

# Tectonics

Age 11-16



**Alfred Wegener Mystery:** Introduce with world map and discussion about the first cartographers noticing the shapes of South America/ Africa. Mix the two versions for a quicker activity. Could link the Atlas version with some work on Longitude/ Latitude – give students clues etc. or work in groups one person doing one continent. Students annotate Pangaea, watch short animation.

**Journey to the centre of the Earth:** Activate interest with discussion about student's knowledge of centre of the earth. Worksheet supports lesson on cross-section and convection currents. Excellent supported by sections of BBC's Power of the Planet episode 'Volcano'.

**The Earth's Plates:** Task reviews convection currents and understanding of Pangaea, then try to predict what may happen in future. Students may try to use arrows to consider direction of movement. Could do activity about where students would be able to walk/ drive to, could mark routes on their versions (place knowledge)

**What happens when two plates meet:** Print copies of the plate map for students. Can they name the places at A,B,C,D? Iceland, California, Chile, Himalayas. What do the arrows show? On worksheets write the names of the plates and arrows to show how the plates are moving. Discuss what might happen? How might it be different? Display sentences and names. Students may be able to guess which is 'collision'. Individual/pair/ class activity to put the sentences in the correct place. Then use animation powerpoint to show each boundary. Support with power of planet (Iceland/ Himalayas).

**Why do earthquakes happen:** Review previous activity, elicit that earthquakes happen at all plate boundaries. Students annotate sheet to show difference between focus/ epicentre. Can they predict which earthquakes most deadly? Should be able to link to ideas of their being houses etc, some may link to depth. Study the sentences, put in correct order. Support with video media. Discuss about any earthquakes they may know of, what damage. How often do they happen? Students write prediction. Show IRIS monitoring – every day. Why not reported? Discuss scales – Magnitude (Richer) vs Mercalli. Which is better?

**Haiti Earthquake:** Activate interest with video news reports of Haiti Earthquake. Find out what students know already about the earthquake or Haiti. Where is Haiti? Elicit from students what is meant by Causes, Effects, Responses. Ensure students are clear. Students complete activity by colour coding the effects, responses, causes and background information. Appropriate for GCSE class – can they use this info to answer a case study exam question?

**Effects of Earthquakes:** Differentiated versions, one allows students to think back to what they can remember from Haiti case study. Explain primary and secondary effects, students match into columns. Discuss with class, any disagreements? Students then answer the questions about the different impacts of earthquakes, discuss reasons – link to LEDC/MEDC. Students may also link to Mercalli vs Magnitude scale.

**Living in an earthquake zone:** Introduce California, where is it? What do students know? Use IRIS to show how common earthquakes are. Discussion (pairs/groups) how could they prepare for an earthquake. Answer multiple choice questions, then using box below plan what they would include in an earthquake emergency kit. Watch shake out video, discuss different views. Drop, Cover, Hold. Do class earthquake drill!

**The ring of fire:** What is the ring of fire? Where is it? Why is it called that? Show Ring of Fire video – how much can students remember. Japan – earthquakes/ volcanoes – what do they know? Who has been to Japan? Use google earth/ IRIS monitoring to highlight the issues. What are Haikus? Students write their own Haikus about tectonics. Students can read out, vote on best etc..

**Volcanoes are\_\_\_\_\_:** Students list as many words as they can to fill the blank, feed back to class. Discuss/ categorise, likely to be mainly negative words. Show video 'Volcanoes are Fantastic', students watch and note why they are fantastic. Feedback to class/ discuss. Students complete cross-section. Video available on icgeography.com.

**Volcano dangers:** What do students think make volcanoes so dangerous? Discuss (pairs), feedback to class. Give students worksheet, discuss – how many do they know. Students watch videos about Pyroclastic flows/ Lava/ Lahars etc. Take notes and then diamond rank/ explain. Videos available on icgeography.com

**The Last city of Pompeii:** A challenging cloze activity, students need to put the words in the blanks. Once done story could be used for a dramatization, or other similar activities. Link to studying Mount Vesuvius today, how great is the risk? Next lesson is a decision making activity about living near Vesuvius.

**Should I Stay or Should I go?** Mix the two versions for a quicker activity. Could link the Atlas version with some work on Longitude/ Latitude – give students clues etc. or work in groups one person doing one continent. Students annotate Pangaea, watch short animation.

**Montserrat:** Two options here for suitable differentiation. The first has 8 pieces of information about the Montserrat eruption, students summarise and create a storyboard style case study with pictures and text. For stronger students give them the article and they have to decide their 8 storyboard sections.

**Coping with Tectonic Hazards:** Class discussion based on the Kobe box, focus on the quote. Then can students use the pictures to identify the possible methods of predicting earthquakes: animal behaviour, levels of radon gas, small tremors before a major quake, and using historical evidence to predict when and where the next will be.

**News Reporter:** Depending on your class and how much work they will do outside of lessons this activity could take 2-4 lessons to be done well. Use the video clips and examples of reports to give them an idea. They should then study the specific ones relevant to their earthquake. Each member of the group will also have a summary sheet that they can have in their books as a case study. Stress to students that whilst they can act and use drama, that is a serious subject and they should ensure that their information is actually factually accurate. Encourage students to film the reports rather than present them live and the best can be uploaded to school blog/website etc. They can also make sure it is slick. Use sheets for peer assessment on each report.

