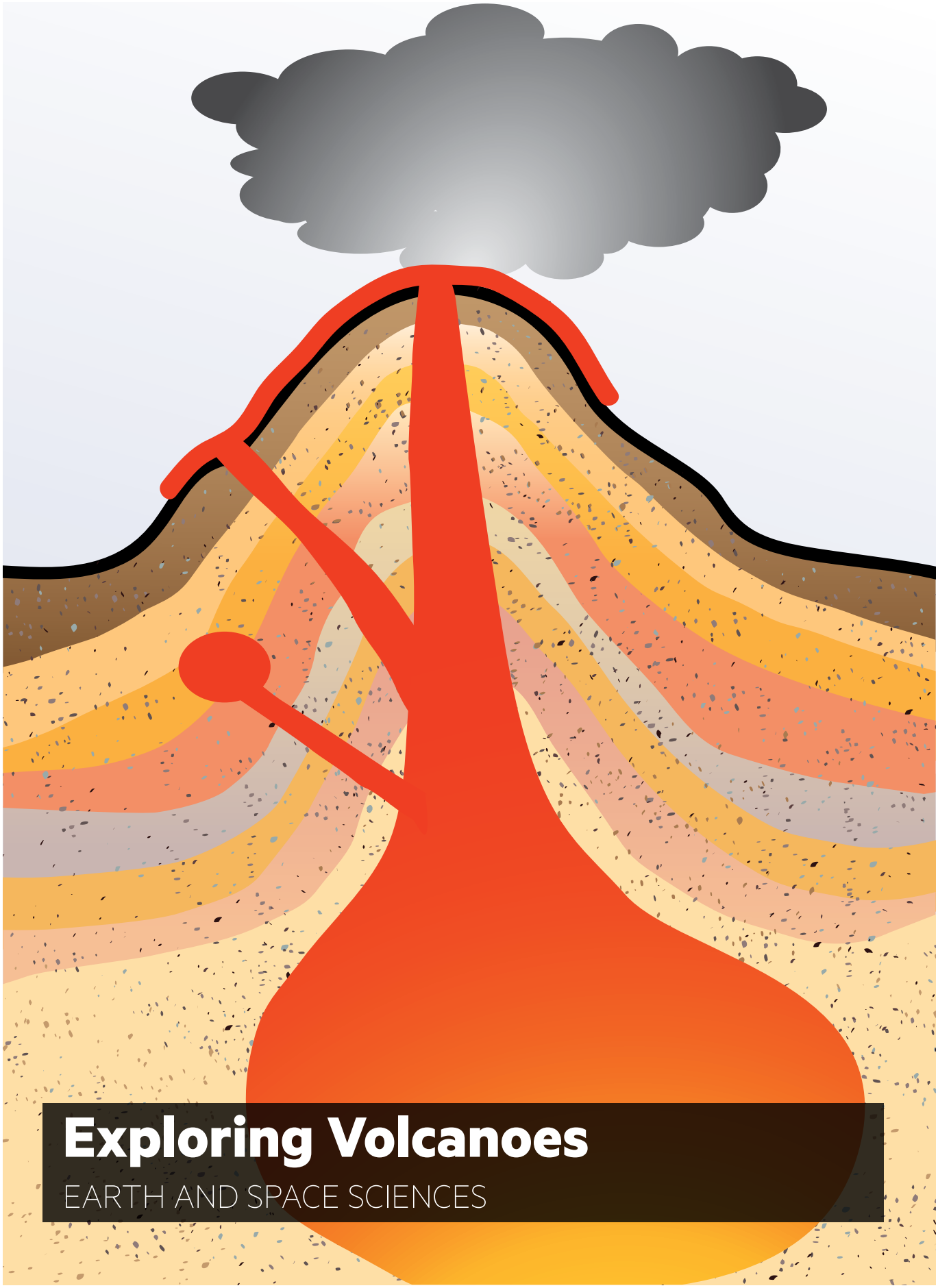


Exploring Volcanoes

EARTH AND SPACE SCIENCES

QGC | FUTUREMAKERS | QUEENSLAND MUSEUM NETWORK | Queensland Government

Introduction

At the Queensland Museum, we research a broad range of topics spanning biodiversity, geosciences, cultures and histories, and conservation practices. Often these research areas overlap; for example, Queensland Museum researchers and scientists may explore how the Earth's landscape shapes our biodiversity, and vice versa.

