Rock detective – rocky clues to the past
Investigating your local rocks to find out how they formed

Rock Clues	→	Bit Clues	→	Predicting properties	→	Comparisons
Recognise rock properties		Recognise grain properties		Testing porosity/permeability		Making everyday comparisons

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Testing toughness	→	Rock sort 1	→	Rock sort 2	→	Rock detective
Finding how easy it is to remove grains		Sorting sedimentary from crystalline rocks		Sorting igneous from metamorphic rocks		Sorting local rocks into three rock groups

Investigating local rocks. Collect examples of different types of rock from your local area (and from further away if you want to) and take your pupils through this investigation sequence - using the clues in the rocks to find out how they formed. Begin with two rocks, one made from sediment, a sedimentary rock, with obvious grains (eg. a sandstone) and the other, a crystalline igneous rock with big crystals (eg. a granite). *Expected answers are shown in italics below.*

Rock clues. Ask the pupils to work in groups of three. One should pick up one of the two rocks and describe it carefully to one of the others. The third person should try to remember key words and phrases used. Repeat this with the other rock – the third person remembers words and phrases used in both descriptions. These are then reported back to the rest of the class. This will identify key properties of rocks, namely: *their colour, that they are made of 'bits', and that the surfaces feel rough.*

Bit clues. Explain that the 'bits' are called grains. Then repeat this activity asking the pupils to describe some of the grains to each other. Common properties of the grains that they describe will be their: *colour, shape, size and surface shininess (lustre).*

Predicting properties. Ask the pupils to predict what will happen to the masses (weights) of the two rocks after they have been put into water. When they have agreed a prediction, they should watch very carefully as both rocks are put into water together and left for about a minute. They will clearly see bubbles of water rising from the sandstone, but many fewer from the granite. Ask for the sandstone: Where on the rock are most of the bubbles coming from? Why do they come

Looking hard at the 'bits' in a rock
Photo: Peter Kennett

from here? What does this tell you about the rock? Why is the sandstone different from the granite?

They should realise that: *most of the bubbles rise from the top of the rock; they do this because the air in the spaces (pores) in the rock rises, allowing water to flow into the bottom; this shows that the rock is quite porous and that the spaces are connected (the rock is permeable).* The granite has no connected spaces, so air and water cannot flow through.

Bubbles from a sandstone
Photo: Peter Kennett

No bubbles from a granite
Photo: Peter Kennett

Prediction test: *They should have predicted that the sandstone would increase in mass because water would flow in, but the granite wouldn't. In fact, the mass of the sandstone usually increases appreciably, while the granite may increase a small amount, because the surface becomes wet. If a balance is available, this can be tested.*

Conclusion: the shape of the grains in sandstone means that there are spaces; the shape of the grains in the granite causes no spaces (rocks with spaces can hold water or other fluids, eg.oil/gas).

Comparisons. Use a piece of bread and a piece of metal as comparisons. Which rock is most like the bread? – *the sandstone, since both have pore spaces.* Which is most like the metal? – the granite, with no pore spaces. *This can be shown by asking pupils to 'weigh' the bread and metal in their hands before and after dipping them into water.*

Testing toughness. Ask pupils to predict what will happen when both rocks are scratched with a metal object. Then let them do it. *They will find that it is easy to scrape grains off the sandstone, but much harder to scrape them off the granite.* This test will distinguish most sedimentary rocks from most crystalline (igneous and metamorphic) rocks. Ask if their predictions were correct. The grains break off the sandstone easily because they are just stuck together by weak 'glue' (natural cement), but the grains in the granite and other crystalline rocks are interlocking – and much harder to break apart. This also explains why the sandstone was porous and the granite wasn't.

Rock sort 1. Ask the pupils to use the tests above to sort the local rocks into two groups – the porous ones from which grains are easily broken off (sedimentary), and the non-porous ones with interlocking grains (crystalline igneous and metamorphic rocks).

