Cracking the clues

Making your own cracking clues to the Earth's past

Your pupils may have noticed that, when a pool dries up, it often leaves a muddy bed, which cracks into regular shapes (polygons) as the wet mud shrinks.

Polygonal cracks in mud on a dried out lake bed in England (*Photo: P. Kennett*)

Therefore, ancient mudcracks show us that the area where they are found must have been mud that dried out in the past. It must have been surface mud rather than mud laid down under deep water. So the cracks are key clues to the conditions in which the mud was laid down.

Polygonal cracking in natural materials is caused by shrinkage and the shrinkage is caused either by drying out or by contraction on cooling. We can simulate shrinkage conditions that cause mud cracks in the classroom, and see the stages as they develop.
Mix about 50g of maize flour ("mealie meal") with enough cold water to make a thin dough. Then cook it over a low heat, stirring in more hot water as it thickens. Continue until it is bubbling gently, and is of the thickness of thick porridge.
Pour the mixture into a container with steep sides (not a shallow plate), until is about 2 cm deep. Leave it to cool, and look at it from time to time to see what happens.
The results are very variable, but within about half an hour or so, the surface of the mixture cools and shrinks. As it does so, it cracks into a range of shapes on its upper surface. Shrinkage continues as the mixture dries out, over several days, usually producing more cracks. Many of these are deep enough to cut through the whole mixture.

Cracks in dried out maize flour porridge. (*Photo: P. Kennett*)

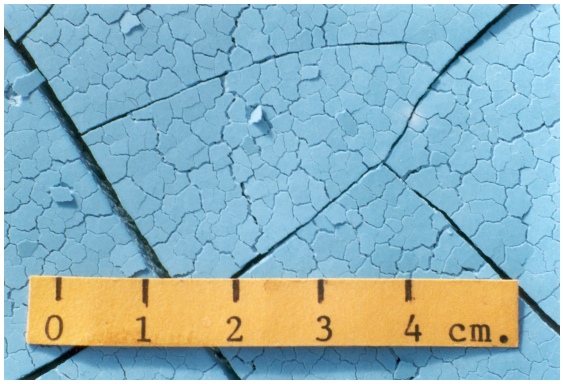
Some cracks have fairly straight sides, and may form polygonal shapes. The cracks in the maize flour porridge are caused by shrinkage first from cooling and then from drying out.
You can compare your cracks produced in the classroom with those seen in ancient rocks, as in the photo below. These are caused by shrinkage due to drying.

Mudcracks in a sedimentary rock 250 million years old (*Photo: P. Kennett*)

Other forms of polygonal cracks occur in thick lava flows. In the best known cases, these form gigantic columns, many metres in height. The process of formation of these is different from that of mudcracks. These columns have formed as molten lava cools, solidifies and contracts. So these cracks form by contraction during cooling, not shrinkage by drying out, as in the mudcracks. The result of the contraction-cooling in lavas is called **columnar jointing**.

Polygonal columns in a thick lava flow. Giants' Causeway, Antrim, Northern Ireland (*Photo: P. Kennett)*

If any cornflour is available, (cornflour is a refined form of maize flour), it may be possible to produce polygonal cracks, in short columns like columnar jointing. Mix equal proportions of cornflour and cold water, pour the mixture into a dish, to about 2 cm depth, and leave it for several days in a warm dry place. Note however, that these cracks are formed by drying out, like mudcracks, rather than by cooling from the molten state as in a real lava flow.



Polygonal cracks producing short columns in dried-out cornflour porridge (coloured blue with ink) (*Photo: P. Kennett*)

The back up

Title: Cracking the clues

Subtitle: Making your own cracking clues to the Earth's past

Topic: Reproducing shrinkage cracks in mud and contraction joints in lavas, using varieties of maize flour.

Age range of pupils: 8 – 18 years

Time needed to complete activity: 15 minutes to set up, but may take a week or two to see the results.

Pupil learning outcomes: Pupils can:

- explain that cracks are caused by shrinkage (contraction) and that the shrinkage is caused either by drying out or by cooling;
- describe what happens when a mixture of flour and water is allowed to cool or dry out;
- explain that regular cracks in ancient mudstones would have been caused by drying out, when exposed to the sun;
- explain that polygonal columns in thick ancient lava flows were produced by contraction as the lava solidified and cooled;
- appreciate that "the present is the key to the past".

Context: This activity enables pupils to understand how local soils and mud deposits may become cracked and how modern evidence can be used to understand past processes.

Following up the activity:
Pupils may be challenged to make their own mudcracks by grating down to powder any available solid clay, or using stone dust, stirring it in water and then leaving it in a container to dry out in the sun.

Underlying principles:

- When wet, muddy sediment dries out, the removal of water results in a loss of volume and causes the sediment to shrink.
- Cooling of a sheet of liquid rock, when it is uniform over a wide area, results in contraction and in the formation of columns.
- When materials dry out, or cool and so contract as above, the resulting pattern is one of least stress, theoretically, a hexagonal pattern. Such hexagonal structures are common in the natural world, too, as in the honeycomb in a bee hive.

Thinking skill development:

- Pupils establish a pattern that shrinkage and contraction tends to produce regular-sided polygons.
- The reasons for the differences between the sedimentary and the igneous situations may pose a cognitive conflict.
- Linking the classroom activity to examples in the landscape is bridging.

Resource list:

- 250g or so of maize flour ("mealie meal"), or cornflour
- water
- some shallow plastic trays or similar containers
- access to a source of heat

Useful links: Try the Earthlearningidea activity - Earth science out of doors: preserving the evidence.
http://www.northantrim.com/giantscauseway.htm

Source: The activity in this form was devised by Peter Kennett, of the Earthlearningidea team