The Queensland Museum Network has one of the largest and most significant Geosciences Collections in the southern hemisphere. The Geosciences Collection consists of 55,000 geological samples and 27,000 mineral samples, as well as over 7 million fossil specimens! This includes nearly 10,000 primary type specimens (reference specimens used to identify, name and classify fossil plant and animal species).

Likewise, the Biodiversity Collection at the Queensland Museum contains over 2.5 million specimens, and scientists from the Queensland Museum have played a role in discovering over 4000 new species since 1862!

This resource may be used individually or with the Queensland Museum resources *'Plate Tectonics Part 1-3'* which cover continental drift, plate tectonics and plate boundaries. Likewise, Queensland Museum has other resources on natural disasters including *'Cyclones'*. More related resources such as *'Igneous Rocks'* can also be found online.

Future Makers is an innovative partnership between Queensland Museum Network and Shell's QGC project aiming to increase awareness and understanding of the value of science, technology, engineering and maths (STEM) education and skills in Queensland.

This partnership aims to engage and inspire people with the wonder of science, and increase the participation and performance of students in STEM-related subjects and careers — creating a highly capable workforce for the future.

Activity Overview
Volcanoes

In this activity you will model two different volcanoes, and explore how and why volcanoes affect Earth's surface, the environment and human populations.

Teacher Tips

- Get students working in groups of 3–4 for collaborative learning and communication.
- In Activity 3 where students develop a protection plan (question 2), you could get students to design engineering solutions and test them using the volcano demonstration activity.
- You may have students working in groups around butchers paper to develop their preparation and evacuation plan for Mt Vesuvius.
- In Activity 5 students could work in groups, and present their ideas to the class as scientists. This could include multimedia presentations.
- To show the difference between pyroclastic flow and lava, you can hold a baking tray on an angle of approximately 30° and pour syrup/honey down the tray to represent lava. Compare this to water with sugar crystals in it (rock) to represent pyroclastic flow.

Jelly Volcano

- The jelly volcano is an effective teacher demonstration. It may also be completed by students in groups.
- A disposable aluminium tray with a hole cut in the bottom can be used if a peg board is not available.
- To make a more 'classic' volcano, a needle can be used to create a fissure through the middle of the volcano, like the cracks in the Earth's crust.
- This activity can be messy and food colouring can stain. It is recommended that this practical activity is conducted outside on a grassy surface while using gloves, safety goggles and a lab coat.

Australian Curriculum Links for this Resource

Year 6

Science Understanding (SU)

Sudden geological changes and extreme weather events can affect Earth's surface (ACSSU096)

Science as a Human Endeavour (SHE)

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE098)

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE100)

Science Inquiry Skills (SIS)

Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS103)

Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS107)

Compare data with predictions and use as evidence in developing explanations (ACSIS221)

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS110)

Year 8

Science Understanding (SU)

Sedimentary, igneous and metamorphic rocks contain minerals and are formed by processes that occur within Earth over a variety of timescales (ACSSU153)

Science as a Human Endeavour (SHE)

Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available (ACSHE134)

Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures (ACSHE226)

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity (ACSHE136)

Science Inquiry Skills (SIS)

Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed (ACSIS140)

Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships in data using digital technologies as appropriate (ACSIS144)

Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence (ACSIS145)

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS148)

Year 9

Science Understanding (SU)

The theory of plate tectonics explains global patterns of geological activity and continental movement (ACSSU180)

Science as a Human Endeavour (SHE)

Scientific understanding, including models and theories, is contestable and is refined over time through a process of review by the scientific community (ACSHE157)

Science Inquiry Skills (SIS)

Plan, select and use appropriate investigation types, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods (ACSIS165)

Use knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSIS170)

Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data (ACSIS171)

Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSIS174)

Cross Curriculum Priorities

Aboriginal and Torres Strait Islander Histories and Cultures

Aboriginal and Torres Strait Islander Peoples have holistic belief systems and are spiritually and intellectually connected to the land, sea, sky and waterways (IO.3)

Activity 1

Volcano Vocabulary

The Earth was formed approximately 4.6 billion years ago as a ball of molten rock. In the time since, the outside crust of the Earth has cooled to rock; however, the middle of the Earth, including the core and mantle, are still very hot.

