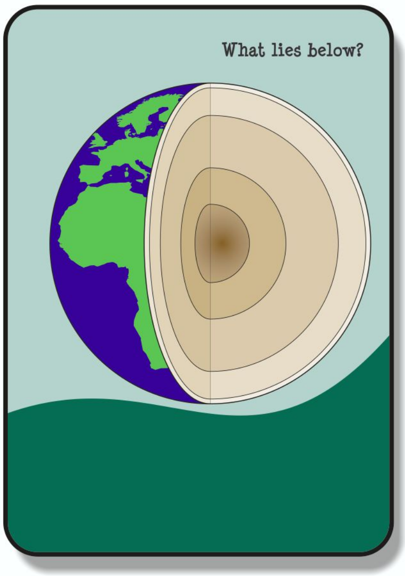
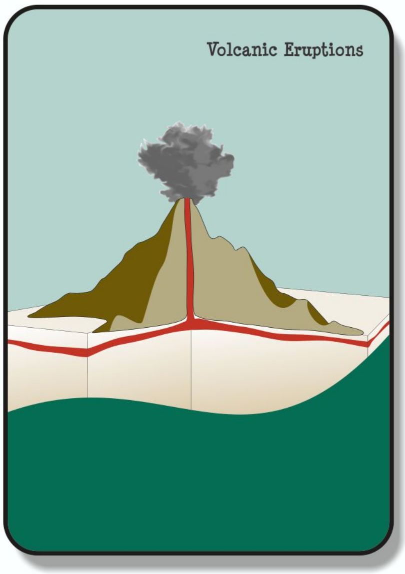
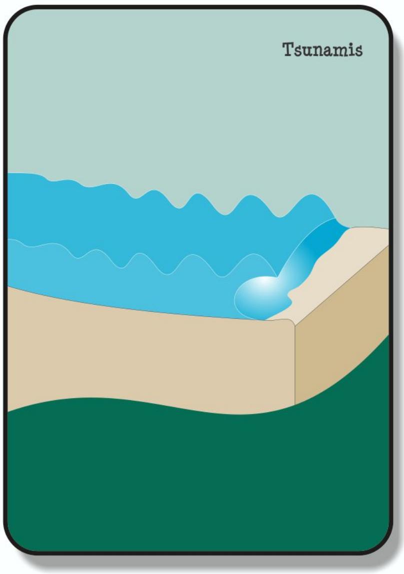
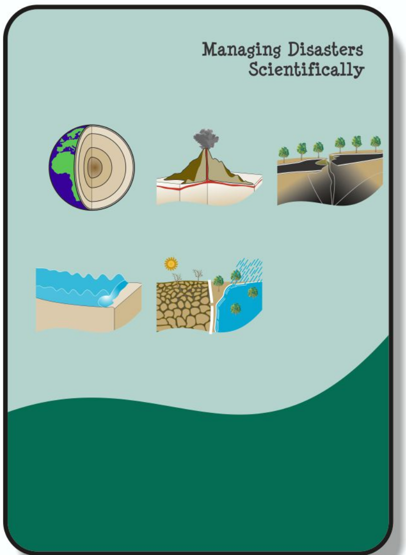
WASP
Woodside Australian Science Project
An initiative supported by Woodside and ESWA

Geological Changes Package







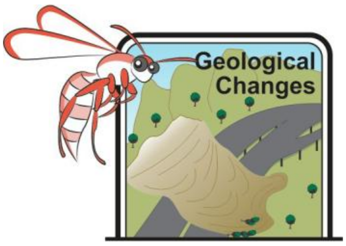


Year 6

Australian Curriculum – Earth Science

Earth Science Western Australia
woodside

Year 6 WASP - Teacher Introduction



The WASP (Woodside Australian Science Project) is an initiative between Woodside and Earth Science Western Australia (ESWA).
These activities are designed to support the Earth Science part of Earth & Space Science topic required by the Year 6 Australian Curriculum.

Copies of this and other supporting materials can be obtained from the WASP website www.wasp.edu.au or by contacting Julia Ferguson at julia@wasp.edu.au.

Topic 1	**What Lies Below?**
Topic 2	**Volcanic Eruptions**
Topic 3	**Earthquakes**
Topic 4	**Tsunamis**
Topic 5	**Droughts and Flooding Rains**
Topic 6	**Managing Disasters Scientifically**

Year 6 Australian Curriculum Science

Earth & Space Science
Sudden geological changes or extreme weather conditions can affect Earth's surface (ACSSU096)

- Investigating major geological events such as earthquakes, volcanic eruptions and tsunamis in Australia, the Asia region and throughout the world
- Recognising that earthquakes can cause tsunamis
- Describing how people can measure significant geological events.
- Exploring ways that scientific understanding can assist in natural disaster management to minimise both long and short term effects
- Considering the effect of drought and extreme weather on living and non-living aspects of the environment

Science Inquiry Skills

- With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be (ACSIS232)
- With guidance, plan appropriate investigation methods to answer questions or solve problems (ACSIS103)
- Decide which variable should be changed and measured in fair tests and accurately observe, measure and record data, using digital technologies as appropriate (ACSIS104)
- Use equipment and materials safely, identifying potential risks (ACSIS105)
- 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)
- Suggest improvements to the methods used to investigate a question or solve a problem (ACSIS108)

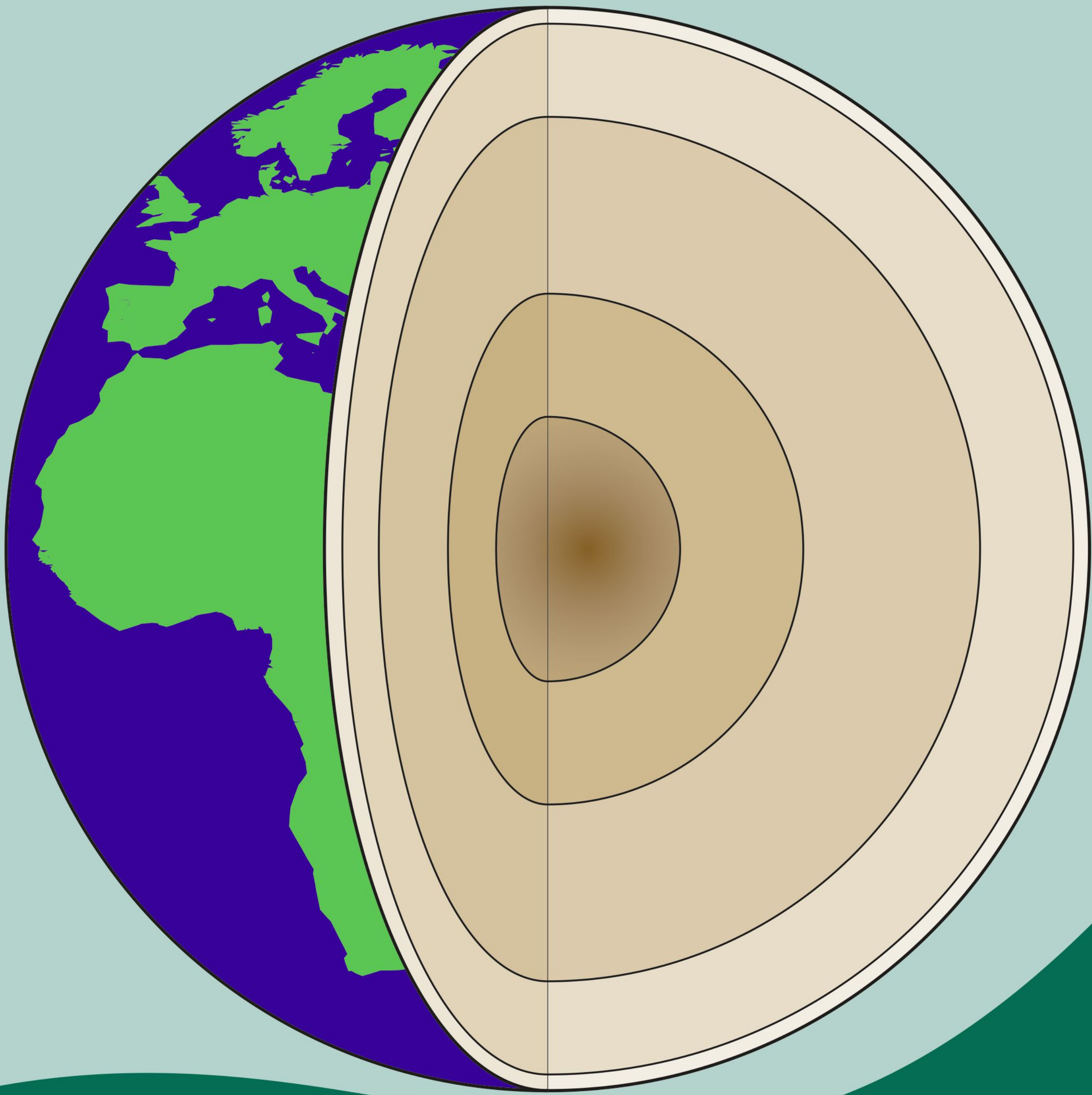
Year 6 WASP - Teacher Introduction

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

Science as a Human Endeavour

- Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena (ACSHE098)
- Important contributions to the advancement of science have been made by people from a range of cultures (ACSHE099)
- Scientific understandings, discoveries and inventions are used to solve problems that directly affect peoples' lives (ACSHE100)

What lies below?

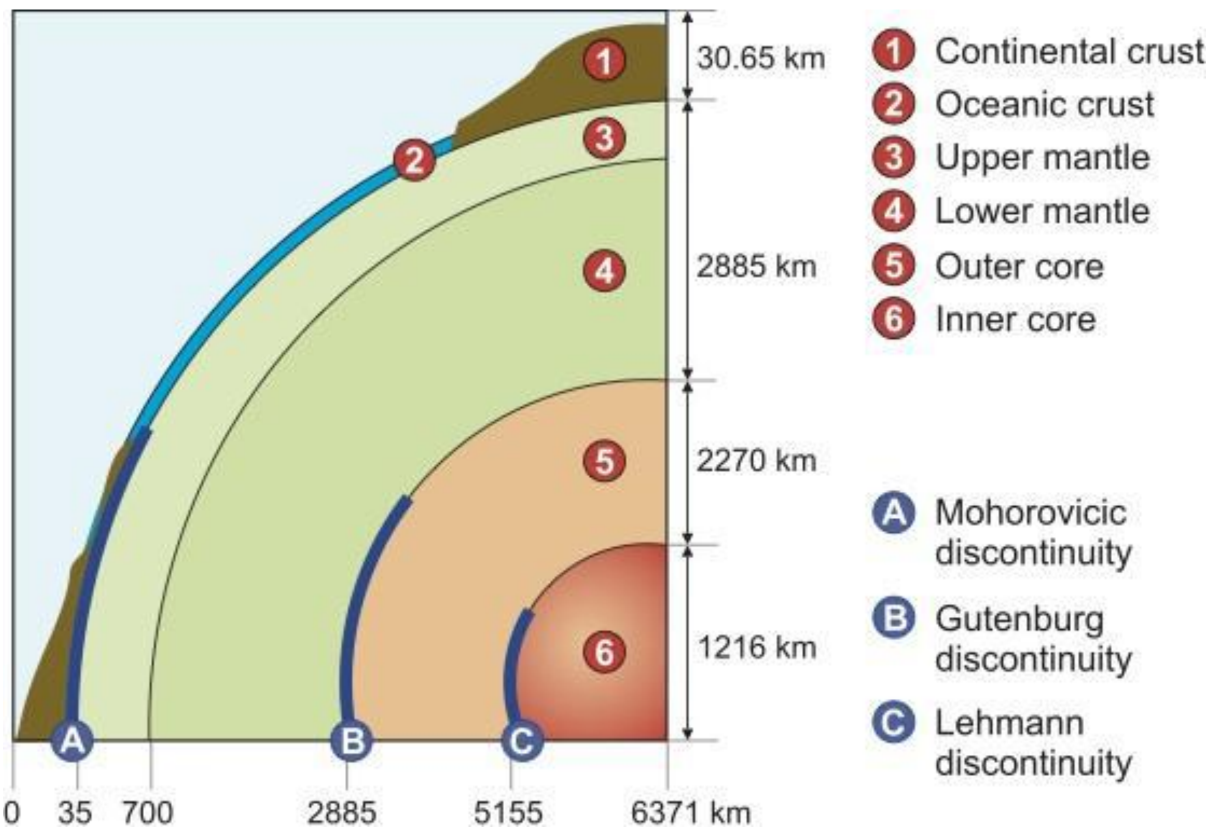


Geological Changes - Teacher Background

Although the Science understandings for Year 6 Earth Science activities relate to changes ***at the surface*** of our planet***,*** a general understanding of what happens within the planet and its structure will help explain the forces at work. Teachers wishing more information may wish to view The Year 9 Plate Tectonics package on the WASP website www.wasp.edu.au

Planetary differentiation.

When our planet first coalesced from a cloud of cosmic dust about 4.5 million years ago, it was very much hotter inside than it is today. It still had heat from all the little pieces of exploded super nova in the planetary disc smashing together under the force of gravity as well as heat from the natural radioactive decay of its minerals. The minerals forming rocks could melt and flow, albeit slowly, within the body of our planet. Heat driven convection currents moved materials in the same way they move the vegetables in vegetable soup when you heat it. The process that resulted in different rocks settling out to create different layers was density separation. The heaviest (or more correctly densest) minerals, those with lots of iron and nickel sank down towards the centre of the Earth to form a core of iron and nickel rich rocks. The lighter silica rich (quartz rich) ones moved slowly upwards to form the rocks of the outer crust. The very light materials rose to form our hydrosphere (rivers, lakes, water table and oceans) and our atmosphere.



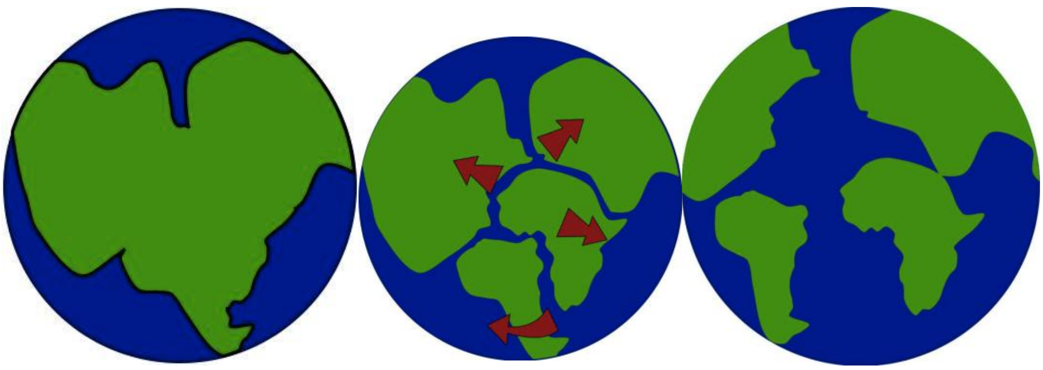
Although most of the original heat from formation has since been radiated out into space radioactive decay still provides enough heat to warm the rocks of our planet from within. In some places, such as the asthenosphere, a band of sticky melted rock which lies between the crust and mantle, hot molten magma still rises to flow out onto the surface whilst in other places cold surface materials are drawn back down towards the mantle to be recycled within it. Movement within the Earth is powered by heat causing molten rock to rise and gravity, which causes it to drop.
Our knowledge of the underlying layers of the Earth can only rarely depend on direct scientific observation and measurement as rocks from the mantle or below do not usually appear at the surface. What happens beneath must be inferred by other means. Early scientists such as Newton realised that the Earth did not have uniform density, as its planetary gravitational "pull" was too great for the observable size of the planet and the density of those rocks at the surface. Some of the ancient rocks in the Yilgarn and Pilbara are from the time when the Earth was more fluid and their mineralogy can give us indications of temperature, pressure and source at depth. The nickel bearing rocks of Kambalda and Kalgoorlie are from a time when nickel from the core flowed like lava onto the surface of the planet. More recent volcanoes bring up specimens from the melted crust.

For students at this stage, the Earth can be roughly classified into four layers:

1. **The crust** a thin, less dense, layer of solid silica rich material.
2. **The mantle** a denser sticky, slow moving layer of silica rich stony material.
3. **The outer core** mostly molten iron and nickel and is very dense.
4. **The inner core** mostly solid iron and nickel.

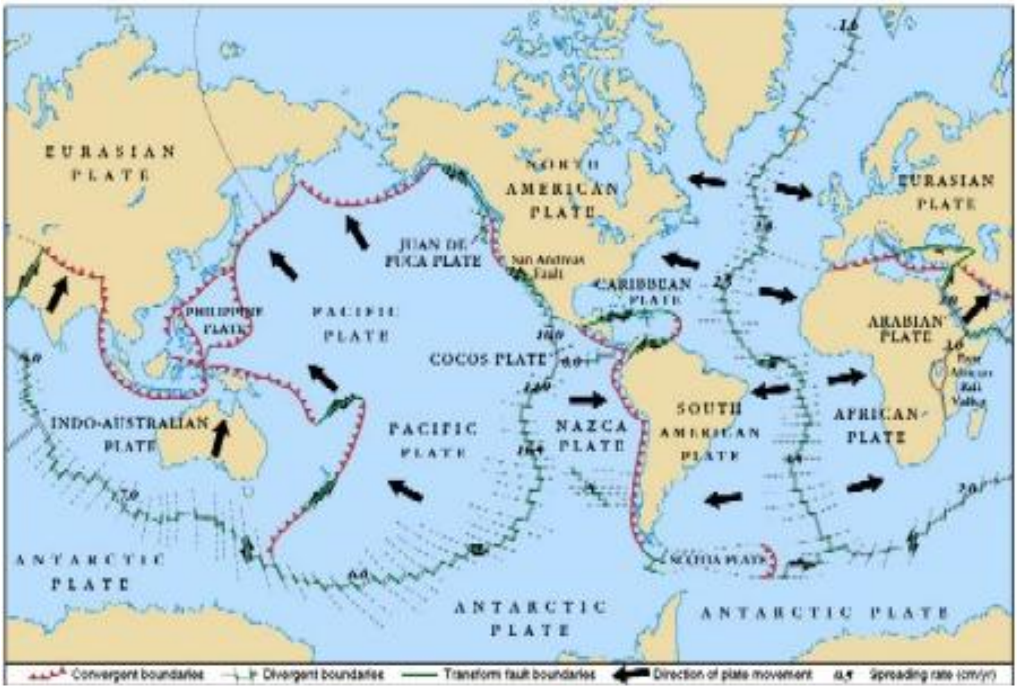
The diagram on the previous page provides more detail for more advanced students.

The crust is very thin and broken into tectonic plates or slabs that "float" above denser material below in the mantle. Plates can include both present continents (dry land) and sea floor. These plates have moved together to create supercontinents and pulled apart over millions of years of Earth's history. Less dense continental crust overlies denser oceanic crust.



Supercontinent Pangaea Modern continents

The movement of these tectonic plates is the source of earthquake and volcanic activity and creates mountain ranges and ocean deeps. The word "tectonic" comes from the Latin meaning building. They are the moving plates that build mountain ranges and create ocean basins.



Tectonic Plates pulling apart

When molten magma rises towards the surface it pushes tectonic plates apart. The crust thins and sags creating basins and oceans. Since magma is sourced from the crust/mantle interface it is dense, dark and flows freely. Basalts are good examples of such free flowing lava. The Atlantic Ocean began to form when the Americas pulled apart from Europe and Africa. Basalts flowed out from volcanoes on the ocean bottom and still do. The band of volcanic islands running down the centre of the Atlantic Ocean is evidence of this. Free flowing lava means that little stress will be built up as rocks push past each other and there are fewer earthquakes of relatively small magnitude. The lava flows out layer upon layer to form a flat dome called a “shield “ volcano. They are called shield volcanoes because they resemble a round warrior’s shield laid on the ground. The Hawaiian Islands are good examples of this type of volcano. Most volcanoes on Earth are undersea and of this type.

Tectonic plates pushing together.

When tectonic plates push together the denser slab is pulled downwards towards the mantle. It also pulls more crust downward after it. Rock is forced past rock creating frequent earthquakes of devastating magnitude. The overlying slab may crumple and form mountains such as the Andes whilst increasing heat and pressure forces the underlying slab to melt. Melted continental crust creates wet, sticky explosive magma and results in high conical volcanoes. The volcanic Pacific Ring of Fire is the result of the Pacific tectonic plate pushing under the Eurasian tectonic plate (see map). High conical volcanoes such as Mt Fujiyama are created and the area is subject to frequent earthquake activity.

Heat driven convection currents push plates over the mantle and cold dense gravity pulls them down again to be remelted and recycled.

Stress within plates

Because the geographic continent of Australia lies well within the margins of the greater Indo-Australian Plate we do not suffer from major volcanism or earthquakes that occur at plate margins. However we do suffer earthquakes from intra-plate stress.

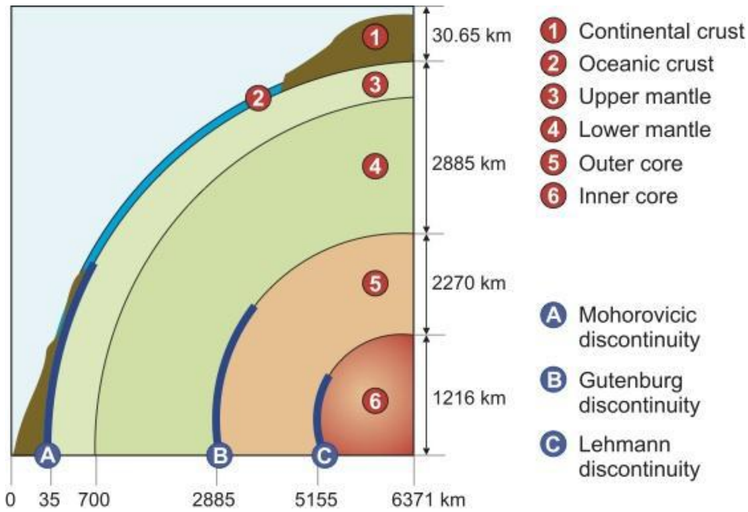
The Australian Plate is presently moving northwards towards South China at roughly the same speed as your fingernails grow. In about 250 million years it will have crashed into Borneo pushing up even more mountains as it ploughs north. Variation of rock types within the Australian plate and friction with plates along its margins means that movement is not uniform across the plate. Internal stresses build up and this is released as earthquakes. These are usually smaller and less devastating than those at plate margins.

Western Australia has many such earthquakes daily. Swarms of minor earthquakes move through our Mid-west. Along major fault lines where brittle rocks have moved against each other for millions of years, stress may build up until it is released as an earthquake. There is a major fault which runs north to south near our western coast (the Darling Fault) and faults near Kalgoorlie move frequently.

Vocabulary	Core, crust, earthquakes, mantle, tectonic plates, volcanoes, earthquakes

Spinning Spirals – Teachers' Notes

Our planet is layered like an old-fashioned trifle pudding. The lightest, or more correctly least dense rocks "float" to form the crust while denser rocks sink downward. Earths crust is made from low-density silica rich minerals, which form rocks such as granite and sandstone. Underlying this is a mantle of iron, magnesium and silica rich minerals that is denser. Dark heavy igneous rocks such as gabbro and peridotite lie below. The densest minerals form the core, which is rich in iron and nickel and has hardly any silica.

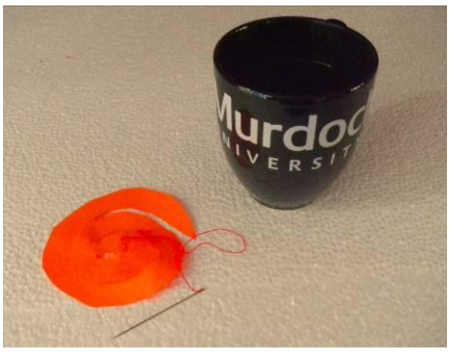


These layers have differentiated due to heat driven convection currents and to density separation. ***A common student misconception*** is that rocks below the crust are always molten and flow easily like a liquid. Apart from the outer core, rocks under the crust act as solids most of the time. They can become molten and flow like sticky toffee in places if the conditions are right. This is particularly true at the asthenosphere, which is the interface between the crust and mantle.

Spinning spirals - Convection (heat driven) currents.

I suggest that this be carried out as a teacher demonstration as heat sources in a classroom can be hazardous. (Versions of this on the Internet suggest using candles or gas burners as a heat source). However, using a cup of hot water instead can make this activity quite manageable in an ordinary classroom. Why not use a hot cup of tea or coffee and enjoy the experiment even more!

Heat creates moving currents called convection currents. Heat causes molecules within any material to move further apart increasing the material's volume and decreasing its density. Heated solids, liquids and gasses form upward moving currents which stream away from the heat source. Students may have observed upward rising convection currents of smoke above a hot fire and observed peas or potatoes being moved about by currents of hot water when they are being cooked by heat from below.



Materials

- A source of hot water. An electric kettle is ideal as the hotter water is the faster and stronger the convection current of rising air above it will become
- A sheet of ordinary paper (not card). Use light materials

- A mug or beaker to contain the hot water
- A piece of knotted thread or lightweight string
- Scissors
- Pen or pencil

Method

1. Place the mug face down on the paper and draw a circle around it.
2. Cut the circle into a spiral and pierce the centre for the thread.
3. Thread the string through the centre of the spiral and knot it.
4. Fill the mug with hot water and hang the spiral directly over the mug.

After about 30 seconds the spiral should begin turning as the current of heated air above the hot liquid starts rising through it.

Observation

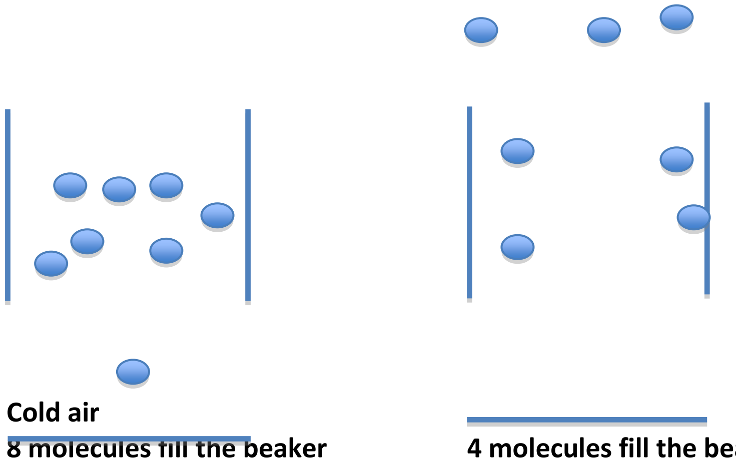
When the spiral is placed over the hot water it begins to spin. If it is moved away from the hot liquid it ceases to spin.
What happens to the air above the hot liquid? It becomes heated and rises causing the spiral to spin.

Conclusion

Heat below creates a convection current/a rising current of hot air.

Teacher explanation of density

Density is a measure of space (volume) matter takes up. When air is heated its molecules have more energy to bounce off each other and the same number of molecules take up more space.



Cold air **Hot air**

8 molecules fill the beaker **4 molecules fill the beaker**

"HEAT" and "COLD" are just descriptions of the amount of movement of molecules in a substance.
What would happen if rocks within the Earth got hotter? They would rise towards the surface.

