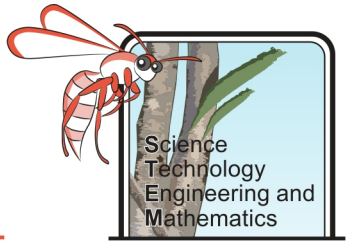


Volcano Monitoring– Teacher Resource

Intended Use of Resources

This project has been designed so that teachers from different STEM areas can pick and choose sections relevant to their subject area to work on. All activities in this package do not need to be completed to get value from the package – each activity can be completed as a stand-alone or can be approached, as a team, as a larger project. The package has potential to be extended into a much longer project to include curriculum points from different STEM subjects.

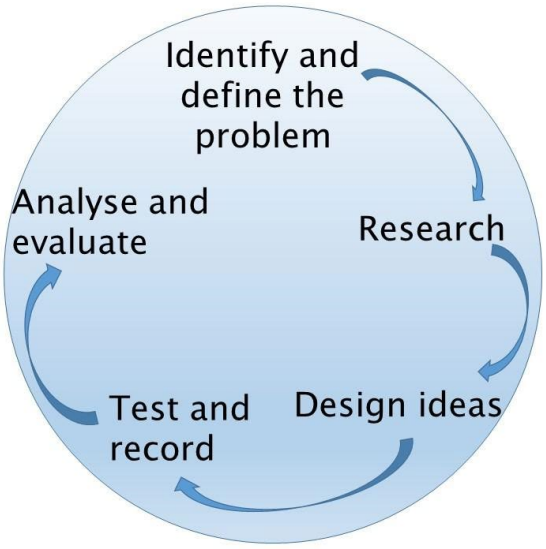
There are three **student workbooks - Open, Guided and Scaffolded,** that go alongside this resource; all have the same suggestions for activities, however, they have been written and edited to provide differentiated learning options to support good teaching practice**.** Teachers may pick and choose which versions they give which students, and may wish to edit them further to address their learning needs. Due to the differentiation of the workbooks, the **Open** activities will enable more syllabus links to be addressed, which is why each activity has its own syllabus links key. However, if you wish to give a truly open-ended investigation then you could just give the students the challenge and background information section of the Student Booklet.

The Woodside Australian Science Project (WASP) STEM resources aim to be accessible and supportive for teachers and students, please contact us if you have questions, feedback, require assistance or would like to arrange an incursion or a professional development workshop - www.wasp.edu.au.

Volcano Monitoring– Teacher Resource

The Challenge

Indonesia is one of Australia's closest neighbours and a frequent tourist destination for Australians. It is also a country which is impacted by volcanic eruptions, which can be very dangerous. To ensure that locals and tourists are safe it is vital that volcanoes are closely monitored so that people can be evacuated from the area, if necessary. Your role is to decide which techniques you will use to monitor a volcano.



Background Information

Indonesia is often described as a tropical paradise. It has rich fertile soils which promote the growth of tropical plants. These rich soils get a lot of their minerals from volcanic ash, so farmland tends to be nearer volcanoes.

People that live near active volcanoes must be cautious as they can emit poisonous gases and eject hot ash and lava. Volcanic eruptions can also cause landslides and small earthquakes.

One of the most famous volcanic eruptions in Indonesia was the 1883 eruption of Krakatoa. The sound of this eruption was so great it could be heard nearly 5,000 km away, and reportedly burst the eardrums of sailors 64 kilometres away (Winchester, 2003). The eruption spewed so much ash and sulphur into the air that it has been linked to global cooling, and weather patterns changing for the following five years (Bradley, 1988).

Volcano Monitoring– Teacher Resource

Figure 1. This map shows some of Indonesia's most active volcanoes.

In 2018/19 Mt Agung on Bali received a lot of attention, with a few small eruptions. These eruptions caused disruption to air travel and thousands were evacuated from the surrounding area to ensure they were safe. A previous eruption in 1993 resulted in landslides and lava flows which led to nearly 2,000 deaths (Wikipedia, 2019)

Luckily, volcanic eruptions tend to have many warning signs. These signs include increased seismicity (small earthquakes, caused by movement of magma below ground), increased temperature below the surface of the volcano, emission of gases and bulging/growth of the volcano. Monitoring of these signs is key to a good warning system which ensures the safety of people living nearby.

Volcano Monitoring– Teacher Resource

Activities

This booklet contains extra information on each activity, including syllabus links the overall activity objective, suggestions for recommended equipment or alternative ways to run investigations as well as useful resources and website links. Please note that any reference websites provided in the entirety of our resource documents were current at the time of publication. Please advise if links are no longer accessible.

