Breaking up – classroom freeze-thaw weathering

Showing how freezing and thawing can break porous rocks in the classroom

Several days before the lesson, take two sets of around six rocks of different types and put them into two plastic trays deep enough for them to be covered by water. A useful rock selection is:

- Granite
- Basalt
- Porous sandstone
- Limestone
- Slate
- Gneiss

Keep one of the trays as a control and put the other into a freezer. When it has frozen, remove it and allow it to thaw; repeat this several (e.g. five to ten) times.

Pour the water away and keep the trays to show the class. (Once prepared, the trays can be kept for several years).

The trays – control on the left, 'freezer' tray on the right. *(Chris King).*

Ask the class if they can spot any differences between the two trays. Apart from slight differences between the rock specimens, the main difference is that there are many more grains on the bottom of the 'freezer' tray than the other – showing that the rocks must have broken up.

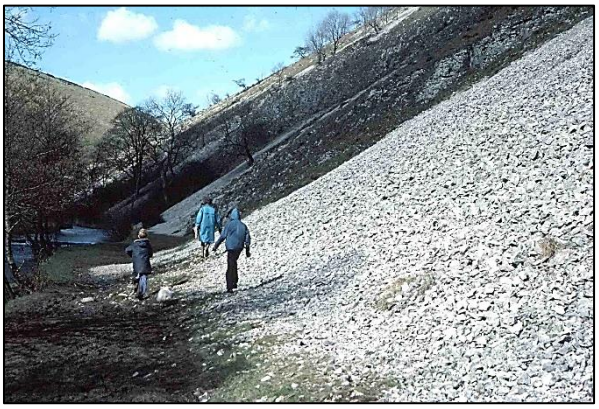
Ask them to study the grains and decide which rock has broken up the most. Most of the grains are clearly sandstone grains – showing that this is the fastest to break up.

Ask why this happens. The answer is that water flowed into the spaces in the porous and permeable sandstone and expanded by 9% on freezing (one of the characteristics of water). When it thawed, it trickled deeper and then froze again. Several phases of this process weakened the rock, so that eventually grains fell off (i.e. were eroded under gravity). The other rocks were not porous and so did not break up in this way.

This weakening by freezing and thawing is called 'freeze-thaw weathering'.

Ask where on Earth freeze-thaw weathering is likely to be most active. The answer is:

- not polar ice caps, which are permanently frozen;
- not deserts, where there is not enough water;
- but anywhere that freezes and thaws frequently, e.g. mountain tops in many parts of the world, but also garden walls in areas that freeze in the winter.



Slope of angular scree. *(Peter Kennett)*.

Ask why mountain sides often have slopes of angular pieces of broken rocks (scree slopes or talus cones) beneath them. The answer is that the rocks were weakened by freeze-thaw weathering until they broke off and fell, being eroded by gravity. There is no opportunity for the corners of the rocks to be eroded away during transportation, so they are angular with sharp edges.

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The back up

Title: Breaking up – classroom freeze-thaw weathering.

Subtitle: Showing how freezing and thawing can break porous rocks in the classroom.

Topic: A classroom demonstration of the physical weathering process, freezing and thawing.

Age range of pupils: 8 years upwards

Time needed to complete activity: 10 minutes using the pre-prepared demonstration

Pupil learning outcomes: Pupils can:

- describe the differences between the control and 'freezer' tray;
- explain the differences, caused by the permeability of the rocks and the expansion of water on freezing.

Context:
This demonstration can be used in lessons on weathering together with the Earthlearningideas:

- *Cracking apart: simulating the weathering of rocks in a desert environment* (https://www.earthlearningidea.com/PDF/71_Cracking_apart.pdf)
- *Weathering limestone – with my own breath!: a classroom demonstration of how limestone is weathered* (https://www.earthlearningidea.com/PDF/214_Weathering_limestone.pdf)
- *Weathering - rocks breaking up and breaking down: matching pictures and descriptions of weathered rocks with the processes of weathering that formed them* (https://www.earthlearningidea.com/PDF/46_Weathering.pdf)

Following up the activity:
Measure the expansion of water on freezing, using the Earthlearningidea: *Ice power: freezing water in a syringe to measure the expansion* (https://www.earthlearningidea.com/PDF/180_Ice_power.pdf).

Underlying principles:

- Water expands by 9% on freezing.
- Water in pore spaces and cracks in rocks prises the rock apart on freezing, trickles deeper on thawing and repeats.
- Rocks and artificial structures are weakened (weathered) by the freeze-thaw process.
- If eventually fragments drop off, they are referred to as being eroded under the influence of gravity.

Thinking skill development:
Cognitive conflict is involved in the questions in this activity, before the results are bridged to the natural environment.

Resource list:

- two trays of mixed rock specimens (suggested rock types above) deep enough for the rocks to be covered by water

Useful links:
Consolidate learning by using the Earthlearningidea: *'Teacher - What's the difference between weathering and erosion?': addressing common misconceptions about weathering and erosion* at: https://www.earthlearningidea.com/PDF/207_Weathering_erosion.pdf

Source: Chris King of the Earthlearningidea Team.

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