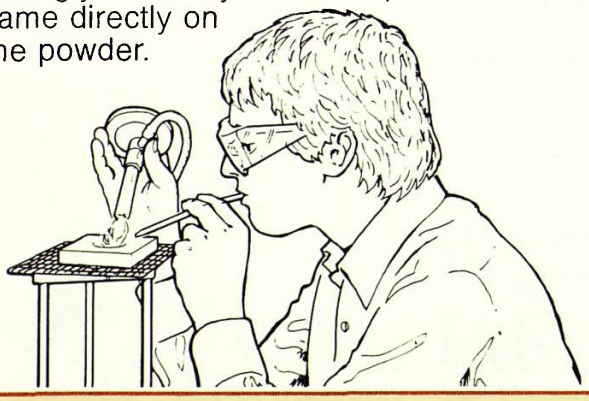
A Fill in the second column of the table. Put one spatula measure of cerussite in the hollow on the charcoal block.



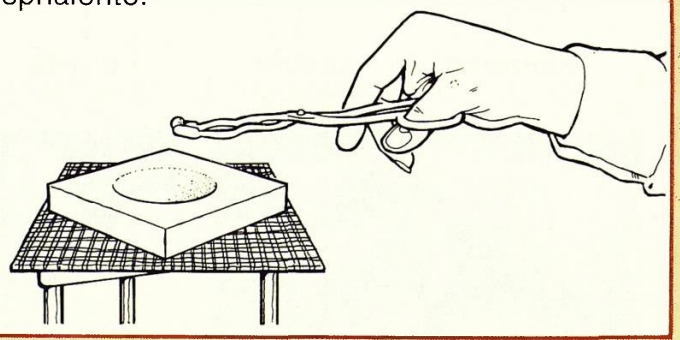
B Put the block on the gauze and tripod. Put on safety glasses. Strongly heat the powder with a Bunsen flame, for about a minute, as shown.



C Hold the burner so the flame is near the powder. Use the blow pipe to heat more strongly. Carefully blow the tip of the Bunsen flame directly on the powder.



D Continue until a bead of metal forms. Allow the apparatus to cool. Using tongs, examine the metal. Fill in the last column of your table. Repeat the experiment using sphalerite.



Q 9 Which metal did you extract from cerussite?

Q10 Which metal did you extract from sphalerite?

Chemicals in the sea

Apparatus

★ flame test wire ★ beaker of acid ★ evaporating dish ★ beaker of sea water
★ four labelled powders containing calcium, magnesium, potassium and sodium
★ heatproof mat ★ Bunsen burner ★ tripod ★ gauze ★ safety glasses

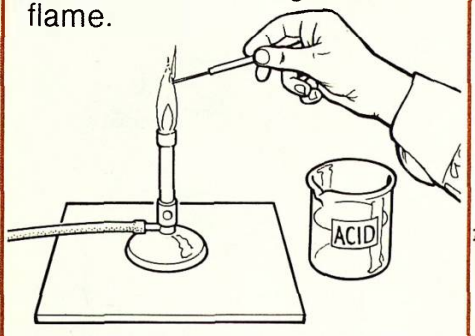
You are going to find out which is the main chemical in evaporated sea water.

Wear safety glasses.

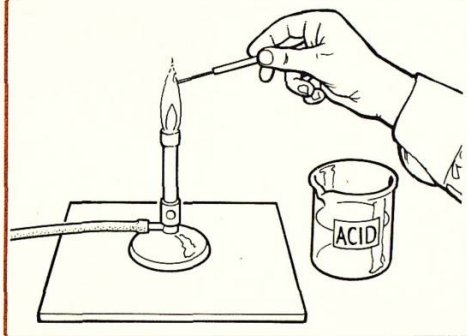
Q11 Copy this table.

	Powders containing:				Substance left after evaporating sea water
	calcium	magnesium	potassium	sodium	
Flame colour					

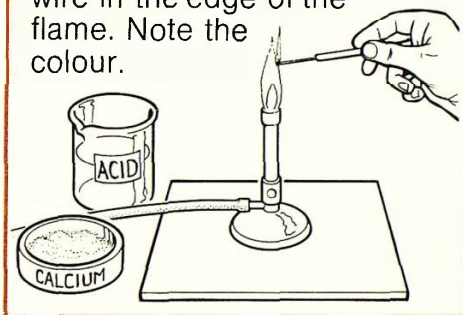
A Clean the flame test wire as follows. Dip it in acid. Heat the wire in a strong Bunsen flame.