The syllabus links have been colour coded – please see the colour key below:

Covered in Scaffolded, guided and Open student workbook
Covered in Guided and Open Student workbook
Covered in Open student workbook

List of Activities

Background Research

Designing a Tiltmeter

Detecting Seismic Waves

Materials for Monitoring:

1. Heat protection
2. Strength of materials
3. Permeability
4. Flammability
5. Suit design

Displaying the Temperature

Monitoring a Volcano – Decision Making

Volcano Monitoring– Teacher Resource

Background Research

Objective

Background research is aimed at providing students with prior knowledge about volcanoes in Indonesia. They will find that Mt Tambora erupted in 1815 and is considered the largest and most destructive volcanic eruption in recorded history.

Students will research the differences between a stratovolcano and a shield volcano and discover that the difference in shape and eruption behaviour is due to the composition of the magma/lava. A stratovolcano has a more silica rich, viscous magma. This makes it harder for gases to escape, so they build up until the pressure is so great that they erupt in a more explosive fashion than a shield volcano. In addition, the viscous lava doesn't flow very far, so the sides of the volcano build up quickly to make steep slopes, unlike a shield volcano where the lava can spread over a large area, making it much more gentle sloping.

The volcanoes in Indonesia are typically stratovolcanoes, which means they are of a more explosive nature.

	Australian Syllabus Links
Science	ACSSU096 Sudden geological changes and extreme weather events can affect Earth's surface.

Useful resources and websites:

- History of the Tambora eruption: https://www.britannica.com/place/Mount-Tambora
- Key volcano terms: https://www.volcanodiscovery.com/volcanoes/faq/active_erupting.html
- Interactive map of recent volcanic eruptions and earthquakes: https://earthquakes.volcanodiscovery.com/
- Explanation of a shield versus Stratovolcano: http://www.geo.cornell.edu/hawaii/220/PRI/PRI_PT_volcanoes.html
- Description of means of monitoring a volcano: https://opentextbc.ca/geology/chapter/4-5-monitoring-volcanoes-and-predicting-eruptions/

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Designing a Tiltmeter

Objective

For this activity, students create tiltmeters that could be placed on the side of a volcano to determine if the ground is moving or not. Students then evaluate their tiltmeters to discuss the strengths and weaknesses of their design.

There are some simple design ideas in the WASP Year 6 resources for Earth and Space Science if your students are struggling to come up with ideas:

http://www.wasp.edu.au/mod/resource/view.php?id=415

You may want to show them a spirit level as an example of methods of measuring tilt.

	Australian Syllabus Links
Science	ACSSU096 Sudden geological changes and extreme weather events can affect Earth's surface. ACSIS103 Identify, plans and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks. ACSIS108 Reflect on and suggest improvements to scientific investigations
Technologies	WATPPS36 Select, and apply, safe procedures when using a variety of components and equipment to make a solution. WATPPS33 Define a problem, and a set of sequenced steps, with users making decisions to create a solution for a given task WATPPS34 Identify available resources ACTDEK023 Characteristics, properties and safe practice of a range of materials, systems, tools and equipment; and evaluate the suitability of their use. WATPPS37 Develop collaborative criteria to evaluate and justify design processes and solutions. WATPPS38 Work independently, or collaboratively when required, considering resources and safety to plan, develop and communicate ideas and information for solutions.

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Useful resources and websites:

- WASP Year 6 tiltmeter design
  http://www.wasp.edu.au/mod/resource/view.php?id=415

- Short video explaining how a tiltmeter works
  https://www.youtube.com/watch?v=fXUyt07PtSo

Volcano Monitoring– Teacher Resource

Detecting Seismic Waves

Objective

Students build a model seismometer and evaluate how well it works. They can either use the suggested design or come up with their own. The main issue with the model seismometers is that the piece of paper underneath where the pen is, is static and needs to be pulled along unlike on a real seismometer, where it is on a reel with a motor and constantly being moved so that fresh paper is below the stylus.

