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Science

Earthquakes

For Upper Primary

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Contents

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Earthquakes

The Four Layers Of The Earth

It is essential to know about the four layers of the Earth in order to understand how earthquakes happen. Read Get The Facts then complete the questions and label the diagram.

Get The Facts

- The **crust** is the rocky outer thin layer of the Earth. It varies in thickness from 5-60 kilometres. It is made up of hard rock which is mainly granite. Sometimes earthquakes happen when the rocks in the Earth's crust bend and break causing shockwaves to travel on the Earth's surface.
- The **mantle** is beneath the crust and is over 2,800 kilometres thick. It is made of a thick layer of hotter, heavier rocks. Parts of this layer are so hot that rocks have melted. This molten rock or lava, called magma, is what the Earth's crust floats on. Plates float on top of the magma. The plates rub together and collide and these movements cause cracks and slips in the Earth. These cracks and slips release huge amounts of energy in the Earth and this energy results in an earthquake.
- The Earth's core (centre) is made of two layers and is extremely hot, possibly over 2,000 degrees. The **outer core** is liquid and the **inner core** is solid iron and nickel.

Questions

1. What can happen to the Earth's crust which causes earthquakes?

_____

_____

_____

2. Where are plates found?

_____

3. How do the plates cause earthquakes?

_____

_____

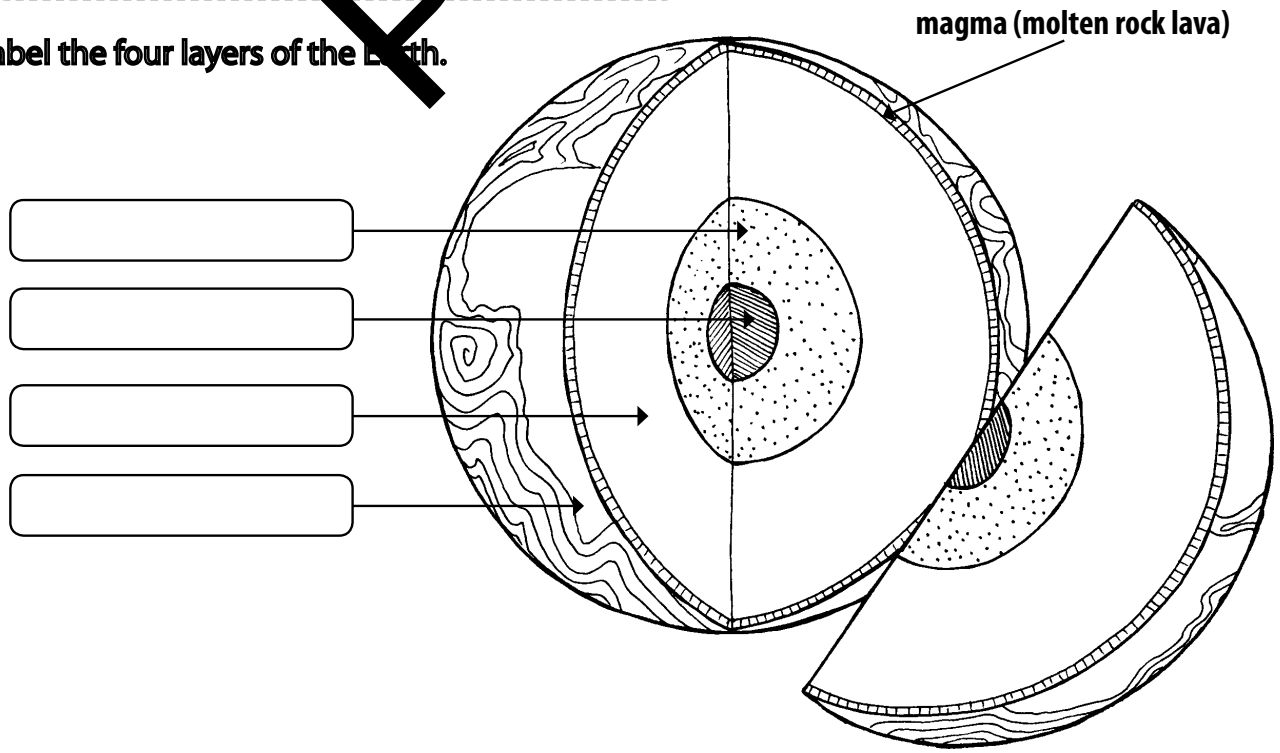
_____

_____

_____

_____

Label the four layers of the Earth.