**San Francisco Decision Making Activity:** The first sheet allows students to analyse each of the three proposals. Assign the cards according to the numbers of students you have in the class. Ideally you would at least two on the bidding teams, and at least 4-5 on the jury. The activity should take at least two lessons (one for prep and one for the debate) and one homework though this could be extended depending on your group. For example you may get them to use the internet for deeper research.

**Tectonics Assessment:** An example of an assessment used with a Year 7 class, the marks and levels are for guidelines only – this is the system that icgeography has used on the basis that there is not really any level 7 content in the assessment.

# Alfred Wegener Mystery



In 1912 Alfred Wegener presented an amazing theory of 'Continental Drift'. He had analysed rock types and fossils and he decided that millions of years ago all the Earth's land masses were in different places, and have moved to where they are now.

**Task:** Look at the land masses below. Can you identify what they are from their shape? Use an Atlas to help you and then label them. Now cut out each of them and try to re-arrange by matching the fossils just as Wegener did.

**Lystrosaurus**, found:

- East Africa
- West and East India



**Cynognathus**, found:

- West Africa
- East Brazil



**Glossopteris**, found:

- West and East Africa
- South Australia
- East South America.
- South India - Kerala



**Mesosaurus**, found:

- South West coast of Africa
- East coast of South America



# Alfred Wegener Mystery



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**Mesosaurus, found:**

- South West coast of Africa – South Africa/ Nambibia
- East coast of South America – Argentina/ Uruguay



**Cynognathus, found:**

- West coast of Africa – Gabon/Congo
- East coast of Brazil around the tropic of Capricorn



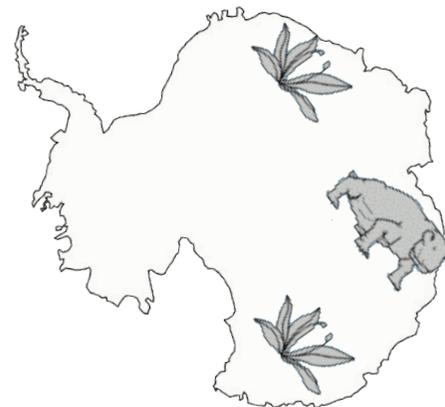
**Glossopteris, found:**

- West coast of Africa – Nambia/Angola
- East coast of Africa – Malawi
- South coast of Australia – West of Adelaide
- East coast South America between Tropic of Capricorn and Uruguay.
- South India - Kerala



**Lystrosaurus, found:**

- East African Coast – Somalia
- West Indian Coast – Mumbai
- East Coast of India from Calcutta to Vishakhapatnam



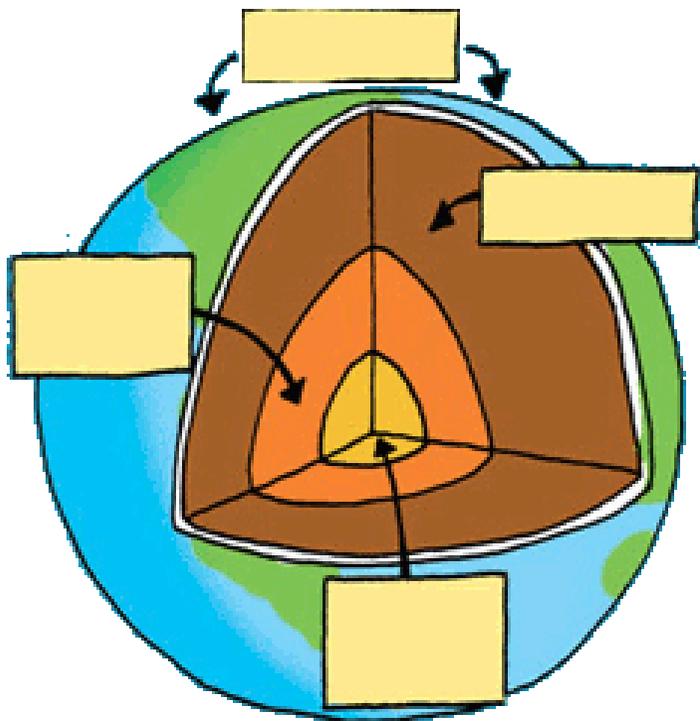
# Journey to the centre of the Earth

## What's it like inside Earth?

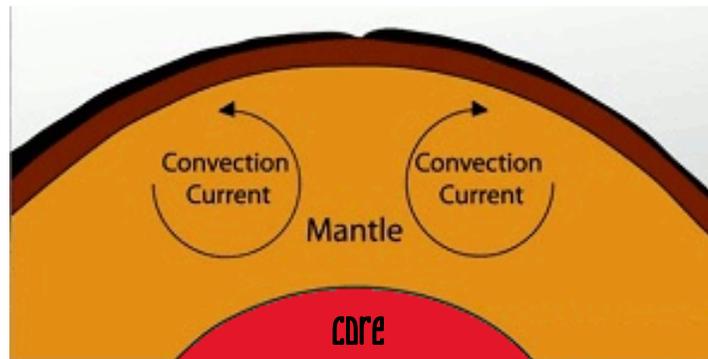
**Task:** Label the cross-section of the Earth with the terms below. Clue card 1 on the right should help you!

