

Blow up your own volcano! Show how gases blast out material in volcanic eruptions

Simulate your own volcanic eruption by using either of these methods. Both examples are best demonstrated outdoors, or in a large flat tray to catch the liquid blown out. Before either of the demonstrations, try asking the pupils what they think causes the lava to come out of a volcano.

a) a soapsud volcano

Drill a small hole in the side of a plastic drinks bottle and fix a drinking straw or similar narrow tube into it, using a sealant, or chewing gum. Let the sealant set, then half-fill the bottle with soapy water. Drill about six small holes in the bottle top and screw it back on.

Blow through the straw and watch the 'eruption' of frothy soapy water. The bottle may be partially hidden inside a paper cone to represent the volcanic structure.

b) a volcano in a coke bottle

Take a fresh 500ml plastic bottle of Coca Cola™ (coke) or similar 'fizzy' (carbonated) drink, and have a sugar lump ready, small enough to be easily inserted into the bottle. Remove the bottle top and immediately add the sugar lump. Stand well back and watch the frothy liquid 'erupt'.

If wallpaper paste or similar glue is available, make a much more viscous 'eruption' as follows: Cool the bottle of Coca Cola™ in a freezer for about an hour (CO₂ is more soluble at lower temperatures). Take it out and pour away the top 5 cm of liquid. Add about a tablespoonful of wallpaper paste granules, replace the top and shake hard to distribute the granules. Allow the bottle to warm up for several hours, shake it gently and then stand it in a tray, or take it outdoors. Remove the top quickly and watch the 'lava' rise up and slowly overflow the neck of the bottle.



The soapsud volcano in action (Photo: Elizabeth Devon)



The coke volcano in action, after adding a sugar cube (Photo: Peter Kennett)



The bottle prepared for a soapsud eruption (Photo: Elizabeth Devon)



The coke and wallpaper paste volcano in action (Photo: Peter Kennett)

The back up

Title: Blow up your own volcano!

Subtitle: Show how gases blast out material in volcanic eruptions

Topic: Simulating the role of gases in volcanic activity

Age range of pupils: 5 – 16 years

Time needed to complete activity: 10 minutes, plus preparation time

Pupil learning outcomes: Pupils can:

- explain that gas pressure can cause liquids to froth up and overflow (or 'erupt'); or,
- explain that dissolved gases can cause liquids to froth up when the pressure on the container is released;
- appreciate that gases bring solids and liquids to the surface and can blast them out in a volcanic eruption;

Context:

The nature of a volcanic eruption depends on many factors, including the type of underlying magma, its temperature, the quantities of gases dissolved under pressure, the thickness of the overlying rock and its extent of fracture. A small range of these variables may be seen in these activities.

Eruptions are caused when the pressure is released above a magma chamber, allowing dissolved gas to come out of solution, expand and force out lava and rock fragments.

One of the types of frothy lava, when solidified, is called pumice.

Some lavas are so viscous that the expanding gases shatter them into very hot ash particles. These form glowing clouds, pyroclastic flows, (nuées ardentes) which flow down the slopes of the volcano at high speed.

Pupils often assume that liquid lava is the only product of volcanic activity. These simple demonstrations show that gases play a vital role in propelling liquid lava (and solid fragments) out of the volcano.

Soapsud volcano - From Surface Tension theory, the internal pressure in a bubble is inversely proportional to its radius. Fairly large bubbles may be formed in the bottle above the liquid, which is at atmospheric pressure, by blowing gently, but it requires a greater pressure to make bubbles which are small enough to pass through the small holes. Having done so, the bubbles revert to atmospheric pressure inside them and expand quite violently, causing liquid to be splattered into the atmosphere. This is somewhat analogous to the situation in a volcano where gas bubbles in molten magma are forced out through small vents. In a real volcano, the internal pressure in gas bubbles is a function of the depth and temperature and can reach very

high values, which implies the bubbles are extremely small. On reaching the surface, the pressure is suddenly reduced to atmospheric pressure, leading to explosive expansion.

Volcano in a coke bottle (viscous liquid)

activity - Even the least viscous lava is much more viscous than water and this activity demonstrates a viscous flow very well, and also works with gases generated from inside the "volcano". However, in this activity, gas production results from nucleation and chemical reaction, neither of which is a significant factor in a real volcano.

Following up the activity:

Pupils could carry out research into historic eruptions where frothy lava has produced pumice deposits, or has led to dense clouds of hot ash flowing down the slopes, e.g. Mt. Pelée (Martinique) in 1902, or the recent eruptions on the island of Monserrat.

Underlying principles:

- Water molecules attract each other strongly, and they link together to form a tight 'mesh' around each bubble (surface tension). It takes energy to push water molecules away from each other to form a new bubble, or to expand a bubble that has already been formed. In the Coca Cola™ activity, when the sugar is dropped in, the dissolving sugar tends to reduce the surface tension, so it takes less work to expand bubbles. At the same time, the roughness of the sweet's surface provides many little nooks and crannies that allow new bubbles to form more quickly (a process called nucleation). As more of the surface dissolves, both processes accelerate, and foam rapidly begins to form.
- Wallpaper paste contains a surfactant (detergent), which has the effect of reducing surface tension and therefore releases bubbles. This is similar to putting soap into a geyser to force it to erupt.

Thinking skill development:

- The reasoning required to explain the frothing is metacognition.
- Applying this reasoning to a real volcano is an exercise in bridging.

Resource list:

a) Soapsud volcano

- empty plastic drinks bottle e.g 500 ml size, and top,
- drinking straw (or two joined together), or similar tube
- sealant, chewing gum, or similar
- water, coloured for effect if possible
- soap solution, e.g. washing up liquid
- paper or cardboard cone to represent the slopes of a volcano

- tray to catch the 'eruption', or access to the outdoors
- b) volcano in a coke bottle**
- 500ml bottle of Coca Cola™ or similar fizzy drink
 - sugar cubes
 - paper or cardboard cone to represent the volcano slopes
 - optional – wallpaper paste or similar cellulose-based glue
 - access to a freezer
 - tray to catch the 'eruption', or access to the outdoors

Useful links: The Monserrat Volcano Observatory has produced a Teacher's Pack with rock samples, CDs etc for US\$30. See www.mvo.ms or contact cheri@mvo.ms for details.

Source: Soapsud volcano – Chris King; coke volcano – Peter Kennett; viscous coke volcano – Mick de Pomerai, Video clip – Elizabeth Devon, all of the Earth Science Education Unit.

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