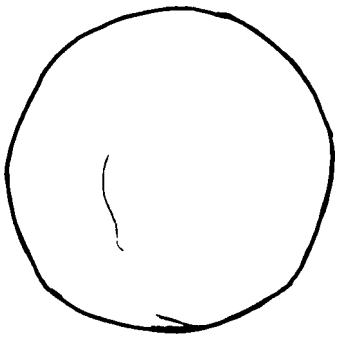


Make A Model Of The Earth

You will need four different colours of modelling clay or Plasticine for this activity. Each colour will represent a layer of the Earth.

Step 1: Inner core

Make the inner core (a ball) about two centimetres in diameter.

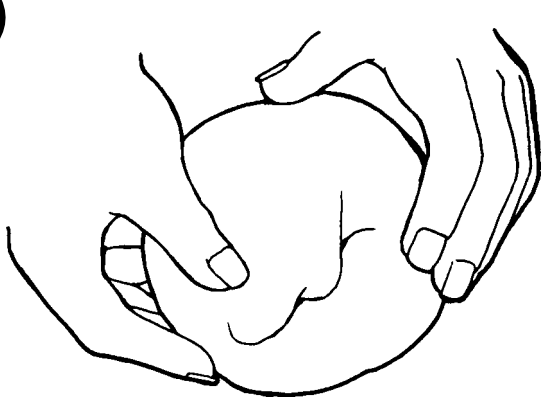


Step 2: Outer core

With a different coloured clay, roll out a thick layer. Place the inner core into the middle and pull the second layer around the inner core. Compare the thickness to that of the inner core.

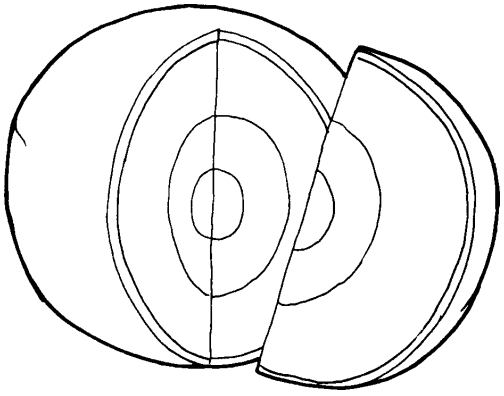
Step 3: Mantle

Repeat **Step 2** using a third colour.



Step 4: Crust

The outer layer must be rolled very thin to represent the crust. When complete, cut with a knife to see the cross-section.



Tectonic Plates 1

The theory that the Earth's crust is broken up into parts called plates, is known as tectonic plates. It is believed that the movement of these plates (they can rub together and collide) causes slips and cracks in the Earth which releases a lot of built up energy and causes earthquakes. Earthquakes usually occur where two plates meet, called faults. When the pressure between two plates is too great for them to be held in place, the rocks snap causing shockwaves (a release of energy). Look at how the plates fit together on the map below.

