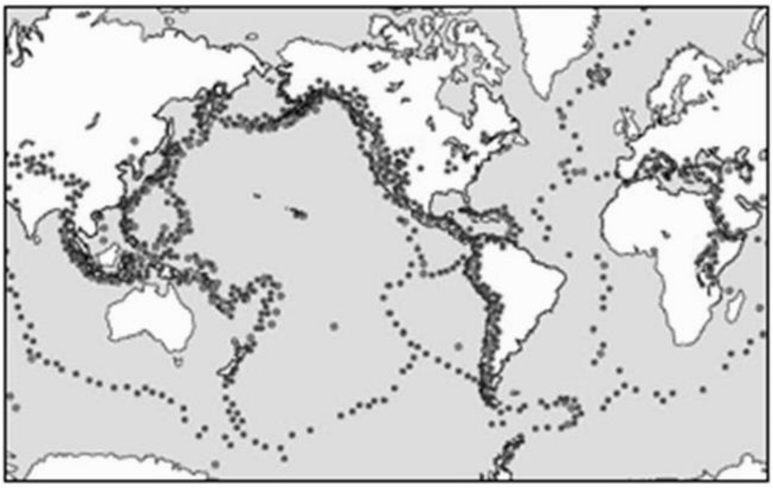
Plate Tectonics

Location and characteristics of tectonic activity

The Global distribution of tectonic activity



Key points for describing the distribution of earthquakes and volcanoes:

a) They tend to occur in **narrow bands** (e.g. along the western coast of America)

b) They are usually located along **plate boundaries**

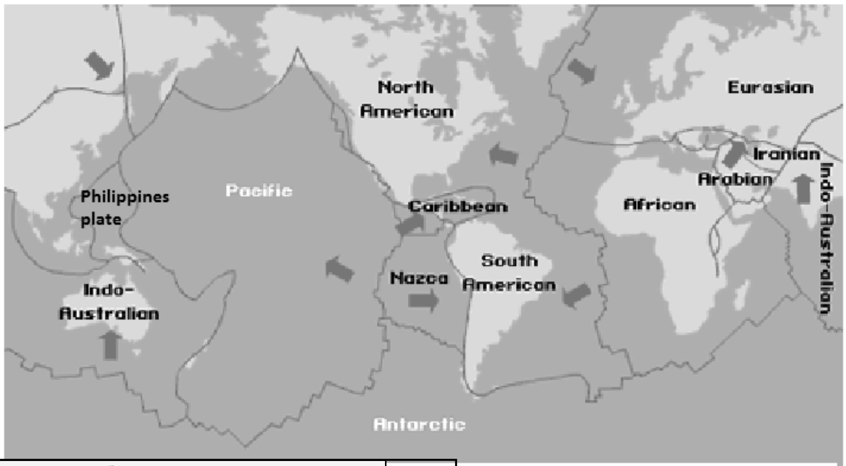
c) They tend to cluster on **coastlines** (particularly true of volcanoes)

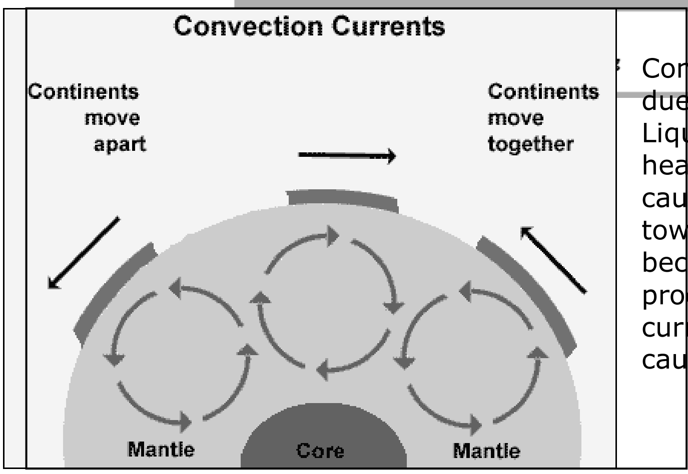
d) There is a loop of tectonic activity around the Pacific Ocean, often referred to as the **'Ring of Fire'**.