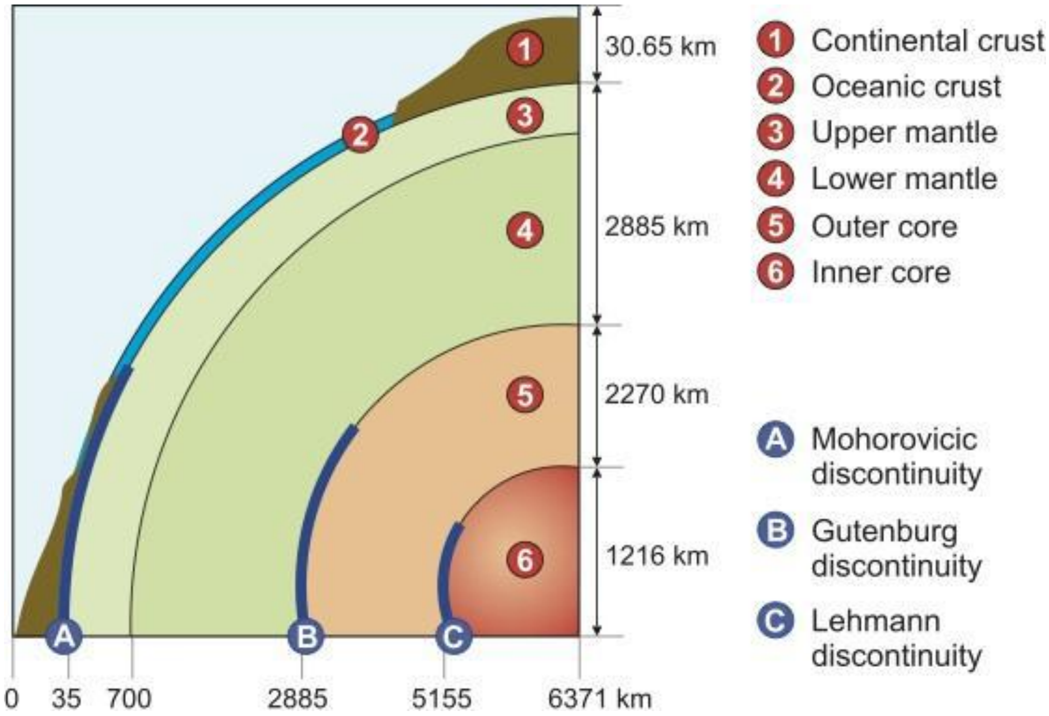
Explanation of heat and cold causing movement to and from the surface of the Earth

Heat from within the Earth can cause local melting, particularly near the boundary of the crust and mantle. These hot currents rise towards the surface bringing melted rock with them and pushing cold crust away on either side. This is a divergent boundary between tectonic plates. Moving away from a divergent boundary plates may crash into others at a convergent boundary. As the rock cools it can become denser and sink down into the planet again. On a human timescale, this moves incredibly slowly perhaps taking millions of years. The tectonic plate that Australia lies within is being pushed northwards at a speed of about 9cm every 100 years. This is roughly the same rate at which your fingernails grow.

Early Earth was much hotter than it is at present allowing materials to move around more easily and to separate into layers because of differing density. At this time plumes of hot rock from the core could rise to the cooler surface. This is why dense minerals from the core are found in very ancient rocks such as the nickel and gold deposits in Kalgoorlie. The Earth has cooled since then and this process occurs extremely rarely. In Hawaii, the progression of volcanic islands that appears to be moving slowly northwards is probably the Pacific tectonic plate moving southwards over such a hot spot. These islands have been built up from magma brought up to the surface by convection currents above mantle hot spots.

Spinning Spirals – Teacher Demonstration

Our planet is layered like an old-fashioned trifle pudding. The lightest, or more correctly least dense rocks "float" to form the crust while denser rocks sink downward.



These layers have differentiated due to two processes:

1. Heat driven convection currents
2. Density separation.

Teacher Demonstration - Spinning spirals (Convection (heat driven) currents)

Your teacher will demonstrate the effect of heat on air.

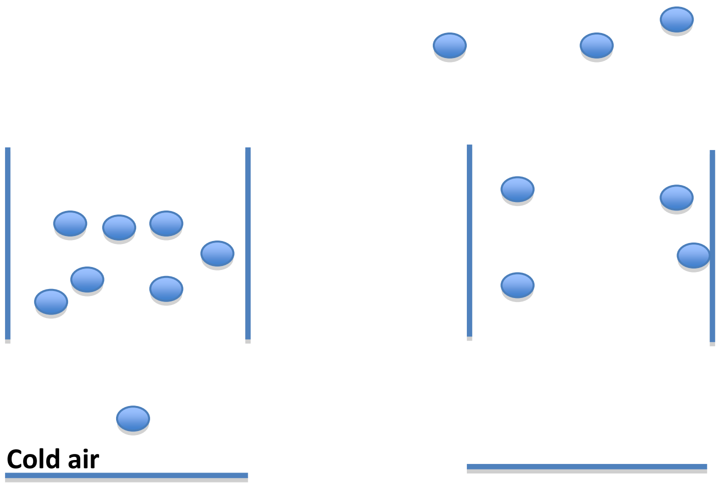
Observation
What happens to the air above the hot liquid? ____

____

Conclusion
Heat below causes ____

Explanation of density
Density is a measure of space (volume) matter takes up. When air or anything is heated, its molecules have more energy to bounce off each other and the same number of molecules takes up more space.

Spinning Spirals – Teacher Demonstration



Cold air **Hot air**

8 molecules fill the beaker **4 molecules fill the beaker**

"HEAT" and "COLD" are just descriptions of the amount of movement of molecules in a substance.

What would happen if rocks within the Earth got hotter? ____________________________________

Denser Down – Teacher Notes

When the Earth was younger it was hotter and more rocks were molten. The minerals, which come together to make rocks, could settle out according to density in the liquid magma. Even today, rock types can separate if there is some movement within the Earth.

Materials

- An empty clean and dry 2L clear cool drink bottle or a large transparent plastic jar
- A cup of Styrofoam bubbles or crumbs. If you are breaking up a large lump it is a good idea to do this inside a paper bag or pillow slip as the particles will become electrostatic and will stick to your hands and clothing. Some students may love doing this for you!
- A handful of marbles or any other dense objects that will fit through the mouth of the bottle (nails, nuts & bolts, washed pea gravel or small rocks)
- Water

Method

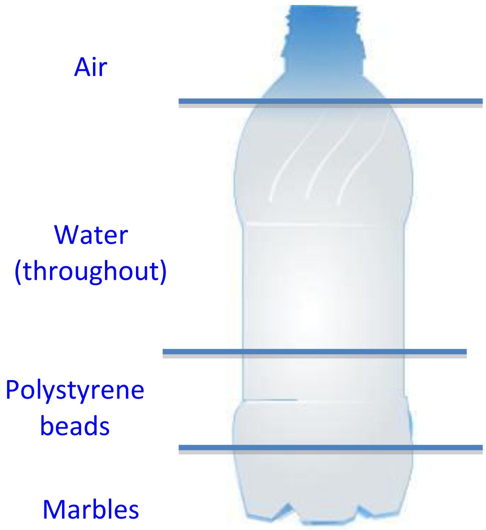
1. Place the solids in the container and fill with water until it is 2/3 full.
2. Replace the cap and ask a student to gently shake the materials in the bottle until they are well mixed (15 seconds).
3. Place container on a flat surface and allow everything to settle.

Observations

List the 4 substances in the bottle.

1. Air
2. Water
3. Polystyrene beads
4. Marbles

What did you observe when the materials in the bottle were allowed to settle.
Use the "bottle" provided to label the four layers.



Denser Down – Teacher Notes

Explanation
Why do you think the materials formed layers? The heavier/denser materials sank to the bottom. The lighter/less dense materials rose upwards. They separated because they had different characteristics.

When materials can move freely the denser materials will sink to the bottom and the less dense will rise to the top. This is why denser material such as nickel and gold come from great depths within the Earth while less dense material such as granite and sand are found at the surface.
An analogy can be drawn with air representing the atmosphere, water the hydrosphere and marbles the lithosphere (rocks).

Conclusion The layers of our planet are a result of the competing processes of:

1. Heat making rocks less dense and rise and cold making them denser and move towards the core.
2. The differing density of rocks. Silica rich rocks like sandstone and granite have low density and form the crust. Iron and nickel rich rocks have high density and form the core.

Denser Down – Student Activity

When the Earth was younger it was hotter below the surface and more rocks were molten. The minerals, which come together to make rocks, could settle out according to density in the liquid magma. Even today, rock types can separate if there is some movement within the Earth.

Materials

- An empty clean and dry 2L clear cool drink bottle.
- A cup of Styrofoam bubbles or crumbs
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Method

1. Place the solids in the container and fill with water until it is 2/3 full.
2. Replace the cap and gently shake the materials in the bottle until they are well mixed (15 seconds).
3. Place container on a flat surface and allow everything to settle.

Observations

List the 4 substances in the bottle.

1. ____________________________ 2. ______________________________

3. ____________________________ 4. _______________________________

What did you observe when the materials in the bottle were allowed to settle.
Draw and label the four layers in the "bottle" provided.

Denser Down – Student Activity

Explanation
Why do you think the materials formed layers? ____

____

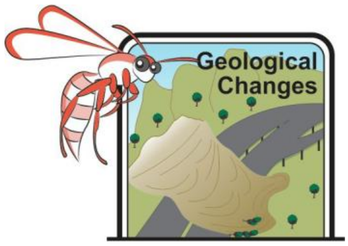
____

Conclusion The layers of our planet are a result of the competing processes of:

1. ____

2. ____

The rock on the left is granite (density 2.5g/cm^3), a typical rock from our planet's crust. The rock on the right is gabbro (density 3.3g/cm^3) which comes from deeper down. Nickel which forms our planet's core has a density of 8.9g/cm^3.



Earth Egg Model – Teacher Notes

Ancient Greeks tried to explain earthquakes and volcanic activity by saying that a massive bull lay underground and the land shook when it became angry.

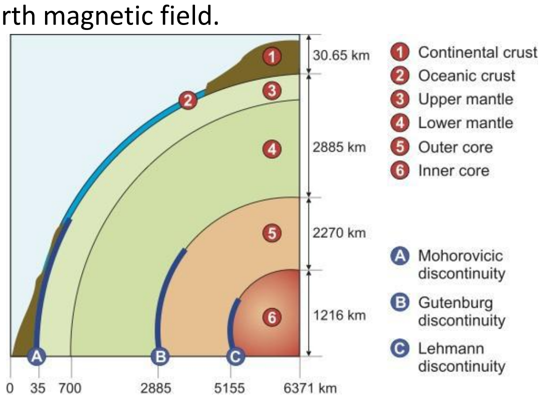
Modern theories rely on an understanding of what happens below the surface. Our Earth is a flattened sphere with an average radius of about 6370 km. The Super pit in Kalgoorlie only penetrates the top 600m of rock. The deepest mine at present is in South Africa and is only 5km deep (0.0007849 of Earth's radius). Movement generated from within our planet causes earthquakes and volcanic activity.

To infer what lies below we need to use information gained from:

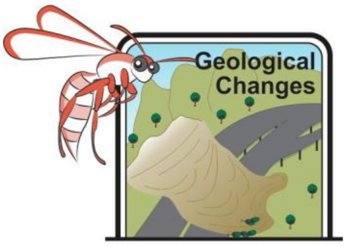
- Examining earth processes that we can see happening at present
- Collecting and examining rocks brought to the surface during mountain building and volcanic activity.
- Interpreting geophysical data produced during gravity surveys, electromagnetic surveys, and seismic surveys.
- Interpreting information from seismic waves produced naturally through earthquakes or artificially during seismic surveys.

Collected and collated data infers that our planet is made of three major layers; the outermost crust, the mantle in the middle and the innermost core.

1. **The crust** is a very thin solid outer layer of the Earth. Continental crust lies above denser oceanic crust. Continental crust can be 25-90km thick and consists of silica and aluminium rich rocks such as granite and sediment. Underlying oceanic crust is darker and denser because it contains rocks richer in heavy iron and magnesium such as basalt. It can be 5-10km thick. This is the rock found below most oceans.
   The crust is broken into about 12 pieces (tectonic plates) that can be pushed together or move apart. Tectonics is the study of Earth movement. These plates move a few centimetres each year, at about the same rate as your fingernails grow. Sometimes they move together to form supercontinents and sometimes they break apart. Most of the world's volcanoes and earthquakes take place at the edge of these moving plates. When plates move together mountains are built and ocean basins form when they move apart.
2. **The mantle** is a 2,900 km thick, dense, mostly solid layer of iron and magnesium rich rock. A thin layer called the asthenosphere lies at the top and can be molten in parts. Movement originating from here causes volcanic eruptions, earthquakes, continental drift and mountain building. These geologically sudden movements can change the surface of the Earth.
3. **The core** consists of a liquid outer core and a solid inner core. It is mostly iron and nickel rich minerals and is very dense. Rare plumes of hot rock rise from here. Movement in the inner core creates Earth magnetic field.



Earth Egg Model – Teacher Notes



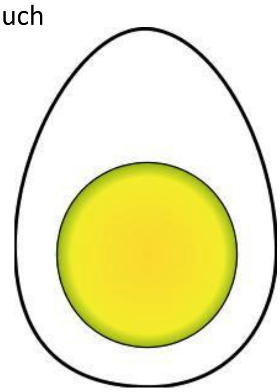
There is a common student misconception that the core and mantle of our Earth are liquid and only the crust is solid. This might have been true at the very beginning of planetary formation about 4.54 billion years ago but not so now.

Earth egg model **Student activities**

Half a boiled egg can be used to demonstrate the approximate proportions of the layers of our planet. The teacher demonstration of separation by gravity should have been performed earlier. (An apple can be cut in half also to represent the layers but the proportions are less accurate and tectonic plates cannot be modelled). Eggs should be prepared earlier and allowed to cool.

Concepts covered

1. Crust – the eggshell. (Actually the Earth's crust is proportionally much thinner).
2. Mantle – the egg white represents the mostly solid mantle. The area between the crust and underlying mantle is partially melted in places. Movement here can result in volcanic activity, earthquakes and continental drift at the surface. (The bluish ring round the yolk is due to hydrogen sulphides produced by the breakdown of amino acids in the yolk).
3. Core – the egg yolk represents the inner solid core and outer liquid core.



Part 1 - The Layers of the Earth

Materials

- One cold half hardboiled egg. (For easy to handle eggs, allow them to warm to room temperature before cooking. This minimises cracking and loss of albumen/egg white. Then place them in cold water, simmer for 8 minutes and allow them to cool).
- A sharp knife and cutting board (to cut eggs in half for students)
- If students are doing this activity it is a good idea to cover their desk with old newspaper to collect bits of egg and shell
- A ruler

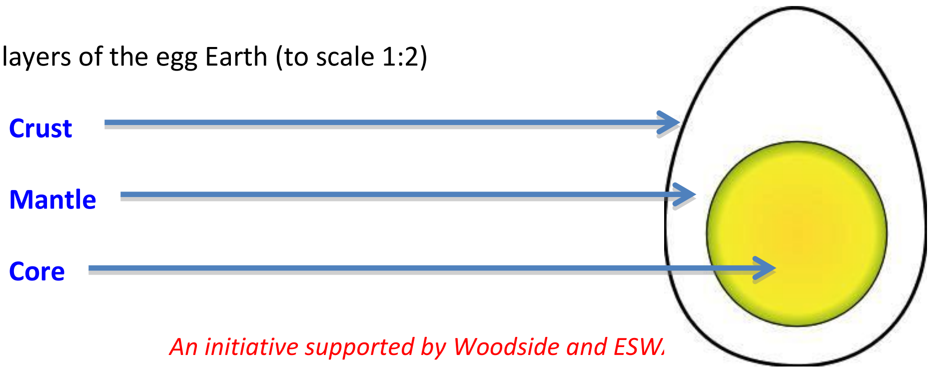
Method

(Prepare the eggs and provides halves to students).

1. Draw your egg to scale in the space provided below.
2. Label the layers of the egg in your diagram. The outermost layer represents the crust of the Earth, the middle layer represents the mantle and the innermost layer represents the core.
3. Measure the thicknesses of the layers of the egg and enter this in the table provided.
4. Calculate the percentage of the whole for each layer and also enter this in the table provided

Observations

Diagram of the layers of the egg Earth (to scale 1:2)



Earth Egg Model – Teacher Notes

Calculations

Earth			Egg		
	Thickness	**Percentage**		**Thickness**	Percentage
Radius	6370km	100%	Radius	Will vary	
Crust	25-90km	0.4 to 1.4%	Shell (crust)	Will vary	
Mantle	2,900km	45.53%	White (mantle	Will vary	
Core	3,380km	53.07%	Yolk (core)	Will vary	

*Don't forget the radius will be half the thickness of the Yolk (core)

Is the egg a reasonably good model for the layers of the Earth? Explain your answer. YES
The egg layers thickness proportions are roughly similar to those of the Earth.

In what way is the egg a poor model for the layers of the Earth? The Earth's shape is a slightly flattened sphere whilst the egg is ovoid.

Part 2 - Tectonic Plates of the Crust

Method

1. With your fingernails press the eggshell to break it into about four pieces. These represent the tectonic plates of the Earth's crust.
2. With your fingers gently push two plates together. Describe what happens.
3. With your fingers gently pull two plates apart. Describe what happens.
4. With your fingers gently try to slip one plate along the edge of another. Describe what happens.

Observations

What happens when two eggshell plates are pushed together? They buckle upwards or one slips under the other pushing it up.

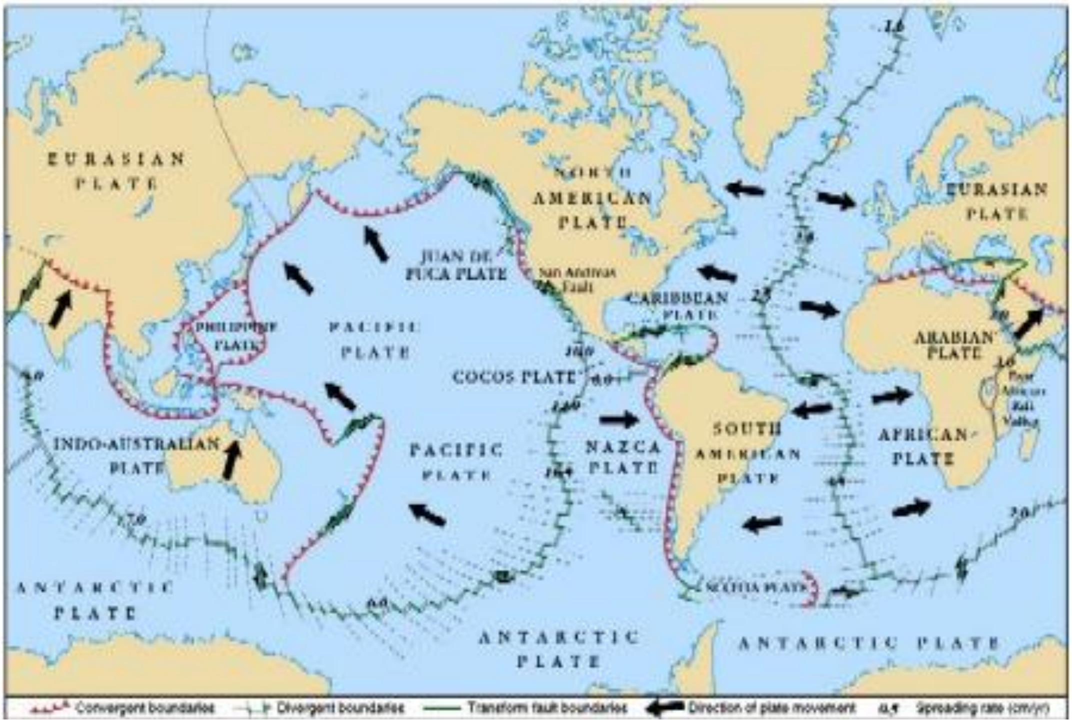
What do you think would happen if two hard crustal plates were pushed together? The same thing would happen. This explains how some high mountains ranges such as the Himalayas or the mountains in Papua-New Guinea are formed. The Australian Plate is moving north pushing up the mountains of New Guinea. Similarly the Indian Plate is moving north pushing up the Himalayas ahead of it. This is called a zone of convergence.
The Himalayan Mountain Range was pushed up when India pushed into Asia.

What do you think would happen if a plate were forced down into the Earth? Heat and pressure would make it molten. It might rise and erupt from a volcano.
The volcano Mt Fujiyama is created where the Pacific Plate is forced under the Eurasian Plate.

What happens when two tectonic plates are pulled apart? A gap is created. When two tectonic plates move apart an ocean basin is created. Sometimes the crust thins and weakens and molten rock bubbles up to form a line of volcanoes along the centre of the ocean. This is called a zone of divergence. Undersea volcanos were found in the Indian Ocean during the search for the lost Malaysian Airways aeroplane MH370.
The Indian Ocean formed when the Australian plate pulled apart from the African plate.

Earth Egg Model – Teacher Notes

What happens when two plates are slipped past each other? They stick and get cracked before moving on. They do not move smoothly. This build up and release of stress creates earthquakes along fault lines which can be devastating such as at San Francisco (San Andreas Fault) and more recently, Christchurch (New Zealand). This is called a transform zone.
The Christchurch earthquakes were caused by stress when the Indo-Australian Plate grated alongside the Pacific Plate.



Look at the position of the Australia on the map above. How does its position explain why we do not have many earthquakes and recent active volcanic activity? Australia lies in the middle of a large tectonic plate. Most tectonic action happens at the edges of plates. This explains why Australia does not have many earthquakes and volcanoes.

Topic - Sudden geologic events can shape the surface of the Earth

What have we learned today?

Name the layers of the Earth from outside to inside. Crust, mantle and core. (3 marks)

The crust is broken into? Tectonic plates. (1 mark)

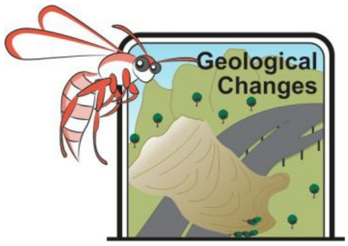
What happens if two of these tectonic plates move towards each other? Mountains and volcanoes are created. Earthquakes can also occur. (3 marks)

What happens if two of these tectonic plates are moved apart? Basins/oceans and volcanoes are formed. (2 marks)

What happens if one plate grates alongside of another? Earthquakes! (1 mark)

Score ________/10

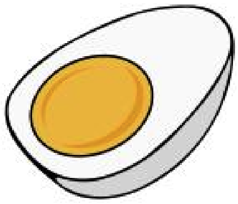
Vocabulary	Core, crust, earthquakes, mantle, tectonic plates and volcanoes



Earth Egg Model – Student Activity

Ancient Cretans tried to explain earthquakes and volcanic activity by saying that a massive bull lay underground and the land shook when it became angry. Romans thought that the Earth moved because people had sinned. Modern Japanese people fear and revere the volcanoes and earthquakes that build and destroy parts of their country.
Earth scientists use information from rocks and seismic evidence to suggest models of what might cause geological changes at its surface. These are then tested.
Half a boiled egg can be used to demonstrate the approximate proportions of the layers of our planet and suggest the processes behind some geological changes we observe at the surface.

Part 1 - The Layers of the Earth



Materials

- Half one cold hardboiled egg
- Newspaper to cover the desk and collect bits of egg and shell
- A ruler

Method

1. Draw your egg to scale in the space provided below.
2. Label the layers of the egg in your diagram. The outermost layer represents the crust of the Earth, the middle layer represents the mantle and the innermost layer represents the core.
3. Measure the radius of the layers of the egg and enter this in the table provided.
4. Calculate the percentage of the whole for each layer and enter this in the table provided.

Observations

Diagram of the layers of the egg Earth (to scale 1: _______)

Earth Egg Model – Student Activity

Calculations

	Earth			Egg	
	Thickness	**Percentage**		**Thickness**	**Percentage**
Radius	6370km	100%	Radius		
Crust	25-90km	0.4 to 1.4%	Shell (crust)		
Mantle	2,900km	45.53%	White (mantle		
Core	3,380km	53.07%	Yolk (core)		

*Don't forget the radius will be half the thickness of the Yolk (core)

Is the egg a reasonably good model for the layers of the Earth? Explain your answer. ______________

____

In what way is the egg a poor model for the layers of the Earth? ________________________________

____

Part 2 - Tectonic Plates of the Crust

Method

1. With your fingernails press the eggshell to break it into about four pieces. These represent the tectonic plates of the Earth's crust.
2. With your fingers gently push two plates together. Describe what happens.
3. With your fingers gently pull two plates apart. Describe what happens.
4. With your fingers gently try to slip one plate along the edge of another. Describe what happens.

Observations

What happens when two eggshell plates are pushed together? ________________________________

____

What do you think would happen if two hard crustal plates were pushed together? _______________

____

The Himalayan Mountain Range was pushed up when India pushed into Asia.

What do you think would happen to a plate if it were forced down into the Earth? _______________

____

The volcano Mt Fujiyama is created where the Pacific Plate is forced under the Eurasian Plate

What happens when two tectonic plates are pulled apart? ____________________________________

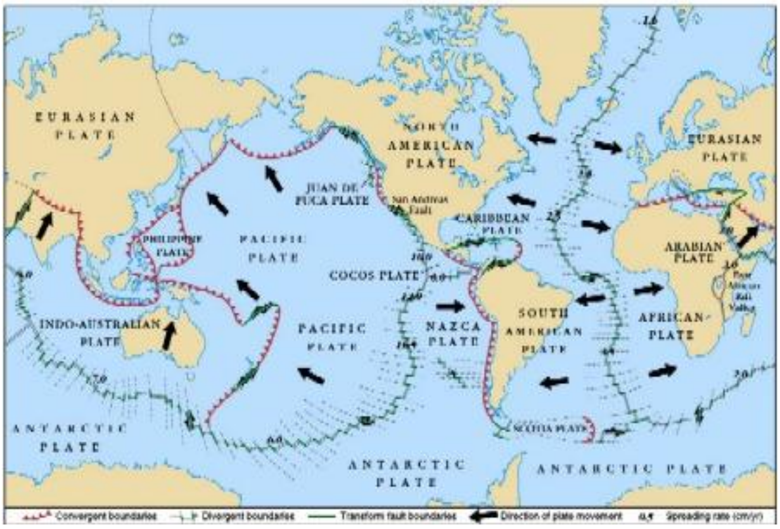
____

The Indian Ocean formed when the Australian plate pulled apart from the African plate.

What happens when two plates are slipped past each other? __________________________________

____

Earth Egg Model – Student Activity



Look at the position of Australia within a "tectonic plate" in the map above. How does its position explain why we do not have many earthquakes and recent active volcanic activity?

____

____

Topic - Sudden geologic events can shape the surface of the Earth

What have we learned today?
(Use your best scientific words or a diagram)

Name the layers of the Earth from outside to inside.

