AQA GEOGRAPHY

FULL SET OF NOTES ON TECTONICS

2012

These notes were copied from an AQA textbook. They contain EVERYTHING you need to know for the exam for the tectonics section.

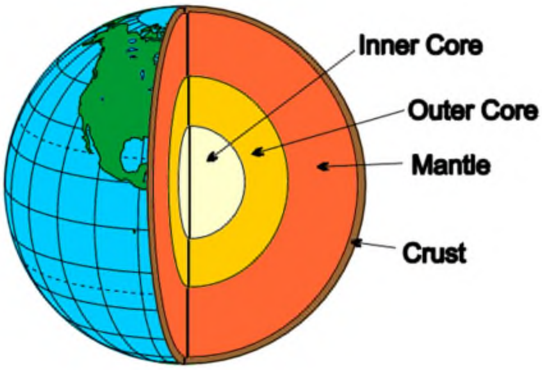
You WILL however, need to use your own case studies as these are not included.

You will need 2 case studies for volcanoes, and 2 case studies for earthquakes.
You ideally need to have one LEDC and one MEDC for each.

You could use Iceland and Pinatubo for the volcanoes; and Haiti and Japan for the earthquakes

TECHTONICS	
TOPICS	**UNDERSTOOD/COVERED?**
PLATE MOVEMENT	
SEISMICITY	
VULCANICITY	

PLATE MOVEMENT



CORE- size of mars, densest part, made of rocks of iron and nickel.
Rigid upper mantle, apart from this most of the mantle is semi molten with temperatures near the core reaching 5000 degrees. These high temperatures generate convection currents.

Thinnest layer is the crust which has the coolest less dense rocks. These rocks are rich In silicon o2 aluminium potassium and sodium.

TWO TYPES OF CRUST: Oceanic and continental. Composed of mainly sedimentary, metamorphic and igneous rocks. Continental crust can be 70km thick.

PLATE TECHTONIC THEORY:
People had noticed that certain continents looked like they had once fitted together. Evidence built up over time and Alfred Wegner was allowed to publish his theory. He suggested that they were once all joined and called Pangaea. Wegner proposed that at some time land had drifted apart.

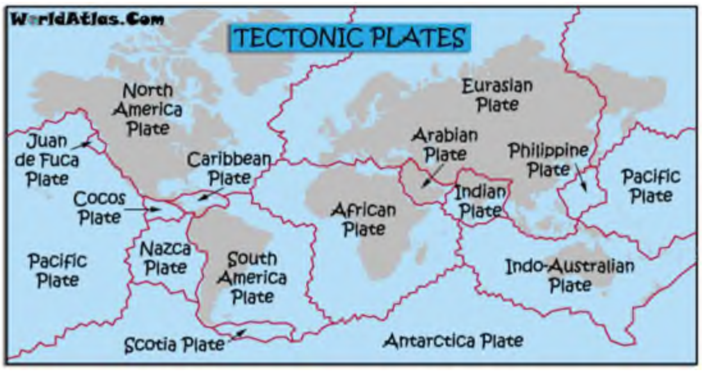
<u>**Evidence included:**</u>

1)Continental fit: seemed to fit together if placed besides each other.

2) Geological Evidence: rocks of the age and type are found in SE Brazil and South Africa. The trends of mountains in East USA and NW Europe are similar when they are placed in old positions. Similar glacial deposits are found in Antarctica, S America

3) Climatological Evidence: Places as far apart as Antarctica, North America and the UK all contain coal deposits of similar age that were formed in tropical conditions. They are no longer in tropical climate zones and must have drifted apart.

4)Biological Evidence: Similar fossil formations are found on either side of the Antartic. Same reptile called meosaurus is found only in S America and South Africa sediments. Plant remains,



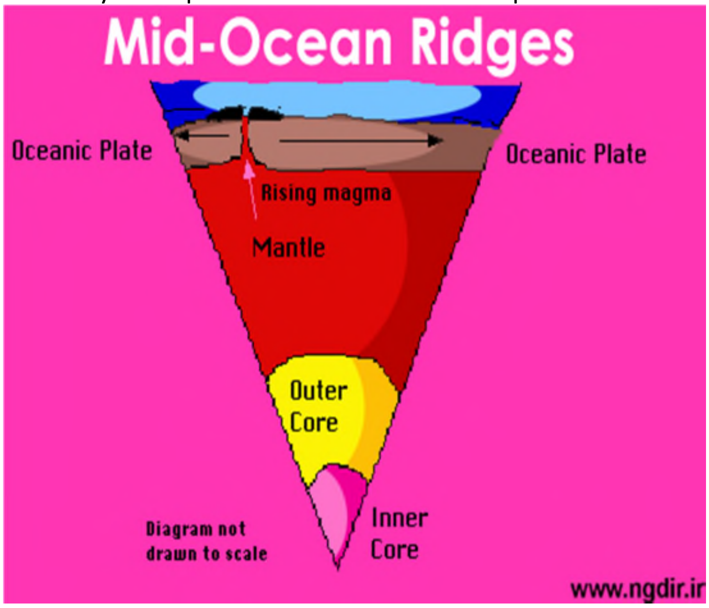
LANDFORMS ASSOCIATED WITH CONSTRUCTIVE MARGINS

OCEANIC RIDGES:

Where two plates pull apart there is a weaker zone in the crust and an increase in heat near the surface. The hotter expanded crust forms a ridge. The central part of the ridge may feature a central valley where a section of crust has subsided into the magma below. The split in the crust provides a low pressure zone where the more liquid lavas can erupt to form submarine volcanoes. If these eruptions persist, volcanoes may develop until they reach the surface. Islands can be formed.

For instance Iceland a volcanic island on a spreading ridge. In 1963 eruptions created the island of surtsey to the south of Iceland.

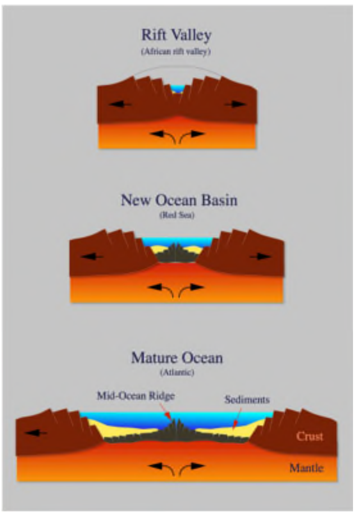
As crust is pushed away from the heat source at the mid ocean ridge it cools, contracts and sinks towards deeper regions. Where it becomes covered in fine sediments. Occasionally fragments of ocean floor are left at the surface during subduction and the layers of pillow basalts and later deep ocean sediments are exposed. E.g. Toodos ophilite suit in Cyprus.

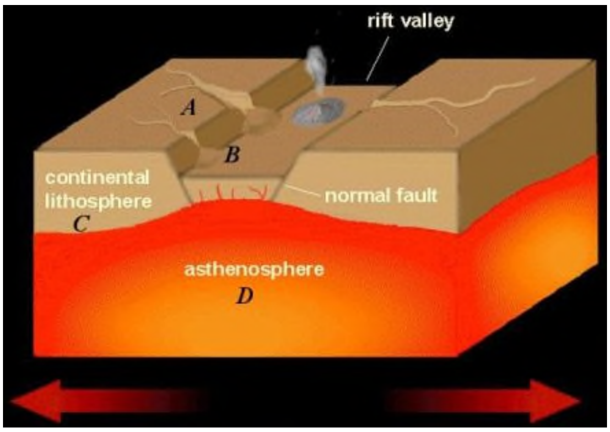


Mid ocean ridges are irregular curving around the planet. If new ocean crust was created equally on both sides, it would appear to create the possibility of over lapping new crust on concave sections and divergence on convex sections. The fact that there are no mountains of ocean floor or sudden gaps in crust is explained by the fact that the seemingly continuous spreading ridges are frequently bisected by transform (slip) faults, which allow the crust created at the ridges to move outwards at different rates. Seismicity associated with such movements on and around the ridges is characterised by shallow focus earthquakes.

RIFT VALLEYS:

When spreading occurs beneath a major land mass, the heating and subsequent updoming of the crust leads to fracturing and rifting. As the sides of the rift move apart, central sections drop down to form rift valleys. Mount Kenya are surface evidence of the igneous activity beneath. As 4000km long up to 50km wide and 600m in depth. This feature can still widen allowing the sea to inundate it. To the North two rifts have widened into the red sea and the gulf of Arabia respectively. Here the rifting has continued and NEW OCEAN FLOOR is forming between Africa on the SW side and Arabia (NE).