List of the Earth's Plates

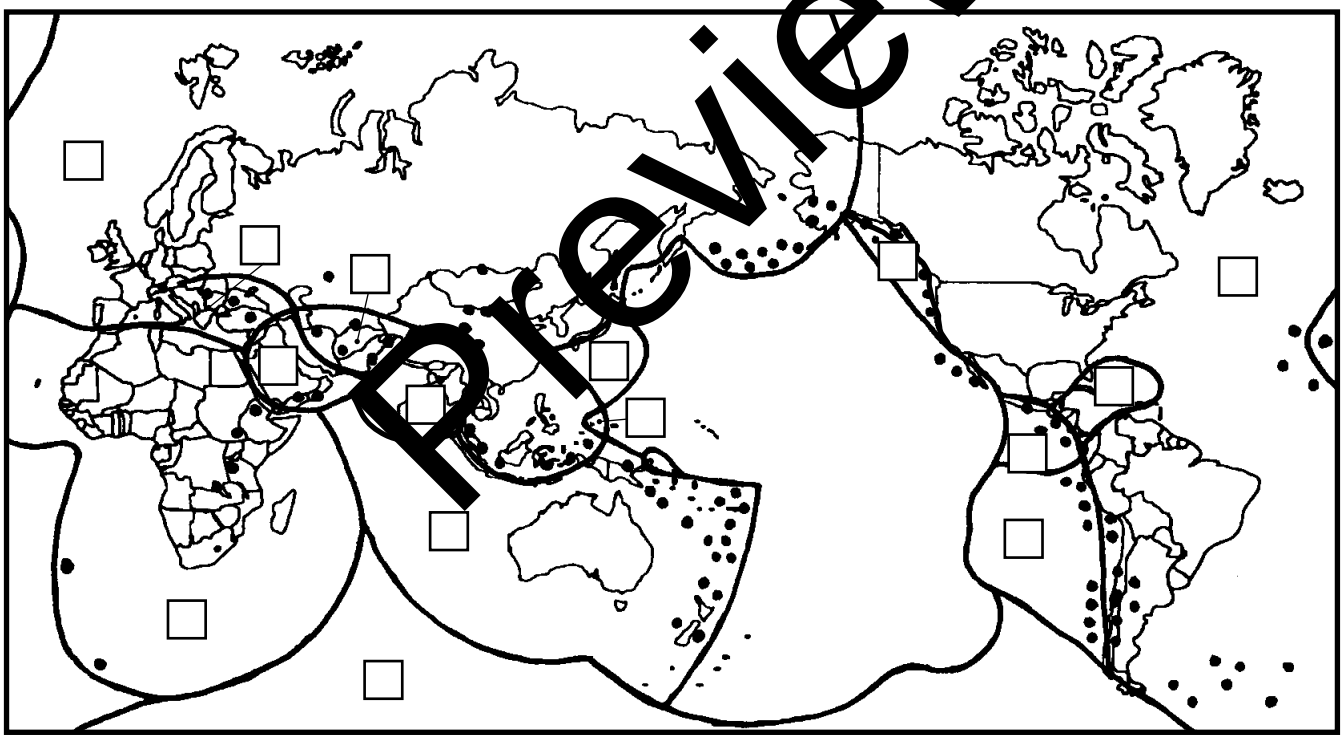
1. North America Plate
2. IndoAustralian Plate
3. Cocos Plate
4. Eurasian Plate
5. Philippine Plate
6. Juan de Fuca Plate
7. Pacific Plate
8. Arabian Plate
9. Indian Plate
10. Antarctic Plate
11. South America Plate
12. Scotia Plate
13. Nazca Plate
14. Caribbean Plate
15. African Plate

Key

Fault lines

Quake zones

Lightly colour each plate a different colour and match the plate names by writing the correct number in the boxes.



Use the back of the sheet to answer these questions.

1. Where do most earthquakes occur?
2. Is Australia considered to be in an earthquake prone area? Explain.
3. Name two countries most likely to be affected by earthquakes in: Asia, South America, North America, Europe and Africa.
4. Name a country (other than your own) where you would like to live. Why?
5. Write down the names of the seven largest plates.

Tectonic Plates 2

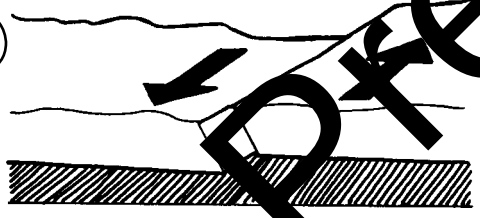
Read Get The Facts then complete the tasks below.

Get The Facts

- Faults are cracks in the Earth where plates are moving in different directions. These areas experience constant pressure and tension.
- There is a correspondence between the earthquake zones of the world and the boundaries of the tectonic plates.
- Any sudden plate movement causes an earthquake.
- Tectonic plates move in different ways at boundaries or fault lines.
- There are four types of earthquake faults:
  - A **normal fault** is when pieces of the Earth's surface are pulled apart.
  - A **reverse fault** is when the plate is being compressed so one part of the Earth's surface is pushed up and one is pushed down.
  - In a **strike-slip fault**, pieces of the Earth's surface move in opposite horizontal directions.
  - A **thrust fault** is similar to a reverse fault. The plates are compressed, but the pieces of the Earth's surface are pushed up lifting the Earth.

After reading Get The Facts, label and describe in your own words the four different earthquake fault types below.

