

# Lesson 5: Volcanoes: a suitable home?

## Factsheet for teachers

### Purpose of Lesson

In the last lesson pupils understood that volcanoes are primarily (but not exclusively) located on the boundary between two tectonic plates. In its simplest terms a volcano is formed when magma penetrates the Earth's crust. This magma then cools and hardens to form solid rock, creating a mountain. Volcanoes can be active, having erupted in recent history, or in some cases erupting on a continual basis. Others can be dormant or extinct. In this lesson pupils will learn how people make use of volcanoes, both active and dormant, and the volcanic environment.

### Vocabulary

This lesson uses the following geographical terms. These should be used and explained to pupils as the lesson is taught. Some of these terms have already been taught in Lesson 4.

<b>Molten rock</b>	Rocks that are in a liquid form.
<b>Magma</b>	Magma is molten rock from the mantle. Magma is <i>within</i> the surface of the Earth. Magma becomes lava only once it flows out over the surface land, for example with a volcano.
<b>Dormant volcano</b>	A volcano that has not erupted in a long time.
<b>Extinct volcano</b>	A volcano that has not erupted in recorded history.
<b>Active volcano</b>	A volcano that has erupted in recent history.
<b>Lahars</b>	Mudflows, a mixture of ash and water that travel at great speed.

### Fertile Soils

The landscape surrounding Mount Etna and Mount Vesuvius has very rich fertile soils supporting agriculture (see the Lesson Plan). **Mount Vesuvius** is best known for its eruption in AD 79, which led to the destruction of the city of Pompeii. That eruption ejected huge clouds of ash, pumice, rocks and gas at a rate of 100km per hour and lasted 24 hours. The energy released by the volcano was many times that released by the Hiroshima bomb. The residents of Pompeii were asphyxiated, suffocated beneath blankets of volcanic debris more than three metres deep. Estimates of the number of casualties vary, but many thousands died.

### Minerals

**Sulphur:** Sulphur, once known as Brimstone, is used to make a wide range of products including fertilisers, pesticides, paint, cosmetics, paper and matches. It is even used to bleach sugar white. Sulphur can be extracted from the vents of active volcanoes. On the Ijen volcano in East Java, pipes are driven into fissures in the rock to extract the sulphur. It is deep red when molten but turns yellow as it cools and solidifies. The solidified blocks of sulphur are then carried out of the crater to be weighed. It is a dangerous job. Poisonous gases can be released through the fissures in the rock. These can burn the eyes and the throat and rot teeth. Lungs can also be permanently damaged. Inside Ijen's one km wide crater is a lake. The water inside has a pH similar to battery acid, which can easily burn through clothes and skin.

However, today most of the world's sulphur is no longer mined, but is a bi-product of industrial production.

**Diamonds:** These are formed when extreme heat and pressure causes carbon to crystallise. When a volcano erupts diamonds are deposited on, or near, the surface, often in rock called kimberlite. Diamond mines in Russia, Botswana and South Africa are the major gem-quality diamond producers. Australia also produced diamonds, but these are generally for industrial use. The Jubilee diamond mine, also known as the Yubileyny diamond mine, is located in Sakha, northern Russia. It is the biggest diamond mine in the world and is estimated to contain more than 153 million carats of diamonds. The mine has been in production since 1986. The open pit mine is presently operating at a depth of 320m, but is expected to eventually reach 720m.

## Geothermal Energy

Geo means 'of the earth' and 'thermal' means heat. Geothermal energy is therefore the heat that naturally occurs underground in volcanic areas. In many cases this geothermal energy is evident in the form of hot springs and geysers (fountains of hot water that shoot out intermittently from the spring). In other cases this hot water is stored deep underground.

Geothermal energy has been harnessed throughout history for cooking, heating, bathing and washing clothes.

It is not usual to use this heat directly. Building your house on top of a steam vent for example, would be unpredictable, dangerous and messy. The steam contains too many dissolved minerals that could clog pipes, corrode metal components and poison the water supply. However, the heat from underground water is used to drive turbines and to produce electricity in power plants.

Over twenty countries now use geothermal energy. **Iceland** has five geothermal plants supplying about a fifth of the country's energy supply and 85% of all heating and hot water to buildings in the country. (See the Lesson Plan for more details).