Volcanoes are formed when magma from inside the Earth reaches the surface, causing eruptions of lava, ash and gases (see Figure 3).

The Earth's crust is broken up into tectonic plates, blocks of crust that move around independently of one another. Volcanoes are often found at boundaries between two plates that are moving towards each other (convergent – Figure 1), or moving apart (divergent – Figure 2). This is because these plate boundaries often create cracks in the crust from which magma can escape, causing volcanoes.

Hotspot volcanoes are different; they occur when the hot magma melts a hole through the Earth's crust, releasing lava and forming a volcano.

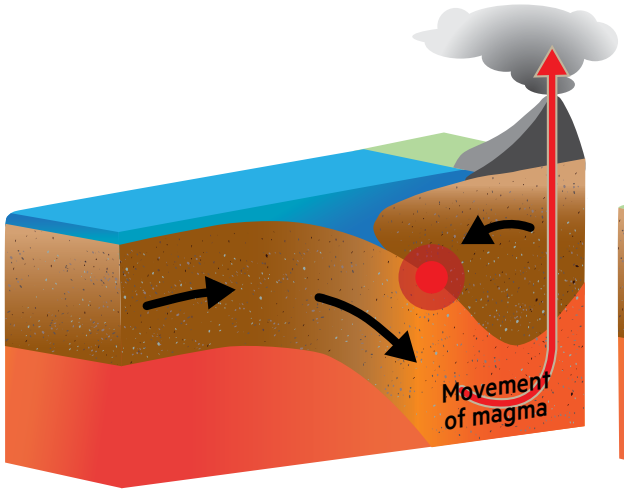


Figure 1: Volcanoes form in subduction zones of convergent boundaries. Subduction zones occur where one plate is pushed under another. This causes the build-up of pressure, and the melting of the plate. Due to the pressure these eruptions are often explosive.

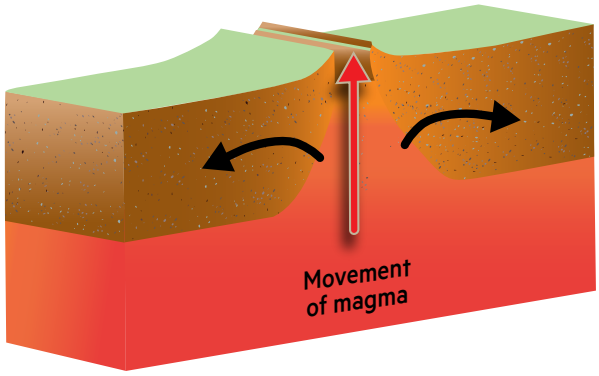


Figure 2: Divergent plate boundaries occur when tectonic plates move apart. Volcanoes can form as the magma seeps out of the space created between the two plates.

1. Use your understanding to match the words in the word bank to their definitions below.

WORD BANK

crust **magma** **lava** **igneous** **subduction zone**

divergent plate boundary **convergent plate boundary**

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

g. _____

Activity 2
Building a Volcano

Objectives

To model a volcano, and explain how volcanoes can affect the Earth's surface.

Materials

- Modelling clay
- Small plastic cup
- Large tray or biscuit sheet
- 1 tablespoon flour
- 2 tablespoons baking soda
- 10 cm square tissue paper
- 1/3 cup vinegar
- 1 drop of food colouring
- Safety glasses