- Outer Core
- Inner Core
- Crust
- Mantle

## Cross-section of the Earth



## What makes the plates move?



**Task:** Look carefully at the picture above and clue card 2, can you work out why the molten rock in the mantle is moving. Remember the earth is hottest at the core.

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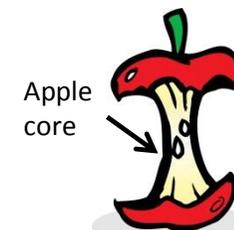
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## Clue card 1



## Clue card 2



What happens to hot air?

# The Earth's Plates

**Task:** The picture on the left is Pangaea, the Earth 250 million years ago. In the box below explain how the Earth has become as it is today.



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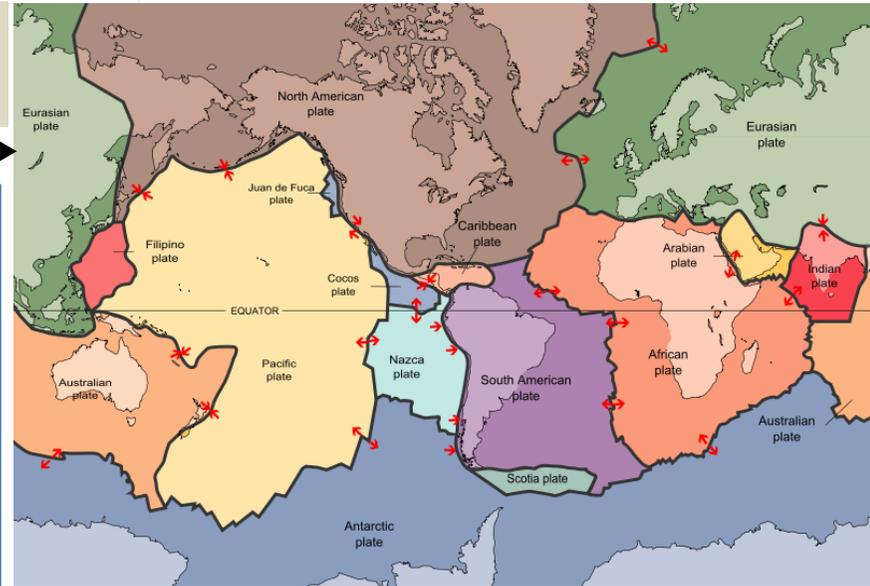
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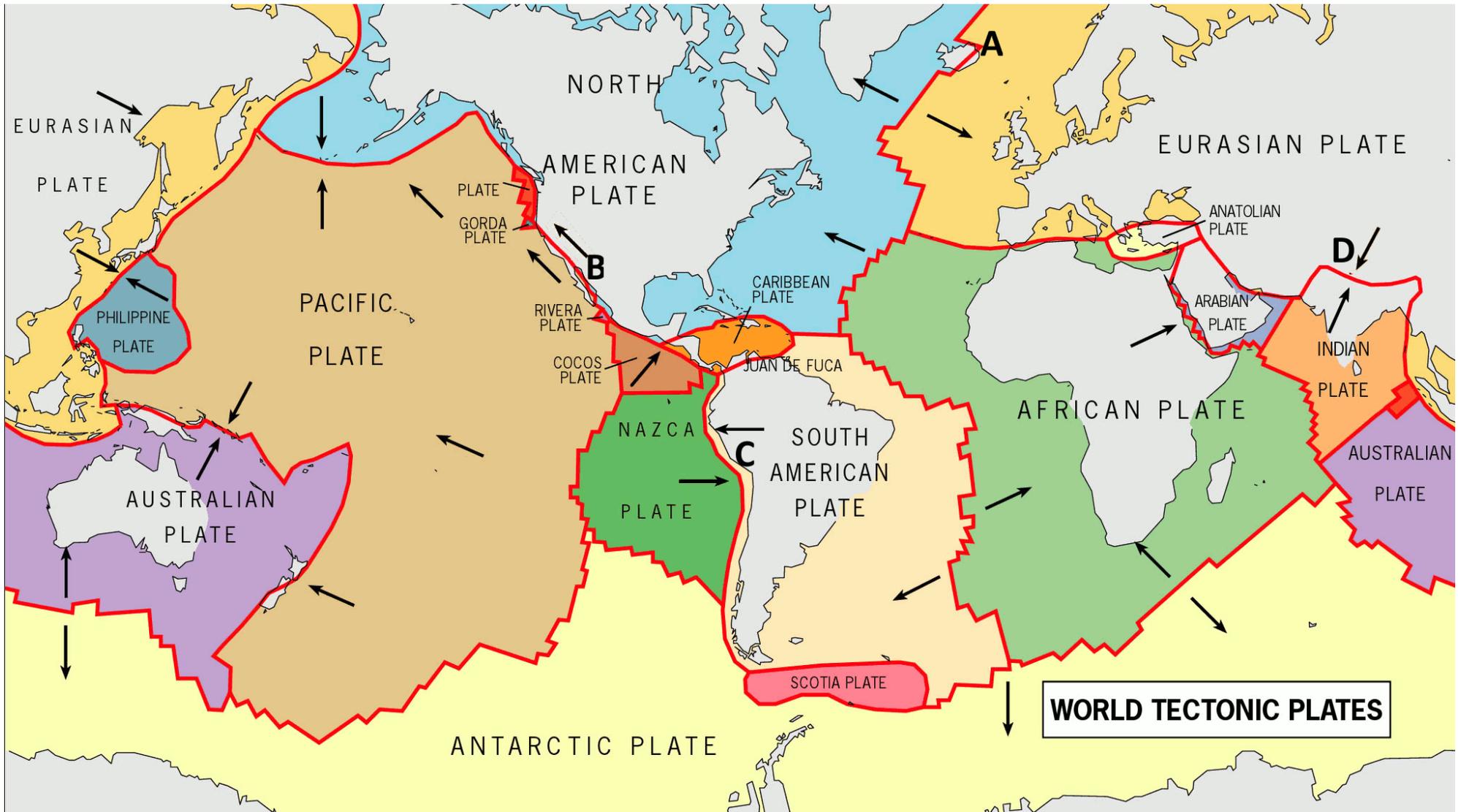
What do you think the arrows in the plate map show?

