This is a peer-reviewed, accepted author manuscript of the following research article: Essex, J. (2023). Earth materials: a fresh look at an old topic. *Primary Science Review*, *179*, 27-29.

Earth materials: a fresh look at an old topic

Introduction

Almost all children notice pebbles when they are out and many are interested in them, whilst fossils (especially dinosaur ones) hold a near-universal fascination. Meanwhile local industrial traditions may well depend on the geology of the area. Yet, despite its obvious relevance and frequent links to pupils' interests, the science of Earth materials is often not well liked by primary teachers. One of the complaints that I quite often hear from student primary teachers is that there are 'too many (long) names to remember' or that the scale of the materials and their transformations seem unimaginably huge for them, never mind their pupils. The other issue is that specialists are often keen to identify different rock and mineral types, of which there are many, so that the subject can appear like 'stamp collecting' but in a stamp album with no apparent system for organising the individual items.

One approach which has been well-liked by the primary student teachers is that of making simple models of various key ideas; these are described below. By contrast, focusing on the processes of chemical and physical change along with the movement of materials in a cycle introduces, or reinforces, concepts that are widely applicable. Designing models to illustrate the behaviour of Earth materials, along with handling samples of the materials themselves, enables student teachers and their pupils to understand the properties of the materials and the processes by which they are changed. The key ideas that pupils need to make meaningful sense of Earth materials can be summarised as:

- The stuff that Earth is made of gets changed into new stuff but you can't get rid of it
- Rocks differ from each other because they contain different materials and are made in different ways.
- Much of the material gets changed and then finally turns back to how it was at the start, that is it goes round in a cycle
- Change in Earth is usually slow but involves a huge amount of material changing
- We can do experiments on small pieces of Earth material to understand better what happens to huge pieces

What they do **not** need is to learn the names of lots of materials early on. However building up an understanding may well give them a conceptual framework to which they can start to relate individual examples, especially those that they encounter in their daily lives.

The following activities have been tried out with a range of learners, both student teachers and pupils, and found to enhance understanding and interest.

<u>Atmosphere in a jam jar</u>

This is a simple, and widely used model. I most commonly see it being carried out in sealed zip lock plastic bags taped to windows, where ethe sun's energy causes the water to evaporate and then re-condense. Both the plastic bag model and the

approach shown here lets pupils see the water cycle as way of circulating water other than by water flow in rivers or seas. The version shown here also lets them understand the key role of the water cycle in purifying water to make it usable.

A clear glass jar with a screw top lid is ideal, but a drinking glass with a saucer over the top works equally well. Put a teaspoon of salt into the jar and add some hot water (from a previously boiled kettle is ideal). The volume of water is not crucial but if you add a large volume the lid tends to heat up and it takes longer to see the water vapour condense. For a drinking glass, I would use about 100 cm^3 of hot water. The hot salty water represents the sea heated by the sun.

Put the lid on top and leave it for about 5 minutes. By this time, pupils should see that water vapour is forming above the hot water and condensing on the lid. The droplets of condensed water represent the water droplets in the clouds.

They can compare the water on the lid and the water it came from by dipping a disposable straw or wooden coffee stirrer into both liquids in turn and tasting it. They will observe that the 'sea' water is salty but the water in the 'cloud' is not. If they collected the rain from the 'cloud' it would be safe to drink.

The activity can act as a starting point for the discussion of the benefits of harvesting rainwater or the use of solar stills to purify dirty water.

To tackle the issue of the many different rocks head on, I consider rocks in their three main groups. These are defined by how the rock was formed and that, in turn, affects the properties and uses of the rocks. I also start by using colloquial terms for the three main groups of rock, so that the focus is on formation and properties rather than technical vocabulary. The three groups of rocks are:

1. 'Boiled' rocks (igneous rocks, made by molten material coming up from hotter parts of the Earth, below the surface)
2. 'Bitty' rocks (sedimentary rocks, usually made from broken up pieces of 'boiled' rock cemented together)
3. 'Squashed' rocks (metamorphic rocks, formed from bitty rocks which care squashed by new layers of rock forming on top of them and by being softened as they move closer to the hot core of the Earth)

These three groups can be readily modelled by making sugar glass, to represent the boiled rock. This has to be done in advance but a video clip of the boiling sugar solution is still impressive.

<u>Model 'boiled' rock.</u>

To make a piece of sugar glass that is about 20 cm in diameter, heat 40 cm^3 of tap water, 25 g of glucose powder (which you can buy from a pharmacy) and 100 g of table sugar. You need to heat the mixture up to 155 ^{o} C. If you do not have a sugar thermometer, heat it up until a drop of the mixture forms a hard shiny bead when it is dropped into cold water. You then need to pour the mixture on to a non-stick piece of parchment or a greased baking tray. Let it cool and the whole piece of shiny clear

'glass' will lift off in one piece. Once it is cool, pupils can handle it and observe that it is very smooth and hard as well as shiny.