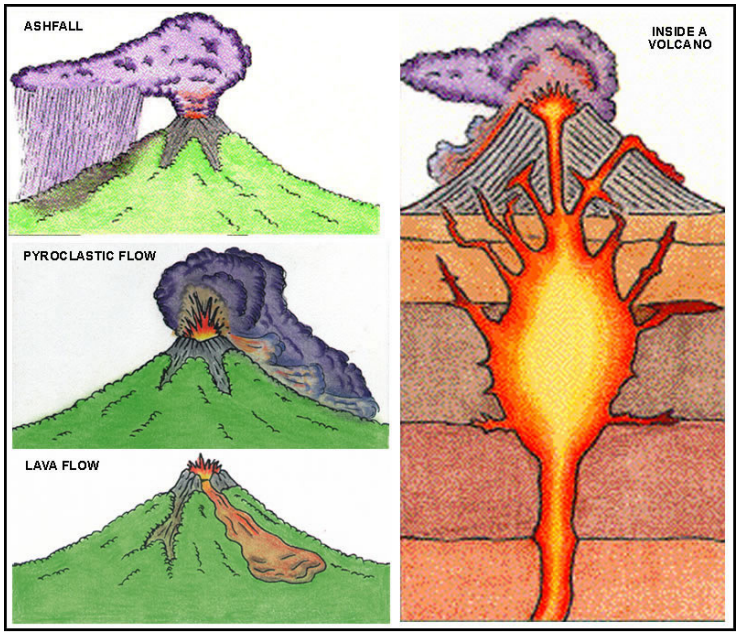


Figure 3: Volcanic eruptions. Image: Geoscience Australia

Method

1. Using the tray as a base, build the volcano with the modelling clay. Make sure that the opening in the top is large enough to hold the small plastic cup.
2. Put the flour and baking soda in the centre of the tissue paper and wrap it up, making sure the ends are tightly twisted.
3. Put the flour and baking soda package in the cup.
4. Add a drop of food colouring to the vinegar.
5. Wearing safety glasses, pour half the vinegar into the cup.
6. When the foaming stops, add the remaining vinegar.

1. **Record your observations and results here.**

2. **If there were houses, habitats and living things at the base of the volcano, what would happen when the volcano erupted?**

Activity 3

Active Volcanoes around the World – Mt Vesuvius

Picture this: ash and dust exploding 19 km into the air (twice as high as Mt Everest!), blocking out the sun and creating darkness in the middle of the day. This is what the people of Pompeii would have seen when Mt Vesuvius erupted in 79 AD.

Mt Vesuvius is an active volcano in Italy (Figure 4). It was formed in a subduction zone, where the African plate is pushed under the Eurasian plate. This causes the rock of the African plate to melt due to the hot temperatures of the Earth's mantle. The melting African plate creates magma under pressure, which can explode from the Earth's crust in violent eruptions.

While Mt Vesuvius last erupted in 1944, the most famous eruption was in 79 AD, as described above. This event covered the cities of Pompeii and Herculaneum in 4-6 m of volcanic dust and pumice (lightweight igneous rock), followed by a pyroclastic surge of hot gases, rock and lava that flowed at high speed out of the volcano. This eruption killed around 2000 people, and left these cities buried in up to 25 m of debris. These towns were then forgotten for over a thousand years!

When the cities were rediscovered during excavations, we were able to see a clear snapshot of life in 79 AD because buildings, art, food and even people were perfectly preserved (Figure 5). We can learn a lot about life in the past from such preserved remains and artefacts, which is why Queensland Museum started collecting and preserving the cultural and natural history of Queensland in 1862. Our collections continue to grow today.

Figure 4: Mt Vesuvius. Towns surrounding the volcano can be seen in the background. Image: Ross Elliott, cc.

Figure 5: People in Pompeii preserved where they were when Mt Vesuvius erupted in 79 AD. Image: Lancevortex, cc.

1. Much of what we know about the eruption of Mt Vesuvius came from a letter written by Pliny the Younger, who watched the eruption from across a bay[1]. Imagine you are watching the eruption of Mt Vesuvius, and write your own account of the eruption.

2. Up to 3 million people currently live within the danger zone of another eruption from Mt Vesuvius. Imagine you are a mayor of a city within the danger zone. What could you do to alert, evacuate and protect your population if the volcano were to erupt again?

There have been many recent volcanic eruptions around the world. The eruption of Mt Rinjani in Indonesia recently grounded many flights to and from Bali. In 1997, a volcano erupted on the Caribbean island of Montserrat burying the main city of Plymouth, and a number of smaller settlements. 19 people were killed. The mortality rate could have been far higher; however, much of the island had been evacuated years earlier due to ash plumes. The pyroclastic flow from the Montserrat eruption was caught on video travelling at speeds faster than a car. You can research these eruptions online to see videos and photographs.

Hotspot Volcanoes

Most, but not all, volcanoes occur at plate boundaries. If you see a volcano that is not on a plate boundary, it is likely a hotspot volcano. It is hypothesised that hotspot volcanoes are formed over unusually hot parts of the Earth's mantle where magma can rise up, then melt and penetrate the crust forming volcanic eruptions. These mantle plumes are stationary, while the tectonic plates move, so hotspots are often observed as a line of volcanoes across the middle of a tectonic plate. Look up "Hawaii" on Google Earth to see an excellent example of island chains formed from hotspot volcanoes.