## The Future Earth

**Task:** Re-arrange your continents into a possible super continent of the future, compare to what experts think will happen in 250million years



# What happens when two plates meet?



# What happens when two plates meet?

**Task:** Use your plate map and find A, B, C, D showing where two plates are meeting. On your 'plates' below name the plates and draw arrows to show the direction they are moving. Then using the sentences on the sheet, complete the boxes to describe and explain what happens. Can you guess which names go with each?

## Tectonic plates

A



Name of plate boundary:

- 1
- 2
- 3

B



Name of plate boundary:

- 1
- 2
- 3

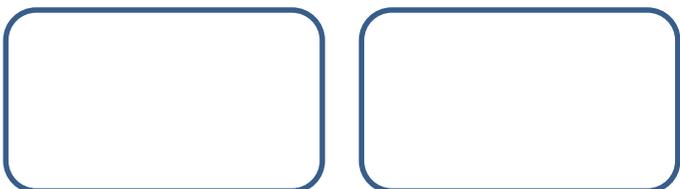
C



Name of plate boundary:

- 1
- 2
- 3

D



Name of plate boundary:

- 1
- 2
- 3

# What happens when two plates meet?

Eventually a sudden release of pressure causes earthquakes, but no volcanoes.

Oceanic crust is heavier so the Nazca plate is pushed under at an Ocean Trench.

The plates are sliding past each other at different speeds

The rock melts and then some of it forces its way through gaps in the crust to form volcanoes.

But there is no melting of rock so you do not get volcanoes here.

Sometimes they get stuck, but friction builds up.

They are both continental crust so they get pushed up to form mountains – the Himalayas.

The plates are pulled apart by convection currents in the soft rock below.

The grinding and movement of the rock causes earthquakes.

The rock slowly grinds it's way down heating up and causing earthquakes.

Magma rises between the gap of the two plates and a volcano is formed.

New land is created, Europe and America are moving apart by 2 cm a year.

*Destructive*

Collision

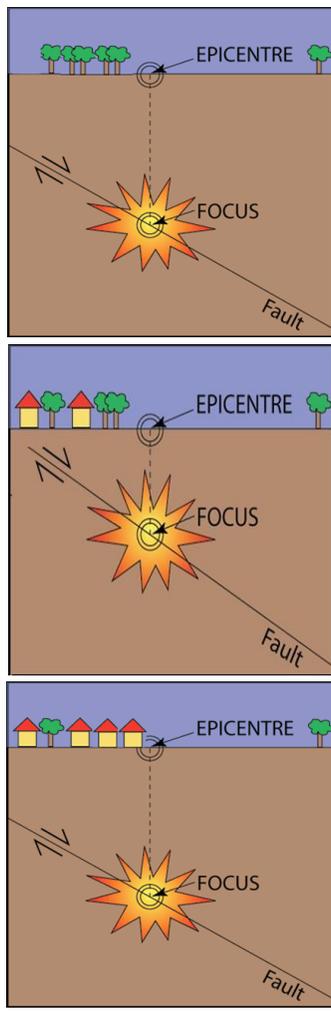
Conservative

*Constructive*

# Why do earthquakes happen?

**Task:** read the sentences and arrange them in the correct order

- Eventually the pressure is too great and there is a sudden movement the point where this happens is the **focus**
- They get stuck as the rock is not smooth
- Eventually the ground is still again, but pressure is starting to build up for the next earthquake.....
- The rocks begin to settle down but there is still some ground shaking as smaller earthquakes called aftershocks occur.
- Two plates are sliding past each other
- Seismic waves travel in all directions and the ground begins to shake
- Huge tension and pressure builds up



Look at the three earthquake scenarios on the left. Which one would you expect to be most devastating, and which one the least? Explain why you think that.

### Mercalli Scale

The Mercalli Scale is different from the MMS because it measures the **effects** of an earthquake. The numbers range from 1 (very rarely felt by people) to 12 (total damage to many structures). Why do you think it might be useful to measure the effects rather than the amount of energy released?

### Moment Magnitude Scale (MMS)

Earthquakes are usually measured on a magnitude scale – which measures how much movement of the earth there is. The higher the number, the more powerful the earthquake. However the difference between 1 point on the scale is equivalent to 32 times more energy released! Can you calculate how much more energy an earthquake of magnitude 7 has compared to one of 5?

# Case study: Haiti Earthquake

The large number of bodies on the street meant that diseases, especially cholera, became a serious problem

Over 4 million people provided with food rations in the weeks following the earthquake

Temporary schools created and new teachers trained.