1. ____

2. ____

3. ____

(3 marks)

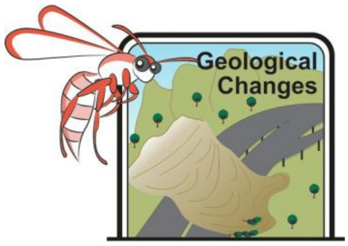
The hard crust is broken into? ____

(1 mark)

What happens if two of these tectonic plates move towards each other? ______________________

____

(2 marks)



What happens if two of these tectonic plates are moved apart? ______________________________

____

(2 marks)

What happens if one plate grates alongside of another?

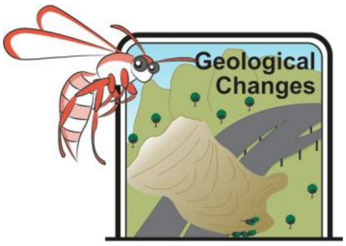
____

____

(1 mark)

Score ________________________

Vocabulary	Core, crust, earthquakes, mantle, tectonic plates, volcanoes, earthquakes



Layers of the Earth (Density) – Teacher Notes

This activity uses secondary data (data/information collected by another reputable scientist). Students will be using the following secondary data to create a reasonably accurate model of the Earth from clay, plasticine or play dough.

When rock becomes stressed it releases unwanted energy as an earthquake. This energy travels through the Earth as seismic waves. (Seismic = shaking (Greek)). When seismic waves pass through rock, particles are moved to release stress. Shock waves travel in all directions away from the source and are slowed and deflected by the materials they travel through. Denser rocks, such as are found in the mantle, slow and deflect the waves more than less dense rocks of the crust. Surface waves travel along the crust whilst body waves can travel through the planet. Some body waves cannot travel through liquids and that is how we know the outer core of our planet is fluid.

Earth statistics

Average radius from crust to core at the equator	6,370km
Average depth to bottom of crust	100km
Average depth to bottom of mantle	2,900km
Average depth to bottom of outer core	5,100km

Why do you think you were given ***average readings***? The readings vary from place to place. The Earth's circumference is greater at the equator than at the poles. The surface of the Earth varies due to high mountain ranges and deep oceanic trenches. Also we do not have accurate readings from all around the world.

If you drew a straight line from the surface to the centre, what percentage of this line would each layer take?

Layer	Thickness (km)	Calculation	Percentage (%)
Crust	100	$\frac{100 \times 100}{6,370}$	1.6
Mantle	2,800 (2,900 – 100)	$\frac{2,800 \times 100}{6,370}$	44.0
Outer Core	2,200 (5,100 – 2,900)	$\frac{2,200 \times 100}{6,370}$	34.5
Inner Core	1,270 (6,370 – 5,100)	1,270 X 100 6,370	19.9

HINT Sneaky students know a quick way to check at the end if they have the correct percentages. What is this? All the percentages added together should make 100% because "per cent" means part of 100 i.e. 10% means 10 parts of one hundred or one tenth.

Layers of the Earth (Density) – Teacher Notes

This activity demonstrates how thin the crust of the Earth really is. If the Earth is represented by an apple cut in half. The skin of the apple is thicker than the crust!

Scientists often construct models to explain important ideas. Using the plasticine or play dough create a model of the layers inside our planet. The model will be small enough to fit into the palm of your hand. *Students will need to work out a scale so that the model will be small enough. A direct scale using the percentage will mean the model would be 39.8cm in diameter!*
Students may work in pairs and have half of the model each. These models make a good display when mounted on cardboard or polystyrene.

Most teachers have their own recipe for play dough but I find this one works well, however it does not last as long as recipes using borax. Borax should not be ingested/eaten.

Materials for making uncooked play dough

- 1 cup of plain flour.
- 1 tablespoonful of vegetable oil.
- ¼ cup of salt.
- ½ cup of water.
- food colouring.

Method

1. Mix together flour and salt.
2. Pour in the oil.
3. Add the colouring to the water and mix in.
4. Knead the dough until plastic. (Some flours require more water).

Colour for crust 1 part in 50
Colour for mantle 20 parts in 50
Colour for core 19 parts in 50

Materials for creating the model

- Play dough or plasticine in four colours
- A sharp knife retained by the teacher to cut the models in half

Method

1. Determine how many colours you will need 4
2. Which layer should you start from? Start with the inner core and add outer layers
3. If we are making this to scale we will need:

- A ball for the inner core with a radius of 0.2cm or a diameter of 0.4cm
- A layer 0.35cm deep round the inner core to represent the outer core
- A layer 0.44cm deep round the core to represent the mantle
- A layer 0.02cm round the mantle to represent the crust.
- Slice the model in half to expose the layers of the Earth.
- Label each layer where possible
- Measure the diameter of your model Earth

Results

Stick a photograph or draw a sketch of your model here
Scale

Will vary

Layers of the Earth (Density) – Teacher Notes

What have we learned today?
(Use your best scientific words or a diagram)

1. The Earth is made of three (four) layers. Core (inner and outer), mantle and crust.
2. Seismic waves are energy released by an earthquake
3. We can use seismic data to estimate the thickness of each layer of the Earth

Vocabulary	Core, crust, earthquake, mantle, seismic, wave.

Layers of the Earth (Density) – Student Activity

This activity uses secondary data (data/information collected by another reputable scientist). You will be using the following secondary data to create a reasonably accurate model of the Earth.

When rock becomes stressed it releases unwanted energy as an earthquake. This energy travels through the Earth as seismic waves. (Seismic = Greek shaking). Shock waves travel away in all directions and are changed by the rock they travel through.

Earth statistics (secondary data)

Average radius from crust to core at the equator	6,370km
Average depth to bottom of crust	100km
Average depth to bottom of mantle	2,900km
Average depth to bottom of outer core	5,100km

Why do you think you were given ***average readings***? ___________________________________

____

If you drew a straight line from the surface to the centre, what percentage of this line would each layer take? Use the table below for your calculations.

Layers of the Earth

Layer	Thickness (Km)	Calculation	Percentage (%)
Crust			
Mantle			
Outer Core			
Inner Core			

HINT Sneaky students know a quick way to check at the end if they have the correct percentages. What is this?

____

This activity demonstrates how ***thin*** the crust of the Earth really is. If the Earth is represented by an apple cut in half. The skin of the apple is thicker than the crust!

Layers of the Earth (Density) – Student Activity

Scientists often construct models to explain important ideas. Using plasticine or play dough create a model of the layers inside our planet. The model will be small enough to fit into the palm of your hand.

Materials

- Play dough or plasticine in a variety of colours
- A sharp knife retained by the teacher to cut the models in half

Method

1. Determine how many colours you will need ____

2. Which layer should you start from? ____

3. If we are making this to scale we will need:
    - A ball for the inner core with a radius of ______________ or a diameter of _____________
    - A layer ______________ deep round the inner core to represent the outer core
    - A layer ______________ deep round the core to represent the mantle
    - A layer ______________ round the mantle to represent the crust.

4. Slice the model in half to expose the layers of the Earth.

5. Label each layer

6. Measure the diameter of your model Earth

<u>Results</u>

Stick a photograph or draw a sketch of your model here

Scale

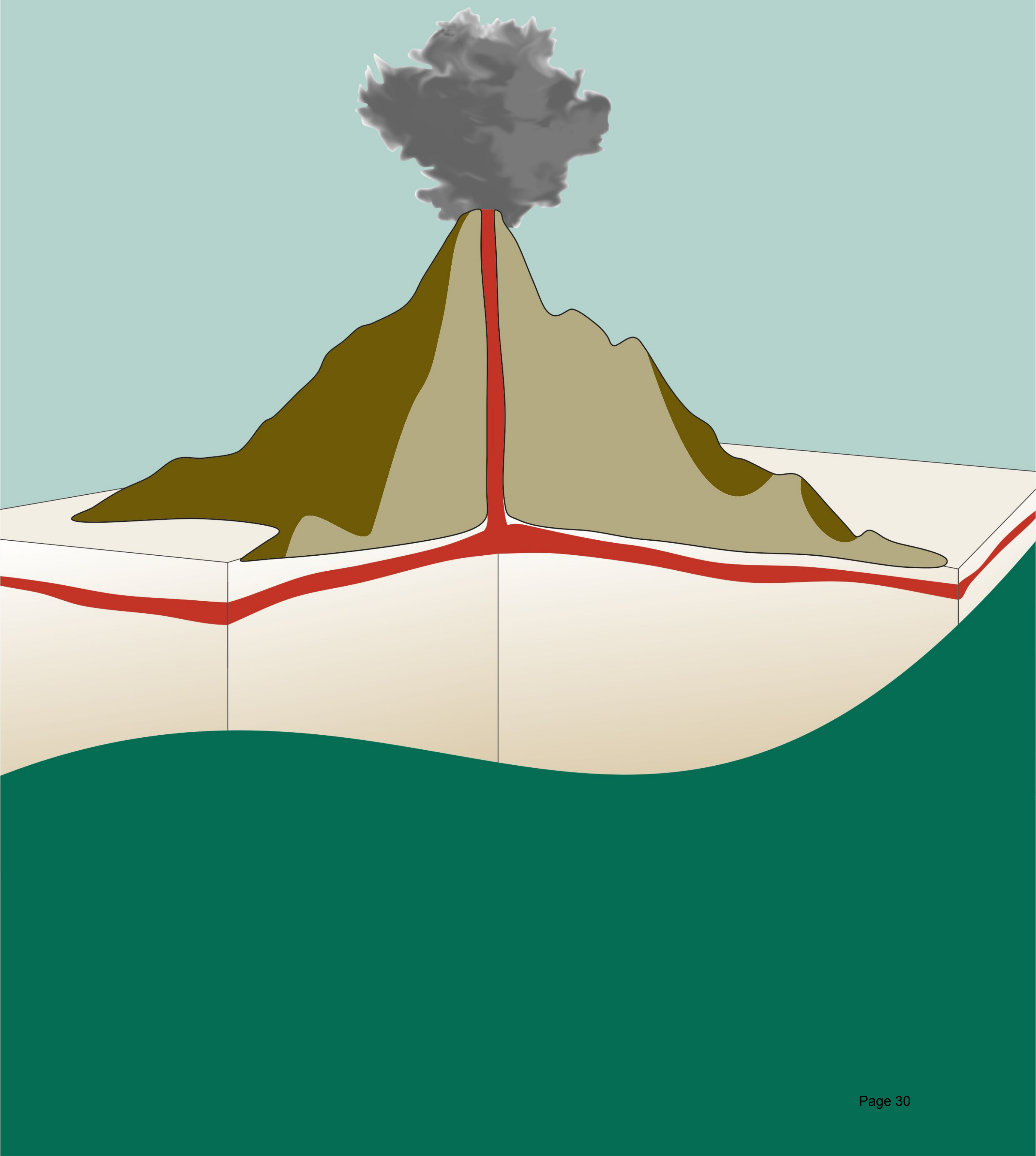
Layers of the Earth (Density) – Student Activity

What have we learned today?
(Use your best scientific words or a diagram)

1. The Earth is made of ___________ layers ____
2. Seismic waves are energy released by an ____
3. We can use seismic data to ____

Vocabulary	Core, crust, earthquake, mantle, seismic, wave

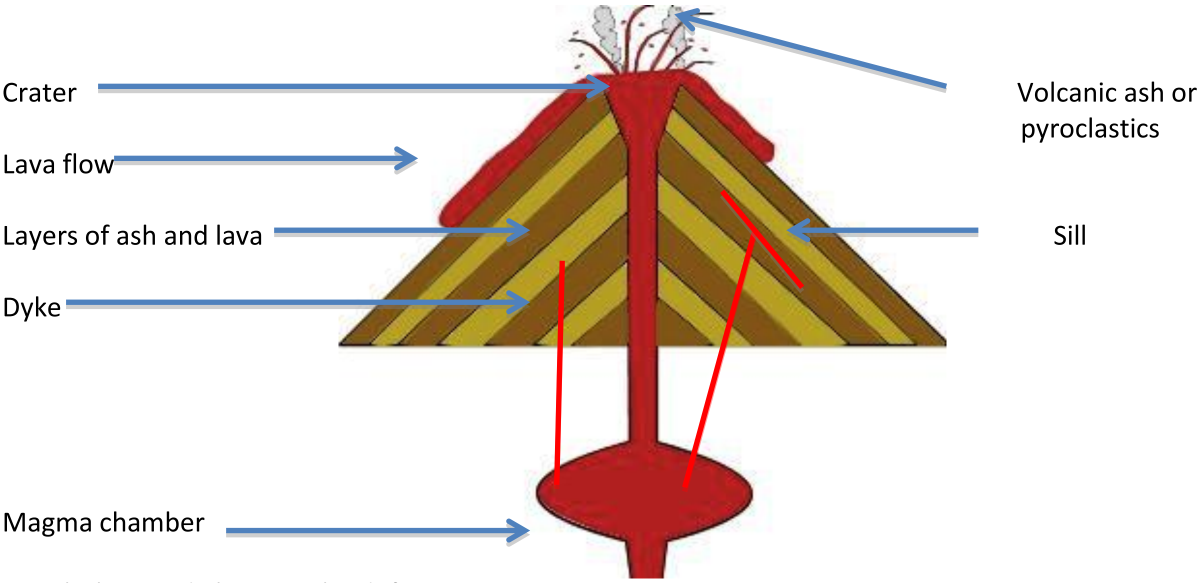
Volcanic Eruptions



Draw a Volcano – Teacher Notes

This activity helps students to learn the names for parts of a volcano. The diagram is for a stratovolcano. It is called “strato” or “composite” because the volcano is built from layers (strata) of ash and lava flows. Later activities will discriminate between strato and shield volcanoes. The terminology for describing strata and shield volcanos is the same.
The source of magma (molten rock) is near the crust/mantle interface and is called the asthenosphere. Here pressure and temperature at some spots appears to permit solid rock to melt. The mantle itself is not usually molten.

Your Task
Using your textbook, Internet or directions from your teacher, draw a cross section of a volcano below and label the following structures:



Match the word above to the definition:

Magma reservoir	A chamber of molten rock which underlies volcanoes
Crater	A vent at the summit of the volcano
Dyke	Igneous intrusions that cut across strata
Sill	Igneous intrusions that are parallel strata
Lava flow	A fluid flow from the vent of a volcano
Volcanic ash	Small pieces of violently ejected chilled lava also called cinders

Heat causes ***magma*** (molten rock) in the *magma chamber* to expand and rise. It forces its way up through any cracks or weaknesses in the country (existing) rock. The main conduit for magma is the ***main vent.*** Where a minor vent injects magma into a crack that crosses layers the rock formed is called a ***dyke***. Dyke is the Northern European term for a rock wall. Since the igneous rock is usually hardest it weathers out to form a wall like shape. Similarly, if the magma pushes its way between two layers it is called a ***sill*** (as in window sill). Magma pours out of the crater of the volcano to become either an ash cloud or a lava flow. The ash travels at high speeds with temperatures exceeding 400°C.

The only active volcano in Australian territory is Big Ben on Heard Island. It last erupted in 2001

Challenge Guess which vocabulary words that you have to learn and write them below. Crater, Dyke, Lava Flow, Magma reservoir, Sill & Volcanic Ash.

Geological Changes

Draw a Volcano – Student Activity

Your Task

Using information from your textbook or the internet draw a cross section of a volcano below and label the following structures:

Pyroclastic Ash

Crater

Lava flow

Dyke

Sill

Magma reservoir

Diagram of a volcano

Match the word above to the definition

_________________________ A chamber of molten rock which underlies volcanoes

_________________________ A vent at the summit of the volcano

_________________________ Igneous intrusions which cut through strata

_________________________ Igneous intrusions which are parallel strata

_________________________ A fluid flow from the vent of a volcano

_________________________ Small pieces of violently ejected lava, also called cinders

The only active volcano in Australian territory is Beg Ben on Heard Island. It last erupted in 2001.

Challenge! Guess which vocabulary words you have to learn is and write them below.

Volcanoes change the surface of the earth. They create classic conical volcanic mountains like Mt Fujiyama and low rising domes like Kilauea in Hawaii. Outpourings from fissures in the crust created major igneous provinces that form the stepped mountains of the Deccan of India and in the past covered most of Siberia to a depth of many kilometres. Collapsed magma chambers result in the cauldron subsidence that on land created the lakes at Mt Gambier and at sea, tsunami. The landforms produced however are dependant on the type of magma extruded from the volcano. There are two major types of volcano, ***stratovolcanoes*** that produce the classical Mt Fujiyama outline and ***shield volcanos*** that are much lower and rounded. They are called shield volcanoes because they have the same profile as a warrior's shield laid on the ground. Hot springs and geysers are also produced by volcanic activity.

These paper models of a stratovolcano (left) and shield volcano (right) are downloadable from Geoscience Australia. http://www.ga.gov.au/metadata-gateway/metadata/record/79350/ and from http://www.ga.gov.au/image_cache/GA8583.pdf.

Moving tectonic plates create conditions for volcanic activity:

1. Plate convergence - Strato (or composite) volcanoes

Where two tectonic plates are pushed together at a zone of convergence, continental crust may be pushed down (subducted) and partially melted. The convergence of the northward moving Pacific Plate and the Asian Plate produce the famous belt of volcanoes known as the "Ring of Fire". Earthquakes will occur from the downward travelling plate rubbing against the over-riding slab. Magma formed from melting crust along with water and sediment pulled down with it, will be rich in silica creating explosive, sticky lava and explosive eruptions. These are the most dangerous volcanoes for living things. They produce clouds of super-heated steam and poisonous gas. They belch out clouds of red-hot volcanic ash (pyroclastics) that can instantly smother and burn the countryside. They can also produce lahars, unstable fast moving mudflows of ash, rocks and water which flow downhill along river valleys. They are the greatest danger from stratovolcano eruptions. Recent examples of volcanoes causing devastating lahars are from Mt Ruapehu in New Zealand, Mt Pinatubo in the Philippines and Mt Rainer in Washington State USA.

2. Plate divergence - Shield volcanoes

When plates diverge (pull apart) continental crust thins and hot melted oceanic crust rises to the surface. At hot spots the mantle also punches up through the crust. There is much less likelihood of earthquakes as tectonic plates are not rubbing together. Most of these eruptions occur under the sea. This silica poor magma is free flowing. Layer upon layer of basalt flows out to form new ocean floor. When the supercontinents of Rhodinia and Pangea broke up about 750 and 250 million years ago, many eruptions happened along fissure lines in the crust. Free flowing magma filled any cracks in the rock or weaknesses between layers of rock to create black dykes (vertical dykes) and sills (horizontal layers). Because the igneous rock is hard and crystalline these rocks will not weather as easily as sediments and become outstanding.

Volcanoes can be described as active (erupt frequently) dormant (presently inactive but liable to erupt again) and extinct.

A combination of lava type and water content controls how a volcano behaves.

Water content	Lava type	Volcano type created	Explosion
Lots	Runny (mafic)	Cinder cone volcano	Often
Little	Runny (mafic)	Shield volcano	Rare
Lots	Sticky/viscous (SiAl)	Stratovolcano	Often
Little	Sticky/viscous (SiAl)	Plug dome volcano	Rare

Viscosity and Lava Flow - Student Activity

Viscosity describes the reluctance of a material to flow.

We cannot work with molten rock but we can observe how liquids with different viscosities behave. High viscosity liquids are honey, sunscreen, Vaseline and margarine or butter. Peanut butter is a fine example of a highly viscous liquid and has almost the same viscosity as the lava erupting from stratovolcanoes. It is not acceptable in the classroom however as allergic students can have fatal reactions.
Low viscosity liquids are water, milk, blood (again not acceptable in the classroom laboratory) and vegetable oil. Most tomato ketchup has medium viscosity.

Materials per group or teacher

- A plate, dish or student tray
- Spoons
- Samples of liquids of different viscosities E.g. Water, tomato sauce, vegetable oil and margarine
- Newspaper to protect the table top

Volcano Variations 1 – Teacher Notes

Method

1. Place one teaspoon of each liquid onto the plate.
2. Observe the shapes the different liquids make on the plate.
3. Describe the shapes of the materials on the plate after one minute in the table below.
4. Place another (second) spoonful of the same material on top of the original ones.
5. Place a third spoonful on top of the pile.
6. Write your observations in the table provided.

Observations

Material	First spoon	Second spoon	Final shape	Viscosity
1 Oil	Spread out	Spread out	Flat and spread out	Low
2 Tomato ketchup	Low mound	Low mound	Rounded low mound	Medium
3 Margarine	High mound	Higher mound	High mound	High

Volcanos erupt layer upon layer of lava. Do you thing the viscosity of lava will control the shape of the volcano? Explain your answer.
Yes. Thick viscous lava will pile up and form a high pointed volcano whilst a less viscous lava will form a low rounded volcano.

Stratovolcanoes have high conical peaks and do not extend over great areas. What kind of lava would build a strato volcano like Mt Fujiyama or Vesuvius? A highly viscous lava (like andesite).

Shield volcanos are low rounded mounds which extend for many tens of kilometres. What kind of lava would build a shield volcano like Mt Kilauea. A low viscosity lava (like basalt)

OPTION

Perhaps the result would be different if these materials were flowing down a slope. Design an experiment to find out what would happen.
HINT This must be a "Fair Test"
What materials are required?
What method will be used?
Which variable or variables will you keep the same?
Which variable or variables will you change?
How will you report your observations

The speed lava travels at depends on its viscosity and the slope it is travelling down. Low viscosity lavas can move at 40-60km/h if a channel has been cut downhill.
Over flat lying ground, viscous lava flows move only a few metres an hour.
Less viscous basalts move at about 6km
Could you run faster than a viscous lava flow? YES (The average human walking speed is 5-7km/h)
Most people can get out of the way of flowing lava. Deaths occur only when they get too close to the lava and become burned or their escape route is cut off by another lava flow.

Vocabulary Strato volcano, shield volcano, lava and viscosity.

Volcano Variations 1 – Student Activity

Volcanoes change the surface of the earth. They create classic conical volcanic mountains like Mt Fujiyama and low rising domes like Kilauea in Hawaii.

There are two main types of volcanoes:

1. Strato (or composite) volcanoes E.g. Mt Fujiyama in Japan & Vesuvius in Italy

Where two tectonic plates are pushed together at a ***zone of convergence***, continental crust may be pushed down and partially melted. Magma formed from melting crust along with water and sediment pulled down with it, will be rich in silica creating explosive, sticky lava and explosive eruptions. These are the most dangerous volcanoes. They produce clouds of super-heated steam and poisonous gas. They can belch out clouds of red-hot volcanic ash (pyroclastics) that can instantly smother and burn the countryside.

2. Shield volcanoes E.g. Mt Kilauea in Hawaii

When plates pull apart at ***a zone of divergence***, continental crust thins and hot melted oceanic crust rises to the surface. At hot spots the mantle also punches up through the crust. There is much less likelihood of earthquakes as tectonic plates are not rubbing together. Most of these eruptions occur under the sea. This silica poor magma is free flowing. Layer upon layer of basalt flows out to form new ocean floor.

Volcanos can be described as active (erupt frequently) dormant (presently inactive but liable to erupt again) and extinct.

Viscosity and Lava Flow - Student Activity

Viscosity describes the reluctance of a material to flow.

We cannot work with molten rock but we can observe how liquids with different viscosities behave.

Volcano Variations 1 – Student Activity

Materials per group or teacher

- A plate, dish or student tray
- Spoons
- Samples of liquids of different viscosities
- Newspaper to protect the table top

Method

1. Place one teaspoon of each liquid onto the plate.
2. Observe the shapes the different liquids make on the plate.
3. Describe the shapes of the materials on the plate after one minute in the table below.
4. Place another (second) spoonful of the same material on top of the original ones.
5. Place a third spoonful on top of the pile.
6. Write your observations in the table provided.

Observations

Material	First spoon	Second spoon	Final shape	Viscosity
1				
2				
3				

Volcanos erupt layer upon layer of lava. Do you thing the viscosity of lava will control the shape of the volcano? Explain your answer.

Stratovolcanoes have high conical peaks and do not extend over great areas. What kind of lava would build a stratovolcano like Mt Fujiyama or Vesuvius?

Shield volcanoes are low rounded mounds, which extend for many tens of kilometres. What kind of lava would build a shield volcano like Mt Kilauea?

OPTION

Perhaps the result would be different if these materials were flowing down a slope. Design an experiment to find out what would happen.

HINT This must be a "Fair Test"
What materials are required?
What method will be used?
Which variables will you keep the same?
Which variable or variables will you change?
How will you report your observations?

Volcano Variations 1 - Student Activity

The speed lava travels at depends on its viscosity and the slope it is travelling down.
Low viscosity lavas can move at 40-60km/h if a channel has been cut downhill.
Over flat lying ground, viscous lava flows move only a few metres an hour.
Less viscous basalts move at about 6km /h
Could you run faster than a viscous lava flow? ______________________________

Most people can get out of the way of flowing lava. Deaths occur only when they get too close to the lava and become burned or their escape route is cut off.

Vocabulary	Strato volcano, convergence, shield volcano, divergence, lava and viscosity

Volcano Variations 2 – Teacher Notes

When tectonic plates come together something has to give! If continental crust is forced down towards the mantle it takes sediments and water down with it. This means the lava will be viscous (not flow easily) and full of gas.

Materials

- Four materials of different viscosities E.g. margarine (high viscosity), tomato ketchup (medium viscosity), vegetable oil (low viscosity) and water (very low viscosity).
- Four drinking straws.
- Four beakers, glasses, bottoms of cool drink bottles or drinking cups (preferably transparent).
- Gladwrap or Cling wrap.
- Four elastic bands.

Method

1. Cover the bottom of each glass with 1cm of the material to be tested.
2. Cover each glass with film and seal tightly with an elastic band.
3. Four students each select one glass.
4. Each student pierces the film with the straw and pushes it down to the base of the glass.
5. Under the direction of their teacher, students blow strongly through the straws at the same time.
6. The class observes any difference in the explosive behaviour of the material as gas is injected.

Observations

Material	Viscosity	Observation
1 Margarine	High	Explosive chunks blown about
2 Tomato ketchup	Medium	Much bubbling
3 Vegetable oil	Low	Not much disturbance
4 Water	Very low	Not much disturbance

Conclusion

Does volcanic gas affect the behaviour of a volcanic eruption? Explain your answer.

Yes. Gas gets trapped in viscous lava and escapes explosively.

Volcano Variations 2 – Teacher Notes

Vocabulary	Strato volcano, shield volcano, lava, gas and viscosity

EXTENSION

When ash mixes with water from crater lakes, heavy rain or from glacial melt they form lahars that can splatter over kilometres almost instantly. They have been described as being like flows of lumpy concrete. They move at 10s of metres per second and can be 140 metres deep.

Could you outrun a lahar? No.

Lahars are the most common causes of death immediately following an eruption. During the eruption of Mt Pinatubo in the Philippines in 1995 only six people were killed by the initial eruption but subsequent lahars killed over 1,600 more.

Gasses such as superheated steam and carbon dioxide, which are vented from volcanos, are also responsible for deaths of humans and other animals during eruptions.

Volcanic Myths
Vulcan was the blacksmith to the Roman gods and he lived under the island of Vulcano near Sicily. When the volcano erupted they said Vulcan was working at his forge.
Blacksmiths were so valued in the ancient world that sometimes the had their heel tendon cut to make them lame like Vulcan, so they couldn't run away and take their precious skill to enemies. Metalworking and warfare go hand in hand.
Sulphur can be collected from fumaroles (gassy vents) on the side of volcanoes and it is still a major component of antibiotics. People thought that volcanoes went down to hell so the Devil was supposed to smell of sulphur.

