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Volcanic Hazards presentation – Teacher's Notes

Learning objectives

- Understand some of the reasons why people live near volcanoes
- Understand some of the natural hazards associated with volcanoes – lava flows, volcanic ash, volcanic gases, earthquakes
- Understand the ways geologists monitor volcanoes to predict eruptions

Presenter notes

Some suggested notes for each slide and information for the presenter. Questions the presenter could ask students are highlighted in **bold**. The Geological Society gives permission for presentations and notes to be adapted to suit the presenter's needs.

Why do people live near volcanoes?

Hundreds of millions of people around the world choose to live very near and even on the slopes of active volcanoes. Some major cities have even been built close to active volcanoes for example Popocatapetl is a volcanic mountain less than 50 miles from Mexico City, home to almost 9 million people. People choose to live near volcanoes because for them the positives outweigh the negatives:

- Volcanic ash and lava are rich in minerals so over time they break down to provide valuable nutrients for the soil. The regions around Mount Vesuvius in Italy are particularly well-known for growing grapes, tomatoes and other vegetables in the rich volcanic soils.
- Volcanoes create beautiful landscapes and are important tourist attractions.
- Geothermal energy – heat from the Earth. Renewable energy resource in which underground heat is used to boil steam and drive turbines and produce electricity, or to heat water supplies that are then used to provide household heating and hot water. In Iceland 85% buildings are heated by geothermal energy and 25% of the nation's electricity is generated from geothermal energy.
- Important minerals such as zinc, lead, tin, copper, silver and gold can be found in volcanic rocks – so they are often areas of mining. Hot gasses escaping through vents of active volcanoes also bring minerals to the surface, particularly the mineral sulfur. Mount Ijen in Indonesia is known having a lot of sulfur, so much so that the volcano actually glows blue at night (sulfur is yellow in colour but when it burns, which it does when it meets the oxygen in the air, it does so with a blue flame). Locals collect the sulfur at the volcano crater and carry it down the mountain where they sell it for around 8 US cents per kilogram.

Natural hazards:

Volcanic eruptions are natural hazards - extreme natural events or process that causes loss of life and/or extreme damage to property and creates severe disruption to human activities.

Lava flows - not usually dangerous to people but can burn down buildings in their path and bury roads and agricultural land. Volcanoes often have ice caps and glaciers, the heat from erupted lava can melt the snow and ice in these ice caps and cause glacial outburst floods (known as jökulhlaups). Lava releases toxic gases, including carbon dioxide, sulfur dioxide, hydrogen sulfide and hydrofluoric acid. When lava interacts with seawater a variety of other toxic gases are produced, including hydrochloric acid, which is highly corrosive. The lava haze, or 'laze', as it is called, can be deceptively deadly.

Volcanic ash - ash and other rock fragments ejected in explosive volcanic eruptions are together known as tephra. Tephra includes large volcanic bombs which can >64mm in diameter right down to volcanic ash at < 1mm. Tephra can get inside aircraft engines and clog them up causing the engines to fail, it can also poison water supplies, smother farmland and vegetation and cause breathing problems in humans and other animals. Tephra of any size can be extremely heavy, especially if it gets wet. Most of the damage caused by falls occurs when wet ash on the roofs of buildings causes them to collapse.

Volcanic ash injected into the atmosphere can have global as well as local consequences. When the volume of an eruption cloud is large enough, and the cloud is spread far enough by wind, ash can block out sunlight and cause temporary cooling of the Earth's surface. Following the eruption of Mount Tambora in 1815, so much pyroclastic material reached and remained in the Earth's atmosphere that global temperatures dropped an average of about 0.5 °C. This caused worldwide incidences of extreme weather, and led 1816 to be known as 'the year without a Summer.'

Gas - magma contains dissolved gases; released to the atmosphere during an eruption. Most of the gas in magma is water vapour which is generally harmless however other gases such as carbon dioxide, fluorine, chlorine and hydrogen sulfide, can be extremely harmful to humans and other animals.

Limnic eruptions – when dissolved CO_2 suddenly erupts from deep lake waters, forming a suffocating gas cloud - associated with volcanoes. Lake Nyos is a volcanic crater lake in Cameroon, West Africa. The magma beneath the lake contains a lot of CO_2 gas which seeps into the lake from below. In 1986 a limnic eruption occurred and over 100,000 tons of CO_2 spilled out of the lake and flowed silently down a valley. CO_2 is heavier than air so displaces it. The gas spread through three villages where over 1746 people lived and caused them all, and over 3000 cattle, to suffocate from lack of oxygen. Estimates of the amount of CO_2 entering the lake from the magma below, indicate that a limnic eruption could occur every 10-30 years. To help prevent further tragedies pipes were installed in Lake Nyos to release the CO_2 from the bottom of the lake into the atmosphere so that it doesn't build up to such dangerous levels.