Support for people without jobs, (nearly 70% of the population), through cash/food-for-work projects

United Nations troops and police were sent to help give out aid and keep order.

The main prison was destroyed and 4,000 prisoners escaped.

People were squashed into temporary homes with poor sanitation leading to further health problems.

Some people in Haiti have to eat biscuits made from mud.

80% of people in Haiti live on less than \$2 per day

\$100 million in aid was given by the USA and \$330 million by the European Union

**Task:** Read the statements about the Haiti earthquake and decide if they are Causes, Effects, Responses or Background Information. Choose four colours and shade each category in a different colour. The definitions below will help you to decide:

## Causes

What actually made the earthquake happen

## Effects

What happened as a result of the earthquake, e.g. what damage did it do

## Responses

How did people respond to the earthquake. E.g. what did people do to help

## Background information

General facts about Haiti – usually relevant to your understanding of the earthquake.

The Dominican Republic provided emergency water and medical supplies as well as machines to help searching underneath the rubble.

Haiti lies right on the conservative plate boundary of the Caribbean and North American plates, pressure had built up and there was a sudden release of pressure.

Many hospitals and schools were badly damaged.

Roads and other transport links were destroyed or severely damaged.

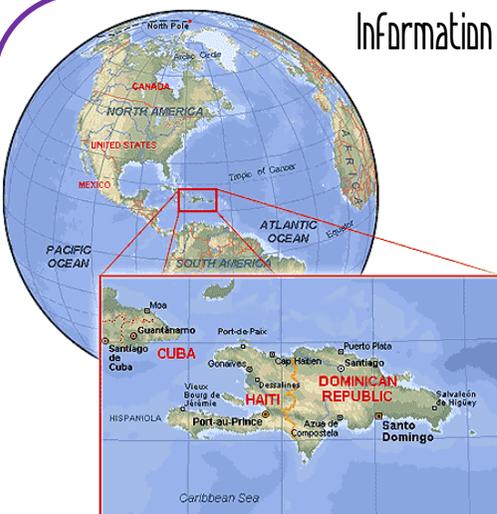
The airport's control tower was badly damaged.

Over 300,000 people were killed and over 1 million people were made homeless.

Haiti, is a Caribbean country. It occupies the western, smaller portion of the island of Hispaniola, which it shares with the Dominican Republic

The problems at the airport meant there were delays getting aid into the country.

1 in 5 people lost their jobs because so many buildings were destroyed.



### Information box

Date: 12<sup>th</sup> January 2010  
 Location: Haiti, Caribbean Island  
 Epicentre: 25km from Port-au-Prince  
 Magnitude: 7.0  
 Depth: 13km  
 Aftershocks: 52



# Effects of Earthquakes

**Task:** Think back to your case study of the Haiti earthquake. In the box below list the main effects of that earthquake. Then decide if they are primary or secondary effects, use the definitions below to help you.

Primary Effects

Secondary Effects

Effects are often split into **primary** and **secondary** effects. Primary effects occur as a direct result of the ground shaking, e.g. buildings collapsing. Secondary effects occur as a result of the primary effects, e.g. fires due to a broken gas main.

Year	Place	Magnitude	Effects
1989	San Francisco, USA.	7.1	143 dead
1993	Latur, India.	6.4	25,000 dead, 150,000 homeless.
1994	Los Angeles, USA.	6.7	57 dead, 20,000 homeless.
1995	Kobe, Japan	7.2	5,500 dead, 310,000 homeless.
2003	Bam, Iran	6.6	31,000 dead.

Look at figure 1 which shows the effects of some major earthquakes. What do you notice about the magnitude and the effects?

Why do you think this might be?



# Effects of Earthquakes

**Task:** The box below shows some typical effects of earthquakes, many of these were observed in the Haiti earthquake that you studied. Using the box below sort these effects into primary and secondary effects by adding them to the columns on the right hand box.

Building collapse

Roads cracking

Homelessness

Burst water mains Leads to difficulties in putting out fires

Psychological effects.

Fires from broken gas pipes

Bridges collapsing

Shattering of glass shop windows.

Cracking of gas and water pipes

Businesses closing

Communications Failing

Primary Effects

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# Living in an earthquake zone - California

## San Andreas Fault

The San Andreas Fault is a 1300km conservative plate boundary that runs through California in the USA. It forms the boundary of the Pacific Plate and North American Plate.

The San Andreas Fault is responsible for the earthquakes that occur daily in California. Most of them are minor, but California also experiences regular significant earthquakes and as a result the state government invests a lot to ensure people are prepared and know how to behave in the event of a major earthquake.



The great California 'Shake Out' is an educational programme to make sure people are prepared and know what to do in the event of an earthquake.

Look at the questions below and see if you can choose the correct answer according to the official advice:

My answer

1) If the earthquake alarm sounds when you are in a lesson at school you should:

- A – Run outside and stand in an open space
- B – Go outside and make your way to the designated earthquake safety zone
- C – Get under your desk and hold on.

2) If you are at home, one of the first things you should do is:

- A – Phone your neighbours to see what they think about the tremor
- B – Check your family pet is ok, and safely locked inside
- C – Turn off the gas, water and electricity supply to your house.

3) How often should you plan and practise your evacuation procedures:

- A - Not much point, if there's an earthquake you will be relying on luck
- B - About twice a year should be ok.
- C - You need to do this every week, you never know when you might need it.