Model 'bitty' rock

A piece of the sugar glass can be put into a plastic bag and broken into pieces; I use a rolling pin to do this. I also show how the 'boiled rock' gets broken down and the bits carried away in the activity described below. The small pieces of sugar glass can then be worked into some homemade playdough. This illustrates how chemicals in water can glue ('cement') the broken bits of rock together to make new rock.

Playdough can be made by mixing the following ingredients together. It doesn't need cooking.

125 g flour

150 g salt

I tablespoon cooking oil

125 cm^3 warm water

(A few drops of food colouring if you want)

The activity helps the learners to see clearly that some common rocks are made of small bits of other rocks, rather than being a single material and, if you retain the model, can be used to look at what happens when water wears rocks away (weathering). This understanding can be further secured by shaking a few bits of 'bitty' rock (such as sandstone or limestone) together. Put the stones into a jar with a screw top, add some water and screw the lid on, then shake vigorously. This shows what happens when rain falls on rocks, or they are carried by rivers along with other rocks. Small pieces will be visible at the bottom of the jar and, if examined carefully, these can be seen to small pieces of the rock that was put in the jar.

Model 'squashed' rock

For this part of the activity to work, you need 'bits' that are not uniform in shape. If you break the sugar glass carefully, you may get pieces that are non-uniform. As an alternative, work some dried rice into a second batch of play dough. This time the focus is on how softening the model rock, by working it rather than heating it, and applying pressure, changes the features of 'bitty' rock.

Keep a small lump of model 'bitty' rock to one side and take the rest of it and squash it into a thin layer, on a chopping board or plate. Then fold the two edges of the thin layer of rock over the central portion. Squash the playdough again and repeat twice more.

When you cut the 'rock', pupils can compare it to the original lump that you put aside. (A visualiser or hand lenses may be helpful). They will see that the bits in the play dough are now less randomly arranged, they now tend to be lined up parallel to the surface on which the 'rock' was squashed. If you really want to underline the change

from ‘bitty’ to ‘squashed’ rock, you can show them a piece of baked playdough to compare to the uncooked dough.

How easily do rocks get worn down?

The playdough ‘rock’ enables the process of how easily the different rocks wear away to be modelled. I use three plastic food boxes e.g. ice cream tubs and put a piece of each model ‘rock into each. Then I let the learners slowly pour water on to the ‘rocks’ and observe what happens. The sugar glass will not change perceptibly (although will, in practice, dissolve if in water for some time) whilst the playdough ‘cement’ will be softened and start to be washed out from between the ‘bits’. The ‘squashed’ rock will be more like the bitty rock but breaks up slightly less; if it has been baked, it will resist the water pretty well on the timescale of the activity.

Having established the three groups of rocks, learners can then consider what they are like and how they are used. If at all possible, I would like learners to see the rocks being used, rather than simply as a set of samples in a box. Ideally, this would take the form of a visit to look at old buildings or gravestones in your locality. Failing that, a set of photos of rocks in use, and any relevant specimens that you can find or borrow, can be combined with specimens. However you approach this, learners can gather evidence on the use of rocks and, with support as needed, infer the properties of the three groups of rocks:

1. Boiled rocks are very hard and shiny. They often have crystals (though sometimes they are to small to see with the naked eye) but they are the same in all directions. They do not get worn away easily, but that means that they are expensive to cut out from where they have formed and expensive to cut into the shape that is wanted. Until engineers built powerful saws and drills, they could not be cut and made useful.
2. ‘Bitty’ rocks are relatively soft, so easy to cut and carve. This commonly makes them the least expensive rocks to use but also means that they are the most likely to get worn away, for example by rain.
3. ‘Squashed’ rocks have properties in between those of the other two groups. They are harder than the bitty rocks but not nearly as hard as the boiled rocks. They do not wear away nearly as easily as ‘bitty’ rocks. ‘Squashed’ rocks are easy to cut in one direction but much harder to cut in the other. This makes them easy to split into layers. They are useful when people want a thin, flat piece of rock, such in roof slates or paving slabs.

Conclusion

Although Earth materials are not always a popular topic with teachers, they are an important resource that often shape the life of an area. With carefully chosen models, and explicit links to pupils’ everyday lives, they can be made accessible, interesting and provide a valuable context in which to consider some key scientific concepts.

Additional ideas for teaching about Earth Materials can be found at:

https://www.earthlearningidea.com/home/Tchg_vids_wkshps_primary.html

With thanks to the late Professor Chris King for his many ideas on the teaching of Earth materials, generously shared with many.