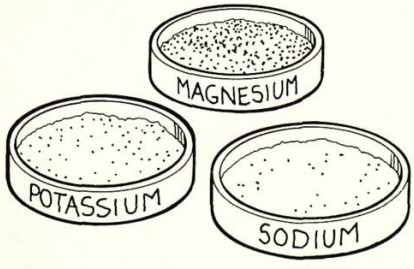
B Repeat step A until the wire does not colour the flame.



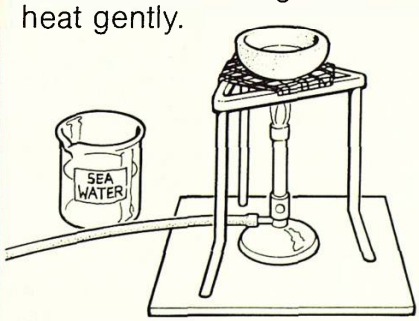
C Dip the wire in the acid and then in the dish of powder containing calcium. Hold the wire in the edge of the flame. Note the colour.



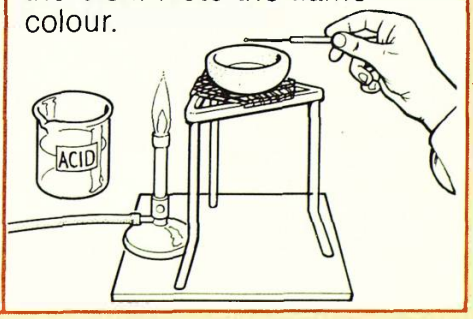
D Repeat steps A to C with each of the other labelled powders. Record your results.



E Put on safety glasses. Half fill the dish with sea water. Put it on the gauze and heat gently.



F When all the liquid has gone, repeat steps A to C using the substance left in the dish. Note the flame colour.



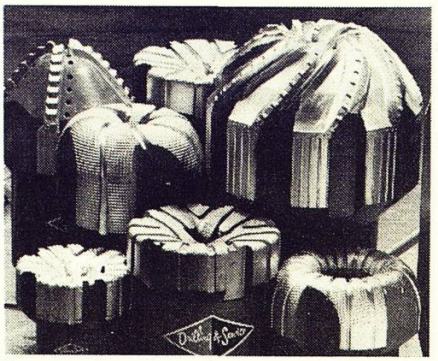
The four chemicals you tested are found in sea water.

Q12 What flame colour did evaporated sea water give?

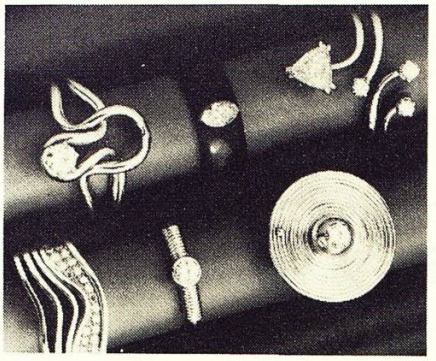
Q13 Which of the four chemicals is there most of in sea water?

Information: Minerals and ores

Some minerals contain very useful substances. **Diamond**, shown above in its natural form, is an example.



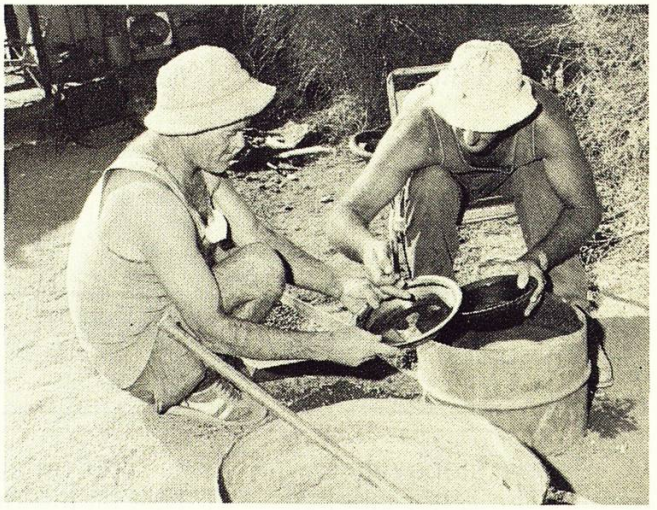
It is very hard so it can be used for cutting and grinding. *Drilling* **bits** (above) can be covered with small, industrial diamonds.