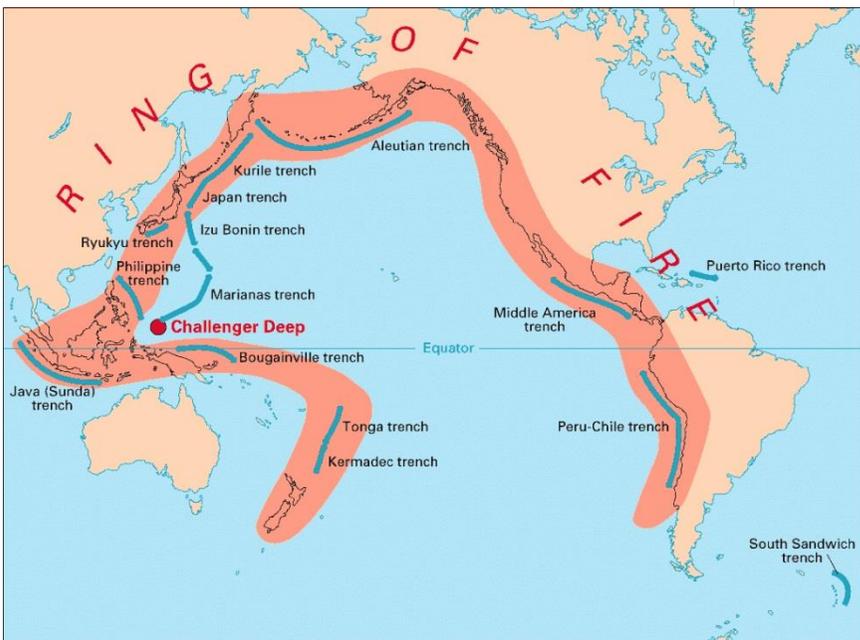
4) Which of the following do you think could be important:

- A – Having earthquake insurance for your home
- B - Arranging an out of town contact for your family to check in with.
- C – Having an emergency pack of essential items prepared in your home.



# Are you prepared?

# The ring of fire



Why is this area known as the ring of fire? Look back to your plate map for clues.

## Challenger Deep

Challenger Deep in the Marianas Trench is the deepest point on the Earth's seabed. It is around 10,900m deep, which means if Mount Everest started at Challenger Deep there would still be nearly 2,000m of water above the peak! When film director James Cameron took a mission there in 2012 it was 52 years after the previous and only people had been to this point.

## haiku

## 俳句

A Haiku is a Japanese poem usually consisting of three lines, with 17 syllables in total. The first line should have 5 syllables, then 7 in the second line and 5 again in the third. Use the box below to experiment and write your own Haikus about earthquakes or volcanoes, the ring of fire or anything to do with Tectonics! Can you improve on the example?



## Focus on Japan

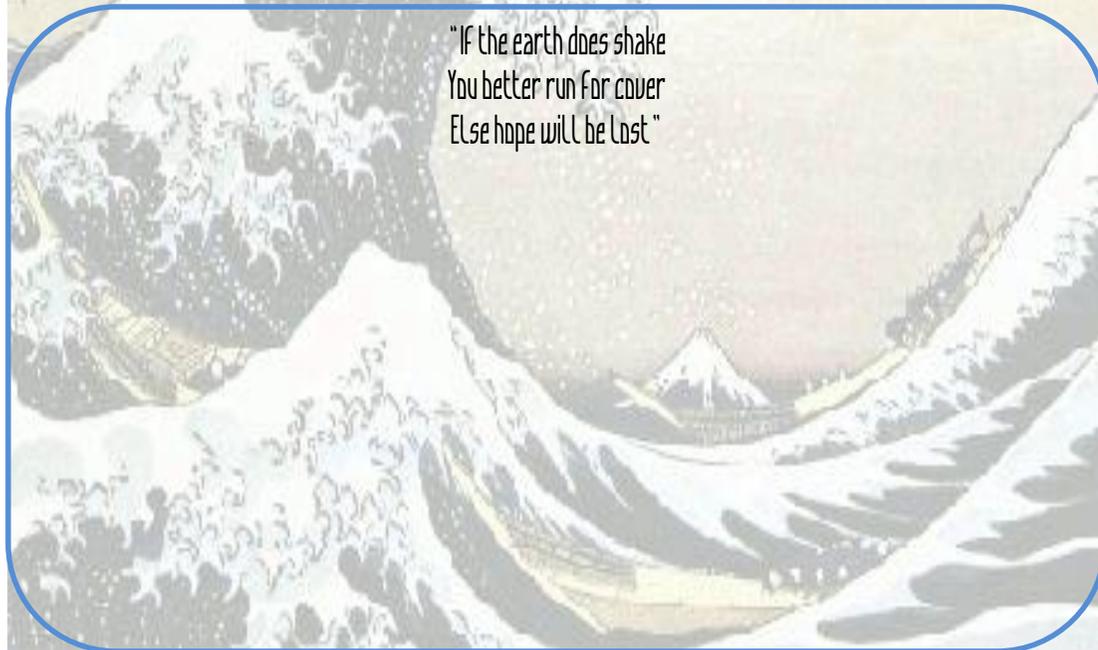
Japan has over 100 active volcanoes and has the most number of recorded eruptions of any country.