Volcano Variations 2 – Student Activity

When tectonic plates come together at a zone of convergence, something has to give! If continental crust is forced down towards the mantle it takes sediments and water down with it. This means the lava will be viscous and full of gas.

Materials

- Four materials of different viscosities
- Four drinking straws
- Four beakers or glasses
- Cling wrap
- Four elastic bands

Method

1. Cover the bottom of each glass with 1cm of the material to be tested.
2. Cover each glass with film and seal tightly with an elastic band.
3. Four students each select one glass.
4. Each student pierces the film with the straw and pushes it down to the base of the glass.
5. Under the direction of their teacher, students blow strongly through the straws at the same time.
6. The class observes any difference in the explosive behaviour of the material as gas is injected.

Observations

Material	Viscosity	Observation
1		
2		
3		
4		

Conclusion

Does volcanic gas affect the behaviour of a volcanic eruption? Explain your answer.

____

Vocabulary	Stratovolcano, convergence, shield volcano, divergence, lava, gas and viscosity

Volcano Variations 2 – Student Activity

EXTENSION

When ash mixes with water from crater lakes, heavy rain or from glacial melt they form lahars that can splatter over kilometres almost instantly. They have been described as being like flows of lumpy concrete. They move at 10s of metres per second and can be 140 metres deep.

Could you outrun a lahar? ____

Lahars are the most common causes of death immediately following an eruption. During the eruption of Mt Pinatubo in the Philippines in 1995 only six people were killed by the initial eruption but subsequent lahars killed over 1,600 more.

Gasses such as superheated steam and carbon dioxide, which are vented from volcanoes, are also responsible for deaths of humans and other animals during eruptions.

Volcanic Myths

Vulcan was the blacksmith to the Roman gods and he lived under the island of Vulcano near Sicily. When the volcano erupted they said Vulcan was working at his forge.

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Sulphur can be collected from fumaroles (gassy vents) on the side of volcanoes and it is still a major component of antibiotics. People thought that volcanoes went down to hell so the Devil was supposed to smell of sulphur.

Pompeii Bodies – Teacher Notes

In 79AD, one of the most famous eruptions in Europe happened in what is now Italy. In this area the northward moving African plate is being subducted (slid under) the Eurasian plate. The volcano is fed by melted African plate. Because the melted material is made of silica rich materials from continental crust, lava is sticky and full of gas. Eruptions are accompanied by earthquakes, gas outpourings and deadly ash falls which smothered plant, animals and man made structures.
Pliny the Younger, a 17-year-old Roman administrator and poet, recorded events over two days of violent earthquakes, eruptions and ash falls. It has been estimated that about 16,000 people in and around the towns of Pompeii and Herculaneum died from the ash and pumice falls and volcanic gas clouds that were released from the volcano Mt Vesuvius.
People would have died instantly from breathing super heated air and from clouds of carbon dioxide gas. If they were in the open, their bodies were blanketed by ash. Layer upon layer of ash covered everything to a depth of several metres. Roofs collapsed and buildings, streets and squares disappeared. Heat from the ash vaporised some bodies instantly and others rotted away but their shapes were still retained within the ash that had cooled and solidified.
Almost immediately after the eruption looters tunnelled down into the city to find any treasure, as Pompeii was a rich city with wealthy merchants, temples, palaces, baths, restaurants, theatres and sports grounds. The site of Pompeii was then forgotten for hundreds of years and the land given over to pasture. It was in the 18th century however that modern excavations commenced. Skeletons of those who had sought shelter inside stone houses were found. Many clutching treasures they had grabbed when they tried to shelter from the volcano. More recently, voids discovered in the solidified ash were examined and found to be moulds of people and animals that had died. These moulds were filled with plaster of Paris or rubber and the casts of victims and their treasures discovered. Fine ash moulds preserved details of faces and clothing. Pictures of these casts can be found on the Internet.

Plaster of Paris (common name gypsum) is the material that is used to set broken limbs and to make a smooth surface on interior house walls. When the white dust mixes with water a chemical reaction occurs (a new substance is formed) and the liquid hardens in about 20 minutes. There is a short research project for students to undertake during this time. Small plastic figures from student's own collections or from cheap "$2.00 shops "can be used to represent bodies. Figures can be shared between students. Fill student trays, bowls, cut off bottoms of used cool drink bottles to the depth of about 20mm with damp sand. The bodies are pressed into damp (N*OT WET!)* sand to create a sand mould. If the sand is too wet, when the body is removed water will fill the void and plaster will not be able to enter the void. Some teachers permit their students to mix plaster themselves but I have found that messy. It is quicker and easier if the teacher makes a mix of approximately two parts plaster to one part water. It should form a thick custard or yoghurt consistency. This is spooned into the void in the sand mould and left to dry.

Pompeii Bodies – Teacher Notes

Activity Pompeii bodies

We will be examining the process by which the Pompeii bodies were copied.

Materials per student:

- 1 plastic figure (to represent the body).
- Damp sand (NOT WET).
- Newspaper to protect the desk.
- Plaster of Paris mix provided by the teacher.
- Soft brush (borrowed from Art?) or tissue to brush off sand.

Method

1. Draw the original "body" to scale in the table below. Describe the body below this.

To create the mould:

2. Cover the work area with newspaper.
3. Firmly press the figure into the sand and then remove carefully.

To create the cast:

4. Fill the mould with liquid plaster and leave to dry. This may take 30 minutes.
5. Answer the research questions in the worksheet while it is drying.
6. Gently lift out the dried plaster cast and leave to dry for a further five minutes.
7. Answer the "Discussing the activity" questions.

Sand moulding

Unbrushed plaster cast (mirror image of original)

<u>Observations</u>

Original body description	**Cast of body description**

Discussing the activity

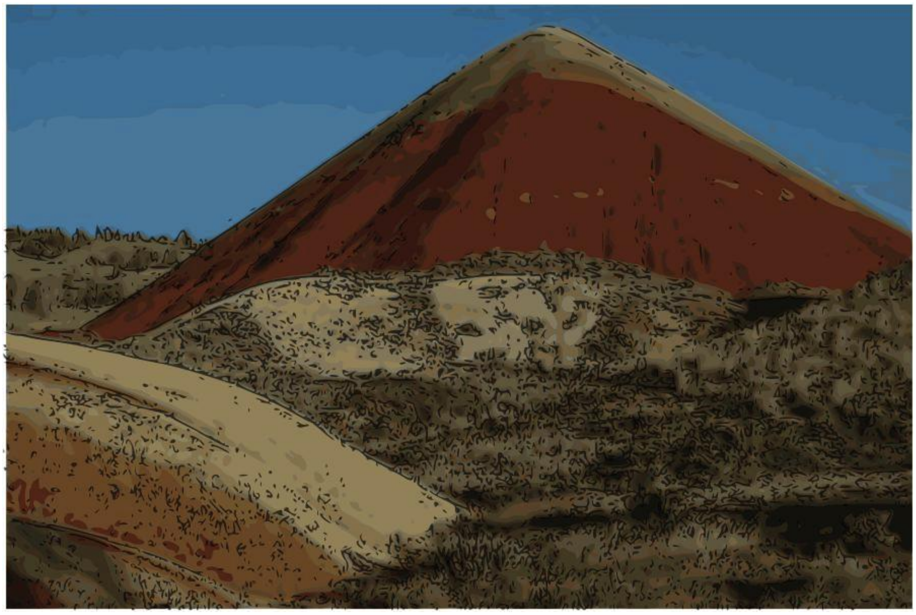
Is there any difference between the original "body" and its cast? Explain your answer or answers.

Yes. They are a different colour. Because they are made of different materials the shapes are different. The edges of the cast are not as sharp as the original. The cast may be misshapen due to mishandling or differences in materials used. The cast is a mirror image of the original body.

Why do you think that the casts in Pompeii are better than yours? The ash was much finer than sand so it was able to give more detail. The ash was hot and melted together to form solid rock almost immediately.

Pompeii Bodies – Teacher Notes

Which kind of volcano must Mt Vesuvius be? It must be a stratovolcano as it released explosive clouds of ash accompanied by earthquakes. Its magma must be very sticky/viscous/silica rich.



Research questions

Look at the picture of the volcano above. What kind of volcano must this be? Explain your answer. It must be a stratovolcano as it has steep sides (an angle above 10^{o})

Using an atlas, books and the Internet answer the following questions.

Place Italy on the World map and mark Pompeii on the map of Italy. (HINT Pompeii is on the Bay of Naples in Italy.

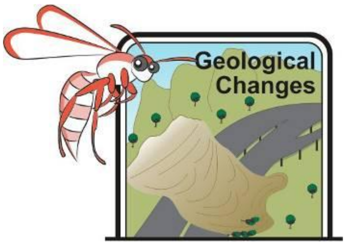
World map

ITALY

Pompeii Bodies – Teacher Notes

When did this terrible eruption occur? 79AD
What was the name of the Roman administrator and historian who wrote about the last two days of Pompeii? Pliny the younger
What happened to his uncle? He went to rescue someone but died. He was gassed
How did the historian describe the eruption? It was like a pine tree of ash rising above the volcano.
What did the local people think was happening? It was the end of the world.
What did they think caused the eruption? The anger of the gods.
How was the Earth's surface changed because of this sudden geological change?
The volcano increased in size
Earthquakes disturbed natural and manmade waterways (rivers, sewers etc).
Everything was deeply covered in ash. Buildings, roads etc. disappeared,
Vegetation and animals also disappeared.

Pompeii Bodies – Student Activity



In 79AD, one of the most famous eruptions in Europe happened in the Bay of Naples in what is now called Italy. Before the eruption local people noticed many little earthquakes, plumbing and river flow being disrupted and disjointed and smoke rising from the crater of Mount Vesuvius. Pliny the Younger, a 17-year-old Roman administrator and poet who was living across the bay recorded events over two days of violent earthquakes, eruptions and ash falls. It has been estimated that about 16,000 people in and around the towns of Pompeii and Herculaneum died from the ash and pumice falls and volcanic gas clouds that were released from the volcano Mt Vesuvius. People would have died instantly from breathing super heated air and from clouds of carbon dioxide gas. If they were in the open, their bodies were blanketed by ash. Layer upon layer of ash covered everything to a depth of several metres. Roofs collapsed and buildings, streets and squares disappeared. Heat from the ash vapourised some bodies instantly and others rotted away but their shapes were still retained within the ash that had cooled and solidified.

Activity **Pompeii bodies**

We will be examining the process by which the Pompeii bodies were copied.
Materials per student:

- 1 plastic figure (to represent the body).
- Damp sand (NOT WET.)
- Newspaper to protect the desk.
- Plaster of Paris mix (provided by the teacher).
- Soft brush or tissue to brush off dry sand

Method

1. Draw, to scale, and describe the original "body" in the table below.

To create the mould

2. Cover the work area with newspaper.
3. Firmly press the figure into the sand and then remove carefully.

To create the cast

4. Fill the mould with liquid plaster and leave to dry. This may take 30 minutes.
5. Answer the research questions while you are waiting.
6. Gently lift out the dried plaster cast and leave to dry for a further five minutes.
7. Answer the "discussing the activity" questions.

Pompeii Bodies – Student Activity

Observations

Sketch to scale of body	Sketch to scale of cast
Original body description	**Cast of body description**

Discussing the activity

Is there any difference between the original "body" and its cast? Explain your answer or answers.

____

____

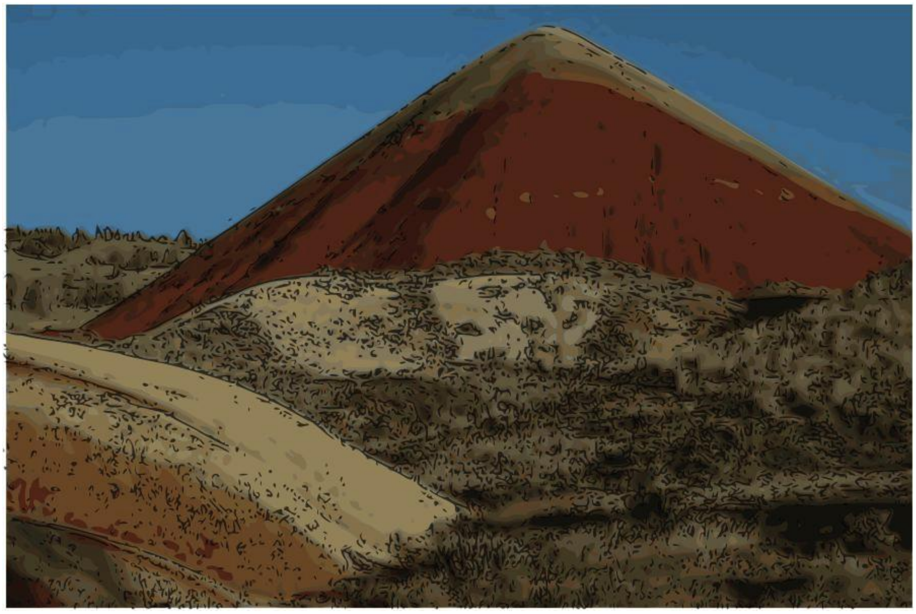
____

Which kind of volcano must Mt Vesuvius be (strato or shield)? Explain your answer. _____________

____

____

Pompeii Bodies – Student Activity



Research questions
Look at the picture of the volcano above. What kind of volcano must this be? Explain your answer.

____

____

Using an atlas, books and the Internet answer the following questions.

Place Italy on the World map and mark Pompeii on the map of Italy. (HINT Pompeii is in the Bay of Naples

World map

Pompeii Bodies – Student Activity

When did this terrible eruption occur? ______________________________

What was the name of the Roman administrator and historian who wrote about the last two days of Pompeii?

____

What happened to his uncle? ______________________________

How did the historian describe the eruption? ______________________________

What did the local people think was happening? ______________________________

What did they think caused the eruption? ______________________________

How was the Earth's surface changed because of this sudden geological change?

____

____

____

____

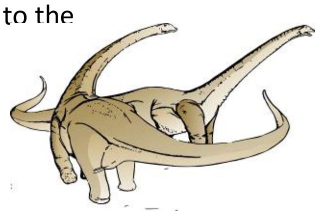
____

An initiative supported by Woodside and ESWA

It is difficult to predict when a volcano will erupt. Statistical probabilities can be calculated if there is an historical record of prior eruptions.

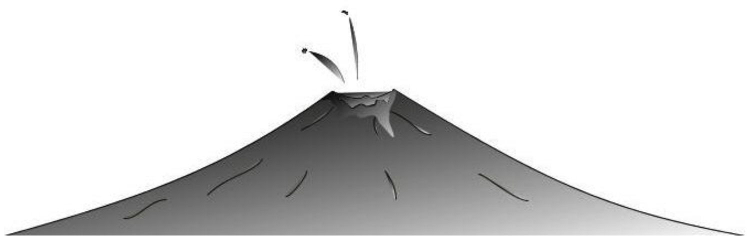
Historical eruptions

Massive volcanic eruptions have been major forcing factors in mass extinction events in the geological past. Earth's most devastating extinction, the "Great Dying" occurred between the Permian and Triassic eras and resulted in the death of over 95% of species on this planet. The major cause of deaths was not a result of hot lava or fires but was caused by volcanic ash and dust and by increased levels of carbon dioxide that outgassed from the volcanoes. Dust obscured the Sun causing a volcanic winter that lasted for up to five years. Plants did not have sufficient light to photosynthesise and many perished. Large animals that depended on plants for food were the first to die. Carbon dioxide induced global warming of 8°C, which lasted thousands of years, followed this. Most importantly, on this occasion, marine species were affected. It took over 10 million years for life on Earth to recover. Similar massive outpourings also contributed to the later and less lethal extinction at the end of the Cretaceous period that resulted in the death of the dinosaurs amongst other species. Massive volcanic eruptions such as these are geologically rare.



Supervolcanic events are used to describe shorter explosive events such as when specific vents eject magma and dust over a wide geographic area. The eruption of Mt Toba in Sumatra 74,000 years ago was the largest recent super volcanic event. An amazing 2,800 cubic kilometres of magma was extruded causing a volcanic winter as ash circulated around the globe and excluded sunlight. The movement of great ice sheets during the Pleistocene had pushed animals, including humans, south into African savannah. Some scientist think that gas and ash from Mt Toba further stressed human population numbers at this time reducing them to about 20,000 breeding pairs.

Vulcanologists have suggested that it takes about 600,000 years for the magma chamber below a supervolcano to refill after an eruption, the explosive release of gas and steam will occur more frequently. The gassy fumaroles and geysers at Yellowstone National Park are monitored to gain information to help predict overdue predicted eruptions.



"Active" volcanoes have erupted in the last 10,000 years.
"Dormant" volcanoes haven't erupted in the last 10,000 years but may still erupt.
"Extinct" volcanoes are never expected to erupt again.

There distinctions are often contradicted by surprise eruptions from "extinct" volcanoes.
Ordinary **active volcanoes** vent frequently. Before an eruption the pressure from gas and magma from below causes the ground to rise and swell. Increasing stress on ground rock is demonstrated as an increasing frequency of geyser discharge and earthquakes as the ground releases pressure. Measuring earthquake frequency, increased rates of geyser discharge and changes of tilt of the walls of volcanic vents can be used to estimate possible eruptions.

Making a tilt-o-meter & clinometer – Teacher Notes

I have included two methods of measuring inclination, the tilt-o-meter and the clinometer. You may wish to use either, however it can be interesting if your groups make one instrument and the other half make the other. Then their effectiveness can be compared and contrasted.

You may wish to demonstrate that “Water always finds its own level” to students before the tilt-o-meter activity.

Water finds its own level - Teacher demonstration

Materials

- Water
- Food dye (optional)
- A funnel (you can use a plastic sandwich bag as a funnel).
- Transparent tube (aquarium hose is perfect).

Method

1. Demonstrate this over a sink, bucket or outside over the grass.
2. Hold the plastic tube in an u-shape.
3. Mix colour into the water and pour through the funnel into the u-tube or alternatively cut a corner of the water filled plastic bag and use this to pour water into the tube.
4. Hold the tube with both open ends at the same height.
5. Alternately raise and lower each end to demonstrate that water will flow from the higher level to the lower level until a single level is obtained.

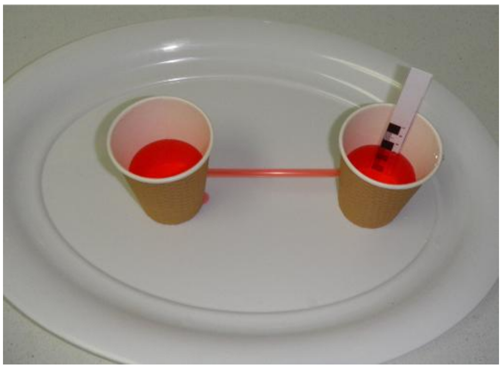
Observation

What did you observe? Water seeks its own level.

Making a tilt-o-meter

The Romans noticed bulging sides to volcanic vents usually preceded an eruption. They tried to monitor the degree of tilt by filling clay vessels to the top with water. The amount of water lost due to tilting could be measured.
Why was this not a very good idea?
If there was warm weather water would be lost into the atmosphere through evaporation. If it rained the vessels would fill with rain. Also animals may come and drink the water.

Materials



- Two paper cups
- Coloured water
- A plastic ruler or piece of cardboard with millimeters marked on it.
- A drinking straw (clear plastic if possible
- A nail or old ball point pen to drill a hole in the cups
- A little Blu-tack, plasticine or modeling clay
- A plastic plate or the empty tray from under a student’s desk
- Text books, blocks, bricks or other objects with which to progressively raise one end of the tray or plate

Method

1. Drill a hole into the side of each paper cup near the base. They should be at the same level and be small enough for the straw to fit snugly into it.
2. Place straw into holes between the cups as demonstrated above.
3. Test for leakage by pouring a little water into both cups.
4. Seal off leaks using Blu-tack, tape or plasticine.
5. Place depth measurer into one cup.
6. Read the depth measurement.
7. Place the first object under the opposite end and read the depth.
8. Repeat the last step four more times.

Observations

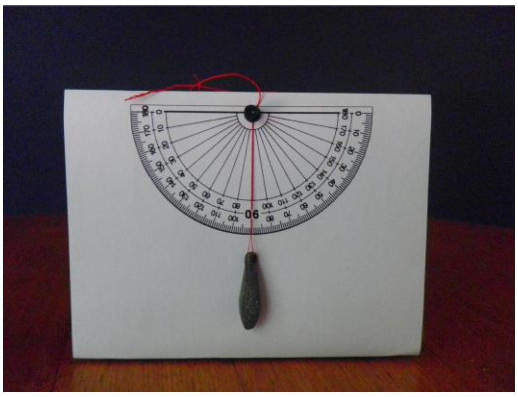
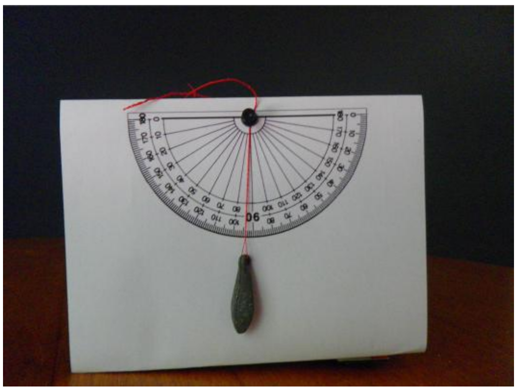
First decide how precise you wish to make readings of the depth. In this case reading to 1mm is sufficiently precise.

	Reading
Horizontal (flat)	
First rise	
Second rise	
Third rise	
Fourth rise	
Fifth rise	

Conclusion

Can you use a tilt-o-meter to measure changes in the slope of a volcano? Yes.

Making a clinometer

Paper clinometer on horizontal surface (left) and with one end raised (right).

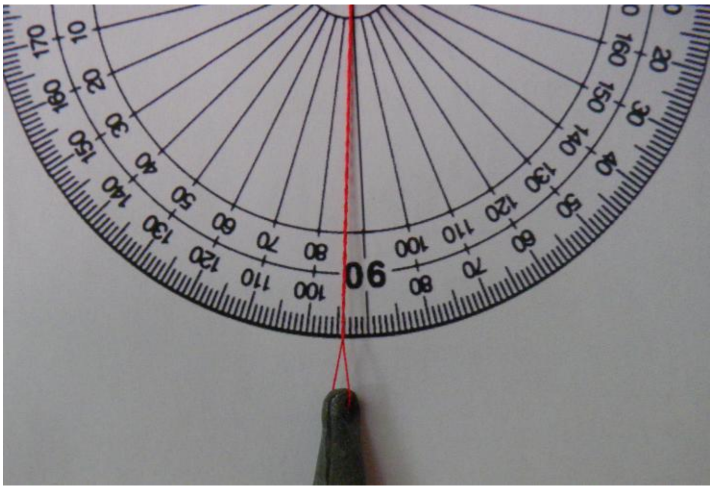
Making a tilt-o-meter & clinometer – Teacher Notes

Materials

- A cardboard box or empty milk carton.
- A protractor with Blu-tack or tape.
- Thread or string with a weight attached. A fishing weight is perfect.
- A drawing pin
- Textbooks, blocks, bricks or other objects with which to progressively raise one end of the box.
- A simple alternative to using a protractor is to print the image of one on a sheet of paper and attach that to the box.

Method

1. Using a drawing pin, attach the top of the string to the box so that the weight hangs freely and is vertical.
2. Slip the protractor under the string and align the 90^{o} vertical line with the string.
3. Place the first object under one end of the box.
4. Read the inclination measurement on the protractor. In the example beside the land is inclining 4^{0} to the left.



Observations

First decide how precise you wish to make readings of the depth. In this case reading to 1 degree is sufficiently precise.

	Reading in degrees
Horizontal (flat)	
First rise	
Second rise	
Third rise	
Fourth rise	
Fifth rise	

Conclusion

Can you use a clinometer to measure changes in the slope of a volcano? Yes

Compare and contrast

When we compare things look for similarities

When we contrast things we look for differences

In what ways do the two apples compare? Fruit, food, contain apple seeds, colourful, sweet, similar shape, plants.

In what ways do the two apples contrast? Different colour, different size, one has a leaf and the other doesn't, one has dew and the other doesn't.

Compare and contrast the devices

In what ways do the two devices compare? Measure inclination, easy to make, inexpensive to make, light to carry and install.

In what ways do the two devices contrast? One measures inclination by the movement of a liquid, one measures inclination by movement of a pendulum weight.

Which device do you think is better to predict the possibility of a volcanic eruption? Explain your answer. Any reasonable answer

List five ways in which volcanic activity changes the surface of the Earth.
Conical stratovolcanoes, flat domed shield volcanoes, flat stepped flood basalt hills (traps), ash covered land, waterways diverted, crops and animals killed, volcanic islands appearing out of the sea.

Making a tilt-o-meter & clinometer – Student Activity

People live in volcanic areas because soils are rich for agriculture, hydrothermal power can be harnessed and economic rocks and minerals can be exploited. It is however dangerous if the volcano is still active.

It is difficult to predict when a volcano will erupt. The survival of people living close to the volcano depends on recognising when this may occur.

The ancient Romans noticed that the sides of a volcano usually bulged before an eruption. They tried to monitor the degree of tilt by filling clay vessels to the top with water and noting how much water was lost as the angle of tilt increased.

This was not a very good idea! What difficulties could there be using this method?