Exception - Some tectonic locations fall outside of this general pattern. e.g. Volcanoes are also found in isolated clusters on so-called **'Hot Spots'**, such as the Hawaiian Islands in the Pacific Ocean. Geographers are uncertain why these hot spots form, some believe it they may occur from particularly powerful convection currents in the mantle, whilst others argue that they are simply areas of weak / thin crust.

The reasons why earthquakes and volcanoes occur where they do – tectonics and hot spots

The Earth's crust is divided into tectonic plates that 'float' on the liquid mantle. Earthquakes and volcanoes occur as a result of the movement of these plates. The plates move due to huge 'convection currents'.





Convection currents are created in the mantle due to higher temperatures closer to the core. Liquid magma deeper within the Earth will heat-up, expand and become less dense – causing it to rise. As this magma moves towards the crust it will cool down, shrink and become denser – causing it to sink. This process repeats, creating huge swirling currents which drag and push at the crust, causing the surface plates to move.

The characteristic features of convergent, divergent and conservative plate boundaries.

Convergent plate boundaries are those where two plates are moving towards one another. This can occur between two oceanic plates, two continental plates or when an oceanic plate meets a continental plate. The features vary between the different types of boundary.

When two continental plates meet (Collision Boundary):

- Formation of Fold Mountains. E.g. the collision between the Eurasian and the Indo-Australian plate which has led to the formation of the Himalayas.
- Frequent earthquakes.

When an oceanic and continental plate meet (Destructive Boundary):

- Subduction of the more dense oceanic plate, creating Ocean trenches
- Volcanoes with violent eruptions (Composite shaped with acidic lava)
- Creation of fold mountains e.g. Andes
- Strong earthquakes (possible triggering to Tsunamis)

Divergent plate boundaries are found when two plates are moving away from one another.

Divergences of two oceanic plates can lead to the formation of:

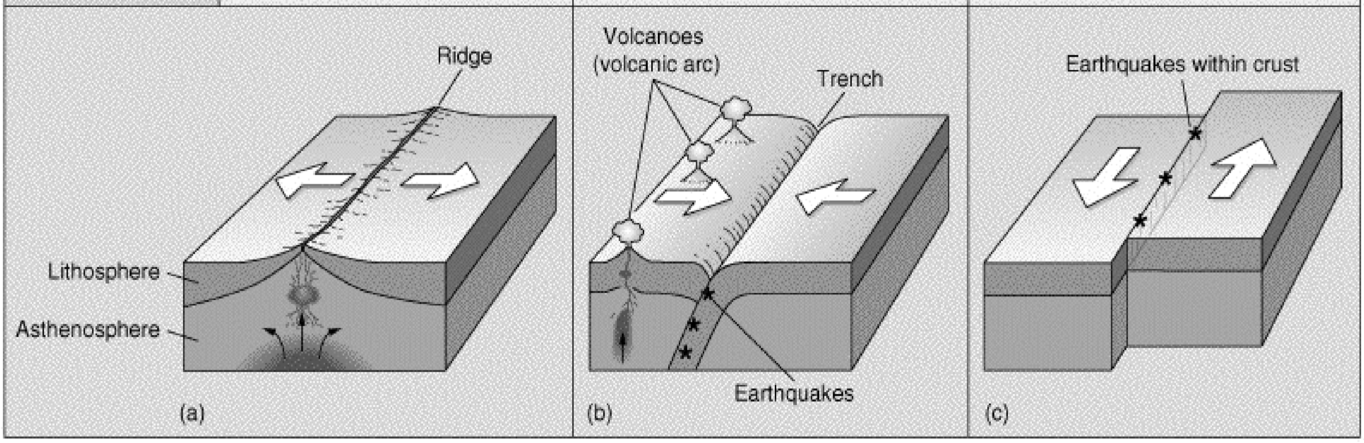
- Volcanoes (Shield Shaped with basic lava)
- Volcanic Islands (e.g. Iceland)
- Mid-ocean ridges (e.g. Mid-Atlantic Ridge)
- Isle Arcs (e.g. Canary Islands)
- Earthquakes

Divergence of continental plates can result in:

- Rift valleys e.g. East Africa
- Volcanoes and earthquakes

A conservative (transform) plate boundary is where two plates slide past each other. E.g. San Andreas fault. No magma is rising in the mantle and no subduction is taking place. Therefore this type of plate boundary has **NO** volcanoes, however earthquakes can be frequent and powerful.

