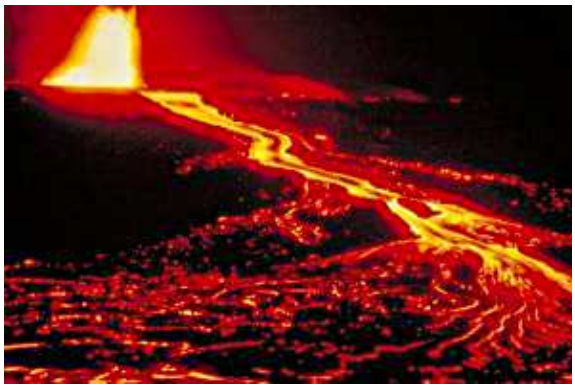
See how they run
Investigate why some lavas flow further and more quickly than others

Ask pupils why they think that some volcanoes erupt lava that can flow for many kilometres, whilst others tend to produce lava domes with no runny lava at all, (try using pictures if you can to stimulate discussion). They can then investigate some of the factors that control the viscosity (or 'stickiness') of fluids, using a viscous fluid, like treacle or honey as a substitute for lava.



Kilauea, on Hawaii, at night, erupting runny lava
Photo no: h57sxr, from www.agiweb.org courtesy of the USGS

Mt. St. Helen's USA erupting in 1980. Steep-sided cone was produced by earlier eruptions of viscous lava. On this occasion the volcano erupted a huge column of volcanic ash
Photo no: h6uuvy from www.agiweb.org courtesy of the USGS

Ask the students to say how they think they could make the treacle or honey more or less runny. Suggestions will probably include: varying the temperature of the fluid; adding some solid particles, such as sand; adding water, blowing air into it through a straw.

Activity 1 Varying the temperature
Prepare three identical clear plastic or glass containers, such as empty drinks bottles, each of which has had the same small quantity of the viscous fluid (in this case, treacle) added to it.
Immerse the containers in water at a range of temperatures,
Viscosity may then be compared by inverting all three

Fig 1 Treacle at three different temperatures, where the containers have been inverted at the same time *(Photo P. Kennett)*

containers at the same instant and timing how long it takes for the first fluid to trickle down to the neck of the container, Fig 1.

Activity 2 Varying the composition
Prepare three samples of honey in plastic cups: one unmodified, one with the addition of half a teaspoon of sand and another with the addition of 3-5 drops of water.
Place equal amounts (about one teaspoon) of each sample along one edge of a ceramic tile or another smooth surface.

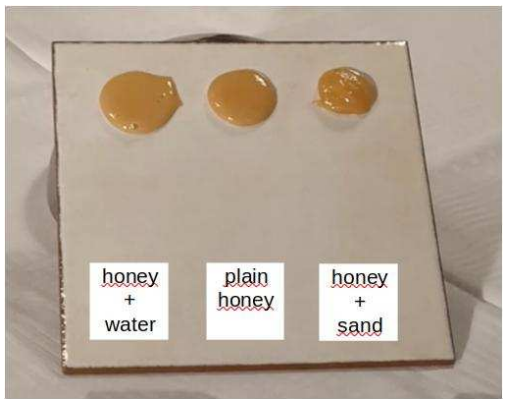


Fig 2 The equipment at the start of the "race"
Photo : Giulia Realdon

Tilt the tile by resting it on a block of wood (or similar support), ensuring the three samples are aligned along the top edge of the sloping surface.
Before adding the samples and timing how long each of them takes to reach the bottom edge of the tile, ask students to predict which sample will move the fastest and which will be the slowest. Then add the samples and watch the outcome, Fig 2. (*The sample with water will be the fastest, and the sample with sand will be the slowest*)

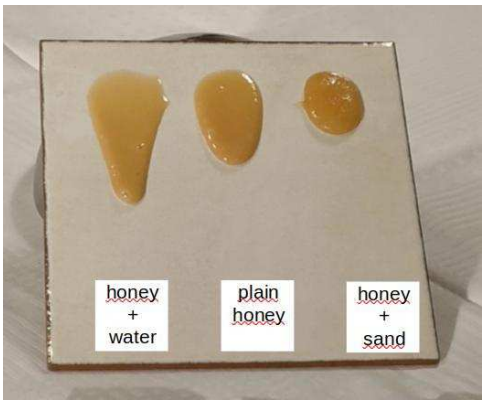


Fig 3 The effects of different viscosities are visible
Photo : Giulia Realdon

After either activity, ask which sort of lava would form a steep sided, cone-shaped volcano and which sort would form a flatter one - they could choose from the pictures in Fig 4.