1

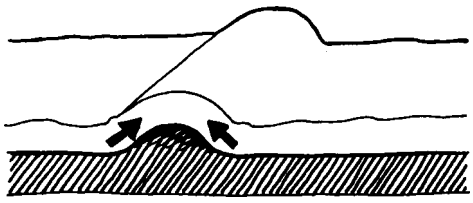


Fault type: _____

Description: _____

_____

2

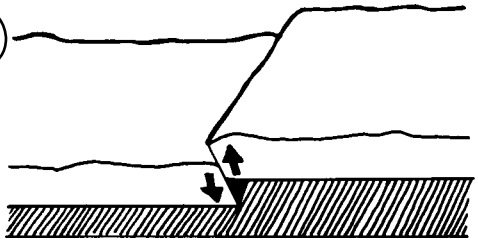


Fault type: _____

Description: _____

_____

3

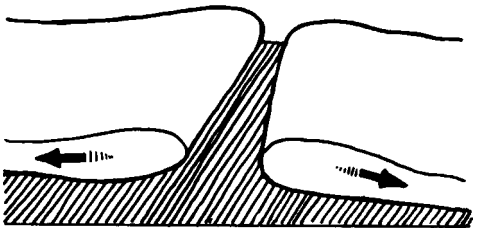


Fault type: _____

Description: _____

_____

4



Fault type: _____

Description: _____

_____

Seismic Waves

When the plates that cover the Earth's crust, slip or fracture, energy is released as seismic waves. These waves cause damage. Read Get The Facts, then answer the questions.

Get The Facts

There are two types of seismic waves: body waves and surface waves.

Body waves move through the inside of the Earth. There are two types of body waves: primary and secondary.

Primary waves move the fastest so they reach the Earth first and are therefore the first to be felt. They can pass through solids, liquids and gases easily. They arrive at the Earth's surface with a large thud which shakes and rattles the Earth.

Secondary waves arrive on Earth after the primary waves. As they pass through rocks they cause them to change and vibrate making the Earth shake vertically and horizontally. They damage the structure of buildings, etc.

Surface waves move along the surface of the Earth and are to blame for most of the devastation caused by earthquakes. They move up and down the surface of the Earth rocking the foundations of structures. They are the slowest moving waves and are the last waves to be felt. This is why the most intense shaking happens at the end of the main earthquake.

Questions

1. Which type of seismic wave causes the most devastation?

_____

2. In what order do the waves hit the Earth?

_____

_____

3. Describe the kind of damage which could be caused by:

primary waves:

_____

_____

secondary waves:

_____

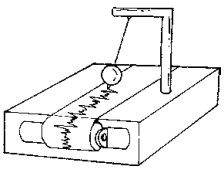
_____

surface waves:

_____

_____

Click IT

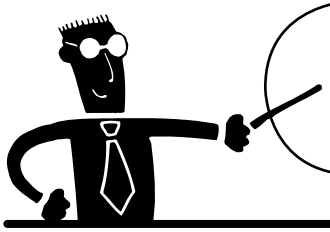


To find out more information about measuring earthquakes go to:

- http://earthquake.usgs.gov/

To play some online geology games go to:

- www.kidsgeo.com



The scientist is not a person who gives the right answers, he's one who asks the right questions.

~ Claude Lévi-Strauss, Le Cru et le cuit

Earthquake Shocks

Read Get The Facts then complete the questions.

Get The Facts

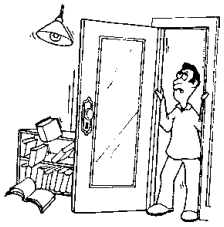
The largest, main earthquake is called the **mainshock**.

Sometimes an earthquake has **foreshocks**. These are smaller earthquakes that happen before the larger earthquake that follows. Some scientists have tried to predict earthquakes using foreshocks but have found this difficult. Foreshocks are unpredictable; they can occur minutes, days or even years before the mainshock. Some earthquakes have no foreshock.

Aftershocks follow the mainshock of an earthquake. They are smaller earthquakes that occur in the same place. Aftershocks can continue for weeks, months or years. Aftershocks are dangerous because they are unpredictable and can cause buildings to collapse that have been weakened by the mainshock. Usually the larger the earthquake, the greater the aftershock.

Hold On!

Doorways are one of the safest places to be during an earthquake because they are usually reinforced and will be the best protection from falling debris. Hold on until the quake is completely over (most casualties occur during aftershocks).



Questions

1. Order the events correctly by placing a number in each box and describe each type of shock in your own words.

☐ mainshock

_____

_____

☐ aftershock

_____

_____

☐ foreshock

_____

_____

2. Why do you think most casualties occur during aftershocks?

_____

_____

_____

_____

3. Why is it difficult to use foreshocks to predict mainshocks?

_____

_____

_____

Click IT

To find out more information about earthquakes go to:

- www.weatherwizkids.com/weather-earthquake.htm

Measuring Earthquakes 1

Read about the Richter scale and the Mercalli scale which are used to measure the power of earthquakes, then answer the questions.