Diamonds can be **cut** to shape and used to make jewellery.

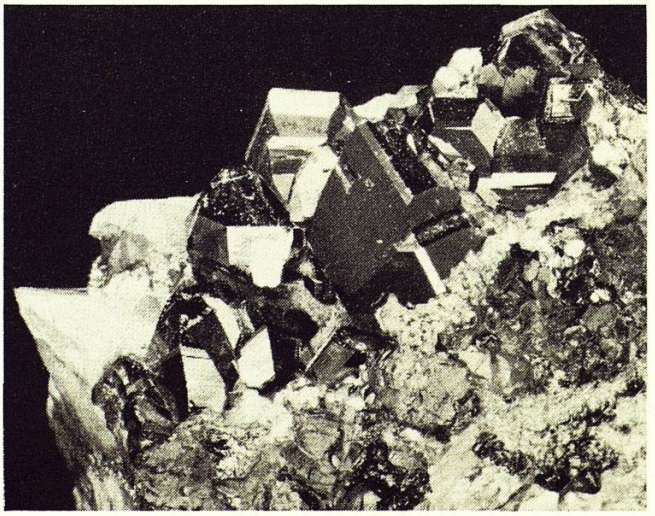
Metals

Metals are very necessary to us. **Gold** and **silver** may be set free from rocks by weathering. These heavy metals fall to the bottom of streams and rivers. The photo shows miners **panning** for gold in Australia. They swirl the water and river sand in large pans. The light sand is swirled out of the pan. The heavier gold fragments collect in the bottom of the pan.



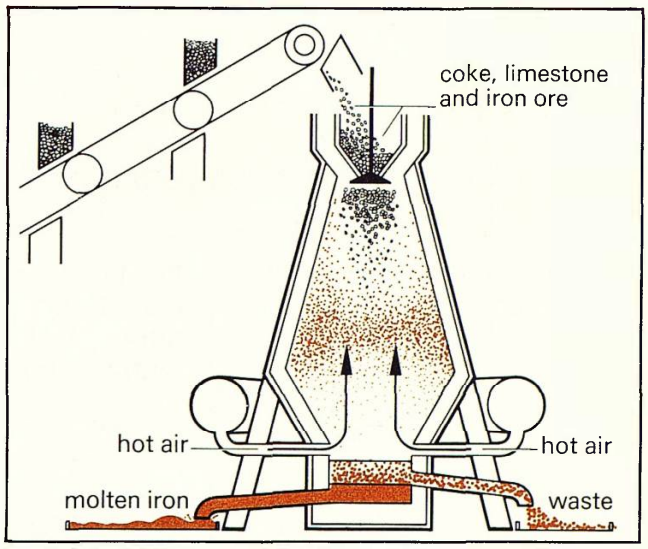
Metal ores

Most metals are found joined to other chemicals in **ores**. Some ores are shown on page 25. Haematite, or kidney ore, is **iron** joined to **oxygen**, galena contains **lead** and malachite contains **copper.** The photo shows the mineral **sphalerite**. This is the metal **zinc** joined to **sulphur**. In the experiment on page 26, you heated sphalerite to drive off the sulphur. This left pure zinc.