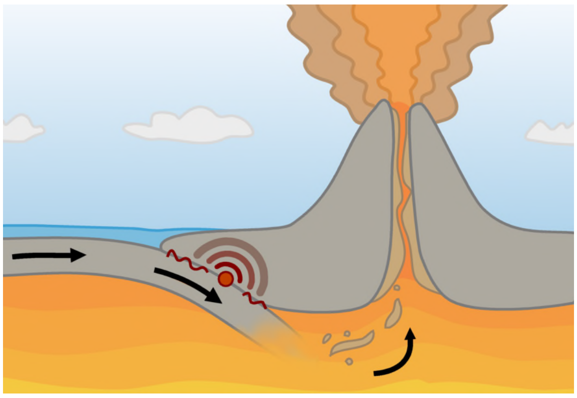


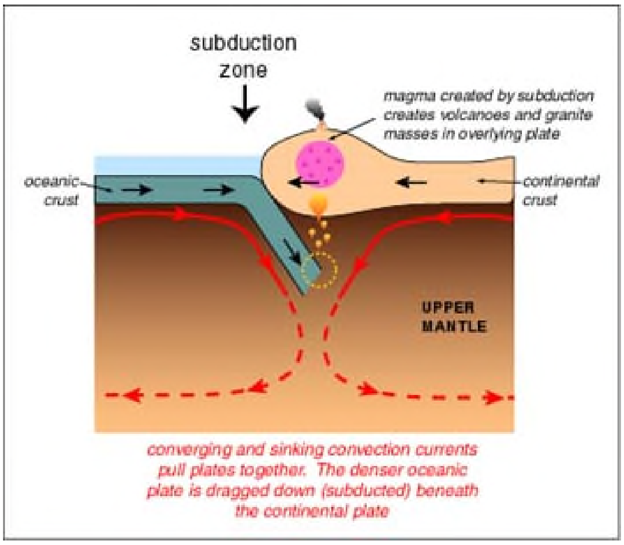


LANDFORMS ASSOCIATED WITH **DESTRUCTIVE** PLATE MARGINS

Destructive plate margins are found where plates converge. There are three types of convergent margin:

1)Oceanic plate meeting continental plate
2)Oceanic plate meeting oceanic plate
3)Continental plate meeting continental plate





2) **OCEANIC PLATE MEETING CONTINENTAL PLATE (CONVERGING)**

Oceanic crust is denser than continental. When plates collide the oceanic crust is SUBDUCTED or taken down into the upper mantle. As oceanic crust descends, friction with the overlying continental crust builds up and can cause MAJOR EARTHQUAKES. Destructive margins are some of the most seismically active zones in the world. Rocks scraped off the descending plate and folding of the continental crust helps to create young fold mountain chains on the edge of continental masses such as THE ANDES (South America). Deep ocean trenches are found along the seaward edge of destructive margins. They mark where one plates begins to descend beneath another. E.g Peru Chile 8km deep trench.

The friction caused by the sinking slab of ocean floor also generates loads of heat leading to partial melting of the crust. Magmas derived from the melting of old ocean floor basalts. They try to rise up through fissures and by burning their way through overlying rock until they reach the surface. Where volcanoes erupt on land they help to create young fold mountains such as the Andes. Because magmas from which the volcanic lavas originate have incorporated elements of older crust and continental rocks as they rose, they are more silica rich and more acidic. These magmas flow less easily & leave intrusive such as batholiths within mountains and generating extrusive such as andesitic lava to erupt through volcanoes. Such sticker lava frequently blocks off their own vents until erupting violently to form conical shaped volcanoes of alternating layers of ash and lava. Vulcanicity is a key feature of subduction zones, around 80% of all active volcanoes are found around subduction zones.

1) **OCEANIC PLATE MEETING OCEANIC PLATE (CONVERGING)**

When two pieces of oceanic crust on DIFFERENT PLATES COLLIDE one is subducted beneath the other. The crust that has subducted may be marginally denser or one is moving faster than the other. The processes that accompany subduction are much the same as in the case of ocean/continental plate collision, BUT where the volcanoes usually erupt on crust covered by oceans they form islands. These form characteristically curving lines of new volcanic land known as island arcs with deep ocean trenches. Such island chains may develop over millions of years to become major land e.g. JAPAN OR INDONESIA. Subduction produces frequent shallow- to deep focus earthquakes, some of which are immensely powerful.

e.g. In Indonesia where the Australian plate is being subducted beneath Eurasian plate there was an earthquake in 2004 measuring 9 on Richter scale.

3) **CONTINENTAL PLATE/CONTINENTAL PLATE CONVERGENCE**

where subduction of oceanic crust draws two continental masses together, a collision margin may develop. As continents have similar density and thus buoyancy, they will not be subducted. Instead they collide with each other. Volcanic associated with earlier subduction and sediments scraped off the vanishing ocean floor are mixed up and compressed to form young fold mountain chains with deep roots in the lithosphere.

The subcontinent of India is an example: It was propelled by sea floor spreading of the indo Eurasian plate some 40 million years ago. This collision formed the Himalayan mountain chain. Himalayas are constantly changing because these highly folded and faulted regions do not become seismically quiet after 1st impact. At this extreme altitude wreathing and erosion reduce mountain height, but isostatic lift in some areas produced by continuing plate motion means that Everest is increasing by 2.5cm a year. The whole region experiences high levels of seismicity causing earthquakes in 2001, Afghanistan 2002, Pakistan 2005, and China 2008.