Type of Margin	Divergent	Convergent	Transform
Motion	Spreading	Subduction	Lateral sliding
Effect	Constructive (oceanic lithosphere created)	Destructive (oceanic lithosphere destroyed)	Conservative (lithosphere neither created or destroyed)
Topography	Ridge/Rift	Trench	No major effect
Volcanic activity?	Yes	Yes	No



EXAM PRACTICE

1. **Describe** the global distribution of volcanoes (4)

2. **Define** the term ‘hot spot’? (2)

3. **Explain** why earthquakes occur on plate boundaries (2)

4. **Explain** the formation of volcanoes on convergent plate boundaries (6)

A* Tip: When distributing the distribution of tectonic activity, always include examples (specific places) to support general descriptive points.

A* Tip: It is often easier to explain the processes associated with plate tectonics with the help of a diagram. If you do decide to use an illustration to support your response, don't forget to include labels (or even better annotations) to highlight the important features.

The measurement of earthq… Richter scales) and diagram… nd epicentre.

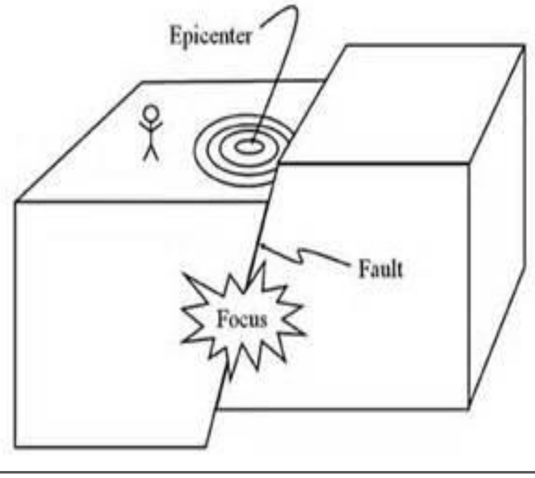
The Earth's crust is broken into sections know as plates. Huge convection currents in the mantle push and pull these plates in different directions. This movement is often jolty as the build-up of friction often results in the plates becoming 'stuck'. Over time, pressure builds-up causing the land to eventually jump – an earthquake.

Key terms:

Focus – The point in the crust where the earthquake starts.

Epicentre – The location on the surface directly above the focus. This is where the shaking is strongest and is often associated with the greatest damage.

Shockwave – A ripple of energy which travels out from the focus.



Aftershock – A smaller earthquake which follows the main quake; can cause considerable damage, as buildings may be in a fragile state as a result of the original earthquake.

The magnitude of an earthquake can be measured in

Aiming for A* – You can calculate how long a response should take to answer, and the amount of writing needed, by the number of points available. 1 point equals just over a minute and usually has two lines.

A) The **Richter scale** measures an earthquake's strength by the amount of energy released during the event. This is measured on a seismograph. There is no upper limit to the Richter scale. The Richter scale is logarithmic, this means that scale goes up by the power of 10, e.g. an earthquake measuring 5 on the Richter scale is 10 times more powerful than a quake measuring 4 and 100 more powerful than one measuring 3.

B) The **Mercalli scale** is a measure of the effects of the earthquake based on what people feel and the amount of damage done. No equipment is needed. The scale runs from 1 to 12. As this scale measures the level of destruction, it is favoured by governments, charities and AID agencies as it gives a better idea of the level of support and help a region nee

Richter Magnitude (M_L)	Mercalli Intensity (Approx.) at Epicenter	Effect on People and Buildings
<2	I–II	Not felt by most people.
~3	III	Felt indoors by some people.
~4	IV–V	Felt by most people; dishes rattle, some break.
~5	VI–VII[b]	Felt by all; many windows and some masonry cracks or falls.
~6	VIII–IX[c]	People frightened; most chimneys fall; major damage to poorly built structures.
~7	X–XI	People panic; most masonry structures and bridges destroyed.
~8	XII	Nearly total damage to masonry structures; major damage to bridges, dams; rails bent.
~9+	>XII	Nearly total destruction; people see ground surface move in waves; objects thrown into air.