Iron

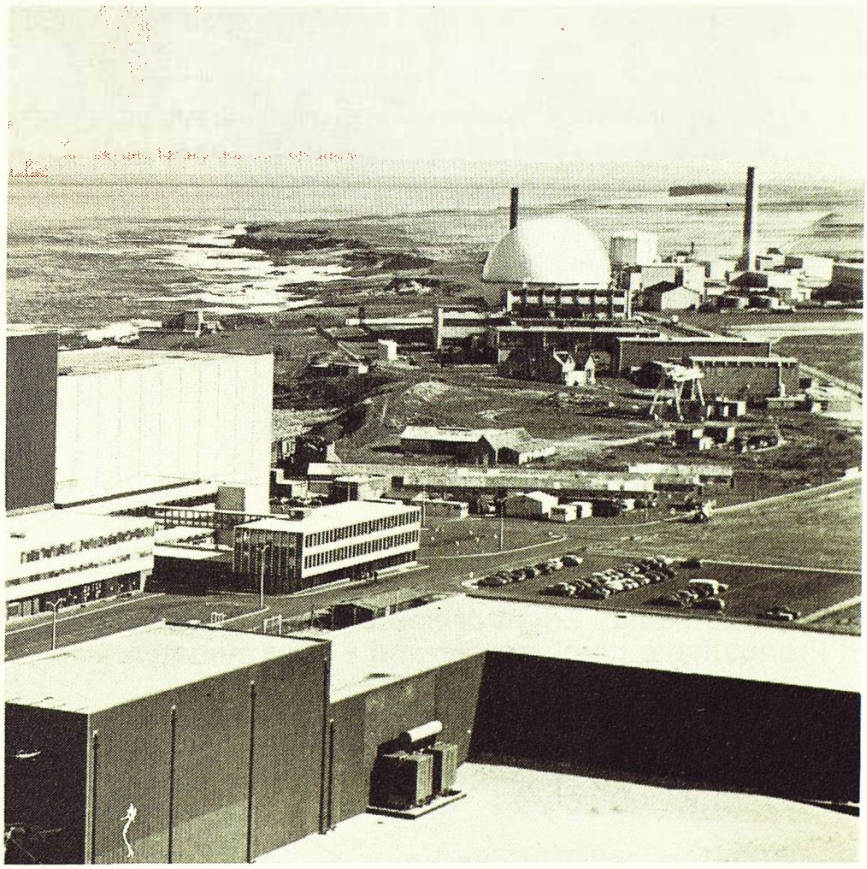
Iron is a metal which is used in very large amounts. The iron ore, such as haematite, is mined and taken to an **iron and steel works**. The ore is mixed with two other **raw materials** – **limestone** and **coke**. The mixture is burnt in a **blast furnace**, as shown on the right. This process is called **smelting**. Soft **pig iron** is produced and is used to make harder types of iron and **steel**.



Other products of the Earth

As coal, oil and gas are starting to run out, **uranium** ore is becoming more important. Uranium is a **radioactive** metal. This means it 'breaks down' or **decays**, changing into other substances. As this happens, heat is given out. The heat can be used to make electricity at a **nuclear power station** (such as Dounreay in Scotland, shown in the photo).

Some important chemicals are obtained from the sea. These include the metals, **sodium, potassium** and **magnesium** and the useful gas **chlorine**.



Q14 What are the uses of diamonds?

Q15 What is panning?

Q16 What is an ore?

Q17 How is iron ore smelted?

7 Rocks for building

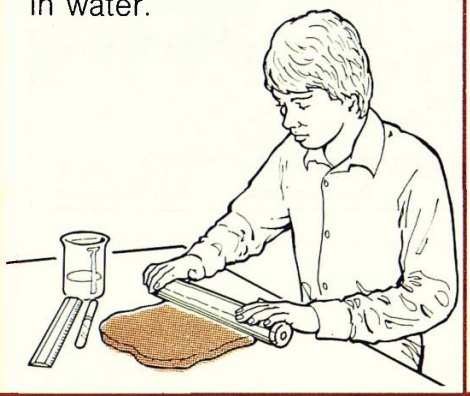
Making bricks

Apparatus

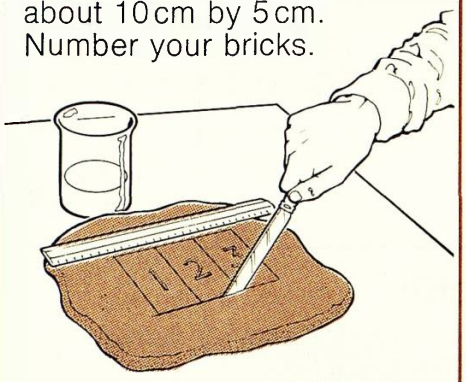
★ clay ★ roller ★ knife ★ ruler ★ beaker of water

You are going to make bricks from clay.

A Roll out the clay until it is about $1\frac{1}{2}$ cm thick. Dip a knife in water.

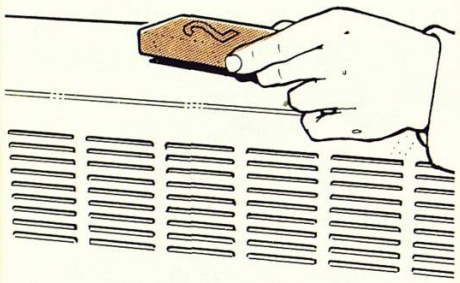


B Cut three bricks from the clay. Each should measure about 10 cm by 5 cm. Number your bricks.

