Rock builder
Simulating the formation of fossiliferous sedimentary rocks

A discussion about why we need to simulate sedimentary processes could be used as a lead-in to this activity. Why cannot some of these processes be investigated in 'real life' conditions?
A. Because sedimentary rocks take millions of years to form.

Through this activity, pupils simulate how sediments become sedimentary rocks by being compacted and cemented, and how fossils can be formed in sedimentary rock. The activity needs to 'dry' for a few days before the class comes back to it.

Explain that we can investigate the formation of sedimentary rocks by setting up and carrying out an experiment which simulates this process.
Show the pupils the dry sand and pebbles. Explain that mud, silt, sand, pebbles and boulders are called sediment.

Rub a piece of soft sandstone with a file and study the grains produced. Discuss how sandstone might be made of 'stuck-together sand', and how the presence of sandstone might have meant that parts of the UK were once covered by sand, either on beaches or in deserts.

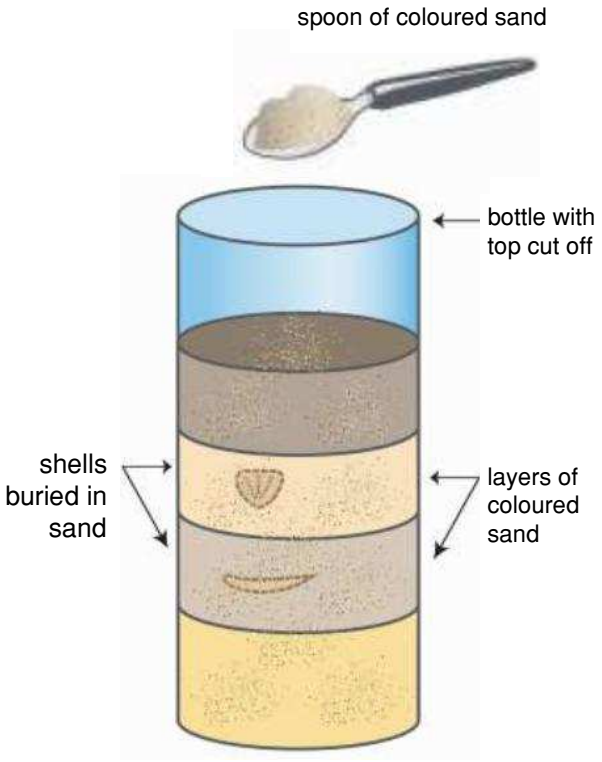
Say that we are going to try to turn sand into sandstone. Ask everyone to get a handful of damp sand. Ask them to try and squeeze it really hard to turn it into rock like the sandstone.
Did anyone manage to do this?
Ask what else they might need to get it to stick.
A. Some kind of glue or natural cement.

Explain that sedimentary rocks are made over millions of years from loose material being squeezed and stuck together.

Ask them where they might see sedimentary rock today e.g. buried beneath the ground, in cliffs, road cuttings, in building stones and gravestones.

Ask what would happen to a shellfish (e.g. mussel, oyster, clam), or a fish, or even a cola can, that was buried in sand for millions of years.
A. The hard bits might be left behind as a fossil.

Then carry out the simulation. This can be done without the filler powder, when the children will see coloured layers of sand and have fun. If done this way then sand layers will have to remain in the clear bottle/pot. However, if you want layers to solidify, to form a more rock-like structure then the filler should be used.



Layered sand © ESEU

Follow these instructions:

1. Put two dessert spoonfuls of sand in one of the bowls and add water to ensure it is wet.
2. Put two dessert spoonfuls of sand in another bowl, add a tea spoonful of powder paint or a little food colouring to colour the sand and then add water to ensure it is wet.
3. Repeat this process to make a third bowl of coloured sand.
4. Smear some petroleum jelly on both sides of two or three shells using your fingers (it makes it easier to lift them out at the end of the activity) - then wash your hands.
5. Add about three tea spoonfuls of powdered filler into each bowl of sand and stir until fully mixed. Your mixture should be like a thick paste.
6. Use the tea spoon to fill a 500 ml plastic bottle with alternate layers of the different coloured sands, putting the shells into different layers. If you place the shells at the edge you will be able to see them through the side of the bottle.
7. After each layer has been added, press it down to compact the sand.
8. Write down predictions for what will happen when your layered 'rock' is left in the bottle for a few days:
   - What will the filler powder do that you couldn't do just by squeezing?

- What will happen to the sand in the bottle after a few days?
- What will happen to the shells after a few days?

Keep your predictions safe so you can see if you were right later.

Leave your layered rock to harden in the bottle for a few days; the plastic bottle can then be cut away. Pupils may need help with this. The 'rocks' may be so hard that tools are needed to break them to find the fossils.

Were the predictions correct?

You can prise out some of the shells at the edge and look at the imprint (or mould) as well as the 'fossil' itself.

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The back up:

Title: Rock builder

Subtitle: Simulating the formation of fossiliferous sedimentary rocks

Topic: An activity to simulate the formation of fossiliferous sedimentary rocks using a variety of sediments and shells in a plastic bottle, with filler acting as cement to 'glue' the grains together.