Pyroclastic flows – or pyroclastic density currents occur when an ash column from an explosive eruption collapses and starts to flow down the sides of a volcano. Formed from a mixture of hot ash, gas and rock fragments, they can race down the sides of a volcano at speeds of up to 1000kmph and temperatures more than 800°C instantly boiling and crushing anything in their path.

When Vesuvius erupted on 24 August 79AD huge pyroclastic flows smothered the nearby cites of Pompeii and Herculaneum boiling inhabitants and burying buildings under volcanic ash. These ancient cities remained buried and undiscovered for almost 1700 years until excavation began in 1748. Pompeii and Herculaneum are preserved as they were on the day in 79AD when they were hit by the pyroclastic flows; they provide a uniquely preserved snapshot of Roman life and culture.

Lahars - mud flow caused when volcanic ash and other volcanic debris mixes with water. Lahars flow like water but have a similar texture to wet concrete. They can be 60-70°C and flow at speeds of 200km/hr in steep areas. They move rapidly like rivers of concrete, often down preexisting river valleys, and can bulldoze and bury anything in their path. An initial lahar flow may be relatively small, but lahars can grow as they pick up rocks, soil, vegetation, and even buildings and bridges. They commonly increase in volume by about 10 times as they flow downslope. Lahars can occur years after a volcanic eruption when fresh volcanic material mixes with heavy rainfall.

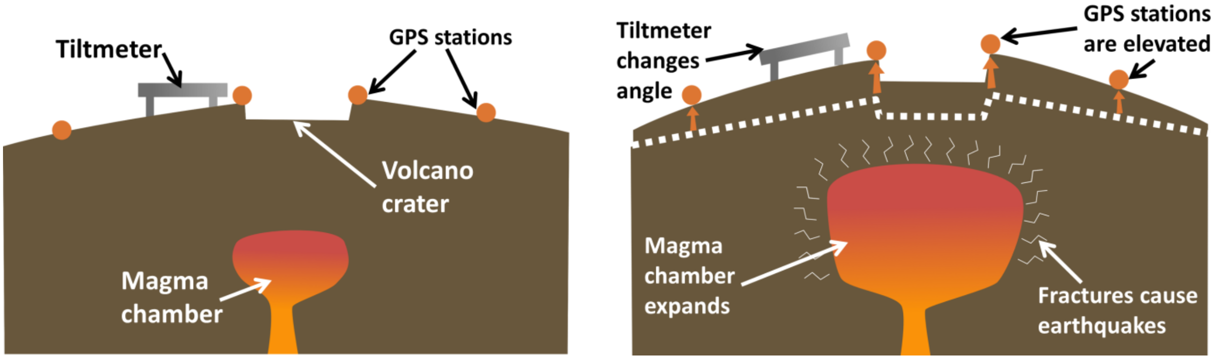
Earthquakes - can occur near volcanoes from the stresses induced by tectonic plates grinding against each other (volcano-tectonic earthquakes) or from cracks caused by magma moving towards the surface (long period earthquakes). This can cause fracturing, ground deformation and damage to buildings.

Landslides - masses of rock and soil that fall or slide under the force of gravity. They are very common on volcanic cones because they are tall, steep and weakened by the rise and eruption of molten rock. If a landslide is large enough and contains enough water it may turn into a lahar. Historically, the most deadly volcano landslide occurred in 1792 when sliding debris from Mt. Mayuyama near Unzen Volcano in Japan slammed into the Ariaka Sea and generated a tsunami that reached the opposite shore and killed nearly 15,000 people.

Volcano monitoring

Monitoring gases - as magma rises toward the surface, the pressure acting on the magma decreases and gas bubbles come out of solution. Because the gas is less dense than the magma, it rises quickly and can be detected at the surface of the Earth through vents called fumaroles. An increase in the amount of gas given off, the appearance of new gas vents, or a change in the chemical makeup of the gas can be some of the first aboveground signs of increased volcanic activity.

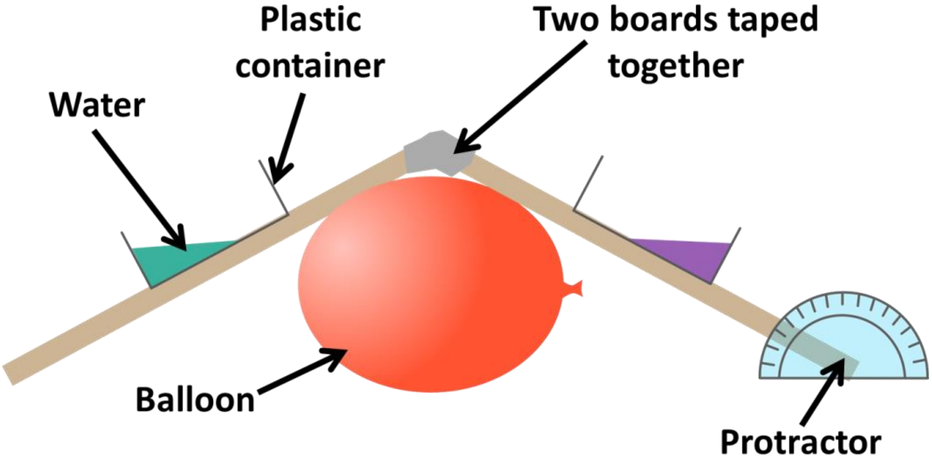
Monitoring ground deformation - Magma, gas, and other fluids moving underground before a volcanic eruption can cause changes in a volcano's ground surface (be swelling, sinking, or cracking). Instruments called tiltmeters are used to detect land surface changes. Another way land surface changes are monitored is to use satellite data. To do this, multiple GPS (global positioning system) receivers are placed around a volcano, satellites travelling around the Earth can then detect whether any of these receivers have moved over time which might indicate that the volcano is bulging with magma and ready to erupt.