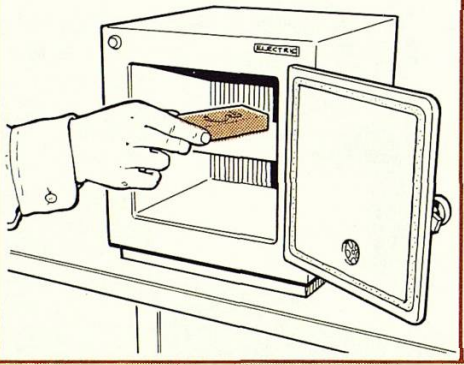


C Leave one brick to dry on a window sill for 3 days.

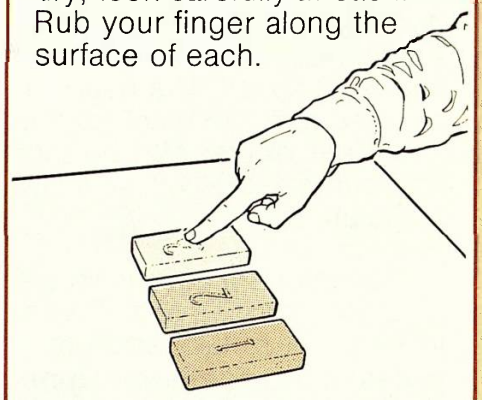
D Leave another brick near a radiator.



E Leave the last brick to dry in an oven set at 150°C.



F When all the bricks are dry, look carefully at each. Rub your finger along the surface of each.



Some countries like Egypt or Saudi Arabia have very hot, dry climates. Countries like Britain and France have much colder and wetter climates.

Q1 Which of your bricks dried:
a) most slowly?
b) most quickly?

Q2 Which of your bricks kept the best shape?

Q3 What happened when you rubbed your finger along the surfaces?

Q4 In which countries could bricks be baked out of doors?

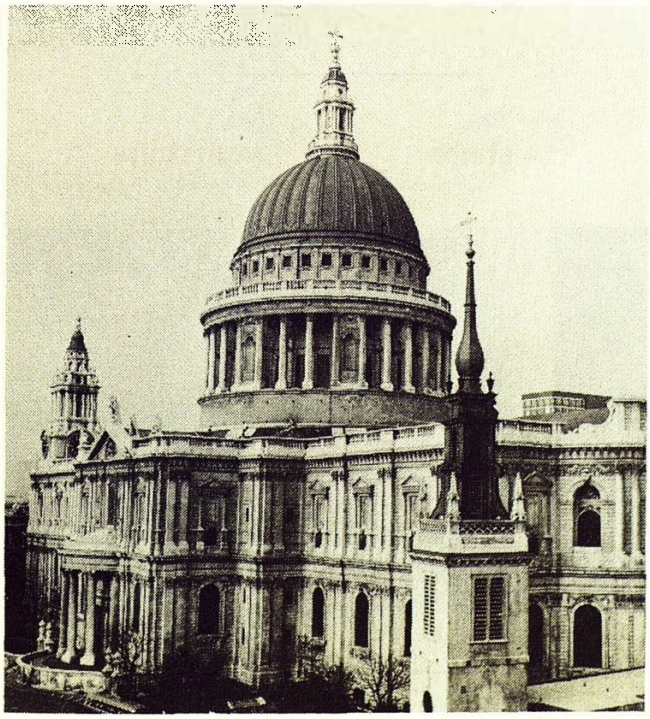
Q5 In which countries must bricks be baked in a **kiln** (oven)?