Volcanoes in Australia

Australia is located in the middle of the Indo-Australian Plate. It does not have any active volcanoes, however, scars left behind tell of a time that was very different. In Queensland alone, there are around 400 volcanic plugs that remain as evidence of past volcanic activity.

These would have once been active hotspot volcanoes – in fact, the longest hotspot volcano chain runs down the east coast of Australia, all the way to Tasmania, and is predicted to be 33 million years old!

The Gugu Badhun People from west of Ingham in northern Queensland, have a creation story of Numunali the bronzed-winged pigeon, and Bunbunba the pheasant, who have an argument and set the country on fire[2]. They describe the land being on fire along water courses and melting rocks, which relate to the volcanic activity in Burdekin Valley, and the eruption of the Kinrara volcano, between 7000 to 20,000 years ago. During this volcanic eruption, streams of molten lava flowed down the tributaries to the Burdekin – hence the land being on fire along water courses. If this lore is indeed describing the eruption of the Kinrara volcano, it has been passed down through approximately 230 generations or more – exceeding the oldest historical records in Egypt and Mesopotania[3].

Volcanoes in Australia
The Glass House Mountains

Figure 6: The Glass House Mountains in Queensland are made of tough, hard rock that resists erosion. While the earth around has worn away, the igneous volcanic plug remains, creating this interesting landscape. Image: QM, Jeff Wright

The Glass House Mountains (Figure 6) are located on Queensland's Sunshine Coast. They were formed when the magma inside hotspot volcanoes cooled, forming volcanic plugs made of igneous rock. The volcanic cones have eroded away, while the tough igneous rock from the middle is all that remains.

Do you know of any mountains that were once volcanoes in your area? Research how they were formed (think about location on tectonic plates). The activity on the next page investigates how these volcanic plugs are made.

Activity 4

Jelly Volcano (Investigating the formation of the Glass House Mountains)

Objectives

To observe how magma moves through the Earth to form volcanoes, and investigate how volcanic plugs form.

Materials

- Packet of clear gelatine
- 150 mL warm water
- Fork
- Volcano shaped bowl/pan
- Fridge to cool gelatine
- 150 mL plastic syringe
- Red food colouring
- 250 mL beaker
- Peg board
- Gloves
- 2 desks to sit peg board above the ground

Important Notes

Volcanoes can be messy, and so is this experiment! It is recommended you conduct this experiment outside in a grassy area, wearing goggles, gloves and a lab coat.

Method

1. Make the gelatine according to packet directions, place in bowl and refrigerate until set.
2. Place peg board horizontally between two desks.
3. Remove gelatine from the bowl and place on peg board.
4. Mix 4 drops of food colouring and 150 mL of warm water, and draw it into the large syringe.
5. Place the syringe through the bottom of the peg board and into the jelly.
6. Slowly squeeze the syringe and record observations!

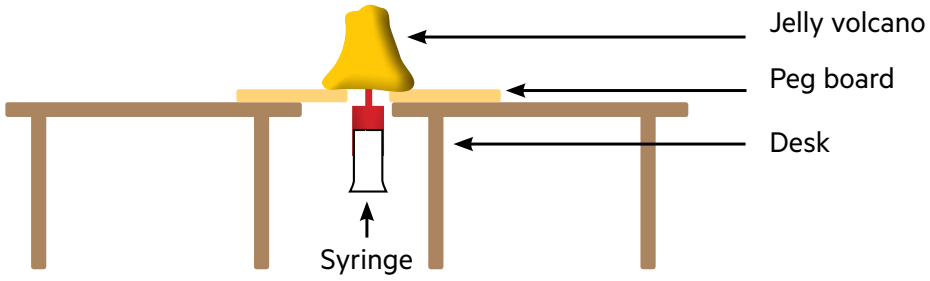


Figure 7: Diagram of jelly volcano experiment.