Richter Scale

- In 1935, Two American Geologists',Beno Gutenberg and Charles Richter developed the Richter scale, which is used to compare the intensity of earthquakes. By measuring the speed or acceleration of the ground when it suddenly moves, they devised a scale that reflects the 'magnitude' of the shock. The scale is a measure of force (the amount of energy it releases) but can't determine damage. Earthquakes measuring less than three on the scale aren't felt by humans. Earthquakes measuring seven or over are considered major. You will not see much damage from an earthquake measuring four on the scale.

Mercalli Scale

- The Mercalli scale measures the actual damage of earthquakes. The Mercalli scale is a set of observations based on what people in the earthquake area feel and see and so it is a fairly subjective report. Results of the Mercalli scale are not as immediate as the results of the Richter scale because information has to be gathered together after the event and this can take time.

i. What does the Richter scale measure?

_____

ii. What does the Mercalli scale measure?

_____

iii. Which measurement is likely to be released soon after an earthquake strikes?

_____

iv. Which measurement is likely to released sometime after an earthquake strikes?

_____

v. Which scale do you think is more useful and why?

_____

_____

Click IT

For tips on how to protect yourself during an earthquake go to:

- www.fema.gov/kids/quake.htm

Measuring Earthquakes 2

Complete the Mercalli scale by cutting out the descriptions below and pasting them into the correct sections.

Mercalli scale	Level of damage	Richter scale
1-4 Instrumental – moderate		0-4.3
5 Rather Strong		4.4-4.8
6 Strong	Damage slight. Windows, dishes, glassware broken. Furniture moved or overturned. Weak plaster and masonry cracked.	4.9-5.4
7 Very Strong		5.5-6.1
8 Destructive	Structure damage considerable, particularly to poorly built structures. Chimneys, monuments, towers, elevated tanks may fail. Frame houses moved. Trees damaged. Cracks in wet ground and steep slopes.	6.2-6.5
9 Ruinous		6.6-6.9
10 Disastrous	Most masonry and frame structures/foundations destroyed. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Sand and mud shifting on beaches and flat land.	7.0-7.3
11 Very Disastrous		7.4-8.1
12 Catastrophic	Damage nearly total. Large rock masses displaces. Lines of sight and level distorted.	>8.1

Damage negligible. Small, unstable objects displaced or upset; some dishes and glassware broken.

Few or no masonry structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Rails bent. Widespread earth slumps and landslides.

Structural damage severe; some will collapse. General damage to foundations. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground; liquefaction.

Damage slight-moderate in well-built structures; considerable in poorly-built structures. Furniture and weak chimneys broken. Masonry damaged. Loose bricks, tiles, plaster, and stones will fall.

No Damage.