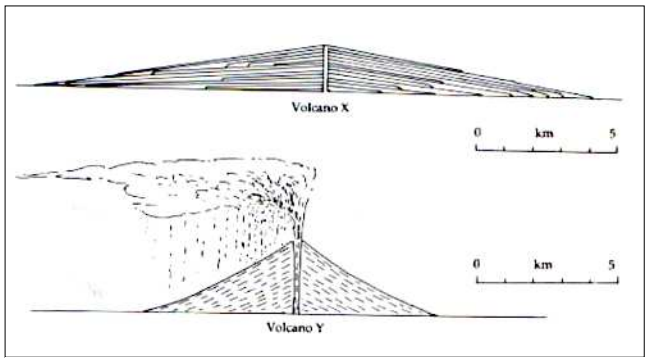


Fig 4 Two volcanoes, one with runny lava and one with viscous lava

This will help them to understand the shapes of modern volcanoes - steep cone = viscous lava; shallow cone = runny lava

The back up

Title: See how they run

Subtitle: Investigate why some lavas flow further and more quickly than others

Topic: An investigation, using suggestions from the class, into some of the factors which can affect the viscosity of lavas

Age range of pupils: 10 - 16 years

Time needed to complete activity: 20 minutes plus preparation time

Pupil learning outcomes: Pupils can:
- explain that the viscosity of a fluid depends on several variables, including temperature, content of solid particles and gas content;
- explain that a fluid of low viscosity will flow further and faster than one of high viscosity;
- appreciate that lavas may contain liquids, solids and gases;
- appreciate that volcanoes which produce high viscosity lava can be more dangerous than those with low viscosity lava, which flows away more freely.

Context:
This investigation could be used to demonstrate an application of physics theory. It could help pupils to understand the differences in landforms produced by different volcanoes. It may also help them to understand the problems faced by civil authorities in trying to limit the effects of volcanic eruptions.

Following up the activity:
Pupils could carry out research into historic eruptions and their effects. Two suggested contrasting styles of eruption could include Kilauea on Hawaii (where lava of low viscosity mostly flows freely away from the vent of the volcano) and Mount St Helen's (where the volcano erupted violently in 1980, killing more than 60 people, even though warnings had been issued).

Underlying principles:
- The viscosity of fluids such as treacle and honey (and lava) is related to their temperature. Generally, the higher the temperature, the lower the viscosity.
- The viscosity of a lava is usually increased in proportion to the amount of solid material which it is carrying when it erupts.
- The gas content of a lava usually decreases its viscosity, enabling it to flow further and faster. However, if gases become trapped behind already solidified lava, this may cause a volcanic explosion, with potentially catastrophic results.
- The chemical composition of a lava is a major factor controlling its viscosity. Most lavas are composed of silicate minerals. Generally, the higher the proportion of silica compared to elements such as iron and magnesium, the higher the viscosity.
- Lavas of low viscosity tend to flow for several kilometres and generally produce volcanoes of a low profile (like Volcano X in Fig 4). High viscosity lavas may produce steep sided lava domes, like the Puy de Dome in central France (Volcano Y). These are liable to "explode" catastrophically, producing volcanic ash, which may cover a wide district when it settles out of the air.

• It is not possible to simulate changes in chemical composition in treacle or honey.

Thinking skill development:
• understanding the relationship between viscosity and variables such as temperature (construction);
• addressing the rôle of water in volcanic eruptions can elicit cognitive conflict;
• applying the results of the investigation to real volcanoes (bridging).

Resource list:
Activity 1
• three identical small clear plastic or glass containers with lids, such as empty drinks bottles (use boiling tubes, if in a laboratory)
• any harmless viscous liquid such as treacle, syrup, or hair shampoo, whose viscosity is dependent upon temperature
• a source of heat and a water bath (bowl of hot water) into which the containers can be immersed
• a watch with a seconds hand, or a stop-clock
• a small quantity of dry sand
• a drinking straw or similar narrow tube thermometer, if available.
Video of the treacle activity:
https://www.earthlearningidea.com/Video/Extrusion.html

Activity 2
• three plastic cups and spoons to prepare the lava models
• treacle, honey or another harmless viscous liquid
• a small amount of dry sand
• a few drops of water
• a ceramic tile or another object with a smooth surface
• support block
• stop-clock or timing device.

Useful links:
Other ELIs on volcanic eruptions, such as Bubble-mania - The bubbling clues to magma viscosity and eruptions
https://www.earthlearningidea.com/PDF/126_Bubblemania.pdf
Best classroom eruption? Which type of classroom eruption best shows how volcanoes erupt?
https://www.earthlearningidea.com/PDF/284_Best_eruption.pdf

Source:
Activity 1: Lava in the laboratory: the treacle investigation, in 'The Dynamic Rock Cycle'
https://www.earthlearningidea.com/home/Teaching_videos_workshops.html#drcws

Activity 2: Giulia Realdon, UNICAM earth workgroup, University of Camerino
https://geologia.unicam.it