Study the causes and effects of a named earthquake.

Bam earthquake, 2003

A large fracture in the earth's crust, called the Bam fault, runs from north to south in the Kerman province in Iran, making earthquakes common in this area. The earthquakes in this region occur as the result of stresses at the convergent plate boundary between the Arabian and Eurasian continental plates.

At 5.26 am on 26th December 2003, an earthquake of magnitude 6.5 on the Richter scale shook the area. The epicentre was 10km south-west of Bam City.

Effects:

Human	Environmental
25,000 people killed*	Fissures (cracks) formed in the ground
50,000 people injured*	Landslides and rock falls
100,000 people made homeless	The ground collapsed above underground irrigation channels
25,000 people treated for trauma	Lack of irrigation led to the death of many date and palm trees

2 hospitals collapsed	
Roads and electricity and phone lines damaged	
***The effects of this earthquake were so great due to the time at which it occurred – most people were still in bed so deaths and injuries were caused by collapsing homes. Additionally, most houses in the region were constructed from traditional mud-bricks which were unable to cope with the power of the quake.**	

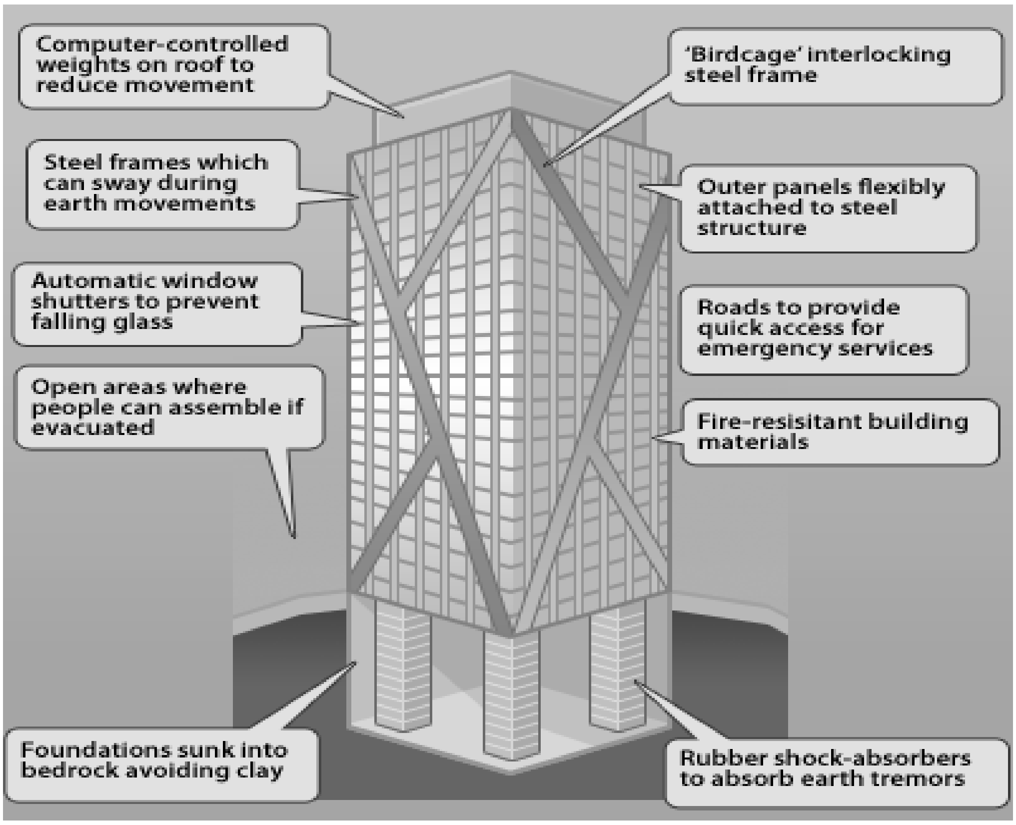
Prediction and prevention of the effects of volcanic eruptions and earthquakes by forecasting, the design of buildings and defences, planning and education.

