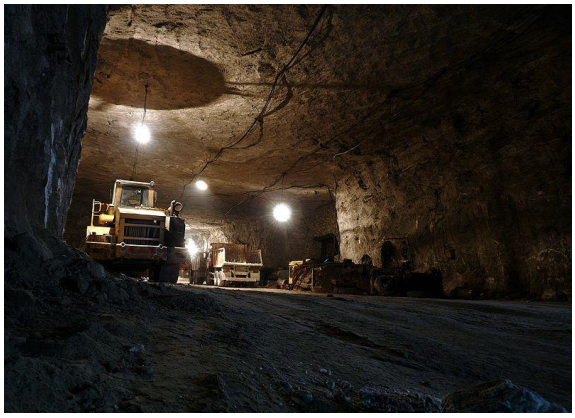
Make and use your own Plaster of Paris
Investigate a large-scale industrial process in a boiling tube

Plaster of Paris is made by heating the mineral gypsum. The heating drives off most, but not all, of the water held in the crystals, called the 'water of crystallisation'.

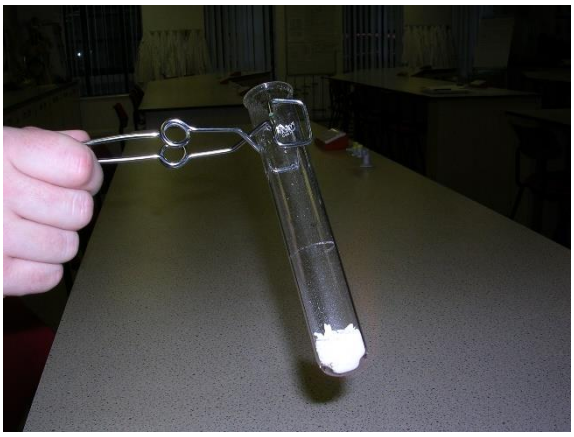
Issue pairs of pupils with the apparatus listed in "Resources" and with enough ground-up gypsum to quarter-fill the Pyrex™ boiling tube. Ensure that they wear eye protection and know how to work safely.

Ask pupils to hold the boiling tube of gypsum in a test tube holder and then to heat it strongly in the hottest Bunsen flame. The gypsum will give off water vapour, which is invisible, but after a few minutes, condensation of water vapour may be observed on the cooler top of the tube. They should not attempt to drive off all the water from the gypsum but should stop while there is still some water vapour coming off. If this is estimated successfully, pupils will have made a small quantity of Plaster of Paris.

A crystal of gypsum (Photo: *P. Kennett*)



Underground working in the Kama-Ustinsky gypsum mine in Russia (*This file is licensed under the Creative Commons Attribution 3.0 Unported licence*)



Heating ground gypsum in a Pyrex™ boiling tube, with water droplets condensing near the top of the tube. (The Bunsen flame is invisible in this photograph). (Photo: *P. Kennett*)

A craftsman plastering a wall (*This work has been released into the public domain by its author, Arpingstone*)

Stand the very hot boiling tube in a metal boiling tube rack and allow the product to cool. Then ask, say, four pairs of pupils to form a group and tip the contents of their boiling tubes into a mortar. Grind the material with the pestle to a powder and transfer it to a disposable cup. Ask the group to press a small object e.g. a coin into modelling clay and remove it, to leave a mould. Add sufficient water to the plaster in the cup until it is like thick cream, and pour it into the mould and allow it to set. Later in the lesson, groups can try removing their plaster cast from its mould and display it triumphantly to the class!

(Note: depending on the quantity of plaster made by each group, it may be necessary to issue a small amount of commercially produced Plaster of Paris, to ensure that pupils can make a reasonably large cast).

The back up

Title: Make and use your own Plaster of Paris

Subtitle: Investigate a large-scale industrial process in a boiling tube

Topic: Making and using a small quantity of Plaster of Paris in the laboratory.

Age range of pupils: 11 – 16 years

Time needed to complete activity: 20 minutes

Pupil learning outcomes: Pupils can:
- handle hot materials safely;
- learn that solid and crystalline materials may contain water as part of their molecular structure;
- understand that many raw materials from the Earth require processing to become useful to society;
- understand why a plastered wall in a building can act as a fire retardant.

Context: A useful activity to be used as part of a lesson on the origin of raw materials from the Earth. It gives a demonstration of the presence of water of crystallisation in a solid substance.

Following up the activity:
- Use commercially available Plaster of Paris to make casts of objects such as fossils.
- Carry out a web-based investigation into the origins of gypsum in the geological record.
- Find out some other uses of gypsum.

Underlying principles:
- Gypsum is a naturally occurring mineral, extracted from the Earth by mining or quarrying.
- Gypsum consists of $CaSO_4.2H_2O$. Heating carefully drives off most of the water of crystallisation, to produce the hemihydrate, $CaSO_4.½\ H_2O$, with the common name of Plaster of Paris.
- When water is added, the hemihydrate absorbs it and reverts to $CaSO_4.2H_2O$, but in a form which can be worked to cast objects or to plaster a wall.
- If a building catches fire, the wall plaster gives off water, helping to dampen the fire.
- If all the water of crystallisation is driven off, the result is $CaSO_4$, anhydrite, which is not capable of reabsorbing water on a human timescale.
- Heat is required to make plaster from gypsum, but the reverse is true when water is added to plaster, i.e. this process is *exothermic* and heat is given off as the plaster sets.
- Plaster has many other uses, such as plaster casts for setting broken limbs.

Thinking skill development:
Thought processes of construction are involved when making plaster from gypsum. Relating the small-scale laboratory activity to the world of industry involves bridging skills.

Resource list: per pair of pupils:
- Bunsen burner
- heat proof mat
- two pairs of eye protection
- test tube holder
- Pyrex™ boiling tube
- metal boiling tube rack to hold the hot tube
- ground gypsum (e.g. from a garden centre)

per group of pupils:
- mortar and pestle
- plastic cup
- stirring rod
- modelling clay
- water
- small object to mould from
- a small quantity of commercially produced Plaster of Paris

Useful links:
http://www.british-gypsum.com/about-us/locations shows the locations of plaster manufacturing, close to the sources of gypsum in the UK.

Source: Adapted by Peter Kennett from articles in journals. It was first suggested by Peter A. Williams in *Geology Teaching* Vol 13.3, 1988. It was developed further by Frank Spode in *Teaching Earth Sciences*, Vol 17.4, 1992. Both journals were published by the Earth Science Teachers' Association (formerly The Association of Teachers of Geology).