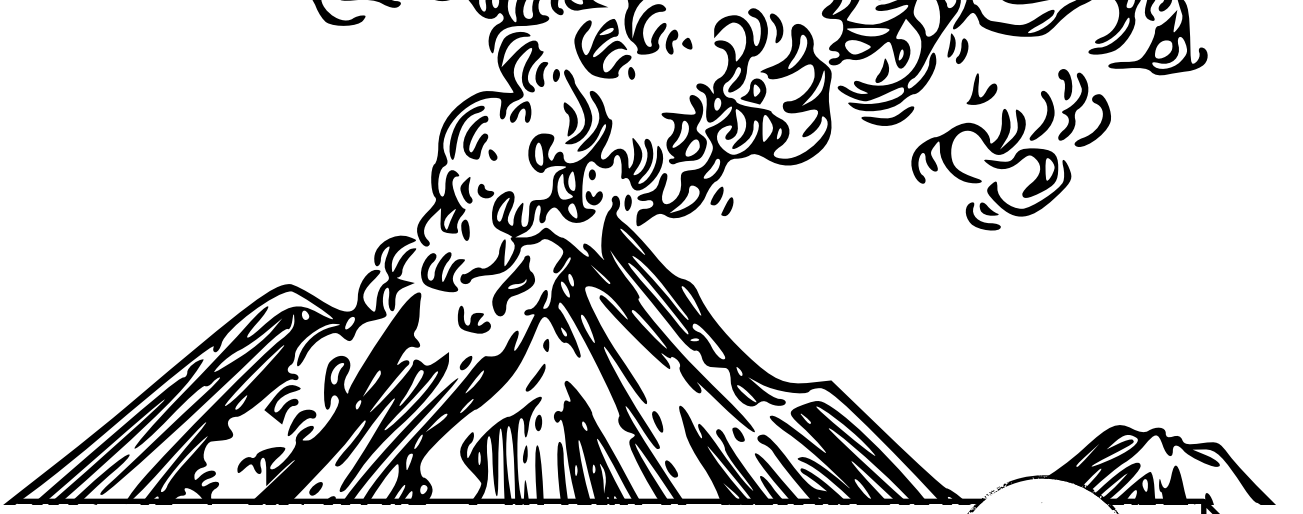

For students and teachers

2

# Learning notes

## Flowing Solids (aka Silly Putty)

Main Article: **Seeing Inside the Earth**

The article explores how we can "see" the movement of the Earth's mantle, mostly by convection. We traditionally think of convection as a process which occurs only in liquids and gases, but the Earth's mantle is made of solid rock – not liquid magma.

The convecting solid-rock mantle is just one example of a solid which flows over time by the accumulation of tiny motions to produce overall flow, a process called creep (in the mantle this happens by the crystals that make up the rock sliding past one another).

### Learning Task:

Silly putty is another example of a solid material which flows through the process of creep. {If you want to make some, we recommend following this recipe: theimaginationtree.com/easy-uk-slime-recipe-contact-lens-solution

Or you can follow this recipe and instructions:

Silly putty recipe:

1) Pour 180 ml PVA glue into a bowl.

2) Mix ½ tsp (2.5ml) of bicarbonate of soda into the glue.

3) (Optionally) mix in any food colouring and glitter as desired.

4) Mix 1½ tbsp (22.5ml) of contact lens solution* into the glue

5) Stir together as the glue forms a putty.

6) Once it all comes together, knead it for a few minutes until its smooth.

When you've finished with your silly putty, and if you want to keep it, it needs to be stored in a plastic, airtight container (e.g. Ziplock bag, Tupperware).

Think about how the putty behaves on different timescales. For example if you throw it against something, versus if you leave it alone for a few minutes-hours? How does this compare to the movement of seismic waves through the deep Earth (travelling at 1000s m per second) vs mantle convection (happening over millions of years)?

You can vary the viscosity (runniness) of the silly putty by adding up to 2tbsp of water at step 3 – how does this affect the behaviour of the putty, especially the timescales of its different behaviours? The mantle is $10^{18}$ times more viscous than silly putty – how fast might you expect it to flow? [spoiler alert: it's about the speed of fingernail growth]

### Take your learning further:

Silly putty, as well as having properties like the solid mantle, behaves similarly to how lava flows (though these are liquids). Try experimenting with how the silly putty flows to explore how lava behaves:

1. Add some rod-shaped sprinkles (vermicelli), or rice, to your silly putty (these represent crystals in a lava).

- When the putty flows, what happens to them?
- How might geoscientists use this when studying volcanoes after the lava has cooled down into solid rock?

2. Use different angles of descent.

- How does the viscosity of the silly putty and the angle of the slope you let it flow down affect how fast the silly putty moves to the bottom?
- What implications does this have for the hazard provided by different volcanoes?

## Take your learning further still:

Solid glaciers of ice also flow due to creep, moving by many metres every year. This can be a big problem for scientists drilling ice cores to study past climate signals recorded in the ice, as the flow of the glacier can cause holes to slowly close up while they are being drilled!

3. Look at this map of ice flow in Antarctica (https://earthobservatory.nasa.gov/images/51781/first-map-of-antarcticas-moving-ice).

- Why does it look the way it does?
- Where would you choose to drill ice cores in Antarctica?
- Compare your chosen sites to the map in this article to see where scientists have previously made ice cores (http://www.antarcticglaciers.org/glaciers-and-climate/ice-cores/ice-core-basics). (Ice cores locations in Antarctica).
- Consider why taking ice core samples is important and what we can learn from this valuable data source.

4. During the cold war, America built the Camp Century military base on/in the Greenland ice sheet, which has now been subsumed into the glacier due to its flow. In hundreds of years, we can expect it to pop out the front of the ice sheet.

- What should we do when this happens?
- How would you want to preserve this piece of history?
- What science questions might we be able to answer from looking at the results of this mistake?

## To find out more:

There are some great resources and information available to support GSCE and A'Level curriculums: Geography, Physics, Biology, Maths and Careers.

**Fire and Ice**

This resource presents some real seismic data recorded before a volcanic eruption and allows students to locate some of the resulting earthquakes by use of graphs and maps. Curriculum links include waves, longitudinal and transverse waves, S waves, P waves, disaster relief, earthquake detection. www.stem.org.uk/rx73m9

**Explosive Earth**

Learn about the volcanic activity that generates earth tremors and the seismologists that measure these tremors to predict future eruptions. This is an article from a previous edition of Catalyst Magazine. www.stem.org.uk/rxcnod

**Mount Etna**

Discover Mount Etna on the Italian island of Sicily, the biggest and tallest active volcano in Europe and one of the most active in the world. This Catalyst article explores the geology of the volcano, its history and the local habitat surrounding it including how the volcanic conditions create rich fertile soil. www.stem.org.uk/rx324m

**Dr Tamsin Mather – volcanologist**

A Volcanologist studies the impact of volcanoes on the atmosphere and our planet. Volcanologists often work to try to understand how to better predict eruptions and minimise the effects on people arising from them. They may use computer modelling or satellite imagery and often work on or around volcanoes taking measurements. www.stem.org.uk/rxfra7

**Earth Science Podcasts**

Produced by the Science and Technology Facilities Council (STFC), these naked Scientist podcasts look at Earth science questions in an accessible and informative way. The podcasts look at: Antarctica; Earthquakes and Ecosystems; Volcanoes, Aeroplanes and our Environment; Hole Punch, Clouds and Making Rain. www.stem.org.uk/rxypz