[isostatic lift= uplift of land mass resulting from tectonic processes]

CONSERVATIVE MARGINS:

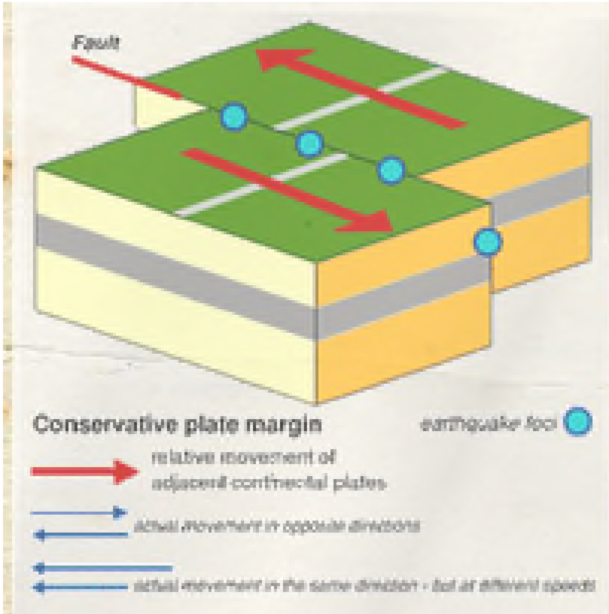
These margins are sometimes referred to as passive or slip margins and occur where two plates meet and the direction of plate motion is parallel.

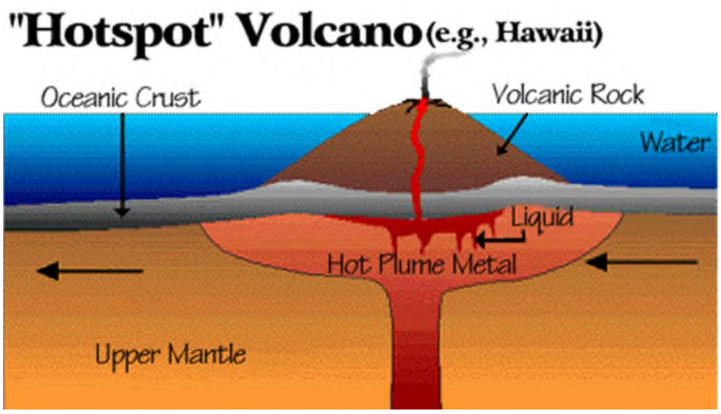
Two examples:

1)San Andreas fault in Calafornia

2)Alpine Fault in New Zealand

No crust is destroyed or created, although these areas of frequent seismic activity as the build up of friction as plates pass each other is released by earthquakes. THEY ARE NOT ASSOCIATED WITH ACTIVE VULCANISM.





HOT SPOTS:

Maps of volcano distribution indicate that although most active volcanoes are associated with divergent and convergent plate margins, others do not conform to this pattern.

Hawaiian Islands are an example. Formed in the middle of the Pacific Ocean more than 3,200km from the nearest plate boundary. Some geologists believe the long lived and stationary hot spots are the result of plumes of magma originating deep within the mantle. Others suggest they are created from far less depth and in fact are moving slowly.

As basaltic shield volcanoes erupt through the drifting oceanic crust, they may build up from ocean floor to form an island over time. However they become part of the plate and are gradually moved away from the heat source. Some islands will become eroded by waves and form flat topped sea mounts called guyots.

Newer volcanoes erupt over the hot sport and a new island is formed. This sequence can form a chain of islands A new island will form to SE of Hawaii when the Loihi submarine volcano builds up to sea level.

SEISMICITY

EARTHQUAKES

Earthquakes occur when a build up of pressure within the Earth's crust is suddenly released and the ground shakes violently. The point within the crust where the pressure release occurs is known as the focus.

This can be:

1) Shallow 0-70kmkm

2)Intermediate 70-300km

3)Deep 300-700km

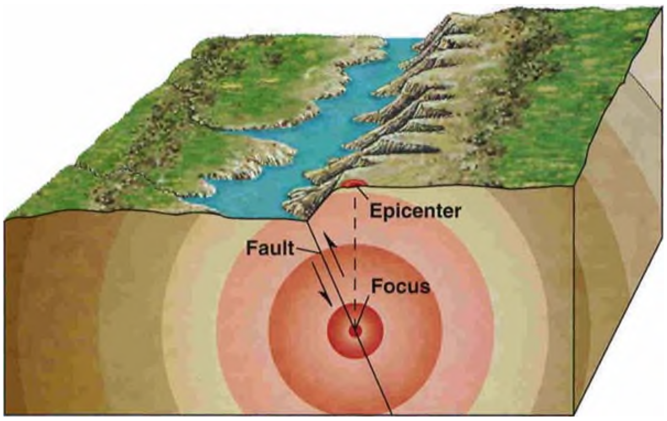
The seismic shock waves have their highest level of energy at the focus; energy decreases as the waves spread outwards. The place on the Earth's surface immediately above the focus is called the epicentre. It receives the highest amount of energy and so the most potentially dangerous location.