Forecasting (prediction)

Strategies for Predicting Earthquakes
Noting strange animal behaviour
Monitoring electrical discharges – there is evidence that these rise before an earthquake
Recording minor tremors – some major earthquakes follow small foreshocks
Quake Mapping – Some faults appear to 'jump' at relatively regular intervals, e.g. every 50 years.
Lasers can be used to measure the land. Prior to the earthquake the land may begin to buckle under the growing pressure.

Defences and building design

Earthquake proof buildings



Education

In the USA, the Federal Emergency Management Agency (FEMA) gives information on how to prepare for a tectonic hazard, including:

1. Checking for hazards in the home (e.g. furniture which could topple over in a quake)
2. Identification of safe places indoors and outdoors
3. Knowledge of evacuation routes and the location of nearby shelters / aid distribution centres.
4. Have disaster supplies on hand – An easy to carry emergency kit with essentials such as food, water and medical supplies.
5. Develop an emergency communication plan

In Japan, 1st September is Disaster Prevention Day. On this day emergency drills organised by the local governments are held across the country. A lot of schools carry out evacuation drill as part of the back-to-school routine. These drills ensure everyone knows what to do in the event of an earthquake or volcanic eruption, hopefully leading to a quick and safe response.

<u>EXAM PRACTICE</u>

1. **Suggest** why some earthquake causes more damage than others. (4)

2. **Define** the term 'epicentre'? (2)

3. **Outline** the techniques used to help predict future earthquakes (2)

4. For an earthquake you have studied, **explain** its impact on both people and the environment. (6)

5. Using examples, **explain** how building design can reduce the effects of an earthquake. (6)

A* Tip: Be extra careful when using tectonic specific vocabulary. Key terms, such as focus and epicentre are often mixed up.

A* Tip: Don't waste valuable space and time giving case studies an introduction – Focus on the question and try to ensure all your response is points scoring.

A* Tip: When learning your earthquake case study, don't forget to include the environmental impacts. These are often forgotten in extended answers, preventing a level 3 score.

Prediction and prevention of t… s and earthquakes by forecasting, th… ences, planning and education.

A volcano is an opening, or **vent**, in th… …gent and convergent plate boundaries as well on hotspots. The impact of future eruptions can be reduced through forecasting, construction, planning and education:

Forecasting …

Aiming for A* – You can calculate how long a response should take to answer, and the amount of writing needed, by the number of points available. 1 point equals just over a minute and usually has two lines.

Volcanologis… …of a future volcanic eru…

U… as…
Ga… increased magma activity beneath the surface.
Geothermal monitoring from space, to record changes in surface temperature as magma approaches the surface

Monitoring of earthquake activity - As magma rises through the volcano it can trigger small earthquakes. These are often shallow and clustered.
Historical records can be used to detect patterns in activity
Water temperatures can increase in springs/rivers flowing from the volcano or may become contaminated with high levels of sulphur.

Education

As with earthquakes, authorities will educate communities living close to active volcanoes to limit the impact of any future eruption. Populations in risk will be encouraged to keep an emergency kit in their home, car and workplace. This kit should include essentials, such as food, water and medical supplies. Local people should practice evacuation routes and know the location of nearby shelters.

Building design and defences

The impact of various volcanic dangers can be reduced through building design:

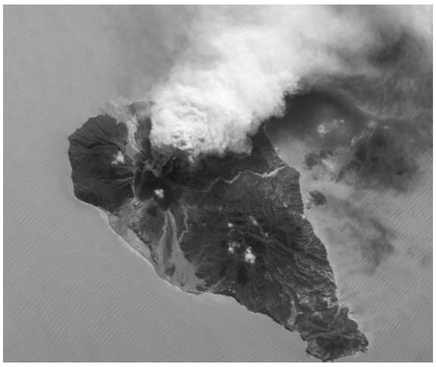
- Houses can have steep roofs to avoid the build-up of heavy volcanic ash
- Barriers can be built to block lava flows
- Diversion channels can be construction to re-direct lahars, mudslides and lava flows
- Concrete shelters can be built to provide protection from volcanic bombs.