Information: Building materials

Natural stones

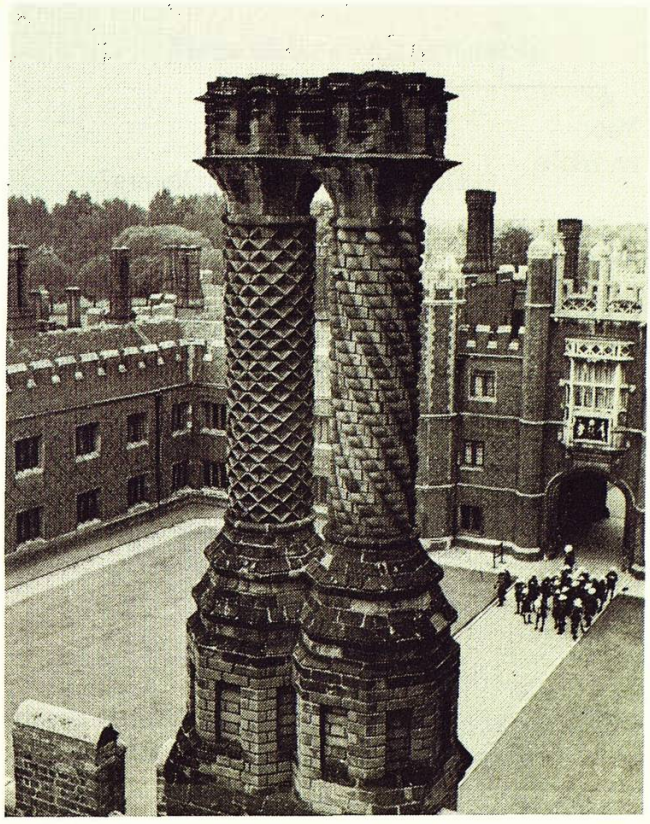
Man has been using rocks to build with for thousands of years. Building stones are very heavy and not easily carried from place to place so rocks were used which could be found locally. In different parts of Britain different rocks are found that can be used for building. For example **Millstone grit** is used a lot for buildings in the North of England.

Very important buildings are often built from rocks that aren't found locally and have to be carried at great expense. St. Paul's Cathedral is built from **limestone** that was brought from Dorset which is about 130 miles away.



Man-made stones

Some places do not have good supplies of suitable natural stones for building. Materials such as bricks and tiles made from baked clay are used instead. Hampton Court Palace in London is made from brick.



Q6 Why are buildings usually made of local stone?

Q7 How far was the limestone brought to build St. Paul's?

Q8 Why do we sometimes use man-made stones?

Q9 Try to find out what type of stone your local church is built from.

Information: A key for identifying some rocks

Like minerals, two pieces of the same rock may look different. To identify rocks, they must be tested and looked at closely.

The key below will help you. The photos show rock samples from a museum. You may not find such clear examples.

START HERE

Is the rock made of crystals or fragments?

Made of crystals.

Does it fizz with dilute acid?

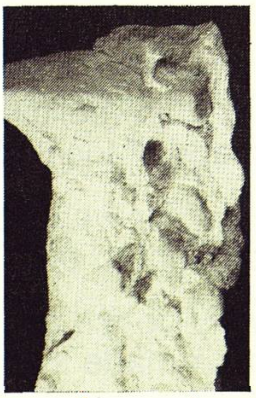
- Yes: **marble**
- No: Does it split into thin layers?
  - Yes: **slate**
  - No: Are the crystals arranged in lines or mixed up?
    - Crystals in lines. Is the rock banded?
      - Yes: **gneiss** (shown below)
      - No: **schist** (shown below)
    - Crystals mixed up. Is the rock pale or dark in colour?
      - Pale: **granite** (shown on page 4)
      - Dark: Are the crystals large or small?
        - Large: **gabbro** (shown below)
        - Small: **basalt** (shown on page 4)

Made of fragments (and may contain fossils).

Does it fizz with dilute acid?

- Yes: **limestone** (shown below)
- No: Is it made of round pebbles?
  - Yes: **conglomerate** (shown below)
  - No: Is it made of sharp-edged pebbles?
    - Yes: **breccia**
    - No: Is it made up of sand grains (small rock fragments)?
      - Yes: **sandstone**
      - No: Is it made of extremely small particles arranged in layers?
        - Yes: **shale**
        - No: **mudstone** (Layers cannot usually be seen.)

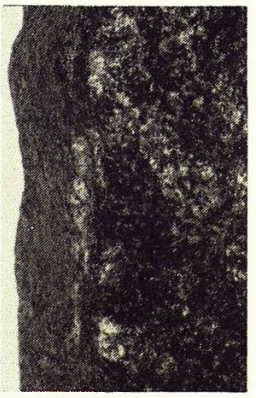
limestone



conglomerate

gneiss

schist



gabbro

Q10 Find out which rocks have been used for building in your area.

Acknowledgements

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