Age range of pupils: 5 - 11 years

Time needed to complete activity: 30 minutes on the activity day; 15 minutes on follow-up day.

Pupil learning outcomes: Pupils can:
- use the term 'sediment' as the general name given to mud, silt, sand, pebbles and boulders;
- describe how sediments become sedimentary rocks by being compacted and cemented;
- describe how sedimentary rocks may contain fossils.

Context:
As sediments become buried, they are compressed by the overlying sediment and water is squeezed out. Compression by the overlying sediment alone can transform mud into mudstone or shale, however, it cannot change coarser-grained sediments into rocks. Pebbles, sand, silt and lime sand must be 'cemented' as well as compressed if they are to be changed into conglomerate, sandstone, siltstone and limestone, respectively. The natural cement is deposited as crystals in the spaces between the grains (pore spaces) by circulating fluids - and these 'glue' the rock together.

This activity simulates both compression (pupils are asked to press down each layer after it has been added) and cementation, when the filler which hardens over time, acts like natural cement.

Following up the activity:
Ask pupils to describe, using observation and touching, what has happened to the sand that they tried to squeeze really hard to turn it into a rock compared to the damp sand they put into the bottle.
A. The sand in the bottle became hard, solid and dry.

What caused this?
A. The sand was compacted (by being pressed into the bottle) and cemented by the filler powder.

Pupils should break apart their rock to reveal the shell 'fossils' and their imprints (moulds). What might have happened to the fossil if more pressure had been used to make the rock?
A. It may have become flattened, crushed and broken up.

How do we get fossils out of real rocks?
A. Chip away at them with a sharp hammer or chisel.

Explore the idea of a simulation in science. Why did we have to investigate sedimentary rocks this way? Why not go out and watch them being formed? Is it right to collect fossils using a hammer/chisel (a discussion about conservation)?

You may want to conduct a much larger fair test investigation around the excitement that fossils often generate as suggested below.

Using this activity as a base, pupils could design, carry out and report on a series of fair tests to find out what the best sedimentary rocks for preserving fossil imprints might be like.

Variables that could be explored include:
- the amount of filler powder (simulating natural cement);
- the amount of time it is left for;
- the amount of compaction (by putting heavy weights on top);
- the amount of water;
- the size of the sediments (sand comes in different 'grades' and you could also offer small pebbles, or mixtures of sand and pebbles, or different layers of sands and pebbles);
- fossils are much more common in some UK rocks than others - why is this?
  A. More organisms lived in some areas than in others, the conditions for preservation were better in some areas than in others, igneous rocks never contain fossils (Pompeii is very exceptional) and *metamorphic rocks rarely do.)*

There is potential for a full report on fossil preservation to be written in a meaningful context.

Underlying principles:
- Sediment refers to unconsolidated material such as mud, silt, sand, pebbles and boulders.
- With the exception of mud, sediments are compressed and cemented to become sedimentary rocks.
- Mud will become mudstone by compression alone.
- Animals and plants live in areas where sediment is forming.
- The remains of these organisms become fossils as the sediments gradually change into sedimentary rocks.
- Sedimentary rocks take millions of years to form.
- Sedimentary rocks reveal the environment of their formation, e.g. a sea shore, shallow sea, deep sea or desert.

Thinking skill development:
A pattern can be seen in the formation of sedimentary rocks. Discussion of the pupils' predictions involves metacognition. Cognitive conflict is caused when pupils realise that the 'rock' they have just made actually takes millions of years to form in the real-world. Relating the hardened results of 'fossiliferous rock' to real fossiliferous rock is a bridging skill.

Resources:
Per class on activity day:
- piece of sandstone
- file
- damp sand
- dry sand (a handful)
- pebbles (a handful)

Per group/pupil on activity day:
- tea spoons
- dessert spoons
- bowls or tubs
- powder paint or food colouring
- 500 ml plastic bottles (with the tops cut off)
- shells
- sand
- powdered wall filler (e.g. Polyfilla™)
- petroleum jelly

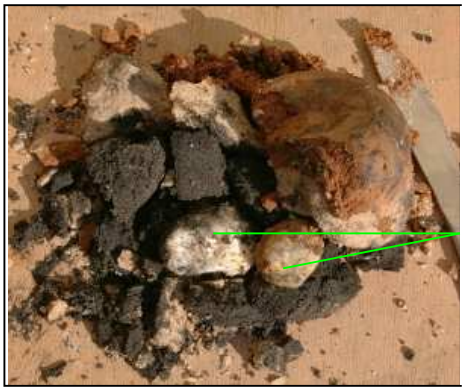
Per group/pupil on results day:
- scissors
- their simulated rock trials (dried and set)
- their predictions from the activity day
- tools may be needed e.g. small hammers, rounded knives, metal spoons

Note that: the Plaster of Paris in powdered fillers (e.g. Polyfilla™) sets with an exothermic reaction and has been known to cause burns when used in large quantities. The amounts being used here are very small and there are, therefore, no recognized hazards in this context.

Source: The Earth Science Education Unit - originally published in the ESEU's 'Scotland Rocks!' workshop booklet.

An example of the 'rocks' placed in the sun to set

(Photo: Elizabeth Devon)



The results after only a few hours

'fossils'

(Photo: Elizabeth Devon)