Cracking apart
Simulating the weathering of rocks in a desert environment

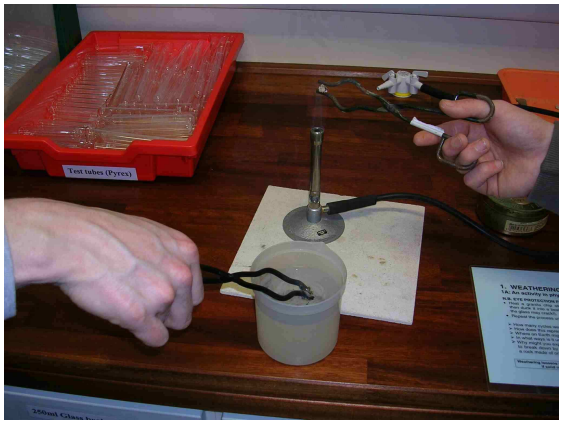
Ask pupils to discuss situations where materials expand in the heat and contract in the cold out of doors. Examples might include steel bridges, or concrete roads; in both cases, expansion joints have to be included to allow for the movement. Explain that rocks also expand and contract and that this can lead to their break up. This is a form of physical weathering.
Revise the standard safety laboratory procedures for the use of Bunsen burners and ensure that pupils are wearing eye protection.
Ask them to investigate how quickly a small granite chip breaks up when it is first held in the Bunsen flame until it glows and is then dunked in a beaker of cold water. Small groups could be challenged to see which is the first group to get its granite chip to break up.

Ask the pupils:
- How many cycles of heating and cooling were needed?
- How might this lab activity represent the natural world?
- Where on Earth might such processes be taking place today?
- Which parts of the exercise are unrealistic?
- Granites contain about three different minerals; would you expect a rock containing only one mineral to break down more or less quickly when heated and cooled in this way?

Then ask them to try heating a rock consisting of only one mineral, such as quartzite, to test their prediction about the rate at which it cracks up. (Do not test limestone, if suggested, as heating of limestone leads to chemical rather than physical breakdown).

The Devil's Marbles, Australia – a boulder cracked apart by weathering, mostly by extremes of temperature.
(*Photo: Prince Roy, Taipei, Flicr.com. This file is licensed under the Creative Commons Attribution 2.0 Licence)*

Breaking up of the outer surface of an exposed rock (exfoliation) in an igneous rock, California
(*Photo: h4vh1e USGS; © Bruce Molnia, Terra Photographics)*



Heating granite chips – teamwork! (*Photo by Peter Kennett)*

The back up

Title: Cracking apart

Subtitle: Simulating the weathering of rocks in a desert environment

Topic: Small chips of granite and other rocks are heated in a Bunsen flame and then rapidly cooled in water. This is repeated to investigate the rate at which they 'weather' by breaking apart.

Age range of pupils: 11 – 18 years

Time needed to complete activity: 10 minutes for the granite chips, plus 10 minutes for extension

Pupil learning outcomes: Pupils can:

- handle a Bunsen burner safely and efficiently;
- demonstrate how cycles of heating and cooling can cause a rock chip to break up;
- predict what might happen when a rock with only one mineral constituent is heated and cooled;
- explain the similarities and differences between the lab investigation and a real desert environment.

Context: Weathering may be studied in a science lesson in the context of the physical processes involved or when considering landscape development in a geography lesson.

- How many cycles of heating and cooling were needed? *This varies with the size of the chip and the pressure of gas in the Bunsen, but about five cycles are usually needed. Pupils may need instructing to hold the chip in the outer blue flame for the highest temperatures and not the inner green-blue one. Some will notice the transfer of heat to the water and will change the water each time.*
- How might this lab activity represent the natural world? *For rocks to break up in this way, they must be exposed to rapid diurnal (day/night) changes in temperature, not the more gradual ones associated with seasonal changes.*
- Where on Earth might such processes be taking place? *Under the clear skies associated with hot deserts, temperatures may reach over 50^{o}C during the day and drop below 0^{o}C at night. The process is accelerated by the presence of moisture from the dew. Rocks have been known to crack with a sound like that of rifle fire.*
- In what respects is the exercise unrealistic? *The temperatures reached in the Bunsen flame are far hotter than in a desert. In the lab, cold water is used to effect rapid cooling, but in the desert cooling is by radiation of heat under a clear night sky.*
- Granites contain about three different minerals. Would you expect a rock containing only one mineral to break down more or less quickly when heated and cooled in this way? *Each of the minerals in the granite has a different coefficient of expansion from the others, causing more stresses in the rock when heated than in a rock such as quartzite, which is made of only one mineral (quartz). Note that marble and limestone are also made of one mineral but should not be used in this investigation. When heated strongly, marble and limestone undergo a chemical change to calcium oxide, and not a physical change as in the granite chip.*

Following up the activity:
Investigate other means by which rocks are weathered, such as repeated wetting and drying; freezing and thawing; etc.
Study pictures of rocks exposed in desert regions and look for evidence of their weathering history.

Underlying principles:

- Most materials expand when heated and contract when cooled; this sets up stresses within the material, including rocks.
- Rocks composed of more than one type of mineral are more prone to weathering because of the different coefficients of expansion of each mineral.
- Experiments have shown that the break up of rocks by heating and cooling them is speeded up by the presence of a little water, compared to a completely dry environment. In a real desert, such water comes from the dew.

Thinking skill development:
Investigating the break up of the rock is a constructive activity. Reasoning out the differences between the lab work and the natural world involves metacognition. Bridging involves making the mental leap from the small granite chip to the large-scale desert environment.

Resource list:

- expendable granite chips up to about 10 mm diameter (e.g. from worktop manufacturers' waste skips)
- expendable quartzite chips up to about 10mm diameter
- eye protection
- tongs

- Bunsen burner, heat proof mat and access to a gas supply **or** a camping gas stove
- matches
- container of cold water, e.g. 250 ml beaker

Source: The Dynamic Rock Cycle workshop, Earth Science Education Unit, 1999 et seq., http://www.earthscienceeducation.com