____

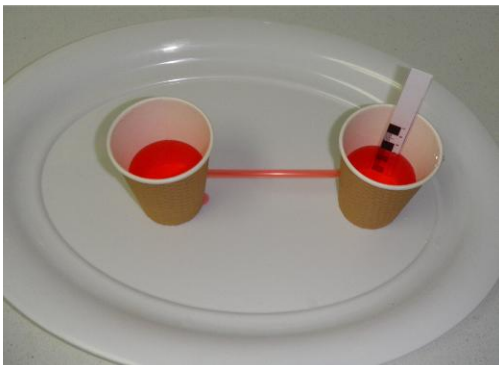
____

A. Making a tilt-o-meter

Materials

- Two paper cups
- Coloured water
- A plastic ruler or piece of cardboard with millimeters marked on it.
- A drinking straw (clear plastic if possible)
- A nail or old ball point pen to drill a hole in the cups
- A little Blu-tack, plasticine or modeling clay
- A plastic plate or the empty tray from under a student's desk
- Text books, blocks, bricks or other objects with which to progressively raise one end of the tray or plate

Method



1. Drill a hole into the side of each paper cup near the base. They should be at the same level and be small enough for the straw to fit snugly into it.
2. Place straw into holes between the cups as shown.
3. Test for leakage by pouring a little water into both cups.
4. Seal off leaks using Blu-tack, tape or plasticine.
5. Place depth measurer into one cup.
6. Read the depth measurement
7. Place the first object under the other cup and read the depth
8. Repeat the last step four more times

Observations

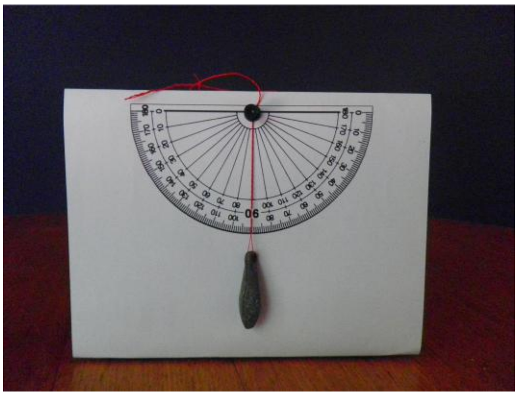
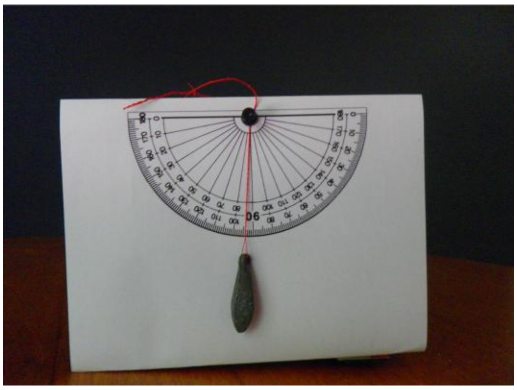
First decide how precise you wish to make readings of the depth. ______________________________

	Reading
Horizontal (flat)	
First rise	
Second rise	
Third rise	
Fourth rise	
Fifth rise	

Conclusion

Can you use a tilt-o-meter to measure changes in the slope of a volcano? _______________________

B. Making a clinometer

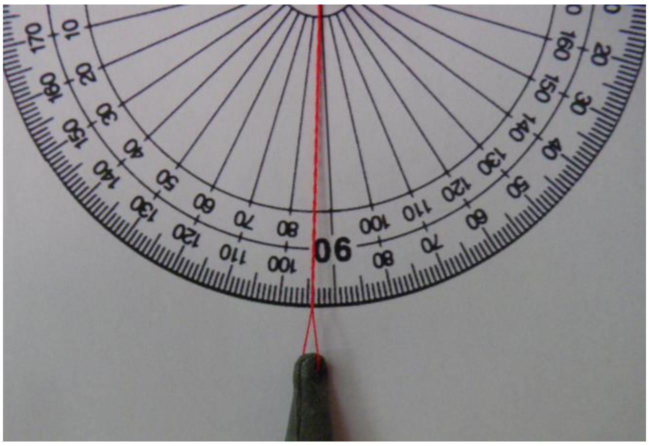



Paper clinometer on horizontal surface (left) and with one end raised (right)

Materials

- A cardboard box or empty milk carton.
- A protractor with Blu-tack or tape.
- Thread or string with a weight attached. A fishing weight is perfect.
- A drawing pin.
- Textbooks, blocks, bricks or other objects with which to progressively raise one end of the box.

Method



1. Using a drawing pin, attach the top of the string to the box so that the weight hangs freely and is vertical.
2. Slip the protractor under the string and align the 90° vertical line with the string.
3. Place the first object under one end of the box.
4. Read the inclination measurement on the protractor. In the example beside the land is inclining 4° to the left.

Observations

First decide how precise you wish to make readings of the depth. ______________________________

	Reading in degrees
Horizontal (flat)	
First rise	
Second rise	
Third rise	
Fourth rise	
Fifth rise	

Conclusion

Can you use a clinometer to measure changes in the slope of a volcano?

____

____

____

Making a tilt-o-meter & clinometer – Student Activity


When we compare things look for ____

When we contrast things we look for ____

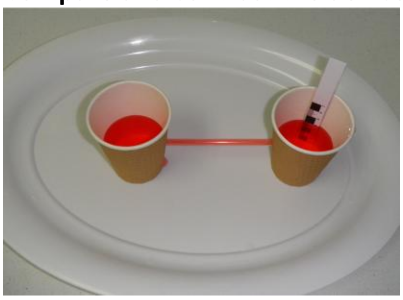
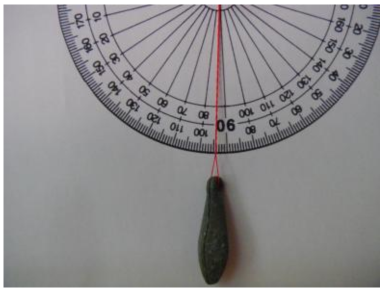
In what ways do the two apples compare? ______________________________________

____

In what ways do the two apples contrast? ______________________________________

____

Compare and contrast the devices

In what ways do the two devices compare? ______________________________________

____

In what ways do the two devices contrast? ______________________________________

____

Which device do you think is better to predict the possibility of a volcanic eruption? Explain your answer.

____

____

____

Making a tilt-o-meter & clinometer – Student Activity

List five ways in which volcanic activity changes the surface of the Earth.

1. ____

   ____

2. ____

   ____

3. ____

   ____

4. ____

   ____

5. ____

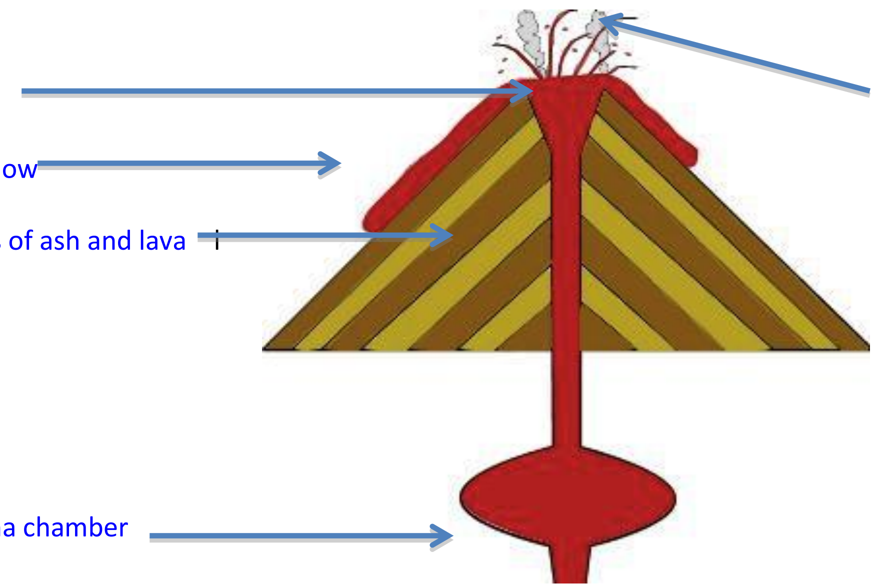
   ____

Volcanoes – Teacher Notes

Sudden geological events can change the surface of the Earth.

Students may be encouraged to use their worksheets (open book) while answering these questions.

Label the arrowed parts of the volcano below



Crater

Lava flow

Layers of ash and lava

Magma chamber

Volcanic ash

Which type of volcano produces this shape at the surface of the Earth? Stratovolcano

Name the other type of volcano. Shield volcano

What shape does this volcano make at the surface of the Earth? A low flat dome or a warrior's shield laid on its back.

Strike out the wrong answer.

Where two tectonic plates diverge pull apart~~/come together~~, low viscosity lava pours out easily~~/explodes as ash~~ and forms ~~high conical hills/~~ low flat hills.

How can you predict that a volcano might be about to erupt? When volcanoes are about to erupt the molten rock rising from the magma chamber causes the surface to bulge. This increase in inclination can be measured. A description of the tilt-o-meter or clinometer might also be added

Wordsleuth provided for those who finish quickly.

Volcanoes – Student Review

Sudden geological events can change the surface of the Earth.

Label the parts of the volcano below

__________________ __________________

____

____

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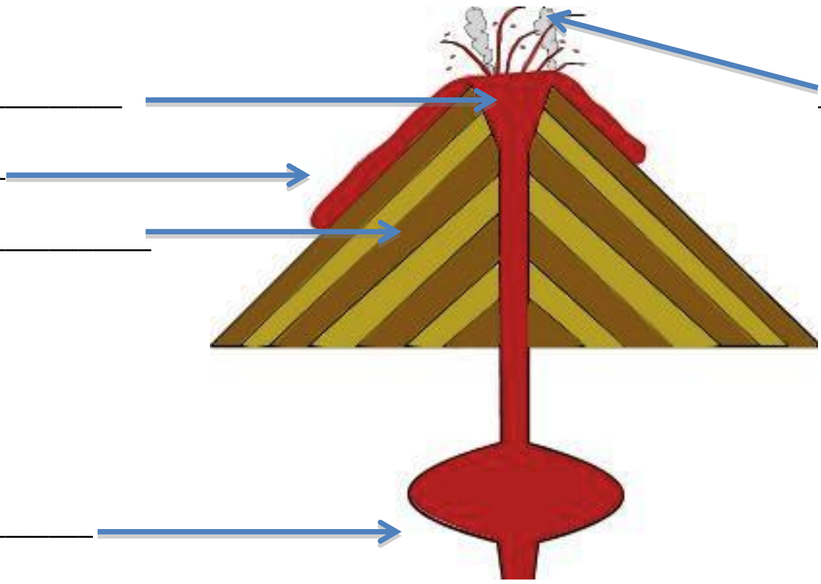

Which type of volcano produces this shape at the surface of the Earth? ________________________

____

Name the other major type of volcano. ____

What shape does this volcano make at the surface of the Earth? ______________________________

____

Strike out the wrong answer.

Where two tectonic plates diverge **pull apart/come together**, low viscosity lava pours out **easily/explodes** as ash and forms **high conical hills/low flat hills**.

How can you predict that a volcano might be about to erupt? __________________________

____

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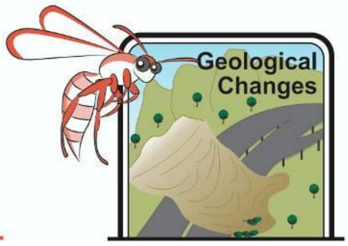
See over for a word puzzle for those who finish quickly.



Volcanoes – Student Review

VOLCANOES

FIND THE 26 WORDS USED IN THIS TOPIC.

K	V	Y	L	W	O	Y	U	R	I	Y	H	V	A	E
H	U	I	O	L	G	E	K	Y	D	T	E	F	M	S
P	N	L	S	O	I	M	B	U	R	S	A	Y	G	P
L	F	A	L	C	O	S	L	A	U	E	V	U	A	G
T	A	O	C	L	O	R	E	V	U	X	A	I	M	A
R	E	H	T	L	T	S	I	J	M	P	L	V	D	S
G	S	E	A	N	U	U	I	B	L	L	I	D	E	T
E	N	E	Q	R	S	V	H	T	Y	O	I	S	A	F
O	N	A	C	L	O	V	K	O	Y	S	E	H	T	J
A	S	H	U	N	S	B	A	L	T	I	P	I	H	H
L	I	G	T	R	E	T	A	R	C	O	M	E	N	T
G	E	R	U	P	T	I	R	C	U	N	O	L	Q	R
B	U	Q	M	O	M	G	C	A	P	J	P	D	O	O
S	U	L	P	H	U	R	Q	S	T	V	Q	C	Z	Y
N	X	L	C	V	H	V	M	D	A	O	K	U	G	A

ASH	DYKE	EXPLOSION	GEOLOGY	LAVA
POMPEII	SHIELD	SULPHUR	VOLCANO	CRATER
EARTH	FLOW	HOT	MAGMA	ROCK
SILL	VESUVIUS	VULCAN	DEATH	ERUPT
GAS	LAHAR	MOLTEN	SCIENCE	STRATO VISCOSITY

Which was the best activity?

____

____

Which part was most difficult to understand? ___________________________________

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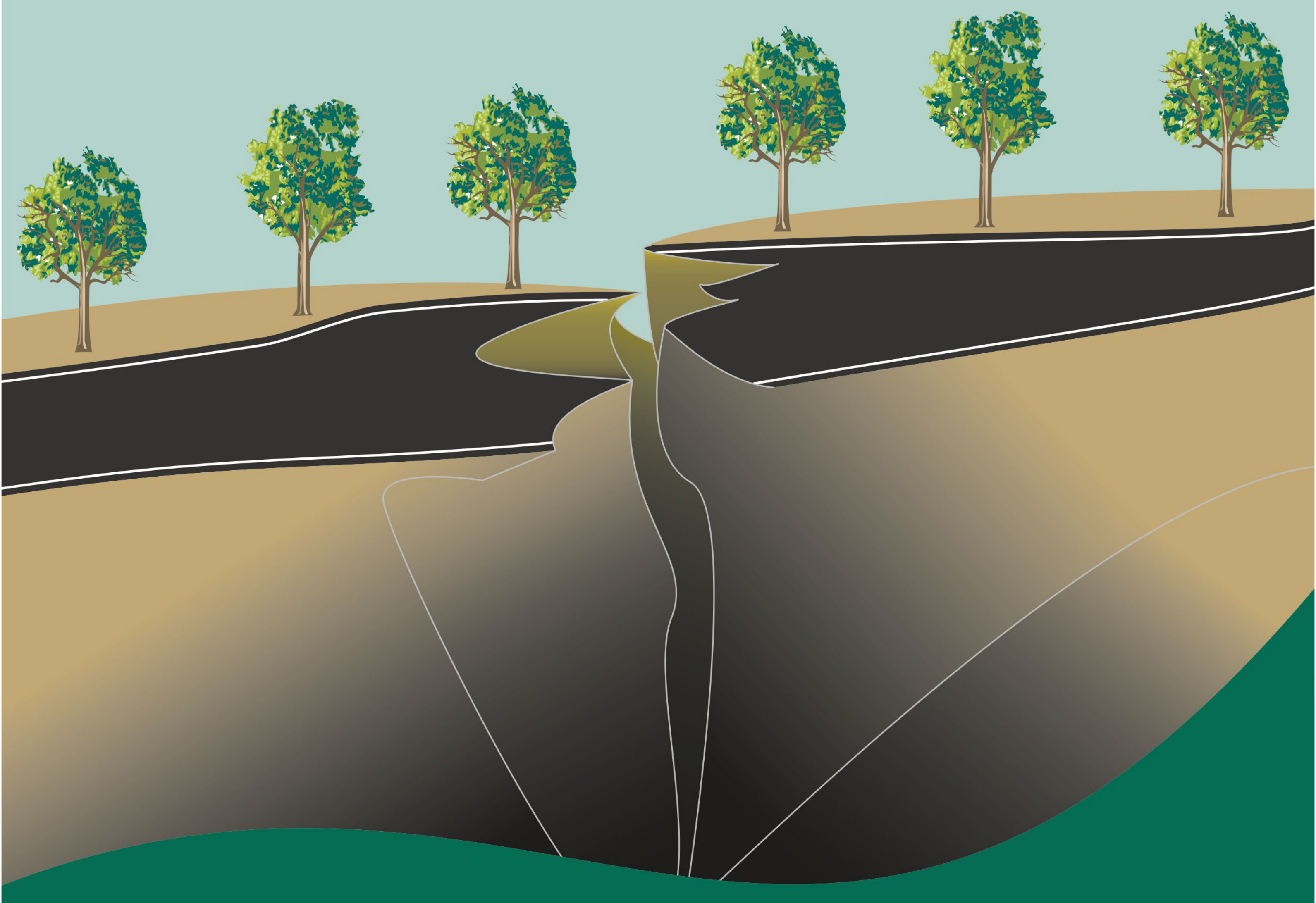
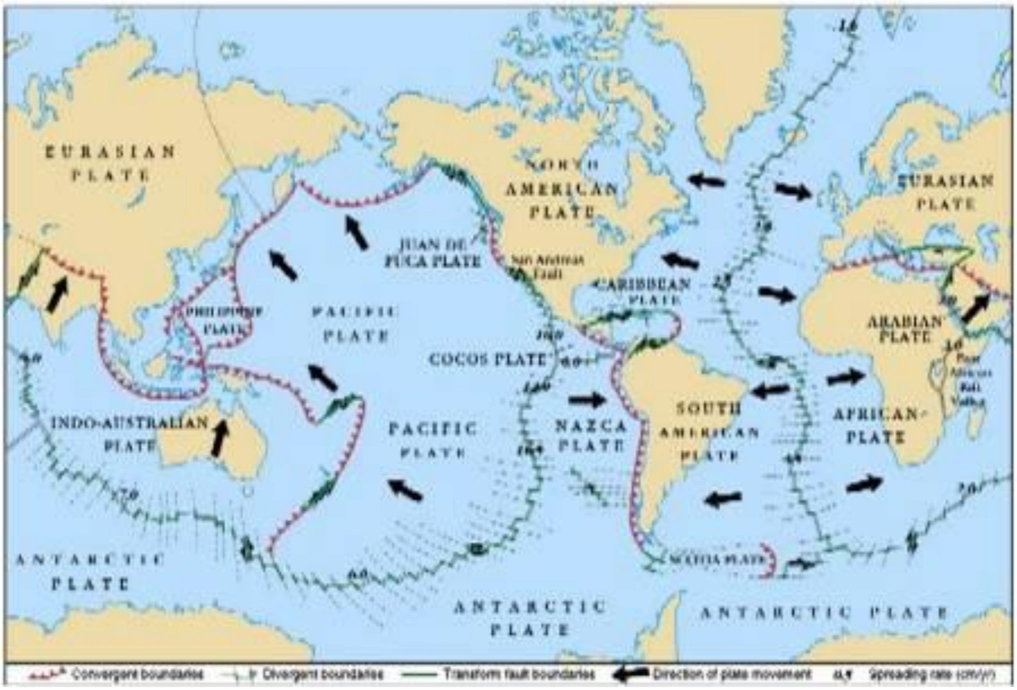
Earthquakes



Earthquake Data – Teacher Notes

Earthquakes and tectonic plates

Tectonic plates can move against each other at zones of convergence. Sometimes it takes a great deal of pressure to overcome friction from the adjoining plate. Stress builds up until it is suddenly released as an earthquake. Rock on either side deforms in response to pressure until its internal energy is overcome and the rock on either side of the break, or fault, move to their new position and regain their original shape. This can be demonstrated by asking students to rub one hand across the other whilst pressing firmly. Movement will be limited by friction between the hands and flesh will be deformed along their interface. However there will be a moment when the pressure builds up to overcome limiting friction and movement starts.



Convergent Boundaries or zones of convergence (**Red** in the diagram above)

When two plates are pushed together the denser plate will slide below the less dense plate. As the plate slides downwards it grates against the overlying structure. Seismic evidence demonstrates a zone of earthquakes originating at the convergence and sloping downwards away from it.

Name two convergent boundaries from the diagram above. Any two boundaries E.g. Indo-Australian Plate & Eurasian Plate, Pacific Plate & Eurasian Plate.

Areas where one plate slides past another are known as **Transform Boundaries** or zones. (**Green** above). Name one transform boundary. A transform boundary in New Zealand where the Pacific Plate rubs against the Australian Plate is responsible for most of the major earthquakes there including the recent Christchurch earthquakes in February 2011. Similarly the San Andreas area is where the North American Plate rubs along the Juan De Fuca Plate.

Areas where tectonic plates move apart are known as **Zones of Divergence**. (**Blue** in the diagram) Here two plates move apart and the Earth's crust between them thins and sags to create an ocean basin. Molten material can burst up through the thin crust from the asthenosphere and form undersea shield volcanoes such as the main islands of Hawaii. Name two divergent boundaries. North American Plate & Eurasian Plate, Pacific Plate & Antarctic Plate.

Earthquake Data – Teacher Notes

Although the continent of Australia lies well within the Australian Plate stresses caused by moving such a large plate north-eastwards result in local earthquakes along fault lines such as those felt in Newcastle in 1989 and Boulder in 2010.

Using "Real Time Data"

Geoscience Australia provides data on earthquake activity not only for the Australian region but also collates information from around the World. This data is updated regularly. Students will have to use the key provided and the map on their worksheet. It is a good idea to visit the website before class to update yourself on locations of recent activity.

Materials

- Internet access either through the student's own laptops or through a class data projector. If your area has problems with Internet access create paper prints.
- Student worksheet.
- Pen or pencil.

Method

Visit Geoscience Australia's site at http://www.ga.gov.au/earthquakes/initRecentQuakes.do and use the real time data.

1. Take 5 minutes to familiarise yourself on the variety of information provided. (After each selection, students must press the update "button" to refresh the map).
2. Plot any significant earthquakes (red circles) in the last 30 days in the World on the tectonic map provided.
3. Plot the magnitude of each significant earthquake beside its location.
4. How many earthquakes happened in the last 4 hours? Will vary depending on day of activity
5. How many earthquakes happened in the last 24 hours? Will vary depending on day of activity

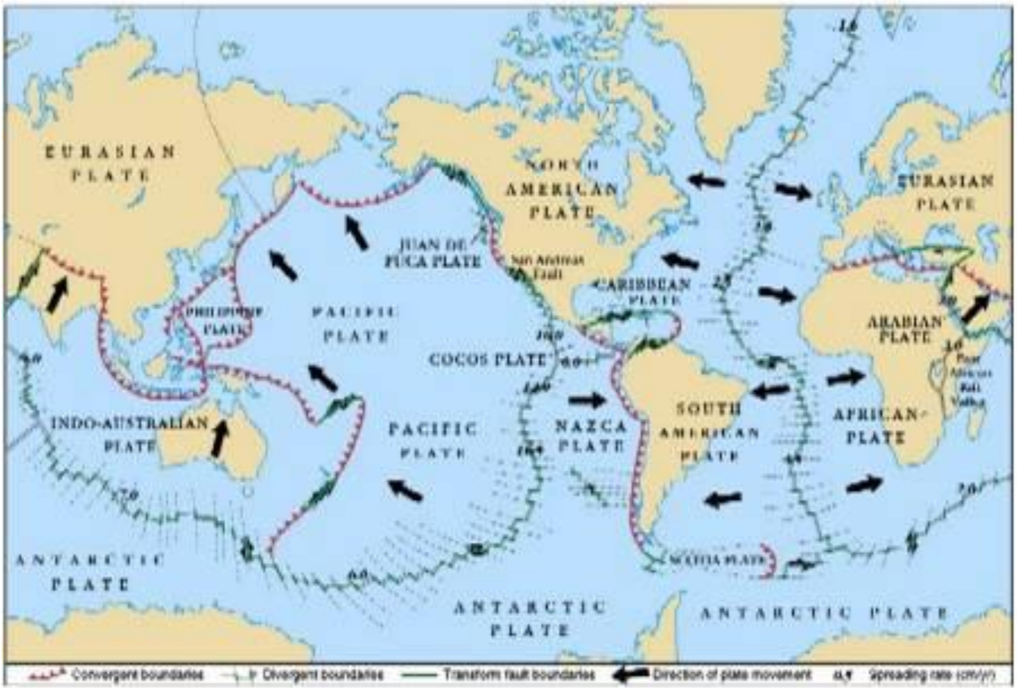
Has anyone in your class experienced an earthquake? What would you expect to happen? Any reasonable answer.

Vocabulary	Tectonics, tectonic plates, convergent, divergent and transform boundaries

Earthquake Data – Student Activity

Earthquakes and tectonic plates

Tectonic plates can move against each other at zones of convergence. Sometimes it takes a great deal of pressure to overcome friction from the adjoining plate. Stress builds up until it is suddenly released as an earthquake. The plates move along fault lines.



Convergent Boundaries (**Red** in the diagram above)

When two plates are pushed together the denser plate will slide below the less dense plate. As the plate slides downwards it grates against the overlying structure. Seismic evidence demonstrates a zone of earthquakes originating at the convergence and sloping downwards away from it. Here one plate may crumple into another pushing up mountain ranges such as the Himalayas and the Andes.

Name two convergent boundaries from the diagram above. ___________________________________

____

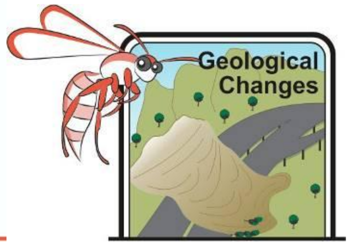
Transform Boundaries are found where where one plate grates past another (**Green** in the diagram above)

These are zones of severe earthquakes such as those which devastated Christchurch in New Zealand and San Francisco.

Name one transform boundary ____

Divergent Boundaries occur where tectonic plates move apart (**Blue** in the diagram). Earthquakes may occur because molten material bursts up from the asthenosphere to form shield volcanoes. These earthquakes are usually less intense and destructive. Here the Earth's crust is stretched thin between the two plates. It sags to form ocean basins.

Name two divergent boundaries ____



Earthquake Data – Student Activity

Although the continent of Australia lies well within the Australian Plate stresses caused by moving such a large plate northeastwards results in local earthquakes along fault lines such as those felt in Newcastle in 1989 and Boulder in 2010.

Using "Real Time Data"

Geoscience Australia provides data on earthquake activity not only for the Australian region but also collates information from around the World. This data is updated regularly. Use the key provided and the map on the first page of this worksheet.

Materials

- Internet access either through the student's own laptops or through a class data projector.
- Student worksheet
- Pen or pencil

Method

Visit Geoscience Australia's site at http://www.ga.gov.au/earthquakes/initRecentQuakes.do and use the real time data.

1. Take 5 minutes to familiarise yourself with the variety of information available. After each selection you must press the update button to refresh the map.

2. Plot any significant earthquakes (red circles) in the World during the last 30 days on the tectonic map provided on the first page.

3. Plot the magnitude of each significant earthquake beside its location.

4. How many earthquakes happened in the last 4 hours? ________________________________

5. How many earthquakes happened in the last 24 hours? ______________________________

Has anyone in your class experienced an earthquake? What would ***you*** expect to happen?

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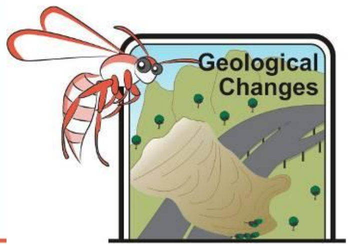
Vocabulary	Tectonics, tectonic plates, convergent, divergent and transform boundaries

Shaky Science – Teacher Notes



In AD 132, a Chinese philosopher Chang (or Zhang) Heng designed a vessel with 8 dragon heads leading out from the lip of the jar pointing towards the principal compass points. Below each dragon was a toad with its mouth open to collect a ball falling from the dragon's maw when the jar shook. An inverted pendulum knocked out the balls inside when it swung in response to seismic waves. The direction of the earthquake's epicentre could be estimated.
http://hua.umf.maine.edu/China/astronomy/tianpage/0012ZhangHeng6539w.html
Much later attempts employed very large pendulums that swung in response to movement. The length and weight of the pendulum and the friction between the graphing instrument and paper made results disappointing. Cecchi designed the first true seismograph in 1876. It attempted to record motion in 3 dimensions.
There are comparative and subjective measures, which can be used to roughly estimate the magnitude of an earthquake.

<u>The Modified Mercalli Earthquake scale</u>

1. Not felt by humans (unless in very tall buildings) but noticed by animals.
2. Felt by people resting indoors.
3. Felt but not registered by everyone indoors. Standing cars may rock.
4. Felt by people indoors but not by those outside. Dishes windows and doors disturbed.
5. Felt by those outside awakening most sleepers. Things fall from shelves and pendulum clocks stop.
6. People run outdoors and have difficulty keeping steady when walking. Windows break. Some plaster falls.
7. Alarm. Difficult to stand up and trees and bushes shake about. Noticed by drivers in cars (People run and ring church bells) Well built structures survive
8. Alarm approaching panic. Chimneys, statues, columns and most poorly built structures collapse (church bells ring by themselves).
9. Panic. Buildings shift from foundations.
10. Most stone or brick buildings fall down. Rail lines bend.
11. Wooden buildings fall down. Bridges destroyed.
12. Total destruction. Objects thrown into the air.