	Australian syllabus links
Science	ACSSU096 Sudden geological changes and extreme weather events can affect Earth's surface. ACSIS103 Identify, plans and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks. ACSIS108 Reflect on and suggest improvements to scientific investigations
Technologies	WATPPS36 Select, and apply, safe procedures when using a variety of components and equipment to make a solution. WATPPS33 Define a problem, and a set of sequenced steps, with users making decisions to create a solution for a given task WATPPS34 Identify available resources ACTDEK023 Characteristics, properties and safe practice of a range of materials, systems, tools and equipment; and evaluate the suitability of their use. WATPPS37 Develop collaborative criteria to evaluate and justify design processes and solutions. WATPPS38 Work independently, or collaboratively when required, considering resources and safety to plan, develop and communicate ideas and information for solutions. ACTDIP019 Design, modify, follow and represent both diagrammatically, and in written text, simple algorithms (sequence of steps) involving branching (decisions) and iteration (repetition)

Volcano Monitoring– Teacher Resource

Useful resources and websites

- Video explaining how a seismometer works: https://www.youtube.com/watch?v=JypTLDLABzM
- Video outlining how to make a seismometer using a shoebox, pen and elastic bands: https://www.youtube.com/watch?v=KnocP26HL5M
- Videos showing how to use a plastic cup, some string, a cardboard box and some weights to make a seismometer: https://www.youtube.com/watch?v=_ECn53uZC3w and https://www.youtube.com/watch?v=FowRDKvniH4
- Step-by-step instructions on how to code an Aduino to create an earthquake detector alarm: https://circuitdigest.com/microcontroller-projects/arduino-earthquake-detector-alarm-circuit
- Instructions and video tutorial explaining how to make an earthquake detector using circuits: https://www.instructables.com/id/Earthquake-Detector-1/

Materials for Monitoring

Objective

This series of short experiments will enable students to find out more about the properties of different materials, to evaluate how useful they will be for making an outfit to sample gases from a volcano. They will have to consider the hazards around a volcano to establish what a safe outfit would look like.

It might be good to test some man made and natural materials, such as wool, cotton, fleece, polyester, canvas, leather and corduroy.

Test 1 – Heat protection

Students test the insulating properties of different materials. We recommend using wool, cotton, nylon and polyester to give a broad range. Students should see a marked difference with the change in temperature, with the man-made fibre being the poorest insulators. Note: We recommended in the method that hot water be observed to see how quickly it cools down. This method has been found to be far safer than taking cool water and measuring how quickly it heats up.

Test 2 – Strength of material

Students should be wearing enclosed shoes and must be mindful of the masses not dropping onto anyone's feet.

Test 3 – Permeability

Although it can make the testing suits very stuffy, it is important the suits do not allow gas to enter.

Possible Test 4 – Flammability test (Optional)

You may wish to run this as a demonstration, if at all. If you do this experiment, we recommend doing it outside on a still day when there is no fire ban in place or doing it in the fume cupboard if you have one. Be aware of placement of school smoke detectors.

Volcano Monitoring– Teacher Resource

Test 4 – Flammability test

It is possible that a volcanologists may be exposed to hot rocks which could potentially set their suit on fire. It is vital that their material is as fire retardant as possible, so this does not happen.

Equipment

- 4 pieces of material
- 4 glass petri dishes
- 1 barbeque lighter

Method

1. Cut a small 2 cm^2 piece of material off your large square and place in a glass petri dish or other non-flammable dish.
2. Use a barbeque gas lighter to set it on fire
3. Time how long it takes to set alight and to burn. Record observations such as how easy it was to light, what colour the flame was, what it looked like after having been on fire.

	Material 1	**Material 2**	**Material 3**	**Material 4**
Observations				

You could do a further test where students investigate different colours of material to determine which colour absorbs the most heat (from the Sun or a heat lamp) and which is the most reflective. Volcanologists usually wear silver if they are going near lava to reflect the heat away from them as much as possible.

Students should design a suit explaining why they have chosen a particular type of material for a specific location on the suit. For example, they may have chosen leather on the soles of the feet as it is tough and hard wearing so will be unlikely to rip.

This could be a nice project for them to present at a science fair or STEM class project.

Volcano Monitoring– Teacher Resource

	Australian Syllabus Links
Science	ACSIS103 Identify, plans and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks. ACSIS108 Reflect on and suggest improvements to scientific investigations
Technologies	WATPPS36 Select, and apply, safe procedures when using a variety of components and equipment to make a solution. WATPPS33 Define a problem, and a set of sequenced steps, with users making decisions to create a solution for a given task WATPPS34 Identify available resources ACTDEK023 Characteristics, properties and safe practice of a range of materials, systems, tools and equipment; and evaluate the suitability of their use. WATPPS37 Develop collaborative criteria to evaluate and justify design processes and solutions. WATPPS38 Work independently, or collaboratively when required, considering resources and safety to plan, develop and communicate ideas and information for solutions.