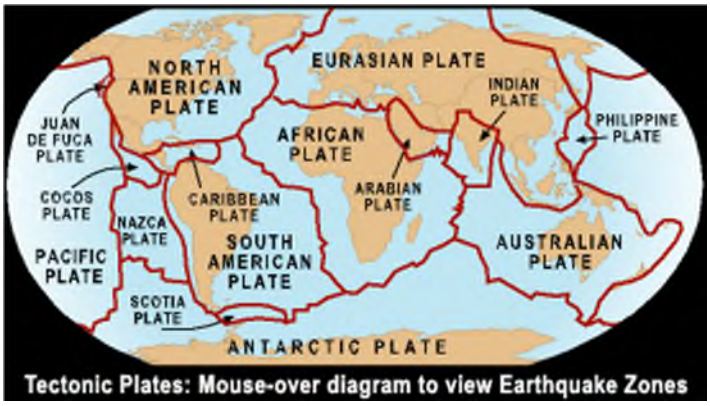
Seismic waves travel out from the focus, there are three types of waves:

1)P Waves- (primary) are the fastest and shake the Earth backwards and forwards. These travel the fastest and move through solids and liquids.

2) S- Waves (Secondary) are slower and move with a sideways motion, shaking the Earth at right angles to the direction of travel. They cannot move through liquids but are more damaging.

3) Surface Waves- these travel near to the surface and slower than the two mentioned already & they're more destructive than either. They include L waves (long waves) which causes the ground to move sideways and Raleigh waves which make it move up and down.





<u>**Magnitude and frequency:**</u>

Magnitude is amount of energy released and is measured using a RICHTER SCALE. A logarithmic scale. An earthquake measuring 7.6 is 10 times greater than one measuring 6.6.

The intensity of an earthquake is measured on the 12 point Mercalli scale which reflects the effects of the event.

Frequency of earthquake events varies greatly between seismically active regions (e.g Sunda Trench off SW coast of Indonesia) and seismic zones within the shield areas of ancient crust (Greenland)

Seismometers are instruments that measure and record the shock waves created by earthquakes. They locate and measure the size of shock waves and are used in establishing patterns of seismic activity that may help predict future earthquakes.

Aftershocks- are earthquakes that follow on from the main event and may last for months afterwards. They are generated by the Earth settling back after the disruption. Aftershocks in Indonesian earthquake of 2004 was followed by a series of aftershocks one being 6.1 in magnitude.

Effects of Earthquakes

TSUNAMI:
Enormous sea waves generated by disturbances on the sea floor. They are most often triggered by earthquakes and submarine landslides. Most devastating example occurred in December 2004 in Indonesia.

LIQUEFACTION:
Violent disruption of the ground causes it to become liquid like. Such extreme shaking causes increased pore water pressure which reduces the effective stress and therefore reduces the shear strength of the soil so it fails more easily. Can cause the movement of groundwater. Even though the surface may appear dry, excess water will sometimes come to the surface through cracks bringing liquefied soil, creating 'soil volcanoes'.

This can cause damage to buildings and underground utilities. Buildings can sink as a result. In San Francisco where development has occurred on reclaimed land in the bay area, the ground is far more likely to fail due to liquefaction. It is estimated that $100,000 million worth of damage was caused by this secondary effect.

AVALANCHES & LANDSLIDES: Where the slope failure occurs as a result of ground shaking.

<u>HUMAN IMPACT:</u>
Depends on population density and distance from the epicentre
Primary Impacts:
*Collapse of buildings, roads and bridges
*disruption to gas, electricity and water supplies

Some are primary effects- directly from the earthquake, some are secondary e.g. electricity breaks so they cannot cook etc.

Secondary include:
*Fires from ruptured gas mains
*Contaminated water
*Loss of trade

Distribution

Fig. 1.29 *Global earthquake distribution*

Earthquakes are not evenly distributed over the planet; but instead, occur in broad, uneven belts. This is because the vast majority of earthquakes are related to plate motion and are therefore found around plate boundaries.

*Most powerful are related to destructive margins where the descent of the oceanic crust creates frequent shallow to deep focus earthquakes.

*Earthquakes at constructive margins are often submarine and usually distant from human habituation, presenting a relatively minor hazard.

*Earthquakes at conservative margins where plates slip past each other a series of fault lines marks where the crust has failed catastrophically. San Andreas Fault for instance is not a single feature but a broad shatter zone of interrelated faults. In addition to this earthquakes occur in regions that do not appear to be near active plate margins. The earthquakes in China and central Asia occur along extensive lines of weakness related to the collision of India with the Eurasian plate over 50 million years ago.