Can you think of any advantages of using this scale? This method requires no infrastructure, it is cheap and easy to ask people about their experiences and damage around them.

Can you think of any disadvantages of using this scale? As it is a subjective scale different people will report it differently. People prone to alarm or experiencing their first earthquake may rate the quake higher on the scale than others. If the earthquake occurs in an unpopulated area it will not be possible to rate it.

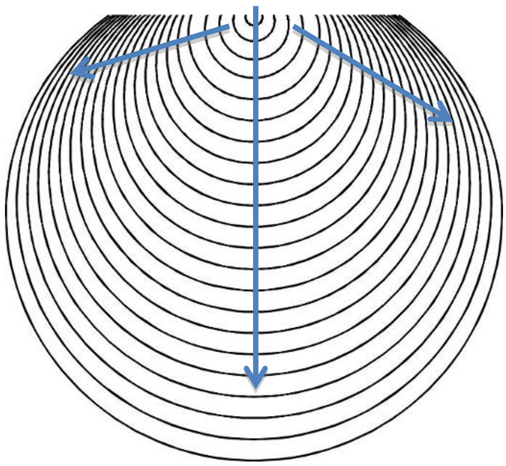
The **RICHTER SCALE** is a mathematical formula by which the magnitude of an earthquake is determined from the logarithm of the amplitude of waves. Each successive magnitude is ten times greater than the previous one (releasing about 31 more times energy). Modern seismologists use MMS or movement Magnitude Scale but this style of reporting is not followed by the media. Australia's largest recorded on-shore earthquake occurred in 1941 at Meeberrie in the south Murchison. It registered a magnitude of 7.2. Since the area was largely unpopulated little damage was done. Meckering's earthquake in 1968 registered 6.8 and caused extensive damage to buildings and roads over most of southwest Australia.

Shaky Science – Teacher Notes

Earthquakes release rock along a fault to move up, down or across. Two major fault systems in WA, which are near well-populated areas, are the Darling Fault running north south down the Darling Ranges and the Fraser (and allied) faults running north east of Esperance. A glance at the geological map of WA will show many, many more faults which are less well known as they pass through less populous areas.

Geoscience Australia has generously created the “Seismograms in Schools” project. For information visit https://www.facebook.com/ausisnetwork

Moonquakes also occur but less frequently than on Earth. They are related to gravitational stresses due to varying distances between the two. They also occur half way between the surface and centre of the Moon.



The epicentre of an earthquake is the point on the Earth’s surface directly above its point of origin. Surface seismic waves radiate from here. It is important to know this as rocks, houses and other structures will be jolted away from and back to their original position in lines radiating from the epicentre. This elastic recoil of different materials at different rates applies to all types of seismic waves.
Because buildings are more massive than the soil on which they are built they have more ***inertia***. They are more “reluctant to move”. The soil moves first and the building follows later. Students may have felt the effect of inertia when a car accelerates and their heavy head is flipped back as it does not move as fast as their body. Whiplash injuries occur when a car decelerates suddenly.
The teacher demonstration “Recoil rates” can be used to help students realise that the initial movement of both pendulum and water is the reverse of the direction the container is moved or more accurately the relative movement of the contents are the reverse of the container. The pendulum remains in its original position longer.

Recoil

Materials

- A clear plastic container or large transparent plastic bottle
- A pendulum or heavy weight tied with string
- A pencil or wooden rod/ruler
- Adhesive tape
- A smooth surface

Method

1. Place equipment on a smooth surface.
2. Three quarters fill the container with water. If you are using a long desk or table be aware that water will spill if the container is filled to the top.
3. Tie the weight to the pencil with string and suspend into the container.
4. Observe the behaviour of the pendulum when the container moves.

Shaky Science – Teacher Notes

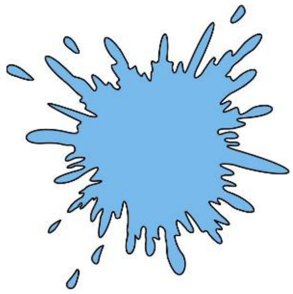
Observations

The pendulum initially appears to move in the opposite direction to the container. This is because it has more inertia than water.

Seismic Splash

Materials

- A small paper or plastic cup, bottom of a cool drink bottle
- A jug or bottle for water
- String or thick thread
- A heavy object
- An outside cemented or tarmac covered area



Method

1. Fill the container to the brim with water.
2. Sharply tap it forwards with the blunt end of the pencil hitting a point near the container's base.
3. Observe what happens.
4. Repeat to ensure accuracy.

Observations

Which variable or variables did you change? The position of the container.
Which variable or variables did you keep the same? All other variables. E.g. Same container, same amount of water and same process.
What happened immediately after the container was tapped? The container moved forwards and the water appeared to move in the other direction.
What happened next? The water slopped back and forward and eventually came to rest.
What happened when you repeated the activity? Usually students get the same result.

Discussion

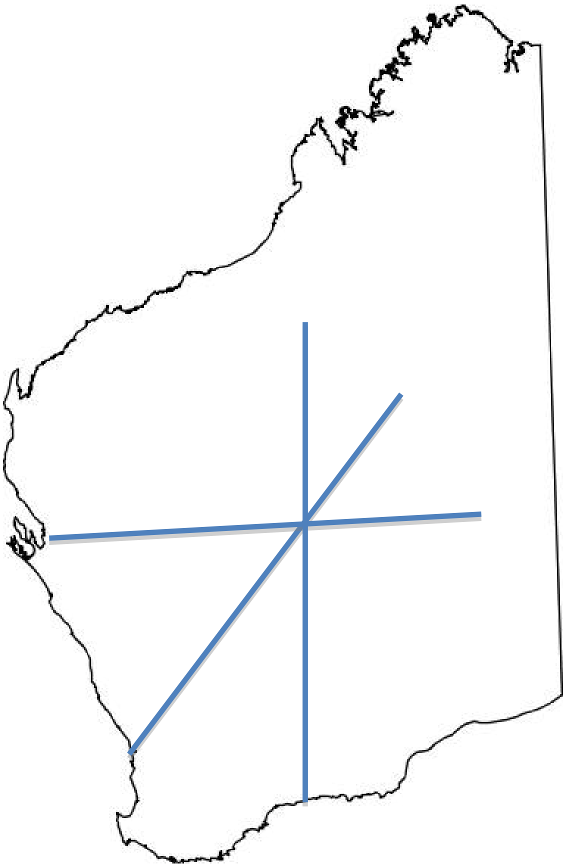
Could you use a container of water to find the direction of the epicentre of an earthquake? Yes. The splashed water falls in the opposite direction to the epicentre.
How could you estimate the energy released by the earthquake using this equipment? You could measure the amount of water displaced. The larger the earthquake, the more water will be displaced. The amount of water displaced could either be collected in a tray under this equipment or you could measure exactly how much water would be needed to refill the container

Brain strain

Your data so far only tells you the direction of the epicentre, not its location along that line. What would you have to do to pinpoint its true location? Use your" little grey cells" and the map provided to explain how the seismic splash equipment could be used.
You would have to have the seismic splash in at least three widely spaced locations and find the spot where the three lines pointing to the epicentre intersect. See map over.

Great activities can be obtained by downloading information from Geoscience Australia's web site
http://www.ga.gov.au/metadata-gateway/metadata/record/gcat_76611

Vocabulary	Earthquake, seismic energy, epicentre and seismic scales



Shaky Science – Student Activity

Scientists need to measure earthquakes because increasing frequency or increasing intensity can indicate that a major volcanic eruption could be on its way.
The energy released by an earthquake is measured by a seismometer. (seismo = shake (Greek)). The recording it makes is known as a seismograph. In AD 132, a Chinese philosopher Chang (or Zhang) Heng designed a brass bowl with 8 dragonheads leading out from the lip of the jar pointing towards the principal compass points (north, northeast, east etc.). Below each dragon was a toad with its mouth open to collect a ball falling from the dragon's maw when the jar shook. An inverted pendulum knocked out the balls inside when it swung in response to seismic waves. The direction of the earthquake's epicentre could be estimated.
http://hua.umf.maine.edu/China/astronomy/tianpage/0012ZhangHeng6539w.html

In the past, a simple scale of intensity was created based on human observations on what happened when the Earth shook:

Earthquake scale

1. Not felt by humans (unless in very tall buildings) but noticed by animals.
2. Felt by people resting indoors
3. Felt but not registered by everyone indoors. Standing cars may rock.
4. Felt by people indoors but not by those outside. Dishes windows and doors disturbed.
5. Felt by those outside awakening most sleepers. Things fall from shelves and pendulum clocks stop.
6. People run outdoors and have difficulty keeping steady when walking. Windows break. Some plaster falls.
7. Alarm. Difficult to stand up and trees and bushes shake about. Noticed by drivers in cars (People run and ring church bells) Well built structures survive
8. Alarm approaching panic. Chimneys, statues, columns and most poorly built structures collapse (church bells ring by themselves).
9. Panic. Buildings shift from foundations.
10. Most stone or brick buildings fall down. Rail lines bend.
11. Wooden buildings fall down. Bridges destroyed.
12. Total destruction. Objects thrown into the air.

Can you think of any advantages of using this scale? ____

____

____

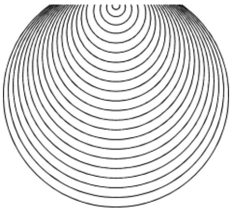
Can you think of any disadvantages of using this scale? ______________________________________

____

____

The **RICHTER SCALE** is a mathematical formula by which the magnitude of an earthquake is given a number. Each successive magnitude is ten times greater than the previous one (releasing about 31 more times energy). If an earthquake registers as 5 on The Richter scale, how much more energy was released than the previous earthquake which registered as 2? _______________times greater.

Shaky Science – Student Activity



The epicentre of an earthquake is the point on the Earth's surface directly above its point of origin. Surface seismic waves radiate from here. It is important to know this as rocks, houses and other structures will be jolted away from and back to their original position in lines radiating from the epicentre.

Recoil

Materials

- A large plastic container
- A pendulum or heavy weight tied with string
- A pencil or wooden rod/ruler
- Adhesive tape
- A smooth surface

Method

1. Place equipment on a smooth surface.
2. Three quarters fill the container with water. If you are using a long desk or table be aware that water will spill if the container is filled to the top.
3. Tie the weight to the pencil with string and suspend into the container.
4. Bump the table and observe the behaviour of the pendulum when the container moves.

Observations

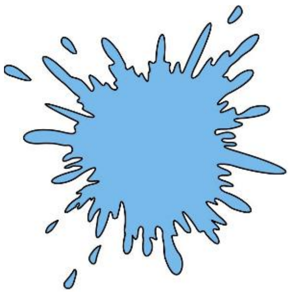
____

____

Seismic Splash

Materials

- A small paper or plastic cup or the bottom of a cool drink bottle
- A jug or bottle for water
- String or thick thread
- A heavy object
- A cemented or tarmac covered area (outside)



Method

1. Fill the container to the brim with water
2. Sharply tap it forwards with the blunt end of the pencil hitting a point near the container's base.
3. Observe what happens
4. Repeat to ensure accuracy.

Shaky Science – Student Activity

Observations

Which variable or variables did you change? ___________________________________

Which variable or variables did you keep the same? ____________________________

What happened immediately after the container was tapped? ______________________________

____

What happened next? ____

____

What happened when you repeated the activity? ____

Discussion of results

How could you use a container of water to find the direction of the epicentre of an earthquake?

____

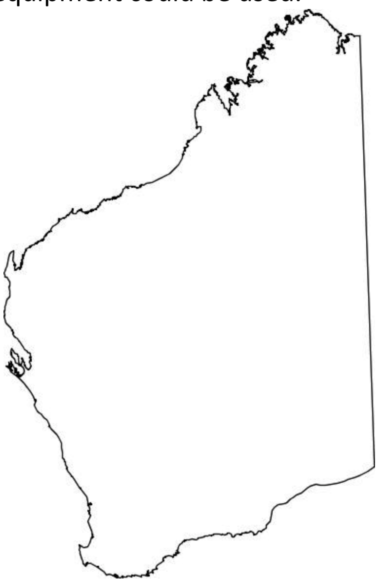
How could you estimate the energy released by the earthquake using observations from using this equipment?

____

____

Brain strain

Your data so far only tells you the direction of the epicentre, not its location along that line. What would you have to do to pinpoint its true location? Use your "little grey cells" and the map provided to explain how the seismic splash equipment could be used.



Vocabulary	Earthquake, seismic energy, epicentre and seismic scales

Seismic Driven Landslides – Student Activity

The most common natural causes for landslides in Australia are heavy rainfall, earthquakes and erosion. However seismic activity also causes unconsolidated undersea sediments on the edge of the Australian Continental Shelf to collapse changing the level of the sea floor and causing localised tsunami. Our continent extends quite a distance under the sea before rapidly dropping down into deep water.

Materials

- A tray or piece of thick cardboard
- Damp sand
- A deep mould for the sandcastle.

Method

1. Fill the mould with damp sand and invert it onto the tray.
2. Place the tray on a long desk or on the cement pavement outside.
3. Hit the tray with your hand or foot to cause a sharp movement.
4. Observe.

Observation

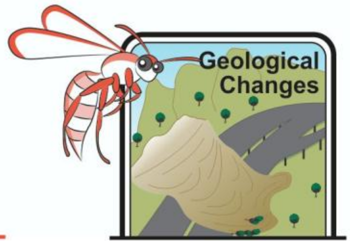
Recent tsunami devastation of Japan in March 2011 was caused by a combination of earthquakes and subsea landslides. Earthquake faulting alone would have only caused a 16 to 18m rise in sea level, not the 40m inundation experienced. Researchers studied images of the sea bottom and discovered a portion of seabed 20km by 40km had collapsed displacing seawater.

On Dirk Hartog Island off the Gascoyne coast of Western Australia Dr P Playford, a famous WA geologist, found large boulders which appear to have been swept up inland over a 5m cliff by wave action. Some boulders weighed over 700 tonnes. Dr Playford suggested that an undersea landslide occurring less than 2,000 years ago might have caused this localised tsunami. This coast is an area not known for tectonic movement.

For more information visit: https://au.news.yahoo.com/thewest/a/17798666/tsunami-finding-rocks-research/

Elsewhere in the world, tsunamis are also created when soil or a glacier ice collapses into the sea. http://www.livescience.com/22133-greenland-iceberg-tsunami-video.html

Vocabulary Sediment, landslide and tsunami

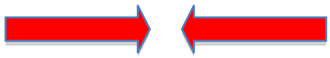
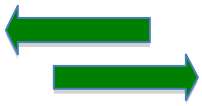


Earthquakes – Teacher Notes

Sudden geological events can change the surface of the Earth.

Students may be encouraged to use their worksheets (open book) while answering these questions.

Earthquakes occur when tectonic plates come together. Please label the diagrams as a zone of convergence, zone of divergence or transform zone. The arrows indicate the movement of tectonic plates.

		
Zone of convergence	Zone of divergence	Transform zone

At one of these boundaries the Earth's crust thickens and crumples. Which one of the zones is this and how does this movement change the surface of the Earth?
Zone of divergence. This sagging forms ocean basins such as the Pacific Ocean.

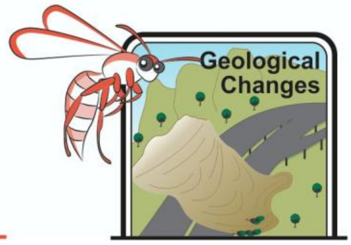
At one of these boundaries the Earth's crust thickens and crumples. Which one of the zones is this and how does this movement affect the surface of the Earth? Zone of convergence. The crumples form mountains such as the Himalayas and the Andes.

At one of these boundaries two plates grate past each other. Which one of the zones is this and what devastating effect happens here. Transform zone. Terrible earthquakes are caused by friction between the plates as they grate past each other. This occurs in places such as Christchurch and San Francisco.

What is the name of the instrument that measures earthquakes? A seismometer.

What effect*s* could a major earthquake have on loose sediments piled on the edge of the undersea continental shelf? Shaking would cause a landslide of the sediments. Plunging down the slope they could rapidly change the sea floor and initiate a tsunami.

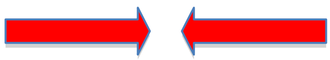
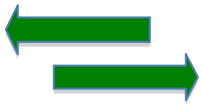
Wordsleuth provided for those who finish quickly.



Earthquakes – Student Review

Sudden geological events can change the surface of the Earth.

Earthquakes occur when tectonic plates come together. Please label the diagrams as a zone of convergence, zone of divergence or transform zone. The arrows indicate the movement of tectonic plates.

At one of these boundaries the Earths crust thins and sags. Which boundary is this and how does this movement affect the surface of the Earth?

____

At one of these boundaries the Earth's crust thickens and crumples. Which one of the zones is this and how does this movement change the surface of the Earth?

____

At one of these boundaries two plates grate past each other. Which one of the zones is this and what devastating effect happens here?

____

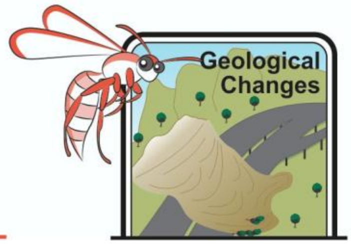
What is the name of the instrument that measures earthquakes? ______________________

What effects could a major earthquake have on loose sediments piled on the edge of the undersea continental shelf?

____

____

____



Earthquakes – Student Review

EARTHQUAKES

FIND THE WORDS USED IN THIS TOPIC

T	S	U	N	A	M	I	E	A	R	T	H	C	M	M
N	K	W	E	C	A	F	R	U	S	R	N	O	H	R
D	S	S	E	R	T	S	W	L	Z	Q	W	N	C	O
B	U	R	W	D	N	Q	Q	G	B	E	O	V	R	F
T	N	E	G	R	E	V	I	D	A	C	J	E	U	S
S	C	I	E	N	C	E	Q	R	S	B	T	R	H	N
D	E	V	A	S	T	A	T	I	O	N	E	G	C	A
C	S	Z	T	C	A	H	C	U	Y	R	C	E	T	R
I	E	O	O	O	Q	N	N	G	T	T	T	N	S	T
M	V	N	F	U	A	D	O	N	L	F	O	T	I	P
S	A	E	A	R	A	L	E	U	Q	S	N	B	R	L
I	W	K	F	R	O	C	A	I	Q	Q	I	S	H	A
E	E	N	Y	E	I	F	I	Y	B	O	C	L	C	T
S	A	V	G	P	L	A	N	D	S	L	I	D	E	E
S	B	D	E	T	N	E	M	E	V	O	M	M	Z	S

23 WORDS

BOUNDARY	DEVASTATION	EARTHQUAKE	GEOLOGY
PLATES	SEISMIC	TECTONIC	WAVES
CHRISTCHURCH	DIVERGENT	EPICENTRE	LANDSLIDE
SAN FRANCISCO	STRESS	TRANSFORM	ZONE
CONVERGENT	EARTH	FAULT	MOVEMENT
SCIENCE	SURFACE	TSUNAMI	

WHICH WAS THE BEST ACTIVITY IN THIS TOPIC AND WHY?

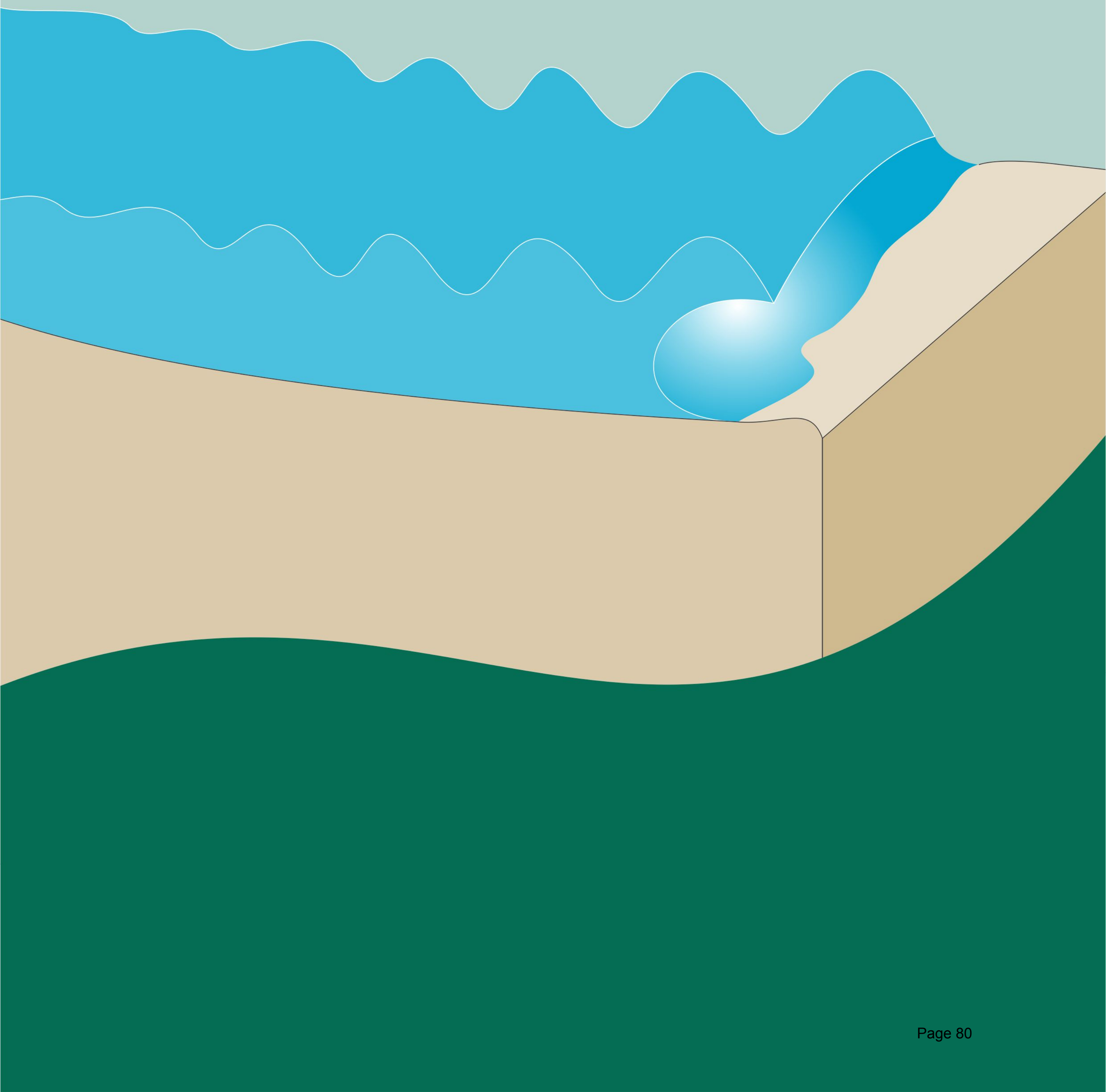
____

____

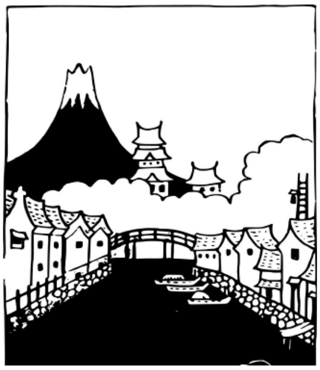
____

____

Tsunamis



Tsunami - Teacher Background



Japan lies on the Pacific Rim where the Pacific Plate is pushing up against the Eurasian Plate. This explains why the country has so many earthquakes, volcanoes and resultant tsunamis.

Japanese sailors noticed that some earthquakes generated unusual waves from the ocean. Although this wave was only noticeable as a slight rise out at sea, it increased in height as it approached land and was catastrophic on arrival. They named them Tsunami, which is Japanese “harbour wave”. (The plural of tsunami is tsunamis). The recent catastrophic tsunami of 2011 devastated the eastern coast and damaged the atomic power station at Fukushima. Water inundated the coastal areas knocking down buildings, trees and living things drowned. Although the waves retreated, infrastructure was disrupted, disease was rife, drainage was diverted or blocked and soil was contaminated by salt.

Earthquakes release energy that will travel through solid earth as seismic waves but not through liquids. As a result of stress from earthquakes, blocks of undersea floor can break or fault and can be moved upwards or downwards. The ocean floor lifted 10m during the Aceh earthquake displacing an enormous volume of water. They can also be caused by landslides on the sea floor, land slumping into the ocean, large volcanic eruptions or meteorite impact in the ocean. Volcanic tsunamis such as Krakatoa in 1883 are not caused by lava outpourings but rather by the collapse of the empty magma chamber below a volcano. Seawater rushes in, expands due to heat and is violently expelled.

Causes of tsunami

Earthquake	75%
Landslides (mostly undersea)	8%
Volcanism	5%
Weather	2%
Unknown	10%

The change in seafloor level generates a bulge or “swell” at the surface that is not particularly obvious to sailors on ships. Energy transfer between water columns is similar to Newton’s swing where most of the movement is only noticeable in the first and last ball. Satellites sensors can however detect the wave and alert inhabitants of low lying coastal areas towards which it approaches. The destructive crashing wave height builds up as the water depth shallows. It is created by the building up of a series of waves as they approach land due to the forwards pressure of those following and the backwards pressure of decreasing water depth.

Tsunamis can travel at the speed of a passenger jet. Their height and direction can be estimated by readings from a network of floating buoys that have been placed in tsunami prone oceans. Lasers in weather satellites monitor the change of height of ocean surface. The Bureau of Meteorology provides information on natural disasters. Information about the possibilities of tsunami strike may be found at The Joint Tsunami Warning Centre http://www.bom.gov.au/tsunami/

On average, Australia is struck by one tsunami every two years. Most recent ones are small and have presented little threat to our coastal communities. The threat is moderately increased on the northwest coast of W.A. due to its closeness to the Indonesian earthquake zone. Along the Kimberly and Pilbara coasts large boulders brought kilometres inland from their coastal outcrops are indicators of fairly recent (in the last 2,900 to 5,000 years) tsunami that must have had a terrible effect on the living things of the coastal savannahs. Aboriginal communities must have been affected but we have no oral record.

Tsunami – Teacher background

On Dirk Hartog Island off the Gascoyne coast of Western Australia Dr P Playford, a famous geologist found large boulders, which appear to have been swept up inland over a 5m cliff by wave action. Some boulders weighed over 700 tonnes. Dr Playford suggested that an undersea landslide might have caused this localised tsunami in an area not known for tectonic movement.

https://au.news.yahoo.com/thewest/a/17798666/tsunami-finding-rocks-research/

Our awareness of tsunami's destructive power was heightened by the ten metre high tsunami that swept through the Indian Ocean at speeds of more than 500 km/hr on Sunday 26th December in 2004. It was caused by a series of powerful earthquakes whose epicentre was 30 km below the seabed approximately 250 km south-southwest of Banda Aceh, an island in the volcanic Indonesian Archipelago. This is the interface between two major tectonic plates. It caused death and destruction along the coasts of India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and the Seychelles. Thailand, Bangladesh, Kenya and Australia were less affected. By March of that year it was known that 273,636 people had died, 7,253 were missing and more than 1 million had been made homeless.