Earthquakes – seismographs detect the amount of shaking form an earthquake, to work out their location, how strong they are and how often they are occurring to determine whether or not an eruption may occur.

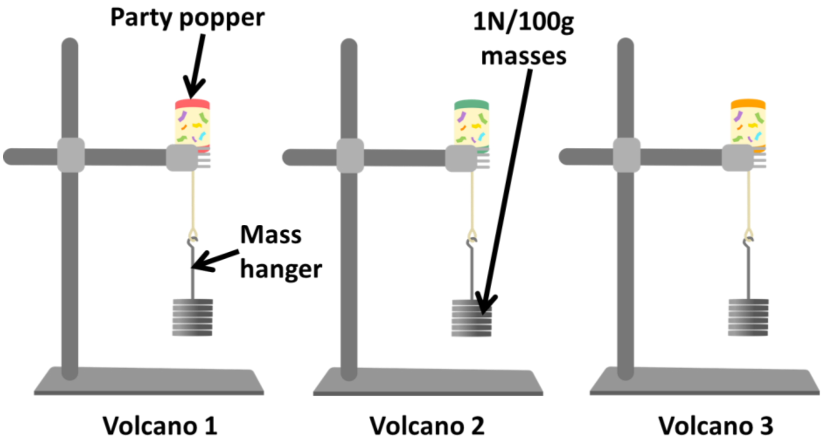
Classroom tiltmeter (Earth Learning Idea www.earthlearningidea.com)

1. Tape two boards together along one edge, and place them near the edge of the table.
2. Pour about 1cm depth of water into two containers and colour the water with food colouring/ink.
3. Place one container on each board, equal distances from the join, held in place by tape.
4. Place a balloon beneath the boards this balloon represents your magma chamber. Students need to inflate the balloon gently! Students measure with a protractor how much the boards are tilted from the horizontal (this is most easily done in relation to the bench, which will give the same angle as that between the tilted boards and the water surface).
5. This is how tiltmeters placed on volcanoes work. If the volcano 'bulges', changing shape because the magma beneath is rising, the liquid in the tiltmeter will move – sending an electric signal 'back to base'.



Party popper volcanoes (Earth Learning Idea www.earthlearningidea.com)

1. Set up three clamp stands, each with a party popper firmly clamped in place.
2. Tie the part popper string to make a secure loop, in order to hold a mass hanger.
3. Don't clamp the party popper too high up the stand, to avoid a big crash when it explodes! Watch out for masses dropping to the floor.
4. Ask three students to take a clamp stand each and explain that they will be loading their mass hangers carefully, adding one 100g (1N) mass at a time, until the party popper goes off.
5. Before they start, ask the class to predict how much mass it will take to set off the party poppers. Then ask the three students to add each mass gently so that they don't suddenly jerk the apparatus. They should avoid putting their heads above the party popper.
6. When all the poppers have popped ask the class how they think this relates to eruption prediction. There is usually considerable variability between the three different party poppers (a range from 300g (3N) up to 3300g (33N) has been found so far – for the latter, it is necessary to add another two mass hangers, each of which itself has a mass of 100g (1N).)



Other useful links:

Timelapse footage of lava – Kilauea 2018
https://www.youtube.com/watch?v=wiRdr5LzbwY

Volcanoes presentation: https://www.geolsoc.org.uk/Education-and-Careers/Resources/Activity-Sheets-And-Presentations

Volcanoes factsheet: https://www.geolsoc.org.uk/factsheets

Volcano case studies presentation: https://www.geolsoc.org.uk/Education-and-Careers/Resources/Activity-Sheets-And-Presentations

Volcano case studies factsheet: https://www.geolsoc.org.uk/factsheets

Lava flow activity: https://www.geolsoc.org.uk/Education-and-Careers/Resources/Activity-Sheets-And-Presentations

Build a volcano activity (aimed at Key Stage 2/3 but could be a fun intro to volcanoes or homework task): https://www.geolsoc.org.uk/Education-and-Careers/Resources/Activity-Sheets-And-Presentations