PREDICTION

PROTECTION

EARTHQUAKE MANAGEMENT

CASE STUDIES

EARTHQUAKE MANAGEMENT

PREDICTION

Currently no reliable way to accurately predict when an earthquake will occur. BUT There are several methods:

1) **Seismic Records**- studying patterns of earthquakes and using these to predict the next event. Seismic shock waves are recorded on a seismometer or seismography.

2) Radon Gas Emissions- (gas sensor) radon is an inert gas that is released from rocks such as granite at a faster rate when they are fractured by deformation.

3) Ground Water-deformation of the ground water can cause water levels to rise or fall.

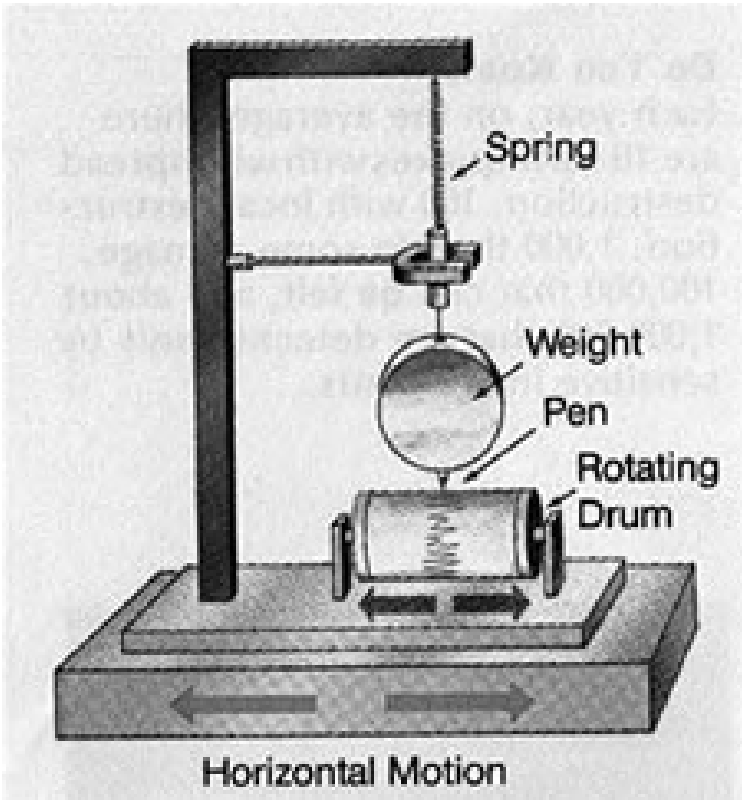
4) Remote sensing- some evidence that electromagnetic disturbances in atmosphere directly above areas about to have an earthquake can be detected.

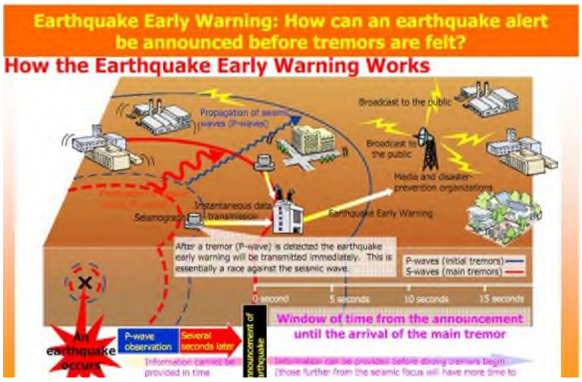
5) Animal movement

6) Low frequency electromagnetic activity- detection of electromagnetic emissions transmitted from Earthquake regions satellite has made observations that show strong correlations between certain types of low frequency electromagnetic activity and the seismically most active zones on the Earth. Sudden change in the ionosphere electron density and

Example of unreliable prediction:
1980's along San Andreas fault in California studies of patterns led to predictions of an earthquake between 1988 and 1992. The predicted earthquake actually happened in 2004.

China 1975 observations of changes in land elevation ground water levels and animal behaviour led to an evacuation warning the day before of a 7.3 magnitude earthquake struck. This saved many lives.
BUT there was no warning of the 1976 Tangshan earthquake 7.6 mag which caused 250,000 fatalities.