As this area is so tectonically active Japan also suffers small earthquakes virtually every day, and many very large earthquakes.

The Great Kanto Earthquake of 1923 resulted in over 120,000 deaths. As a result earthquakes a part of life in Japan and they have made many great advances in earthquake proof construction and preparing for earthquakes.



"If the earth does shake  
You better run for cover  
Else hope will be lost"



# Volcanoes are

How many different words could you use to fill the blank in the worksheet title? Be ready to explain why you chose that word!

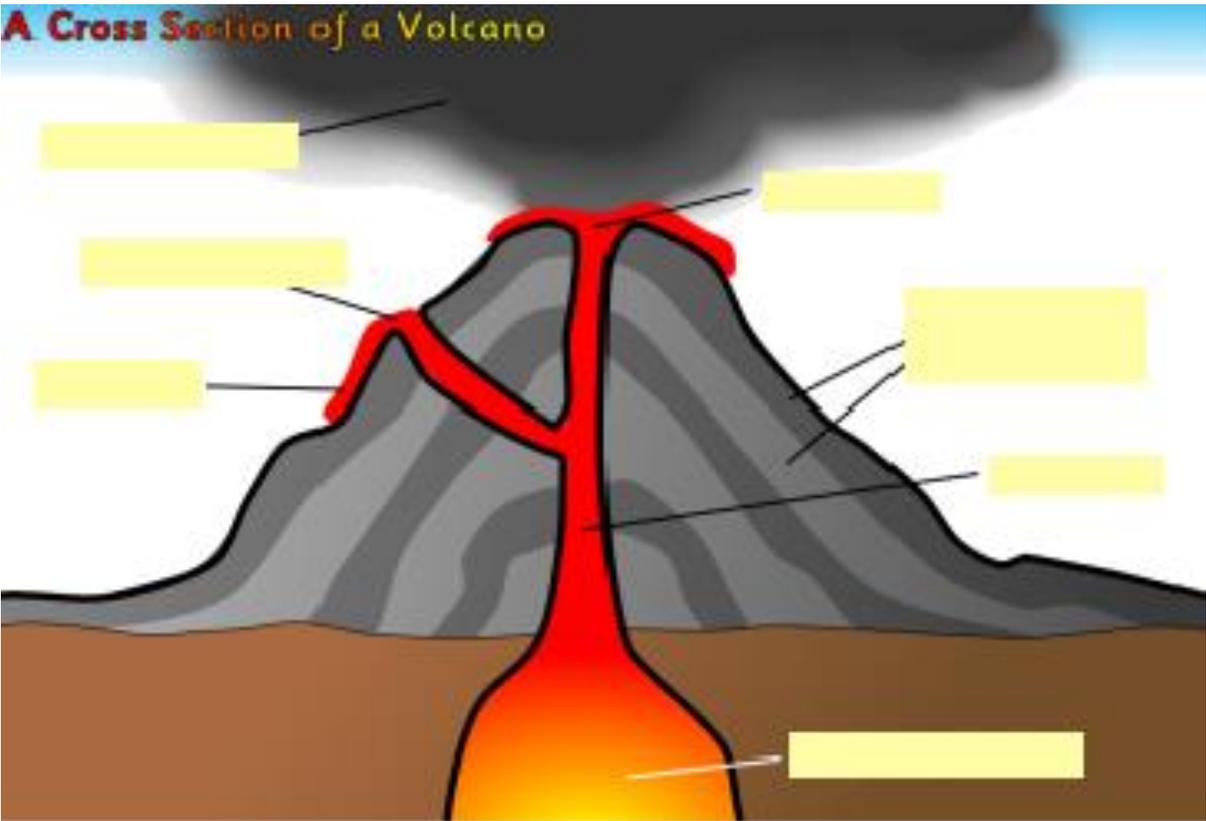
**Task:** Complete the cross-section of a volcano below by adding the labels:

- Lava Flow
- Secondary cone
- Crater
- Main Vent
- Ash Cloud
- Magma Chamber
- Layers of Lava and ash

Now watch the video resource and write down the word used to describe volcanoes, and match the pictures to a reason why.....

Volcanoes are \_\_\_\_\_

A Cross Section of a Volcano



**Task:** The boxes below show the main hazards that result from volcanoes. Which do you think would be the most dangerous? Use the pyramid to rank them (the most dangerous at the top). Explain why you think that in the box below

## A. Volcanic Ash

What is it?



What damage does it cause?

## D. Volcanic Dust

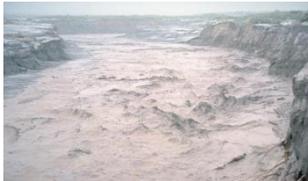
What is it?



What damage does it cause?

## B. Mudflows (Lahars)

What is it?



What damage does it cause?

## E. Pyroclastic Flows

What is it?



What damage does it cause?

## C. Lava Flows

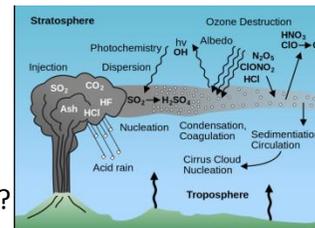
What is it?



What damage does it cause?

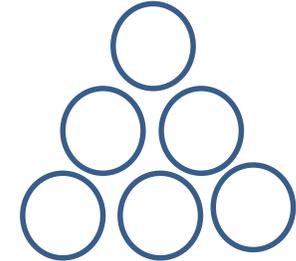
## F. Volcanic gas

What is it?