Useful resources and websites

- This video clip contains a scene with a volcanologist is in a special suit taking samples from a volcano: https://www.youtube.com/watch?v=egEGaBXG3Kg

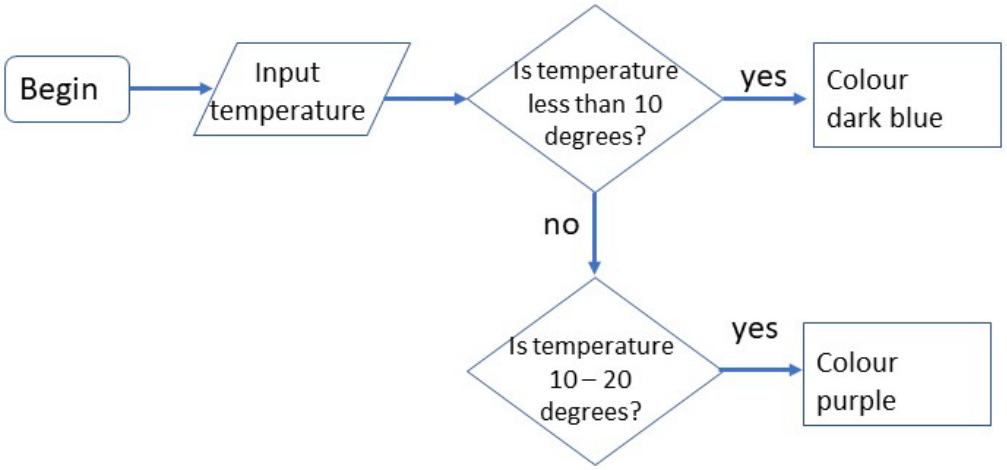
Volcano Monitoring– Teacher Resource

Displaying the Temperature

Objective

Students will create a branching algorithm to tell a computer which colour it should output to create a visual representation of a volcanic eruption. Students could break down the colours even further if they wanted to show more information.

Below is an example of what the start of the algorithm might look like.



	Australian Syllabus Links
Science	ACSSU096 Sudden geological changes and extreme weather can affect Earth's surface. ACSIS107 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.
Technologies	WATPPS33 Define a problem, and a set of sequenced steps, with users making decisions to create a solution for a given task ACTDIP019 Design, modify, follow and represent both diagrammatically, and in written text, simple algorithms (sequence of steps) involving branching (decisions) and iteration (repetition)

Volcano Monitoring– Teacher Resource

Mathematics	ACMNA124 Investigate everyday situations that use integers. Locate and represent these numbers on a number line. ACMSP148 Interpret secondary data presented in digital media and elsewhere.

Useful websites

- Explanation of what an algorithm is with an example: https://www.bbc.com/bitesize/articles/zqrq7ty
- More in depth explanation with diagram example of what an algorithm is: https://www.bbc.com/bitesize/guides/zpp49j6/revision/1
- Short video demonstrating the use of algorithm from the television show The Big Bang Theory: https://www.youtube.com/watch?v=k0xgjUhEG3U
- Short video clip of a volcano erupting using a thermal imaging camera: https://www.youtube.com/watch?v=-8AUEqMpBzw

Volcano Monitoring– Teacher Resource

Monitoring a Volcano - Decision Making

Objective

Students consider the pros and cons of different monitoring methods and decide which ones they would choose is they were to monitor Mt Agung, Bali, Indonesia. The students undertaking the open option are given a budget that they have to stick to and prices for each monitoring method (an important consideration in real world volcanic monitoring).

A lot of the sampling methods require someone to physically go to the volcano to take measurements, this makes them high risk and more dangerous (for example, gas sampling and groundwater sampling). Others require the use of satellites like GPS monitoring, and so are very expensive to set up initially.

	Australian Syllabus Links
Science	ACSSU096 Sudden geological changes and extreme weather can affect Earth's surface. ACSHE100 Scientific knowledge is used to solve problems and inform personal and community decisions
Technologies	ACTDEK023 Characteristics, properties and safe practice of a range of materials, systems, tools and equipment; and evaluate the suitability of their use. WATPPS38 Work independently, or collaboratively when required, considering resources and safety, to plan, develop and communicate ideas and information for solutions.
Mathematics	ACMNA124 Investigate everyday situations that use integers. Locate and represent these numbers on a number line.

Bibliography

Figure 1: Map of Indonesian volcanoes, accessed at https://commons.wikimedia.org/wiki/File:Map_indonesia_volcanoes.gif on 25/5/19

Figure 3) East Han Seismograph, accessed at https://commons.wikimedia.org/wiki/File:EastHanSeismograph.JPG on 25/5/19

Figure 5) Infrared wolves, USGS Scientists examine thermal images, accessed at https://www.flickr.com/photos/usgeologicalsurvey/12611657165 on 25/5/19

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