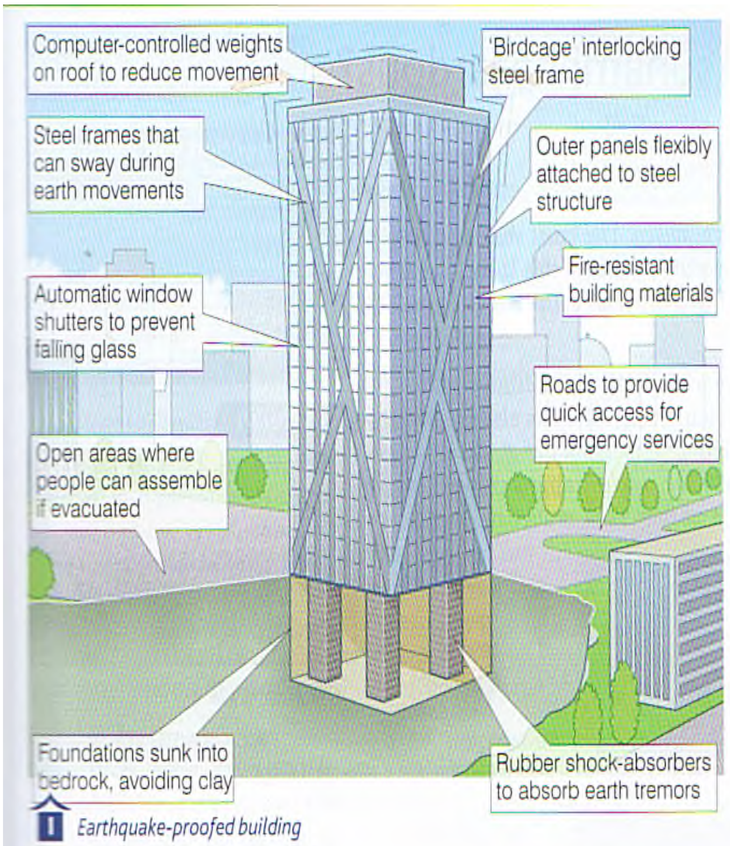




PROTECTION

Authorities focus on:
1)Making buildings/cities more earthquake resistant
2)Raising public awareness about disaster prevention via an education programme
3)Improving earthquake prediction

*Better evacuation routes and sites to receive evacuees make cities better able to withstand the effects of the earthquake.
*To reduce the risk of fire after an earthquake Japanese government encourage the building of fire resistant buildings and advanced fire fighter facilities
*All buildings have strict standards to be earthquake proof (New law in 2007 which ensure buildings are double checked to ensure they meet requirements) – problematic for construction firms
*Focus on areas prone to earthquakes such as KOBE and or cities like Tokyo where people from all over the world go to. Here there are real time equipment and dense observation methods.
In dense populated areas such as Tokyo there are several buildings designed to be more resistant to earthquakes. (See below)



Earthquake-proofed building

Citizens are advised to keep some supplies like food, water and blankets as well as first aid kits and emergency tools. Police info sheets ensure that people know what to do in each stage of an emergency.

Smart meters are installed. These are fed seismic data to allow them to shut down gas supplies automatically in the event of an earthquake.

Land use planning attempts to identify the areas at most risk and plan where to build schools and hospitals away from these areas.

Insurance is available but even in rich countries like Japan few people are willing to pay for such specific cover. Only 7% of people of Kobe had insurance at the time of the earthquake in 1995.

Using an example - Describe the characteristics and explain the causes of tsunamis.

Using an example describe the effects of tsunami.

“The hazards presented by volcanic and seismic events have the greatest impact on the world’s poorest people.”
To what extent do you agree with this view? *(40 marks)*
june 10

VULCANICITY

VULCANICITY

DEFINITION:
EXTRUSIVE ROCK-
Igneous rock formed by the crystallisation of magma above the surface of the Earth

INTRUSIVE ROCK- Igneous rock formed by the crystallisation of magma below the surface of the Earth

Volcanoes are openings in the Earth's crust through which lava, ash and gases erupt. Molten rock beneath the surface is referred to as magma but once it is ejected at the surface it is called lava.

**At depths the enormous pressure upon hot rocks keeps them in a semi solid state.*
**Fissures and fractures in the crust create low pressure areas that allow some material beneath the crust to become molten and rise.*
**If these molten rocks reach the surface they are said to be extrusive but if they're injected into the crust they are said to be intrusive.*
**But both are termed igneous.*

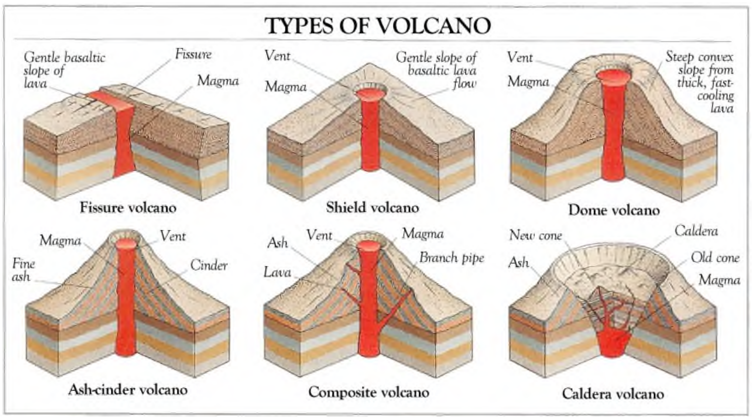
EXTRUSIVE LANDFORMS

BASALTIC (basic) LAVAS: - Originate largely from the upward movement of mantle material. They are most common along spreading ridges but are also found at hot spots and within more developed rift systems

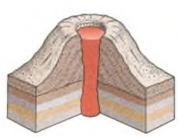
ANDESITIC (intermediate) LAVAS: - Are typical of destructive plate margins where crust is being destroyed

RHYOLITIC (acid) LACAS: - Are most often found at destructive and collision margins.