The Most Damaging Earthquakes

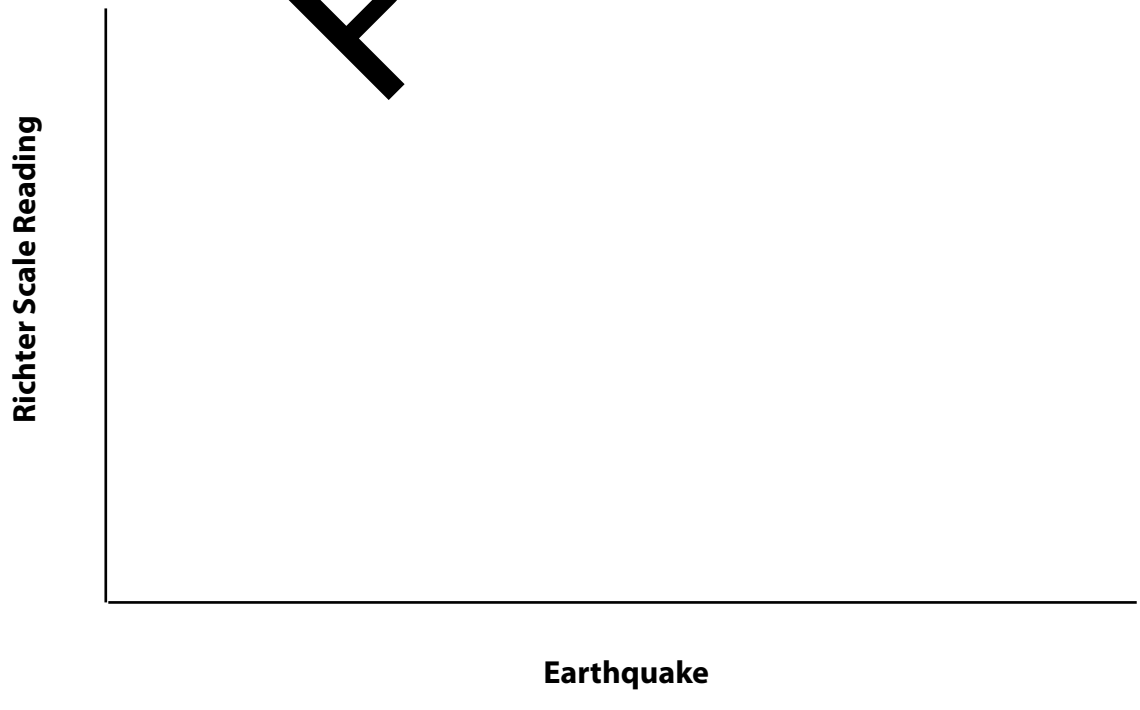
Get The Facts

Earthquakes are common, There are around 500,000 detectable earthquakes in the world each year. Less than 100,000 of those can be felt and less than 100 cause damage to human settlement. Sadly there have been some very large earthquakes across the world, but large earthquakes don't happen very often.

Look at the list of the world's most damaging earthquakes. Create a bar graph from this information.

The World's Most Damaging Earthquakes

Location	Date	Richter Reading
Northern Sumatra, Indonesia	March 28, 2005	8.7
Off western coast of Sumatra, Indonesia	Dec. 26, 200	9.0
Prince William Sound, Alaska	March 28, 64	9.2
Andreanof Islands, Aleutian Islands	March 9, 19 7	9.1
Offshore Maule, Chile	Fe 27, 010	8.8
Japan	March 11, 2011	9.0
Kamchatka	N . 4, 1952	9.0
Chile	M 22, 1960	9.5
Off the coast of Ecuador	Jan. 31, 1906	8.8
Rat Islands, Aleutian Islands	Feb. 4, 1965	8.7



Earthquakes Create Tsunamis

Read Get The Facts then complete the experiment.

Get The Facts

When an earthquake occurs along the edge of two plates, the plates can buckle or slide beneath each other. This is known as subduction. Earthquakes can also happen along faults which are breaks in the Earth's crust that are away from plate boundaries.

Many earthquakes occur in the sea as the Earth's crust is thinner than it is below landmass. Undersea earthquakes sometime generate tsunamis, waves that are pushed along by the initial disturbance and can travel hundreds of kilometers at great speeds.