Tsunami and tidal waves

A common student misconception is that tsunamis and tidal waves are the same thing.

Tidal waves are caused by gravitational pull between the Sun, Moon and Earth. This pull can cause a rise in sea level.

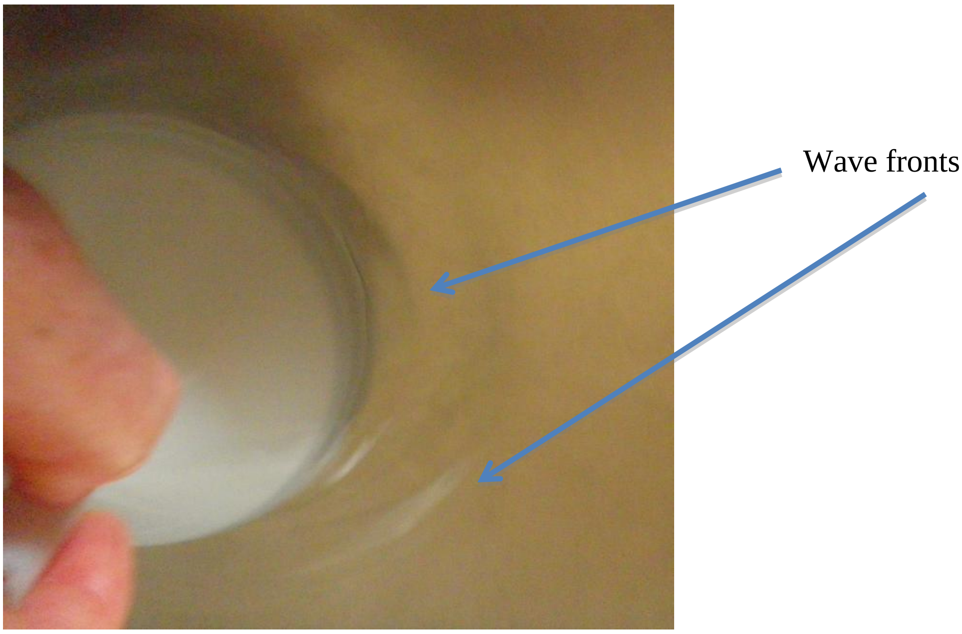
Tsunamis are not caused by gravitational pull. They are caused by rapid geological events that change the floor of the sea displacing large masses of water.

This can be:

1. Faulting of rock uplifting or dropping seafloor.
2. Collapsing of a magma chamber under a volcano.
3. The rise of the volcano from the seafloor.
4. The collapse of sediments down the continental shelf.
5. The collapse of glacier ice into a fjord.
6. Meteorite impact at sea.

Making Waves – Teacher Notes

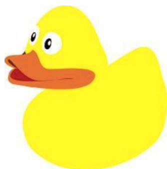
Waves in water (energy transfer)



This is a lovely activity to be performed outside on a hot day.

Materials

- An empty student tray (from below their desk), laboratory tray, large basin or sink. The deeper the water the better the effect.
- Water.
- An inverted cup or glass. (A blocked inverted filter funnel is ideal – see above).
- A small floating object (bath toy, ping pong balls, cork, piece of wood).
- Newspaper if not using wet area.



Method

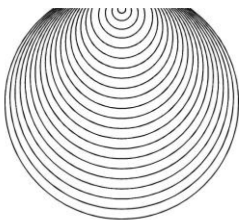
1. Lay down newspaper to collect any splashes, if directed to.
2. Fill the container with water, almost to the top.
3. Place the blocked filter funnel into the water (upside down) and push it up and down to create waves. This needs to be done near to the surface and slowly.
4. Observe and note down what happens.

The moving raised surface of water is called a "wave front".

5. Place the floating object (e.g. bath duck) half way along the container.
6. Gently raise and lower the blocked filter funnel to create waves again.
7. Observe and note down what happens to the floating object.

Observations

What did you observe when the surface of the water was disturbed? Waves or ripples formed.



In which direction did was the movement? They moved away from the disturbance in every direction.

Making Waves – Teacher Notes

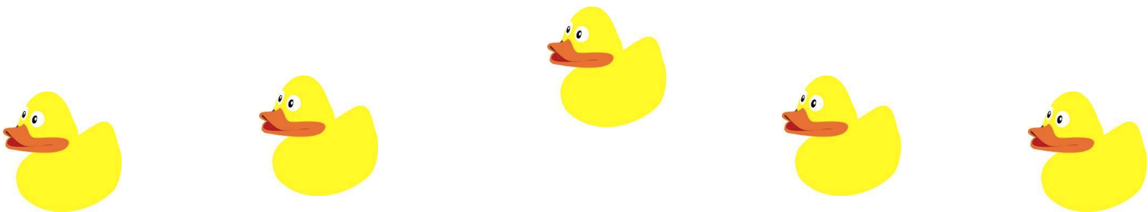
Sketch the shape and movement of the waves below.
Diagram of waves
Scale 1:

HINT if your sketch is one fifth of the size of the real object, the scale is 1:5. Similarly if your sketch is one tenth of the real object then the scale is 1:10

Describe how the floating object moved when the wave passed through the water. It bobbed up and down. It moved slightly but returned to its original position. ***Only if the water is shallow (near shore) will the object move in front of the wave as it is affected by friction from the sea bottom***

At this point you may wish to either demonstrate with a Newton's cradle or by visiting http://www.youtube.com/watch?v=GyhaVaZgqTI how energy can be passed through molecules of seawater without them being displaced.

Draw what would happen to the ducks as a wave front passed through them from left to right



Students may use arrows to demonstrate the ducks bobbing up and down in sequence as the energy from the wave front passes through them.

Vocabulary	Column of water, wave, wave front and tsunami

Extension or Homework

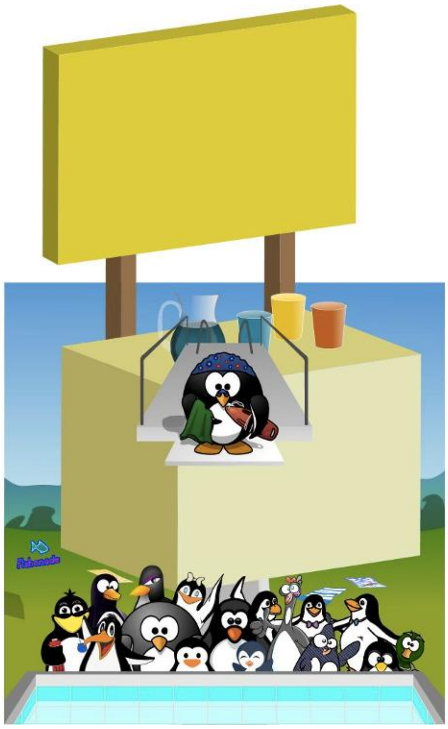
This can also be carried out in a swimming pool using floating empty cool drink bottles. Waves could be generated by students (or their families) jumping into one end of the pool. Pool safety rules must be strictly followed.

Which safety rules must you follow when in a pool area? Local pool safety rules apply

Place a line of bath ducks or something else that floats across the water and send out a wave. Describe what happened to them.
They defined or outlined a wave front.

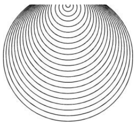
Repeat with the ducks (or other) in a line leading away from the initial water disturbance. Describe what happened.
The ducked bobbed up and down in sequence away from the disturbance.

Extension - Plunge a penguin in a pool



What shape would the wave fronts generated by the plunging penguin be? Concentric circles increasing outward from the penguin

Diagram



Could a plunging penguin in a swimming pool cause a tsunami? Explain your answer.

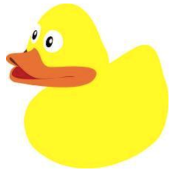
No. Tsunamis need water to shallow towards the shore to build up the tsunami wave. (Unless the swimming pool shallows to one end)

Making Waves – Student Activity

Ordinary waves are created when a column of water is moved up and down.

Materials

- An empty student tray, laboratory tray, large basin or sink.
- Water
- A blocked filter funnel.
- A small floating object e.g. bath duck.
- Newspaper if not using wet area.



Method

1. Lay down newspaper to collect any splashes, if directed to.
2. Fill the container with water, almost to the top.
3. Place the blocked filter funnel into the water (upside down) and push it up and down to create waves. This needs to be done near to the surface and slowly.
4. Observe and note down what happens.

The moving raised surface of water is called a "wave front".

5. Place the floating object (e.g. bath duck) half way along the container.
6. Gently raise and lower the blocked filter funnel to create waves again.
7. Observe and note down what happens to the floating object.

Observations

What did you observe when the surface of the water was disturbed? ___________________________

____

In which direction was the movement? ____

Sketch the shape and movement of the waves below.
Diagram of waves

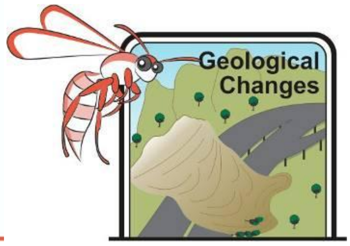
Scale 1:

HINT if your sketch is one fifth of the size of the real object, the scale is 1:5. Similarly if your sketch is one tenth of the real object then the scale is 1:10

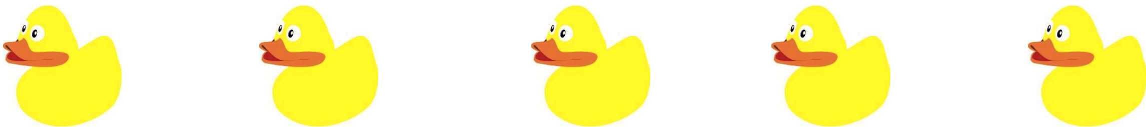
Describe how the floating object moved when the wave passed through the water. ______________

____

Making Waves – Student Activity



Draw what would happen to the ducks as a wave front passed through them from left to right.



1.

2.

3.

4.

5.

6.

Waves only become tsunami if they reach shallowing water and start to build up.

Tsunami waves are not the same as tidal waves.

Vocabulary	Column of water, wave, wave front and tsunami

Extension or Homework

This can also be carried out in a swimming pool using floating empty cool drink bottles. Waves could be generated by students (or their families) jumping into one end of the pool.

Pool safety rules must be strictly followed. Adults must be informed before proceeding!

Which safety rules must you follow when in a pool area?

____

____

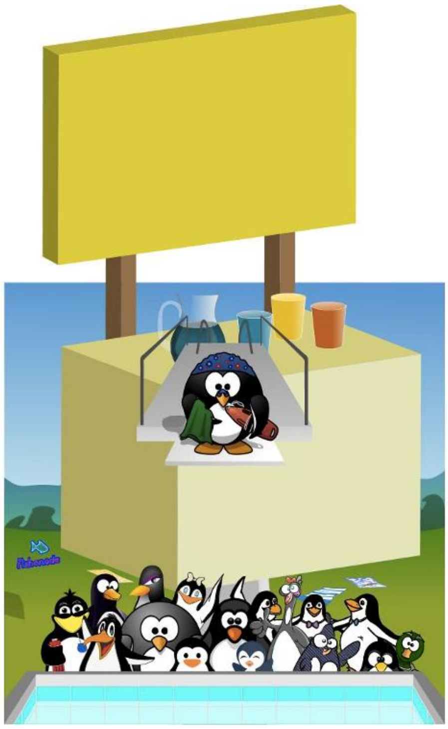
Place a line of bath ducks or something else that floats across the water and send out a wave. Describe what happened to them.

____

Repeat with the ducks (or other) in a line leading away from the initial water disturbance. Describe what happened.

____

Extension - Plunge a penguin in a pool



What shape would the wave fronts generated by the plunging penguin be?

____

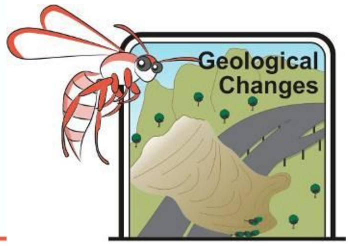
Diagram

Could a plunging penguin in a swimming pool cause a tsunami? Explain your answer.

____

____

____



Tsunami – Teacher Demo Notes

Teacher Demonstration - The effect of seafloor movement and shallowing on the creation of a tsunami

Before tsunami

After (only tree remains upright)

Materials

- A large foil roasting or baking tray
- A sharp knife
- A large balloon, rubber glove or piece of flexible plastic
- A small rubber band
- A pebble or small object
- Sticky tape (gaffer tape is best)
- Water
- A sink, draining board or outside wet area (lawn)
- Sand
- Garnish options (plants, plastic houses etc.)

I placed a board under the tray to support it and partially withdrew it to gain access to the plastic below

Method - Part A

1. Place the stone at the centre of the flexible plastic sheet and secure it there with a rubber band.
2. Cut a hole in the base of one end of the baking tray (to the size of the pebble).
3. Stick the plastic covered stone on the bottom of the foil tray to tightly cover the hole.
4. Half fill the tray with water. This represents deep ocean.
5. Pull down on the enclosed pebble and release or quickly push up on the plastic. This represents ocean floor movement.
6. Observe

Results Part A

What did the movable plastic section represent? Underwater movement from an earthquake or the collapse of the magma chamber of a volcano.

What happened when the extended plastic was released? A large wave ran the length of the foil tray.

Tsunami – Teacher Demo Notes

Method - Part B

1. Place enough sand to one-third fill the end farthest from the flexible plastic. This represents shallowing to beach and land.
2. Mound the sand to represent a beach
3. Garnish with materials representing houses, vegetation and people.
4. Send the tsunami pulse again.

Results for part B

What happened to the tsunami wave when it approached the beach? The waves became higher and more destructive.
What happened to the sand on the beach? It was spread about smothering the animals. It flowed inland and then some of it flowed back into the sea.
What happened to the plants and animals? Most died from drowning or being knocked over.
How was the landscape changed? The land was flooded and flattened.

An animation of the creation of a tsunami can be found at:
http://www.pbs.org/wnet/savageearth/animations/tsunami/index.html
An explanation of the stages of a tsunami can be found at:
http://news.bbc.co.uk/2/hi/science/nature/7533972.stm

RESEARCH - Using the library or Internet.
What is a **TSUNAMI**? A destructive wave caused by movement of the sea bottom

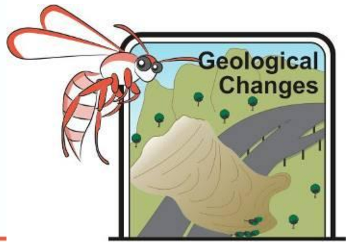
What are the four main causes of a tsunami?

1. Earthquakes 75%
2. Volcanism 2%
3. Landslides 8%
4. Unknown 10% & Weather 2%

What effect will a tsunami have on low lying coastal land and on the plants and animals that live there? It will be swamped. Vegetation will be torn up and people and animals drowned unless they can move to higher ground.
What effect will a tsunami have on forests and farmland? Trees and crops will be flattened and the ground will be soaked with salt water which will make replanting impossible until rain washes it out of the soil.

EXTRAS FOR EXPERTS

You are a passenger on a boat sailing between Australia and Indonesia. You hear that there has been an earthquake and there might be a tsunami passing your boat in three minutes. Your surfboard is on deck. You decide to "ride the wave". What will happen?
You might bob up and down as the low tsunami waves passes but you would not have a "wave" to ride unless you were near the shore where the wave builds up.



Tsunami – Teacher Demonstration

Your teacher will demonstrate the effect of seafloor movement and shallowing on the creation of tsunami waves

__Results__

Part A

What did the movable plastic section represent? ______________________

What happened when the extended plastic was released? ______________

____

Part B

What happened to the tsunami wave when it approached the beach? _________________________

____

What happened to the sand on the beach? ____

What happened to the plants and animals? ____

How was the landscape changed? ____

____

RESEARCH - Using the library or Internet.

What is a **TSUNAMI**? ____

What are the four main causes of tsunamis?

1. _________________________ 2. __________________________

3. __________________________ 4. ___________________________

What effect will a tsunami have on low lying coastal land and the plants and animals that live there?

____

What effect will the tsunami have on forests and farmland? _________________________________

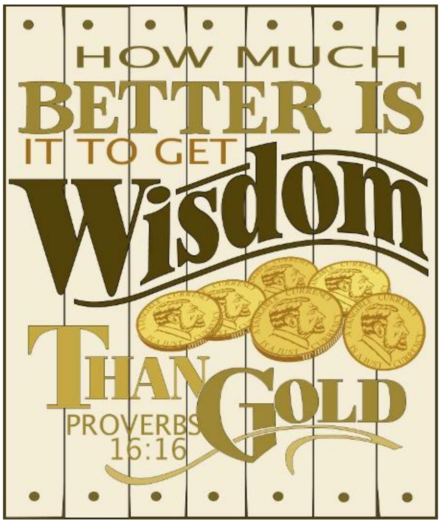
____

EXTRAS FOR EXPERTS

You are a passenger on a boat sailing between Australia and Indonesia. You hear that there has been an earthquake and there might be a tsunami passing your boat in three minutes. Your surfboard is on deck. You decide to "ride the wave". What will happen? _________________________________

____

Tsunami Project – Teacher Notes



This activity can be covered at the end of the tsunami section or at the end of this package for assessment. To prevent all students researching the same subject and requiring the same information, research projects are at the end of the Earthquake, Volcano and Tsunami sections.

A wise Science student reads everything before starting anything!
A wise Science student also notices how many marks are awarded for each question. This usually indicates how many good answers there should be.

Students are recommended to visit:
https://www.emknowledge.gov.au
http://www.bom.gov.au/tsunami/
www.dfes.wa.gov.au

What is a tsunami? Large ocean waves caused by large underwater disturbances.

How long can the distance between wave crests be? 150km.

How fast can a tsunami travel? 1,000km/hr.

What symbol is used to indicate a tsunami event on the web site?

Have there been any tsunami events in the region of Australia in the last two years? Since this changes over time teachers will have to visit the first site above.

Students are asked to research a tsunami event in the Asia– Pacific region that has occurred since 2000AD.

Give the geographic location of the tsunami of your choice.
When did it occur?
Was there sufficient warning?
How did the tsunami affect the landscape?
How were the plants and animals (including humans) affected?

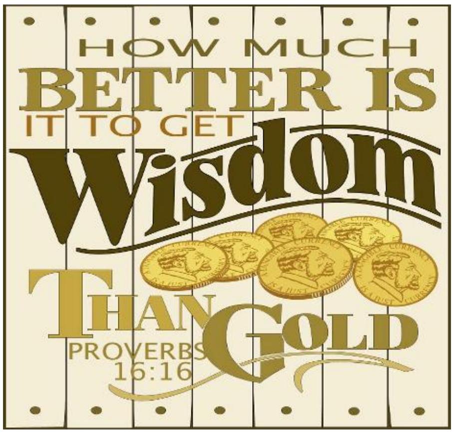
What words would be useful when you make an Internet study for this section? Tsunami, events, Australia, Asia – Pacific, dates.

What five things can you do to reduce tsunami risk if you live in a low-lying area, which is prone to tsunami damage?

1. Know your warning signals
2. Know where to go
3. Know how to call the DFES (Department of Fire and Emergency Services) – 132500
4. Know your plan if a tsunami strikes
5. Get your kit prepared
6. Know where your nearest DFES is (third web site)
7. Keep calm and help others

Tsunami Project – Student Research

A wise Science student reads everything before starting anything!



A wise Science student also notices how many marks are awarded for each question. This usually indicates how many good answers you should write.

A wise Science student also writes rough notes before producing the final copy.

A wise science student chooses the best scientific words for their answers.

Students are recommended to visit:
https://www.emknowledge.gov.au
http://www.bom.gov.au/tsunami/
www.dfes.wa.gov.au

What is a tsunami? ____(1 mark)

How long can the distance between wave crests be? ____________________________(1 mark)
(This is only slightly shorter than the distance between Perth and Kalgoorlie!)

How fast can a tsunami travel? ____(1 mark)

What symbol is used to indicate a tsunami event? (1mark)

Have there been any tsunami events in the region of Australia in the last two years? _______(1mark)

Please research a tsunami event in the Asia– Pacific region that has occurred since 2000AD.

Give the geographic location of the tsunami of your choice. __________________________(1 mark)

When did it occur? ____(1 mark)

Was there sufficient warning? ____(1 mark)

Tsunami Project – Student Research

How did the tsunami affect the landscape? (3 marks)

How were the plants and animals (including humans) affected? (5 marks)

What words would be useful when you make an Internet study for this section? (5 marks)

What five things can you do to reduce tsunami risk if you live in a low lying area which is prone to tsunami damage? (5 marks)

Due date

Please list your bibliography here. (What sources did you use?)

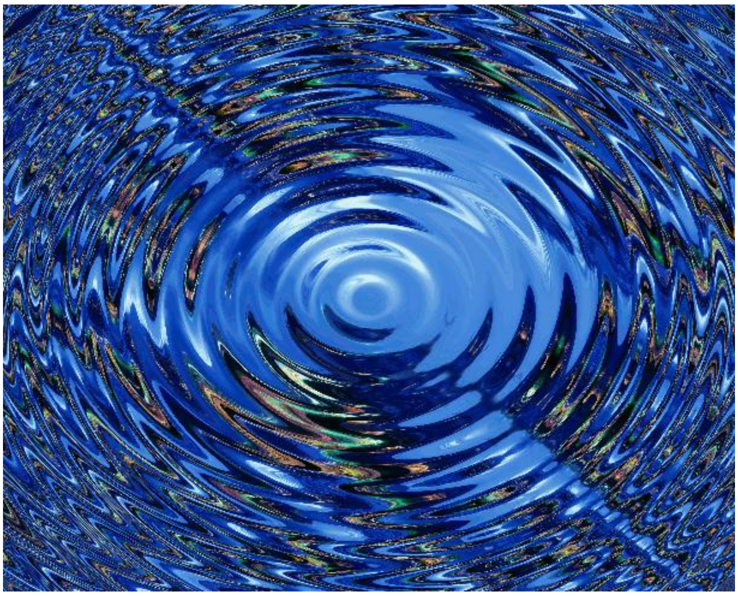
Tsunami – Teacher Notes

Sudden geological events can change the surface of the Earth.

Students may be encouraged to use their worksheets (open book) while answering these questions.

Name the types of sudden geological events that may trigger tsunamis? Earthquakes, volcano craters collapse/cauldron subsidence, landslides into the sea or under the sea, glacier collapse, undersea fault uplifting and very occasionally barometric changes.

If an earthquake causes the sea floor to suddenly be raised, in which direction will the tsunami waves travel? Sketch the wave fronts in the space provided below. Concentric rings travelling outwards from source.



See over for Wordsleuth for those who finish quickly.

Geological Changes

FIND THE WORDS USED IN THIS TOPIC.

"HOW TSUNAMI CAN CHANGE THE EARTH'S SURFACE"

Tsunami

L	K	E	T	H	V	S	B	N	V	C	R	D	X	G
A	E	S	R	E	D	N	U	O	F	P	X	I	L	E
N	G	H	E	U	A	P	E	I	P	R	M	A	K	T
D	V	N	F	L	S	R	E	T	A	A	C	A	W	N
S	B	O	J	F	U	S	F	C	N	I	U	S	E	E
L	N	W	L	P	U	M	E	U	E	Q	R	N	A	M
I	D	A	T	C	Q	K	S	R	H	B	E	F	T	E
D	W	I	E	I	A	T	U	T	P	P	T	A	H	V
E	O	L	V	C	W	N	R	S	T	Y	A	S	E	O
N	C	X	A	J	O	A	O	E	H	S	W	P	R	M
D	U	C	K	S	E	M	V	D	Q	I	N	P	L	S
P	A	C	I	F	I	C	X	E	I	O	M	L	H	B
C	O	N	C	E	N	T	R	I	C	E	E	A	J	G
N	F	G	E	V	I	V	R	U	S	W	S	N	V	Q
H	B	U	V	W	D	C	M	I	S	N	C	K	B	D

CONCENTRIC	DESTRUCTION	ERUPTION	EARTHQUAKE
GLACIER	OCEAN	PRESSURE	TSUNAMI
WATER	LANDSLIDE	PACIFIC	SURVIVE
UNDERSEA	WATER	DUCKS	FUKUSHIMA
MOVEMENT	PLAN	SWELL	VOLCANO
WEATHER			
DUCKS			

Which was the best activity and why?

____

____

____

Tsunami – Student Review

Sudden geological events can change the surface of the Earth.

Name the types of sudden geological events that may trigger tsunamis?

____

____

____

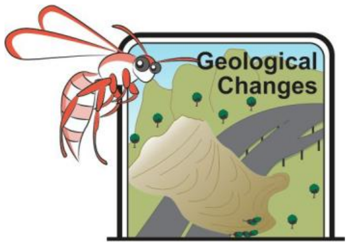
____

If an earthquake causes the sea floor to suddenly be raised, in which direction will the tsunami waves travel? Sketch the wave fronts in the space provided below.

____

See over for a wordsleuth

Final – Tsunami student



FIND THE WORDS USED IN THIS TOPIC.

