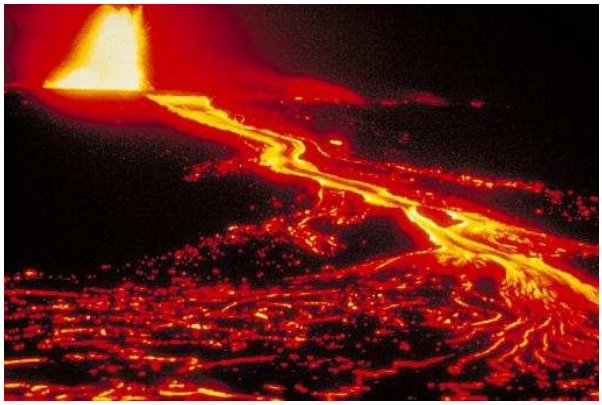
See how they run
Investigate why some lavas flow further and more quickly than others

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 as a substitute for lava.



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

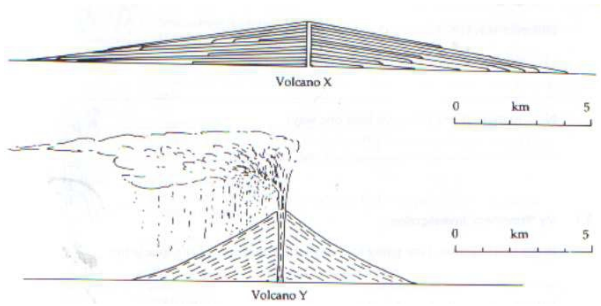
Mt St Helen's, USA, erupting in 1980. The steep sided cone was produced by earlier eruptions of viscous lava. On this occasion, the volcano erupted a huge column of volcanic ash. *(Photo no: h6uuvy, from www.agiweb.org, courtesy of the USGS)*

Show the class 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 added to it. Ask them to say how they think they could make it more or less runny.

Suggestions will probably include: varying the temperature of the fluid; adding some solid particles, such as sand; blowing air into it through a straw. Carry out their ideas with demonstrations, immersing the containers in water at a range of temperatures, if temperature is one of the factors that they wish to test.
Viscosity may then be compared by inverting all three containers at the same instant and timing how long it takes for the first fluid to trickle down to the neck of the container.

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

Then 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 below:



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 emitting lava of high viscosity may be more dangerous than ones 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 a fluid such as treacle (and lava) is related to its 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 get 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 the diagram). 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 the treacle.

Thinking skill development:

- understanding the relationship between viscosity and variables such as temperature (construction)
- applying the results of the investigation to real volcanoes (bridging)

Resource list:

- 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

Useful links: Try the Earthlearningidea activities 'When will it blow? – predicting eruptions…', published in September 2007; and 'Blow up your own volcano', published on 14th July 2008; www.agiweb.org for an excellent source of photographs.

Source: Lava in the laboratory: the treacle investigation, in 'The Dynamic Rock Cycle' on the Earth Science Education Unit website: http://www.earthscienceeducation.com