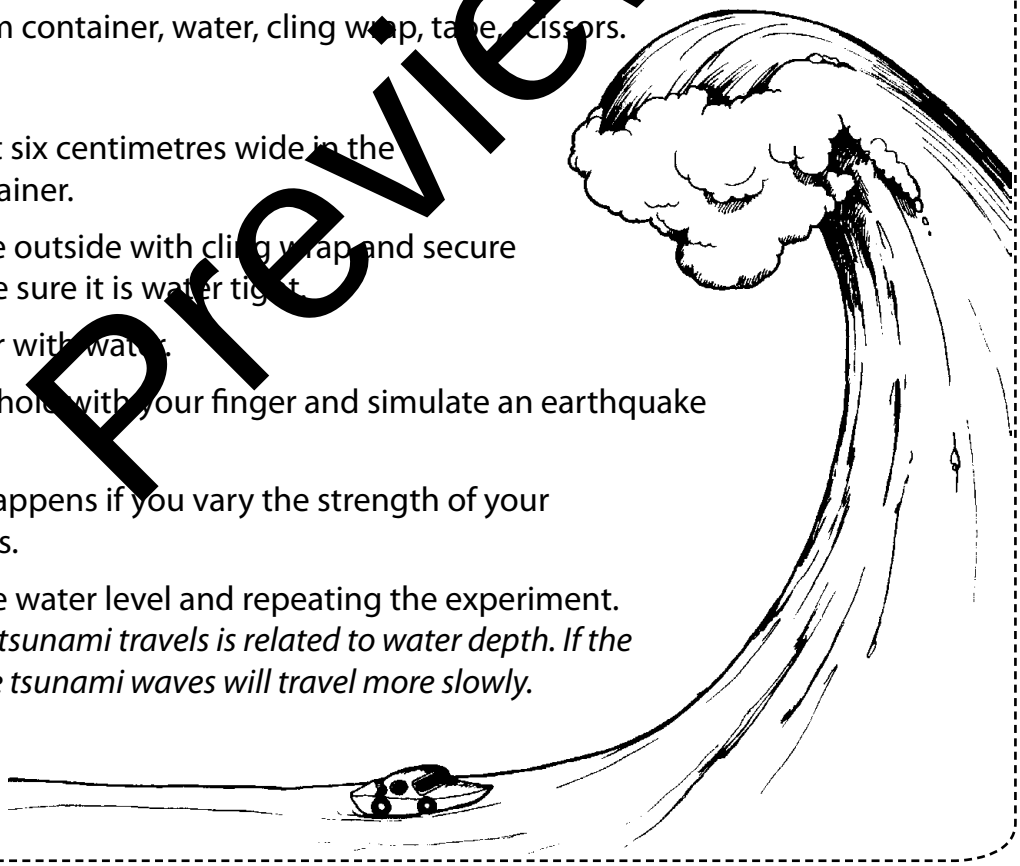
Experiment: Quake making Waves

Aim: To test how an earthquake triggers a tsunami.

Materials: ice cream container, water, cling wrap, tape, scissors.

Process:

1. Cut a hole about six centimetres wide in the base of the container.
2. Cover it from the outside with cling wrap and secure using tape. Make sure it is water tight.
3. Fill the container with water.
4. Tap the wraped hole with your finger and simulate an earthquake on the sea floor.
5. Observe what happens if you vary the strength of your 'earthquake' taps.
6. Try changing the water level and repeating the experiment. *The speed that a tsunami travels is related to water depth. If the water is deep, the tsunami waves will travel more slowly.*



Research

- ❑ Find out if we have any faults in Australia.
- ❑ Find out when the last major earthquake was in Australia.

Click IT

Earthquake animation

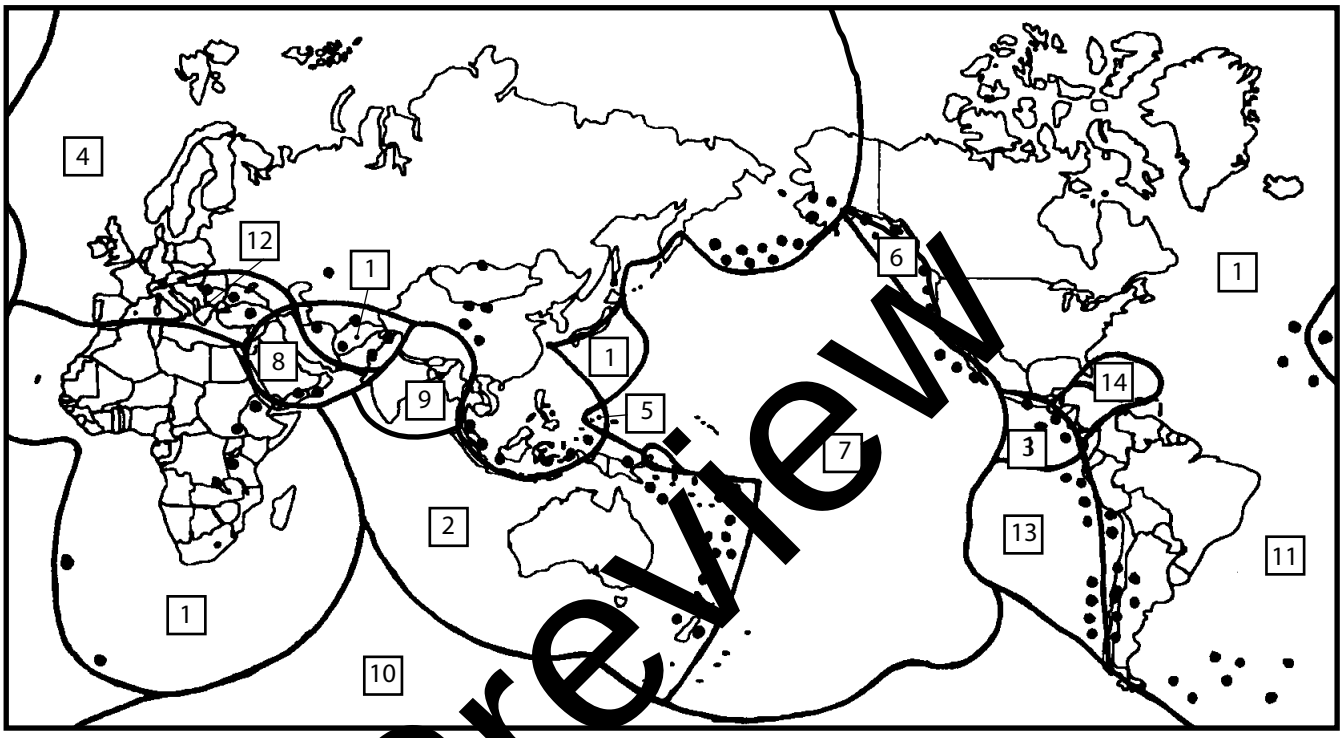
- http://news.bbc.co.uk/2/hi/4126809.stm