1. Record observations. Was there anything that you did not expect?

2. This experiment represents what occurs in a real volcanic eruption. Write down the objects in your experiment that represent the following parts of the volcano.

a) Volcanic mountain:

b) Magma:

c) Lava:

d) Pressure from tectonic plate movement:

3. Compare your experiment to a real volcanic eruption by writing 2 similarities and 2 differences.

Similarities:

1.

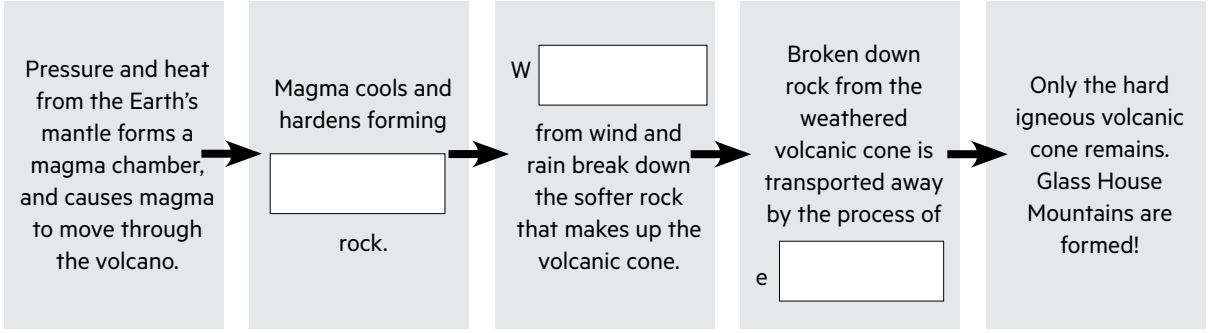
2.

Differences:

1.

2.

4. The magma inside your volcano is still liquid. Fill in the blanks to complete the steps to the formation of a volcanic plug like the Glass House Mountains.



Activity 5

STEM Careers in Real Life: Queensland Museum Research

Figure 8: Images of a volcanic eruption off the coast of Tonga, 16th March 2009. Pumice from these eruptions regularly washes up along the Queensland coast. On the right you can see pumice with biogeographic vectors such as goose barnacles (top), algae (middle) and casts of tube worms (bottom). Images: QM, Dr. Alex Cook

Scientists at the Queensland Museum work with volcanoes in many different ways. As well as studying rocks and the Queensland landscape, researchers from the Queensland Museum have studied pumice from eruptions like the one in Tonga (Figure 8), and the creatures that live on pumice.

Pumice is a lightweight, porous igneous rock that is formed when lava cools quickly, trapping gas bubbles within the rock. Although most rocks sink, pumice often floats due to the light gasses trapped within the rock. Billions of pieces of pumice can be formed from one eruption.

Organisms such as corals, oysters, snails, sponges and algae use pumice as rafts. Researchers from the Queensland Museum and the Queensland University of Technology followed and documented pumice floating from Tonga to the Australian east coast, and they found that more than 80 species 'hitchhike' on pumice[3]. They also found that pumice can travel more than 7000 km/year! These pumice rafts are hypothesised to be important for building new reefs (and rebuilding reefs after destruction).

5. **Imagine you are given a project to map pumice rafts travelling through the ocean, and learn what creatures grow on them. Explain how you would conduct this experiment and collect your data.**

6. **Scientists often require funding from governments and corporations, and must explain the importance of their work to receive funding. Justify why the research and experiments planned in question 5 are important to Australians?**

References

[1] Pliny, Martin, K. and McAllister, A. (2008). *Vesuvius: Two Letters by Pliny the Younger*. San Diego, California: Iron Bear Press.

[2] Cadet-James, Y., James, RA., McGinty, S. and McGregor, R. (2017). *Gugu Badhun: People of the Valley of Lagoons*. Canberra, ACT, Australia: Aboriginal Studies Press.

[3] Cohen, B., Mark, D., Fallon, S. and Stephenson, P. (2017). Holocene-Neogene volcanism in northeastern Australia: Chronology and eruption history. *Quaternary Geochronology*, 39, pp. 79-91. DOI: 10.1016/j.quageo.2017.01.003

[4] Bryan, S., Cook, A., Evans, J., Hebden, K., Hurrey, L., Colls, P., Jell, J., Weatherley, D. and Firn, J. (2012). Rapid, Long-Distance Dispersal by Pumice Rafting. *PLoS ONE*, 7(7), p.e40583.