Geothermal energy has many advantages. It is a sustainable energy source as the heat from the earth will not be exhausted. In addition, geothermal energy releases less carbon dioxide into the atmosphere than burning fossil fuels to produce electricity. Unlike solar power or wind turbines geothermal power plants are unaffected by changing weather conditions. It is also relatively inexpensive. However, geothermal energy's one disadvantage is that it is not easily transportable. While coal can be transported to a power station over a great distance, hot water and steam cannot. The smell of hydrogen sulphide can also pervade the area, giving off a 'rotten eggs' odour.

**The Geysers:** This is the world's largest geothermal field, containing a complex of 22 geothermal power plants standing in an area 76km<sup>2</sup>. The power plants draw steam from more than 350 wells, located in the Mayacamas Mountains (116 km north of San Francisco, California). The source of heat for the steam reservoir is a large magma chamber more than 13 km in diameter and over 6 km below ground. The Geysers produces enough electricity to power 900 000 homes, or a city the size of San Francisco.

## Tourism

**Yellowstone National Park:** Yellowstone's hot springs, geysers and bubbling mud pools are all outward manifestations of a huge body of magma beneath the surface. Yellowstone is a supervolcano- a volcano on a massive scale. Yellowstone is thought to have last erupted 70 000 years ago. The large volume of material from the last Yellowstone eruption caused the ground to collapse, creating a large depression called a caldera. Supervolcanoes are often hard to detect because they are so large: frequently they can only be observed from space. The Yellowstone caldera is 55 km long and 80-100 km wide. The next eruption is predicted to have catastrophic worldwide effects. It could cool global temperatures for many years and plunge the Earth into a dark winter.

**Other locations:** Visits and tours of the volcanic mountains of Italy are also big business. You can even buy souvenirs at the summit of Vesuvius. Likewise, The Giant's Causeway has guided tours and offers a visitor centre, shop, cafe and hotel. Edinburgh castle is also Scotland's most popular tourist attraction with 1.4 million visitors recorded in 2013 (perhaps many visitors are unaware that they are stood on an extinct volcano).

## The Disadvantages:

**Lava:** Everything in the path of advancing lava will be surrounded, buried or ignited. Lava can reach temperatures of  $1000^{\circ}\text{C}$ . Many homes are destroyed because, even if the lava flow misses them directly, the intense heat in its vicinity can set everything on fire. Lava moves quickly at the peak of a volcano. At lower lying areas, however, it travels relatively slowly (between 1km and 10km per hour). At this speed lava can be out run. However, deaths still occur when people choose to watch the lava flows and then find that their escape routes have been cut off.

**Gases:** Volcanoes can emit large quantities of gas on a regular, sometimes constant, basis. The volume of gas expands as it leaves the volcano and can rise tens of kilometres into the atmosphere and spread great distances. Different volcanoes have gases in different quantities. However the three main gases are water vapour, carbon dioxide and sulphur dioxide. Carbon dioxide is heavier than air, so the gas may flow into low lying areas in great concentrations which can be lethal. Sulphur dioxide has a pungent 'bad egg' odour. It can irritate the eyes, nose, throat and skin and can cause permanent lung damage.

**Ash:** Ash can bury vegetation and soil and can choke people. Falling ash can also turn daylight into complete darkness. While we often think of ash as soft and fluffy, volcanic ash is hard and abrasive; it does not dissolve in water, can be corrosive and can even conduct electricity when wet.

**Popocatepetl:** In Mexico, in 1998, the release of ash and gas from the Popocatepetl volcano (50km from Mexico City) resulted in the mass evacuation of 30,000 people. The ash and gas spread 25km. More recently in 2013 ash spread 3 km into the air and caused the cancellation of 40 flights into Mexico City.

The mixture of hot ash and gas is called a pyroclastic flow.

**Lahar** is an Indonesian term for a mixture of water and rock that flow down the slopes of a volcano. Lahars resemble a mass of wet concrete and can contain anything from small pebbles to massive boulders. They can also strip the surrounding landscape of vegetation. Many lahars are fast moving and cannot be out run. The water contained in lahars can either come from rainfall during or after an eruption, from the ice and snow that frequently covers the peaks of volcanoes, or from the lake within the crater. Composite volcanoes are more likely to produce lahars than shield volcanoes because they are higher, have steep sides and are more likely to contain crater lakes.