What damage does it cause?

Which is the most dangerous?



# The lost city of Pompei

*“Broad sheets of flame were lighting up many parts of Vesuvius; their light and brightness were the more vivid for the darkness of the night... it was daylight now elsewhere in the world, but there the darkness was darker and thicker than any night.” Pliny the Younger*

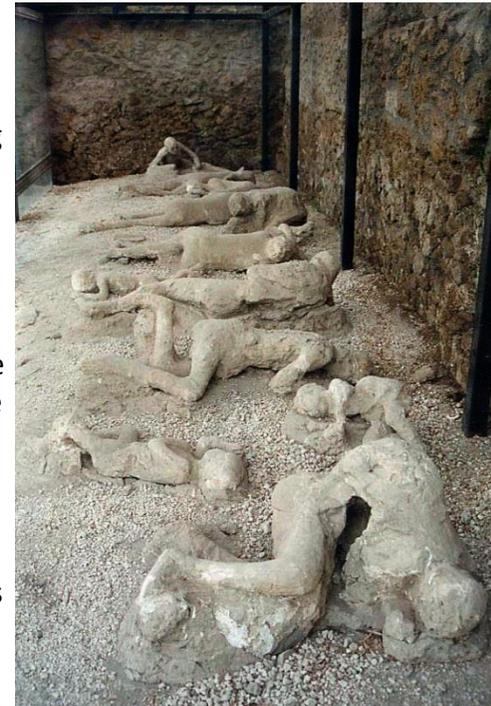


**Task:** Read the story below about the famous eruption of Mount Vesuvius in AD79, fill in the blanks in the story using the word box below.

The city of Pompeii was a Roman city near modern day Naples in the Italian region of Campania. Pompeii was destroyed and \_\_\_\_\_ under metres of ash and pumice in the great \_\_\_\_\_ of Mount Vesuvius in 79 AD. The site was lost for almost 1500 years, and when discovered had been well preserved because of the lack of air and moisture. As a result there is an eerie look of bodies in the position they perished.

Mount Vesuvius is a \_\_\_\_\_ which formed as a result of the collision of two \_\_\_\_\_, the African and the \_\_\_\_\_. One plate was \_\_\_\_\_ beneath the other and the result rise of \_\_\_\_\_ broke through the surface to create a volcano. The eruption of AD79 was preceded by a powerful \_\_\_\_\_ seventeen years earlier. Pliny’s accounts of the time noted that earthquakes were not a concern as they were so frequent. So when minor \_\_\_\_\_ were felt from August 20<sup>th</sup> AD79, no-one took much notice. At around 1:00pm on August 24<sup>th</sup>, Mount Vesuvius \_\_\_\_\_ exploded, throwing up a tall column (up to 30km) from which ash began to fall plunging the area into \_\_\_\_\_. This was not the worst of it, sometime in the night or on the following day \_\_\_\_\_ flows began to roar down the side of the volcano.

People tried to flee for their lives but the fast-moving flows of very hot ash and \_\_\_\_\_ incinerated or suffocated anyone in its path. The landscape and coastline was forever altered. The flows were accompanied by more minor earthquakes and even a \_\_\_\_\_ in the Bay of Naples. The result was utter devastation. The writings of Pliny the Younger were one of the few accounts that survived, his uncle Pliny the Elder died from \_\_\_\_\_ gases as he tried to rescue people. Mount Vesuvius is a popular tourist attraction today, but it remains the most deadly volcano on the European mainland.



subducted

rocks

eruption

inhaling

darkness

buried

pyroclastic

earthquake

tsunami

Eurasian

stratovolcano

tremors

magma

tectonic plates

violently

The last major eruption of Mount Vesuvius was in 1944, this period of relative quiet makes some people fear a big eruption is looming.....



# Should I stay or should I go?

**Task:** Carefully read the statements below and decide whether this is a reason to stay living near the volcano or to go somewhere else, tick ? If you are unsure. You should explain your reason. The last box has been left blank for you to add your own reason from the information you have.

1. The volcanic soils are extremely good for growing plants and crops and your vineyard is very successful.

Stay go ?

Explanation

2. Scientists warn that the next eruption could be as big as 1631 when 3,000 people were killed.

Stay go ?

Explanation

3. The volcano is monitored constantly with some very high tech equipment.

Stay go ?

Explanation

4. Vesuvius usually erupts at least every five years. The volcano has now been quiet since 1944.

Stay go ?

Explanation

5. The Bay of Naples is a beautiful area to live and there are more economic opportunities than in other parts of Italy.

Stay go ?

Explanation

6. In 1984 40,000 people were evacuated from the area, but the volcano did not erupt.

Stay go ?

Explanation

7. Many of the houses in your area were built quickly and illegally after 1944, using simple building methods.

Stay go ?

Explanation

8.

Stay go ?

Explanation



Look at all your reasons and decide which are the most important. Add the numbers in the circles below with the most important at the top:

Most important



Least important

Your final decision

Stay

go

# **Tectonics Pack Part 2 is also available for FREE!**

Just send an email requesting  
part 2 to [josh@icgeography.com](mailto:josh@icgeography.com)

Or enter your email address at:

<http://www.icgeography.com/free-resources.html>