Rock sort 2. They should sort examples of crystalline rocks into those with layers and those without. The layers in the layered crystalline rocks developed as the rock formed from other rocks under great pressure and often, high temperature (metamorphic rocks) - because of the high temperatures and pressures, the crystals interlock with no pore spaces. The non-layered rocks crystallised as liquid rock cooled down, with the crystals interlocking in random directions to form hard non-porous rocks with different crystal sizes.

Note: Two rocks that often cause problems are:
- limestone, that can look crystalline, but fossil clues show that it is sedimentary;
- slate, this can look like a layered sediment, but the grains are hard to scratch off, showing that it is crystalline.

Rock detective – the verdict. Local rocks:
- with spaces between the grains and grains that can easily be broken off, formed from ancient sediments – sedimentary rocks;
- that are non-porous, hard and have layers of interlocking crystals, formed from other rocks by high temperatures and pressures – metamorphic rocks;
- that are hard and non-porous with interlocking grains in random directions (and so have no layers), formed from liquid rock that cooled down – igneous rocks.

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The back up

Title: Rock detective – rocky clues to the past.

Subtitle: Investigating your local rocks to find out how they formed.

Topic: Sorting rocks according to their properties, which depend upon how they were formed.

Age range of pupils: 10 – 16 years

Time needed to complete activity: 30 – 45 minutes

Pupil learning outcomes: Pupils can:
- describe rocks as being formed of grains that are arranged in different ways;
- investigate rocks for porosity and toughness, using water and a metal object;
- divide rocks into porous less tough sedimentary ones and non-porous, tough crystalline ones;
- subdivide crystalline rocks into crystalline layered rocks (metamorphic) and crystalline non-layered rocks (igneous);

- explain how sedimentary, igneous and metamorphic rocks formed.

Context: Pupils use the characteristic properties of a set of local rocks to sort them into sedimentary, igneous and metamorphic rock groups. This works reasonably well for most rocks, but there are exceptions, including:
- some sedimentary rocks are well-cemented with a tough cement and so are not porous or crumbly;
- some metamorphic rocks are not formed under pressure (but mainly by heat) and so have no layering;
- some metamorphic rocks contain only one mineral, and so banding or layering cannot be seen;
- some igneous rocks can be weakened by gas bubbles or weathering and so can be fairly crumbly
- some limestones can look crystalline, while slates can look sedimentary (see above).

Following up the activity:
- Ask pupils to sort out a wider selection of rocks, using the principles they have learned.
- Ask them to look for further clues in the rocks, on how they may have formed, eg.
  - sedimentary rocks may contain fossils or other sedimentary features 'fossilised' from the place where they were first laid down;
  - igneous rocks that have easily seen crystals = cooled slowly deep underground; those with crystals almost too small to see = cooled quickly from volcanic lavas at the surface;
  - metamorphic rocks with small grains have not been metamorphosed greatly; those with easily seen grains have been highly metamorphosed.

Underlying principles: These have been described as the story 'unfolded' above.

Thinking skill development: When pupils make predictions, they use their understanding to produce a mental model of what is likely to happen and why (construction). If this fails, they have to re-think (cognitive conflict). They can be asked to explain their thinking at these stages (metacognition). They should be able to apply what they have learned to new situations (bridging).

Resource list:
- A selection of local rocks, that should include a sandstone with obvious grains and a granite. If either or both of these are not available locally, they should be 'imported'. It may be necessary to import other types of rock as well, to give variety. Each rock should be about the size of an adult big toe.
- A container (preferably transparent) of water.
- A metal object, eg. a knife, fork or spoon.
- Examples of: something porous, eg. a piece of bread; something non-porous, eg. a piece of metal.
- A balance, if available.

Useful links: 'Spot that rock' and the 'ESEU virtual rock kit' on the Earth Science Education Unit website: http://www.earthscienceeducation.com/

Source: This activity is based on a workshop devised by Duncan Hawley (Swansea University) and used as 'Spot that rock' by the Earth Science Education Unit.