Planning

Authorities often use hazard zoning to reduce the impact of volcanic eruptions. Volcanologists will use modelling to predict the areas which are most likely to be severely affected by a future eruption. These danger zones will be closed-off to the public. Additional areas may also be evacuated if a large eruption is predicted.

The causes and effects of a volcanic eruption or an earthquake on people and the environment, in a named location.

Case Study: Montserrat volcanic eruption, 1995



The island of Montserrat lies on an oceanic - continental convergent plate boundary. As the plates merge, the oceanic plate is forced down (subducted) beneath the continental plate. The heat created by the friction between the two plates melts the descending crust to form liquid magma which rises through faults and cracks to the surface, forming a volcano – The Soufriere Hills. Between 1995 and 1997 this volcano erupted huge quantities of ash and released frequent lava and pyroclastic flows.

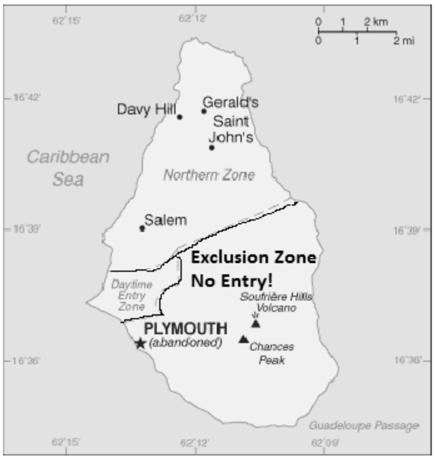
Effects:

- 23 people died
- 2/3 of the island covered in ash
- ½ the population evacuated to the north of the island
- ½ the population left the island
- Plymouth, the capital, became an abandoned ' ghost town'

- Crops and animals were destroyed by layers of ash
- Forest fires were caused by the ignition of volcanic gases
- River channels became blocked by ash resulting in flooding
- The island's main source of income, tourism, was greatly reduced leading to unemployment and economic hardship.

Human response:

- £41 million in aid was donated by the British government
- Money was given to individuals to help them move off the island
- There were riots in the streets as the locals felt the British government were not doing enough to help
- The Montserrat Volcano Observatory was set up to monitor the volcano
- A risk assessment was undertaken to help locals prepare for future eruptions
- Exclusion zone created to keep locals away from the volcano… and danger



The reasons why people continue to live in areas of volcanic and earthquake activity

Economic

- Volcanic soils are especially fertile – great for farming.
- Minerals such as tin, gold, copper and diamonds can be found in volcanic rock – great for mining. Locals think the income from mining is worth the risk of harm from volcanoes/ landslides caused by earthquakes.
- In Iceland the volcanoes provide very cheap geothermal energy.
- The areas may be popular tourist attractions – provides jobs for the locals
- It is also possible that locals may be ignorant of the risks in their area

Social

- A lot of poorer people, especially in LICs, don't move because they can't afford to.
- People do not want to move away from their family and friends
- Some volcanoes can remain dormant for hundreds (even thousands) of years so locals do not always consider the volcano to be a risk.
- At Mt. Merapi in Indonesia locals worship ancient spirits who they believe will warn them of an eruption.
- People in MICs feel safe in tectonic zones due to advances in prediction technology, response teams and earthquake proof infrastructure.

Environmental

- Some volcanoes are popular tourist destinations e.g. Mount Etna in Sicily

- Some places are known for their beauty or pleasant climate and some individuals buy houses despite being aware of earthquake/volcano risk

EXAM PRACTICE

1. **Outline** how planning can reduce the impact of future eruptions (2)

2. **Explain** how hotspots can lead to the formation of volcanoes. (3)

3. **Describe** two techniques used to forecast future eruptions (4)

4. **Explain** why volcanic regions are often densely populated. (6)