Pyroclastic material comprises a wide range of volcanic fragments from ash to larger volcanic bombs. They are characteristic of more gaseous phases of eruption, where the build up of gas beneath blocked volcanic vents creates a violent explosion, shredding the magma into finer particles.



Volcano Classification

SHAPE		
Fissure Eruptions	Occur where an elongated crack in the crust allows lava to spill out over a large area. Found at spreading ridges where tension pulls the crust apart. E.g Iceland in 1973. Found at rifts and early constructive margins. Made of: Basaltic Eruption: Gentle, persistent	
Shield Volcanoes	Made of basaltic rock and form gently sloping cones from layers of less viscous lava. Example: Mauna Loa in Hawaii (taller than mount Everest – from ocean floor). Found in hot spots where oceanic crust meets oceanic crust Eruptions: Gentle and predictable	
Composite Volcanoes	Most common found on land. Created by layers of ash from initial explosive phases of eruptions and subsequent layers of lava from the main eruption phases. E.g. Mount Etna and Vesuvius. (Italy) Rock type: Andesitic Location: Destructive Margins	
Acid or Dome Volcanoes	These are steep sided volcanoes formed from very viscous lava. As the lava cannot travel far it builds up convex cone shaped volcanoes. Lava may solidify in the vent	
Calderas	From when gases that have built up beneath a blocked volcanic vent result in a catastrophic eruption that destroys the volcanic summit, leaving an enormous crater where later eruptions may form smaller cones.	

Minor Extrusive Features

***GEYSERS AND HOT SPRINGS:** Even in areas where vulcanism does not produce active volcanoes water heated at depth in the crust by magma chambers can periodically escape as stream and hot water.

A geyser is an intermittent turbulent discharge of superheated water ejected and accompanied by a vapour phase.

***FUMAROLES:** Are areas where superheated water turns to steam as it condenses on the surface. These features are typical of areas such as Solfatara in Italy where the mixture of steam and water mixed with sulphur rich gases gives rise to the collective name for these features of solfatara.

intrusive features

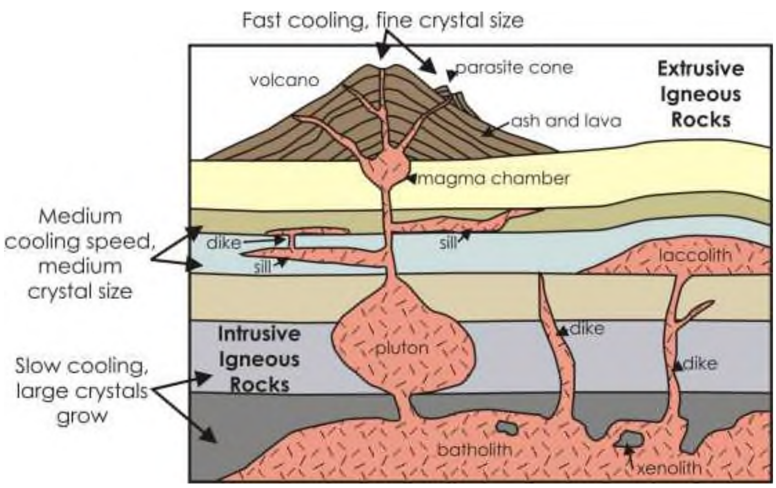
With all volcanic regions, the majority of magma never reaches the surface but cools to form coarser grained igneous rocks beneath the ground. These rocks may contribute to surface geomorphology through uplift, erosion and expose at the surface. Batholiths form when large masses of magma cool very slowly producing coarse grained rocks.

Where magma has been squeezed between existing strata it may form a sill (concordant) or a dyke (discordant).

Dyke: A vertical intrusion with horizontal cooling cracks. Cools rapidly on contact with surrounding colder rock. Contracts and cracks, cuts cross bedding planes

Batholiths: Being deep seated and surrounded by hot rock the magma cools slowly so that 1) large crystals form and 2) there is a large metamorphic contact zone

Sill: A horizontal intrusion along bedding planes with vertical cooling cracks. Cools rapidly on outside on contact with surrounding rocks. Contracts and cracks.



ACTIVITY: Volcanoes have erupted in living memory

DORMANT: Volcanoes have erupted within historical record

EXTINCT: Volcanoes will not erupt again.