"HOW TSUNAMI CAN CHANGE THE EARTH'S SURFACE"

Tsunami

L	K	E	T	H	V	S	B	N	V	C	R	D	X	G
A	E	S	R	E	D	N	U	O	F	P	X	I	L	E
N	G	H	E	U	A	P	E	I	P	R	M	A	K	T
D	V	N	F	L	S	R	E	T	A	A	C	A	W	N
S	B	O	J	F	U	S	F	C	N	I	U	S	E	E
L	N	W	L	P	U	M	E	U	E	Q	R	N	A	M
I	D	A	T	C	Q	K	S	R	H	B	E	F	T	E
D	W	I	E	I	A	T	U	T	P	P	T	A	H	V
E	O	L	V	C	W	N	R	S	T	Y	A	S	E	O
N	C	X	A	J	O	A	O	E	H	S	W	P	R	M
D	U	C	K	S	E	M	V	D	Q	I	N	P	L	S
P	A	C	I	F	I	C	X	E	I	O	M	L	H	B
C	O	N	C	E	N	T	R	I	C	E	E	A	J	G
N	F	G	E	V	I	V	R	U	S	W	S	N	V	Q
H	B	U	V	W	D	C	M	I	S	N	C	K	B	D

CONCENTRIC	DESTRUCTION	ERUPTION	EARTHQUAKE
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WATER	LANDSLIDE	PACIFIC	SURVIVE
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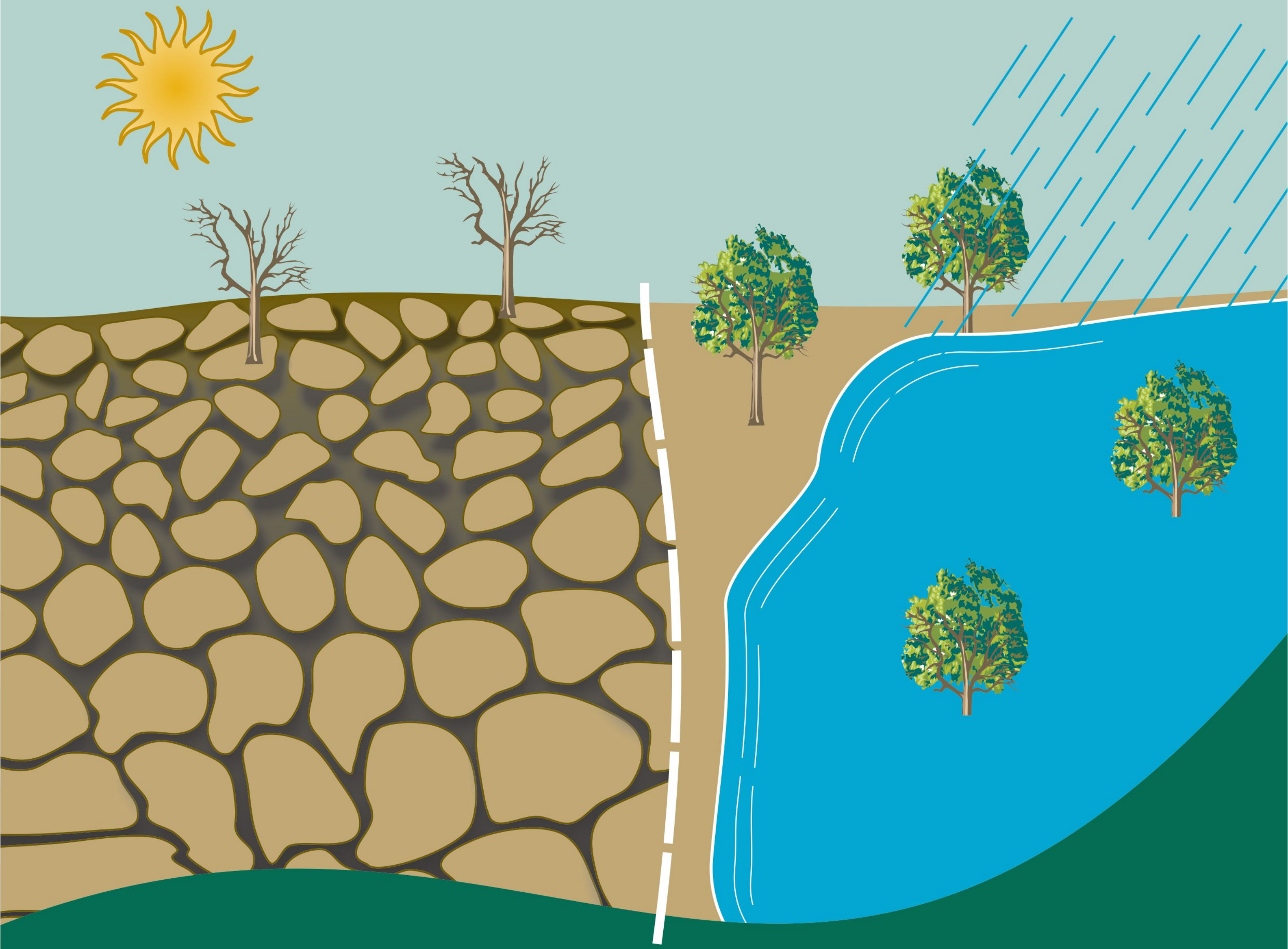
WEATHER			

Which was the best activity and why?

Droughts and Flooding Rains



Scientific Data – Teacher Notes

We love our sunburnt country but droughts and flooding rains affect our landscape. Recent warming of the Pacific Ocean appears to be responsible for increasing the frequency and intensity of ENSO (El Nino Southern Oscillation) events. Under El Nino conditions warm water from the equator is blown towards South America increasing the chance of drought conditions in Australia. The opportunity for bushfire consequently also increases.
Research to date suggests that La Nina events when rain-bearing winds approach the east coast of Australia are becoming rarer but the rainfall is becoming more intense. More research is necessary to build more accurate models of what is happening.
Aboriginal belief is that natural disasters such as Cyclone Tracy which devastated Darwin on Christmas day are the direct result of their ancestors being angered by poor behaviour of mankind.

When we discuss changes in climate we cannot just give general statements such as “I think it is getting drier” or “This must be a drought”. We need to give information and measurements in a way that can be understood the same way by everyone across the world.

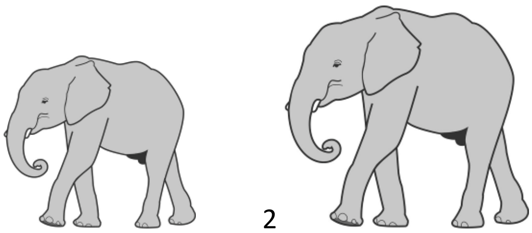
Science requires data (information and measurements) that can be:

OBSERVED using four of your five senses.

Which four senses do we use? Sight, touch, hearing and smell.

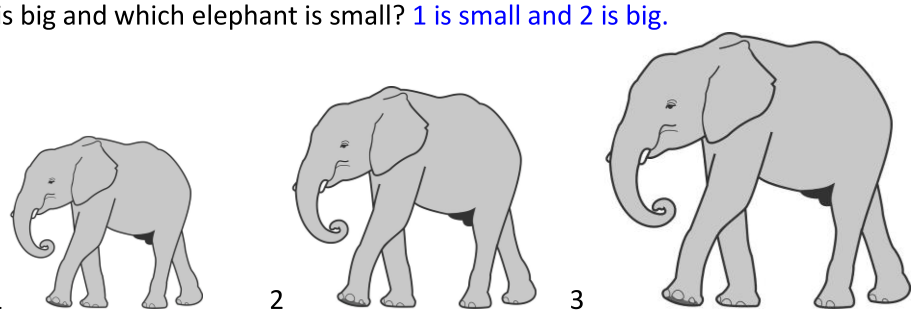
Which sense do we not use and why? Tasting can lead to poisoning and disease.

MEASURED using objective measurements and not subjective measurements.
Subjective measurements describe the feelings and ideas of each particular person. They aren’t necessarily the same for everyone. E.g. big and small, nice and nasty or hot and cold.



1 2

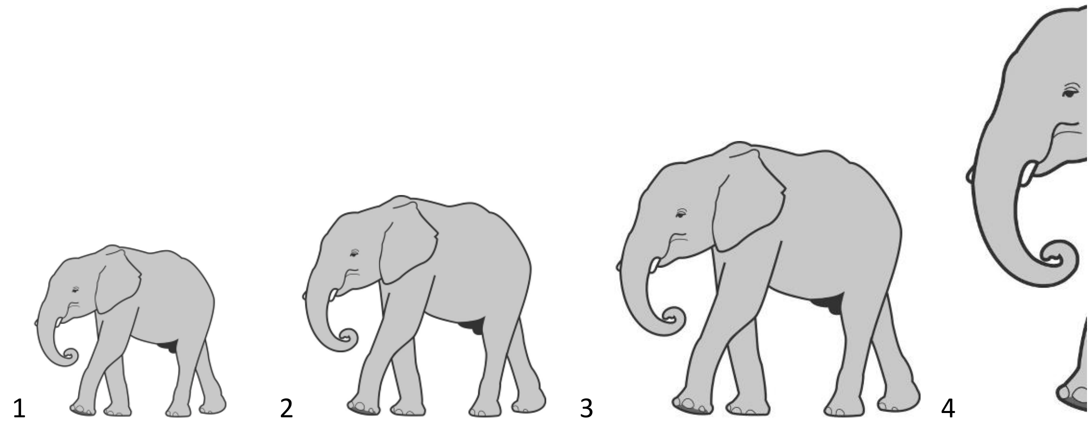
Which elephant is big and which elephant is small? 1 is small and 2 is big.



1 2 3

Which elephant is big and which is small this time? You can only say that one is bigger or smaller than the other. There is no standard size. To elephant 3 elephant 2 is small while it would appear tall to elephant 1.

Scientific Data – Teacher Notes

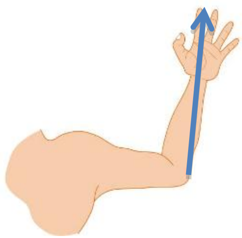


Which elephant is big and which elephant is small now? Again size is relative to comparison with another elephant.

Objective measurements use International standards measurements such as metres, degrees Celsius, kilograms and seconds.

If we have a standard measurement for the first elephant of 1 metre, what could we estimate as the height of elephant 2? About 1.5 m
What could we estimate as the height of elephant 3? About 1.75m
What could we estimate as the height of elephant 4? Insufficient information.

Ancient Egyptians used the length of their arm from the tip of their fingers to their elbow as the standard measurement of **1 cubit** and the standard width of one finger as **1 digit.** Ask the class to measure the length of the side of the classroom in cubits using their own arms and measure using their rulers. (The length of benches or tables out in the yard might be also be measured on a fine day with a fine class). The results can be compared and decisions made as to whether using internationally standard measurements are more accurate and precise.



Length of whatever in cubits and digits ___________________________
Class readings ranged from ______________ to ___________________

Length of whatever in metres and centimetres ____________________
Class readings ranged from ______________ to ___________________

Which method of measurement is most accurate and precise? International Standard Measurement

Scientific Data – Student Activity

We love our sunburnt country but droughts and flooding rains affect our landscape.
When we discuss changes in climate we cannot just give general statements such as "I think it is getting drier" or "This must be a drought". We need to give information and measurements in a way that can be understood the same way by everyone across the world.

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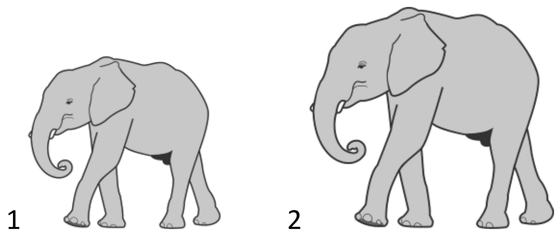
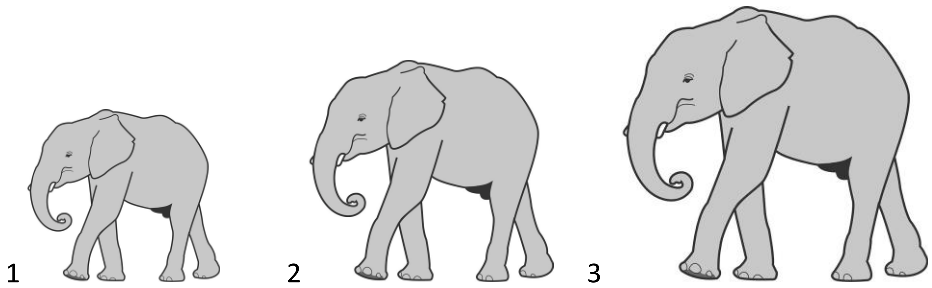


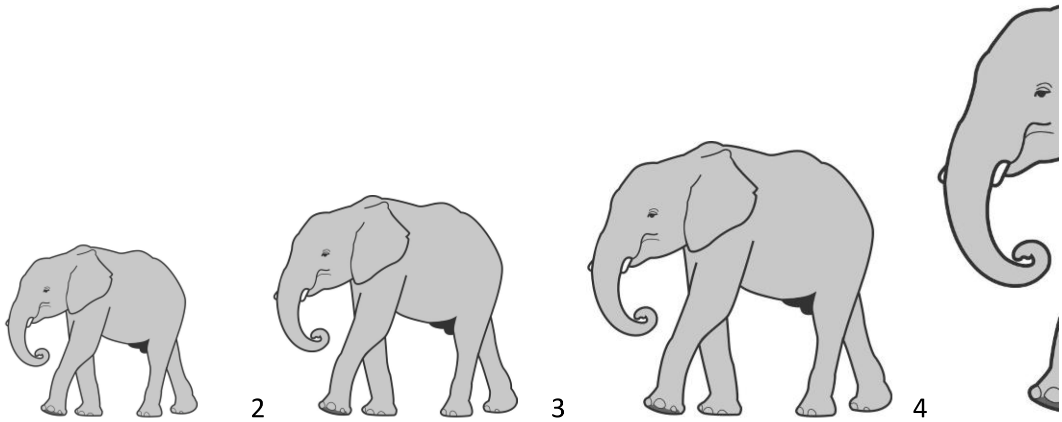
Which elephant is big and which elephant is small? ____



Which elephant is big and which is small this time? ____

____

Scientific Data – Student Activity



1 2 3 4

Which elephant is big and which elephant is small now? ______________________________________

Objective measurements use International standard measurements such as metres, degrees Celsius, kilograms and seconds.

If we have a standard measurement for the first elephant of 1 metre, what could we estimate as the height of elephant 2? ____

What could we estimate as the height of elephant 3? ______________________________________

What could we estimate as the height of elephant 4? ______________________________________

Ancient Egyptians used the length of their arm from the tip of their fingers to their elbow as the standard measurement of **1 cubit** and the standard width of one finger as **1 digit.** Measure the length of the side of your classroom in cubits using your arms (to give readings in cubits and digits)

The length of the classroom was _____________________ cubits and _________________ digits.

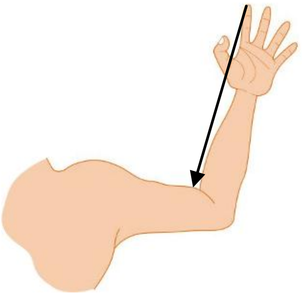
Our class readings ranged from _______________ to _______________.

Now measure it again using measuring tape or rulers.

The length of the classroom is _____________ metres and ______________cm

Class readings ranged from _______________ to ___________________

Which method of measurement is most accurate and precise?



____

The Effect of Drought on Landscape – Teacher Notes

Aim: To demonstrate the effect of drought on a landscape.

Materials

- Three prepared plant pots of the same size.
  One filled with moist potting mix and sprouted alfalfa (or grass seed).
  One filled with moist potting mix only.
  One filled with dry soil or potting mix.
- A drinking straw

Method

1. Place each plant pot at the end of a sheet of A4 paper or newspaper.
2. Use the straw to blow strongly at the surface of the plant pot modelling the effect of a strong wind.
3. Compare the differing amounts of soil blown away by the "wind".

Results

What happened when the "wind" blew on the pots? Wind had little effect on the pot with the plant and on the pot with moist soil. Most soil was lost from the dry pot.

How could we produce scientifically measurable results? We would have to measure the amount of soil blown away. This could be done by collecting the lost soil on each sheet of paper and weighing it or measuring its volume in a measuring jug or cylinder. That way we could estimate the percentage of soil loss. Conversely each pot could be weighed before and after the "wind" blew and percentage loss estimated.

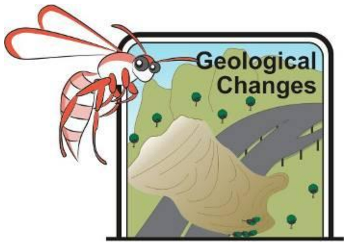
Conclusion

Can drought with wind change the landscape of Australia? Yes.
Loss of plants and loss of animals leads to salinity and loss of topsoil.

- Some plants die from lack of water and produce fuel for fire.
- Most shallow rooted plants die, except drought tolerant ones
- Nutrient rich topsoil blows away. The water holding ability of the soil is reduced.
- Animals dependent on those plants die.
- Loss of trees and scrub with long roots means the water table rises bringing salt to the surface.
- Salt in soil affects shallow rooted plants.
- Loss of plant roots to hold the topsoil when wind blows or water flows over it.
- Further degradation of land and salinity increases.
- Those areas which still have plants can become overgrazed and water table can drop due to overuse of groundwater.
- The length and frequency of drought is important. Many drought tolerant plants require roughly two good years out of seven.
- Plant and animal biodiversity is reduced making its capacity to withstand another change difficult.

Our landscape becomes desertified.

Something to think about: Every day the equivalent of five football pitches of topsoil blows away from our wheat belt and is "lost" at sea.



The Effect of Drought on Landscape – Student Activity

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Results

What happened when the "wind" blew on the pots? ____

____

____

____

How could we produce scientifically measurable results? ___________________________________

____

____

Conclusion

Can drought with wind change the landscape of Australia? __________________________________

____

____

____

Something to think about: Every day the equivalent of five football pitches of topsoil blows away from our wheat belt and is "lost" at sea.

The Effect of Flood on Landscape – Teacher Notes

Geological Changes

Aim: To demonstrate the effect of flood on landscape.

Materials

- 1 large transparent jar
- Mix of potting mix, sand and rock
- Water
- Basin or bucket

Layer of humus or topsoil floats to surface

Method

1. Half fill jar with rock and soil mix.
2. Add water until 2/3 full.
3. Shake until completely mixed to copy flood turbulence.
4. Allow to settle for 1 minutes then pour out the water into a basin or bucket.
5. Observe the liquid in the bucket.

Results

What was washed from the soil mix when the floodwaters had passed through? The fine nutrient rich topsoil.

How could you measure this loss? By removing the top layer (humus/topsoil) drying it and then weighing it. Or carefully pouring off the water and topsoil, allowing the jar to dry out and measuring the decrease in volume (via pre-marked line).

Conclusion

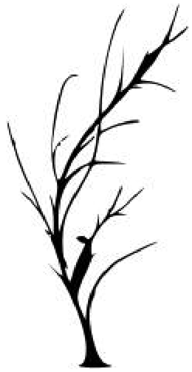
Can floods change the landscape of Australia? Yes. Our topsoil is removed.
The effects of flood on our landscape

- Loss of plants and animals.
- Topsoil washed downhill and downstream to smother plants or be "lost" at sea.

Vocabulary	Drought, desertification, salinity, floods, soil degradation

The Effect of Flood on Landscape – Teacher Demonstration

Aim: To demonstrate the effect of flood on landscape.



Materials
- 1 large transparent jar
- Mix of potting mix, sand and rock
- Water
- Basin or bucket

Method
1. Half fill jar with rock and soil mix.
2. Add water until 2/3 full.
3. Shake until completely mixed to copy flood turbulence.
4. Allow to settle for 1 minute then pour out the water into a basin or bucket.
5. Observe the liquid in the bucket.

Results

What was washed from the soil mix when the floodwaters had passed through? ________________

____

How could you measure this loss? ____

____

____

Conclusion

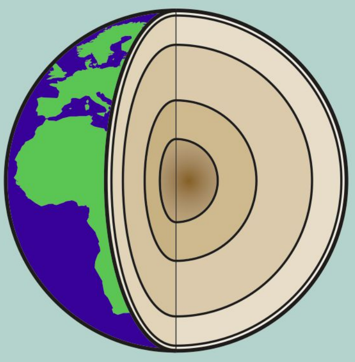
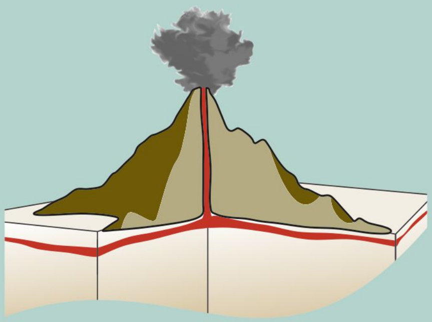
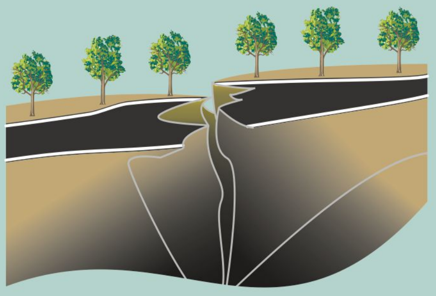
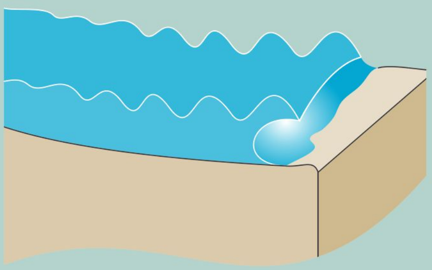
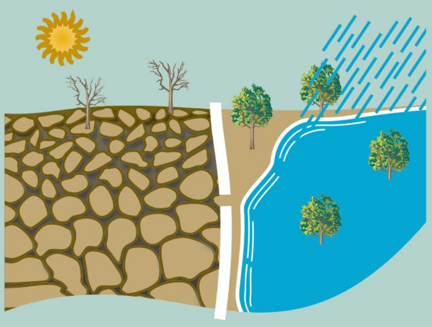
Can floods change the landscape of Australia? _____________________________________

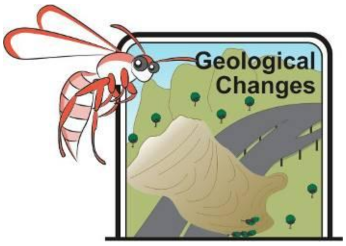
____

____

Vocabulary	Drought, desertification, salinity, floods, soil degradation

Managing Disasters Scientifically



Prepare, Act, Survive – Teacher Notes

San Francisco - A case of poor planning

The western American city of San Francisco lies on a major transform fault line. One tectonic plate grinds its way north past another grinding south. Earthquakes are common. The city had a devastating earthquake in 1906. 3,000 people died and 80% of the city was destroyed. 90% of the damage was not caused by the ground shaking but by fires that followed the earthquake. There was no city plan for earthquakes and earthquake damage. Many of the houses were built of wood and were close together. Wood fires were used in kitchens for cooking and on this occasion breakfast fires spread quickly from collapsed houses to their neighbours. Some of the fires were also caused by untrained firemen using dynamite to bring down dangerous buildings. It is believed that many others were started by building owners in an attempt to get insurance compensation, as companies did not provide cover for earthquake damage. No one was prepared. No one knew what to do.
People and trade moved elsewhere and it took years for the city to regain its infrastructure and status.

Being prepared is essential for survival.
In 1979 Jimmy Buffet sang:
"I don't know.
I don't know.
I don't know where I'm a gonna go
when the volcano blows."

We certainly have little chance of stopping natural disasters from happening but we can, with scientific research, understand what is happening and how to mitigate their outcomes.

Bushfire or fire caused by lightning strike - what can we do?
Bushfires are not uncommon in Western Australia. Country schools have established plans, which are known to staff and students. Recent hot summers have shown that suburban metropolitan schools can be threatened as well. Schools may wish to use the generic fire plans.

DFES suggests that we ***"Prepare, Act and Survive".*** Information can be found at:
http://www.dfes.wa.gov.au/safetyinformation/fire/bushfire/Pages/default.aspx

Your school has plans for how to act in case of any kind of fire.

1. ***PREPARE***
   What has already been ***prepared*** in case of a fire at your school?
   Building with fire retardant materials, clearing flammable materials (scrub, rubbish, and leaves etc.) to form a firebreak, fire extinguishers/blankets, sprinklers and fire escapes. Staff and students informed of fire drill and "random" fire practices organized. Bushfire warnings noted and monitored. Designated wardens/monitors established.

How would you know there was a fire at your school? Bells, horns, whistle

Prepare, Act, Survive – Teacher Notes

2. ACT

How should teachers and students act teachers and students be advised to do?

Don't panic. Switch off gas, leave everything, take students to fire assembly area in an orderly fashion, provide information on names of students present, contact fire brigade, school contact roll taken, inform brigade of location of fire and any dangers. Look after your mates and those less able than yourself.

3. Survive

What would be done if anyone had been hurt? Calm those panicking. Local first aid people alerted. School administration to call ambulance, contact parents and contact authorities.

What should those who have not been hurt do? Keep calm, follow directions and help if asked.

What would happen if the building had been badly damaged? Will vary on location. Students are moved to another safer location. Usually parents are contacted and asked to take students home. Usually a temporary arrangement is made with nearby schools or local halls. Later demountable classrooms may be moved in.

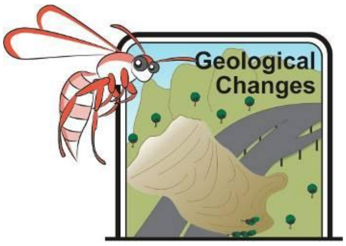
Planning for natural disasters requires:

1. Understanding the cause of disaster events and whether it may occur locally.
2. Suggesting what may happen if the disaster occurs.
3. Suggesting what can be put in place before the disaster event to reduce damage during the event.
4. Informing and training personnel to act effectively.
5. Advising local people what to do during the event to keep their families as safe as possible.
6. Creating plans for rehabilitating the area and supporting displaced people in advance.

Natural Disasters

List five natural disasters you can think of below

Drought, bushfire, floods, cyclone or extreme storm, tsunami, earthquake and volcanic activity.



Prepare, Act, Survive – Student Worksheet

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People and trade moved elsewhere and it took years for the city to regain its infrastructure and status. The effects of more recent earthquakes have been handled better.

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1. ***PREPARE***

What has already been ***prepared*** in case of a fire at your school?

____

____

____

____

____

____

How would you know there is a fire at your school? ________

____

2. ***ACT***

How should teachers and students act? What would you advise teachers and students to do?

____

____

____

____

____

3. Survive

What would be done if anyone had been hurt? ________________________________

____

____

____

What should those who have not been hurt do? ______________________________

____

____

What would happen if the building had been badly damaged? ____________________

____

Natural Disasters

List five natural disasters you can think of below

1. ____
2. ____
3. ____
4. ____
5. ____

Managing a Disaster – Teacher Notes

Create a poster explaining a plan of action during a natural disaster

Teachers may wish to visit http://www.ga.gov.au/metadata-gateway/metadata/record/75909/ and view or download posters of "Tsunami and you" or "Volcanoes and you".

Materials

- Reference materials gained from activities covered during your work on this topic, from books and from the Internet.
- Scrap paper for rough draft
- A3 paper for the poster
- Pens/pencils/lap tops as required

Each group of students should select or be given one of the natural disasters they have studied or have some experience of. Each student should then select one of the two aspects of managing a disaster below and prepare a poster on it.

A. How to ***prepare*** for the disaster event.
B. How people should ***act*** during the event to keep as safe as possible.

Posters should be eye catching, simple and memorable.
Too many words cause clutter and confusion. On the scrap paper provided write down key words that might be used and then select three or four of the best to be explained for the poster. Different colour tones can be used to separate different ideas.

A suggestion:
Students living along the northern coast of Western Australia or from Shark Bay to Geraldton may be directed to reporting on tsunami plans.
Students living along the Darling Fault, Central Midlands and in the Kalgoorlie Boulder area may be directed to report on established earthquake plans.

POSTERS DUE ______________________________

Marks

Rough draft attached to poster with important words and layout	**2 marks**
Name of researcher on back	**1 mark**
Title	**1 mark**
Use of colour	**3 marks**
Writing legible	**2 marks**
Good ideas based on science	**3 marks**
On time	**1 mark**

Vocabulary Act, prepare and survive

Managing a Disaster – Student Poster

Create a poster explaining a plan of action during a natural disaster

Materials

- Reference materials gained from activities covered during your work on this topic, from books and from the Internet.
- Scrap paper for rough draft
- A3 paper for the poster
- Pens/pencils/lap tops as required

With a group of your peers choose a natural disaster you have studied this year.

For this disaster select topic A or B (below) and prepare a poster on it.

A. How to ***prepare*** for the disaster event.
B. How people should ***act*** during the event to keep as safe as possible.

Check your choice with your teacher before starting.

Posters should be eye catching, simple and memorable.
Too many words cause clutter and confusion. On the scrap paper provided write down key words that might be used and then select three or four of the best to be explained for the poster. Different colour tones can be used to separate different ideas.

POSTERS DUE ________________________

<u>Marks</u>

Rough draft attached to poster with important words and layout	**2 marks**
Name of researcher on back	**1 mark**
Title	**1 mark**
Use of colour	**3 marks**
Writing legible	**2 marks**
Good ideas based on science	**3 marks**
On time	**1 mark**

Vocabulary	Act, prepare and survive.