Modelling for rocks: What's hidden inside – and why?
Investigating the permeability of rocks and how they let water, oil and gas flow through

Rocks - the bubble test

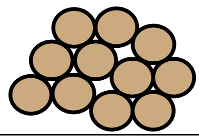
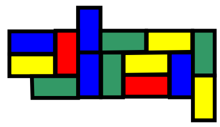
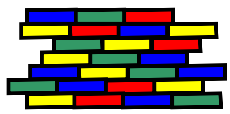
Collect samples of local rocks of similar sizes, put them all into a container of water at the same time and watch for bubbles. Watch the 'bubbly' rocks carefully to see where most of the bubbles came from. What is the order of the rocks, from the most to the least 'bubbly'?

The 'bubbly' rocks have spaces between the grains that air and water can flow through – so they are permeable (liquids and gases flow through permeable things). This test has shown which local rocks are permeable and which rocks don't allow air and water to flow through and so are impermeable.

In the permeable rocks, bubbles rise from the top. This is because the air 'hidden' in the pore spaces in the rock is less dense than the water and so rises through the connected pores. Atmospheric pressure on the surface of the water then pushes water into the spaces left behind – so water flows into the bottom of these permeable samples.

Rocks – 2D modelling

Make your own models:

Permeable rocks	gaps between the grains	sediment-ary rocks	use several large coins of the same size side by side – you can easily see the spaces between the 'grains'	
Impermeable rocks 1	interlocking crystals	igneous rocks	use rectangles of paper, cardboard or plastic side by side – with no gaps between the "crystals"	
Impermeable rocks 2	interlocking crystals	metamor-phic rocks	use long thin rectangles of paper, cardboard or plastic side by side – with no gaps between the "crystals"	

Rocks – 3D modelling

Ask the pupils to work out how they could produce 3D models like the 2D ones – they may suggest:

Permeable rocks - gaps between the grains	balls fruit spheres (eg. oranges) in a container
Impermeable rocks 1 - interlocking crystals	a model of concrete blocks with random orientations
Impermeable rocks 2 - interlocking crystals	a model of concrete blocks laid on their sides, in layers

Rocks – sorting out the impermeable ones

Ask the class to use the models they have made to work out why the impermeable local rocks are impermeable.

Rocks – what are the uses?

- Which of the rocks might store water in the pore spaces underground?
- Which of the rocks might be best under a dammed lake of water, to make sure it didn't leak?
- Which of the rocks might be best for a quarry for storing waste material?
- Which of the rocks might store oil or gas in the pore spaces underground?
- Which of the rocks might trap oil or gas underground, i.e. would prevent them leaking out?
- Which of the rocks is no good for any of these things?

The back up

Title: Modelling for rocks: What's hidden inside – and why?

Subtitle: Investigating the permeability of rocks and how they let water, oil and gas flow through.

Topic: An investigation of local rocks for their permeability; their potential for extracting water, oil or gas from them, or for sealing water storage lakes and oil/gas traps.

Age range of pupils: 8 – 18 years

Time needed to complete activity: 40 minutes

Pupil learning outcomes: Pupils can:

- test rock permeability and put rocks in order of permeability;
- make 2D/3D models to show different sorts of permeability/impermeability;
- explain why some impermeable rocks are impermeable;
- apply their knowledge of rock permeability to real world situations.

Context:
Pupils test and explain the permeability/ impermeability of a selection of local rock types.

Some rocks don't fit this simple pattern, for example;
- a sandstone with a mixture of grain sizes (a poorly sorted sandstone) may have only poor permeability;
- a sedimentary rock that was once permeable, but has become well cemented (natural cement has filled the pore spaces between the grains 'gluing' the rock together) may now be impermeable;
- fine grained sedimentary rocks like clay, although having gaps between the grains like the sandstone, have gaps that are so small that water and oil/gas can't flow through, so they are impermeable.

Possible answers to the '**Rocks – what are the uses?** Questions include:
- Which of the rocks might store water underground? *Permeable sandstones or cracked rocks make the best underground water stores (aquifers)*.
- Which of the rocks might be best under a dammed lake of water, to make sure it didn't leak? *The rocks beneath a dammed lake (reservoir) should be impermeable and not cracked so the water doesn't leak*.
- Which of the rocks might be best for a quarry for storing waste material? *They should be impermeable and not cracked so poisonous liquids and gas can't leak.*
- Which of the rocks might store oil or gas underground? *Permeable sandstones or cracked rocks make the best rocks for holding oil/gas.*
- Which of the rocks might trap oil or gas underground? *Rocks which hold oil/gas are sealed underground by impermeable rocks like clay.*
- Which of the rocks is no good for any of these things? *Rocks that are a bit permeable are not very useful for any of these purposes.*

Following up the activity: Discuss, based on these findings, where local dammed water storage lakes, or waste disposal might go and where underground water supplies (or even oil/gas supplies) might be found.

Underlying principles:
- Rocks which are good for holding oil/gas and water must be both porous and permeable.
- Porosity is the percentage of pore space in a material, which is not being directly considered in this activity (rocks which are good for holding oil/gas and water often have around 15% porosity).
- These rocks must also let fluids flow through – be permeable. Permeability is measured as a volume of flow per second through a fixed area of rock.
- The most permeable rocks are well sorted sandstones (with grains of similar sizes) or fractured rocks.
- The least permeable rocks are usually fine-grained sediments, like clays, since the pore spaces are too small to allow oil/gas or water to flow through.
- Many crystalline rocks are fractured and so may be more permeable than expected.

Thinking skill development:
The translation of a 2D to a 3D model and then to a rock involves the application of understanding (bridging) as well as spatial thinking skills.

Resource list:
- samples of local rocks (size of a big toe or larger)
- container of water to put the rocks in
- coins of different sizes; paper, cardboard or plastic rectangles of suitable shapes
- if the 3D modelling is to be undertaken: balls (spherical fruit) with containers; cement blocks

Useful links: 'Spot that rock' on the Earth Science Education Unit website: http://www.earthscienceeducation.com/
Try the Earthlearningidea to be published on 30th June 2008, 'The space within – the porosity of rocks'.

Source: This activity was originally devised by Duncan Hawley, Education Department, Swansea University, and used in the Earth Science Education Unit 'Spot that rock' workshop