Answers

Page 3

1. The rocks in the Earth's crust can bend and break causing shockwaves to travel on the Earth's surface.
2. The Earth's plates float on top of the molten rock lava.
3. The plates can rub together and collide and these movements can cause cracks and slips in the Earth which release huge amounts of energy resulting in an earthquake.

Page 5



1. Most earthquakes occur along the edge of the oceanic and continental plates, sometimes called fault lines.
2. Australia is not on the edge of a tectonic plate and so is less likely to have large earthquakes. Adelaide has the highest risk for earthquakes. Students can learn more at: http://www.ga.gov.au/earthquakes/
3. Asia: Japan and Indonesia
South America: Argentina and Chile
North America: Mexico and Alaska
Europe: Spain and Italy
Africa: Iran and Morocco
5. Antarctic plate, Eurasian plate, African plate, South American plate, Indo-Australian plate, Pacific plate and North American plate.

Page 6

1. Fault type: A thrust fault.
2. Fault type: A strike-slip fault.
3. Fault type: A reverse fault.
4. Fault type: A normal fault.

Page 7

1. Surface waves cause the most devastation.

Answers

2. Primary waves hit the Earth first, then secondary waves, then surface waves.
3. Primary waves: damage to contents inside houses, some windows or glass smashed. Secondary waves: structural damage to poorly built structures. Roof damage, chimneys dislodged, trees damaged and uprooted. Surface waves: can cause the collapse of infrastructure, damage to dams, dikes, embankments.

Page 8

1. 2 = mainshock, 3 = aftershock, 1 = foreshock.
2. Aftershocks are very unpredictable taking people by surprise and can bring down infrastructure weakened by the initial shock.
3. Foreshocks are unpredictable; they can occur minutes, days or even years before the mainshock. Some earthquakes have no foreshock.

Page 9

i. The Richter scale is a measure of force (the amount of energy it releases) but can't determine damage.
ii. The Mercalli scale measures the actual damage of earthquakes.
iii. The Richter scale.
iv. The Mercalli scale.

Page 10

Mercalli	Level of Damage	Richter
1-4	No Damage.	0-4.3
5	Damage negligible. Small, unstable objects displaced or upset; some dishes and glassware broken.	4.4-4.8
6	Damage slight. Windows, dishes, glassware broken. Furniture moved or overturned. Weak plaster and masonry cracked.	4.9-5.4
7	Damage slight-moderate in well-built structures; considerable in poorly-built structures. Furniture and weak chimneys broken. Masonry damaged. Loose bricks, tiles, plaster, and stones will fall.	5.5-6.1
8	Structure damage considerable, particularly to poorly built structures. Chimneys, monuments, towers, elevated tanks may fail. Frame houses moved. Trees damaged. Cracks in wet ground and steep slopes.	6.2-6.5
9	Structural damage severe; some will collapse. General damage to foundations. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground; liquefaction.	6.6-6.9
10	Most masonry and frame structures/foundations destroyed. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Sand and mud shifting on beaches and flat land.	7.0-7.3
11	Few or no masonry structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Rails bent. Widespread earth slumps and landslides.	7.4-8.1
12	Damage nearly total. Large rock masses displaces. Lines of sight and level distorted.	>8.1

Page 11

Yes, Australia has numerous fault lines across the continent but no major ones. There are several near the Queensland and New South Wales coasts and in the centre of the country. Students can lean more at Geoscience Australia: http://cooberpedyregionaltimes.wordpress.com/2008/09/26/fault-lines-weaving-their-way-across-southern-australia/