Topic: Sedimentary Rock Formation Demonstrations – Imitating Nature

Descriptions of eight possible modelling activities are given below. A selection of these should be incorporated into the work of the class as appropriate. Some are dependent on the availability of local resources, although all of them are capable of adaptation and modification to suit your particular circumstances.

Modelling the Formation of Sedimentary Rocks

A number of simple experiments can be used to model the processes described in the *Sedimentary rock formation* topic. Many of them are probably best carried out as demonstrations, although pupil involvement is easily worked into all of them.

a) Expanding Ice

The aim of this experiment is to model the way in which freezing water can shatter rock. Unfortunately, freezing saturated specimens of real rock does not always produce convincing results even when repeated several times. Instead, it is probably better to fill a glass bottle with water, seal it tightly and place it in a thick polythene bag in a freezer overnight. Provided there is little or no trapped air in the bottle, it should shatter convincingly as the water freezes. Obviously, the shattered glass should be observed but not touched.

Jars with large lids may also work although the expansion may be achieved by doming of the lid rather than shattering of the glass. Note that the volume increase when water freezes and turns to ice is about 9%.

Everyday examples of this phenomenon include burst water pipes and shattered plant containers in frosty weather. Although rarely seen happening, frost shattering of rock is a very common phenomenon in Scottish hills and mountains. Most scree slopes are maintained by the constant addition of angular rock fragments through this process.

b) Landslides

The way in which frost-shattered rock fragments slide downhill can be modelled fairly easily. All you need is a heap of gravel piled up as steeply as possible. 10mm aggregate chips for road surfacing are ideal, although any similar material will do. For every material, there is a maximum angle of slope beyond which instability and sliding occurs. Sand is also good for demonstrating slope instability. Different sands will have different maximum angles, as do wet and dry samples of the same sand.

The best way to induce a landslide in the model is to remove material from the foot of the slope. This would happen in nature, for instance, when a flooding river eroded the bottom of an unstable slope. It also happens when roads are constructed through mountainous regions and was a major concern for engineers rebuilding the A9 road in the 1970s.

c) Sediment Transport In Rivers

This activity could generate a lot of fun and interest! Provided you have access to a bridge over a reasonably flowing river or stream, this could be less of a modelling activity and more of a real-world experiment. The aim is to observe how flowing water is able to transport various sizes of rock material downstream. Simply drop various batches of mud, sand and pebbles from the bridge and record what happens. It is important that pupils are able to see what is happening and that they are able to do so safely.

Only the finer grained materials such as mud, silt and fine sand are likely to be washed away as soon as they are dropped in the water. Coarser materials will migrate more slowly and may require regular monitoring over an extended period. It is likely that coarser materials will only move downstream when the river or stream is in flood. In a real flood, all but the largest boulders may be swept away entirely.

To make the materials more visible, try using pale-coloured sand and pebbles. It might even be desirable to paint larger pebbles to make them stand out from the material already in the river bed. Use emulsion paint which will be relatively short-lived. This may not be such a good idea, however, if the location is a local beauty spot.

Clearly, this is an activity that needs to be thought out in detail, especially from the safety angle. It would be inadvisable to use anything coarser than sand if pupils are likely to return to the site at a later date and try to investigate progress at close quarters in the river.

A different approach that should avoid all risk to pupils would be to take a sequence of photographs over a long period of a specific area of river bed. This would be a genuine experiment with an outcome that would depend very much on local conditions and the timescale of the experiment.

Yet another approach would be to model the action of flowing water on sand and pebbles in the playground using beach materials, a sloping surface and lots of water. This could be a good opportunity for pupils to design their own investigation. Control will need to be exercised over the flow rate and angle of slope if meaningful results are desired. On the other hand, a lot can be gained from simply observing the processes without being too rigorous and scientific.

d) Breaking Down Rock Fragments

Because of the timescale involved, there is no simple way of showing how rivers break down the rock materials they transport into ever smaller pieces. If there is a local river with which pupils are familiar, it may be possible to make the observation that the large boulders and cobbles that tend to fill the river bed near its source are reduced to sand and gravel at the river mouth. With luck, pebbles near the river mouth should be of the same rock types as upstream but of smaller size.

e) Deposition Of Sediment

This is a standard activity that generally works well. It involves the use of clear jars or plastic containers. If glass jars are used, precautions should be taken to avoid injury should a jar be dropped. The aim is to observe how sediment of different grain-sizes is carried around by moving water.

Pupils can add their own sediments to jars, fill them with water and then seal them. Alternatively, they can experiment with a range of prepared jars each containing different sediments. These might include clay, mud, silt, fine sand, coarse sand, grit, and fine gravel, all as discrete samples and as mixtures. Many soils are natural mixtures containing sediment of various grain sizes.

When the water in the jars is made to swirl around, it should be possible to observe that fine grained materials get carried around in suspension, coarser materials may jump up briefly and fall back again, while pebbles simply slide or roll along the bottom of the jar. This models quite closely what happens to sediment in a fast-flowing river.

An additional observation is likely to be that, as motion ceases, sediment settles out of the water in order of grain size with the finest material settling out last. This can explain why grain sizes are sometimes seen to get smaller upwards in beds of sedimentary rock. As with the material in the jar, a bed of rock may represent a single episode of deposition of mixed grain sizes carried by water that ceased to flow.

f) Converting Sediment Into Rock

In nature, this process can take a very long time and involve complex chemical reactions. As layers of sediment accumulate one on top of the other, the lower layers are subjected to increasing pressures and temperatures. Water contained in the spaces (pores) between the grains of sediment gets squeezed out and slowly carries dissolved minerals through the rock as it escapes upwards. These dissolved minerals often precipitate in the colder layers above and act as a cement, binding the grains of sediment to form a durable rock.

Although various materials such as dissolved sugar and plaster are sometimes suggested to model this process in the classroom, the most reliable 'cement' for making DIY sedimentary rocks is diluted PVA glue. It has the advantage of remaining transparent and thereby allowing the nature of the component rock fragments to be seen. Pupils should add about one part water to four parts glue and stir some into a little gravel in a plastic cup. The best results are obtained when there is just enough glue to wet all of the gravel. The mixture should be left to harden overnight before peeling off the plastic cup. Gravel is preferable to sand which soaks up a lot of glue and produces less rock-like specimens.

g) Building Up Layers Of Rock

The *Law of Superposition* is crucial to the understanding of rock sequences such as those exposed at Knockan Crag. Fortunately, perhaps, pupils do not need to identify the 'law' as such! All that matters is that they fully appreciate that, as layers of sedimentary rocks are laid down, each new layer is younger than any below it.

Although the point is a very obvious one, it may still be worth making a simple model by adding layers of different sediment to a clear-sided container. Different coloured sands are very effective. Try to avoid adding sand on top of coarse gravel since it will trickle down into the voids below and obscure the layering.

Piling sheets of paper on top of one another is another way of modelling sedimentary layers. Bricks or building blocks in a wall clearly demonstrate the *Law of Superposition* as well.

h) Mountain Building

Plasticene or modelling clay can be used to show how mountain chains are created when thick sequences of rock strata are squeezed between advancing continents. One problem with this model is that it is difficult to show that real strata get pushed downwards as well as upwards. Many of the rocks exposed in the Highlands today show obvious evidence of high temperature conditions in the 'root zone' of an ancient mountain chain as they were pushed downwards into the hotter regions of the Earth's crust.

Another problem with this model is recovering the plasticene for future use!