IGCSE Revision Booklet Tectonics

Tectonics revision checklist

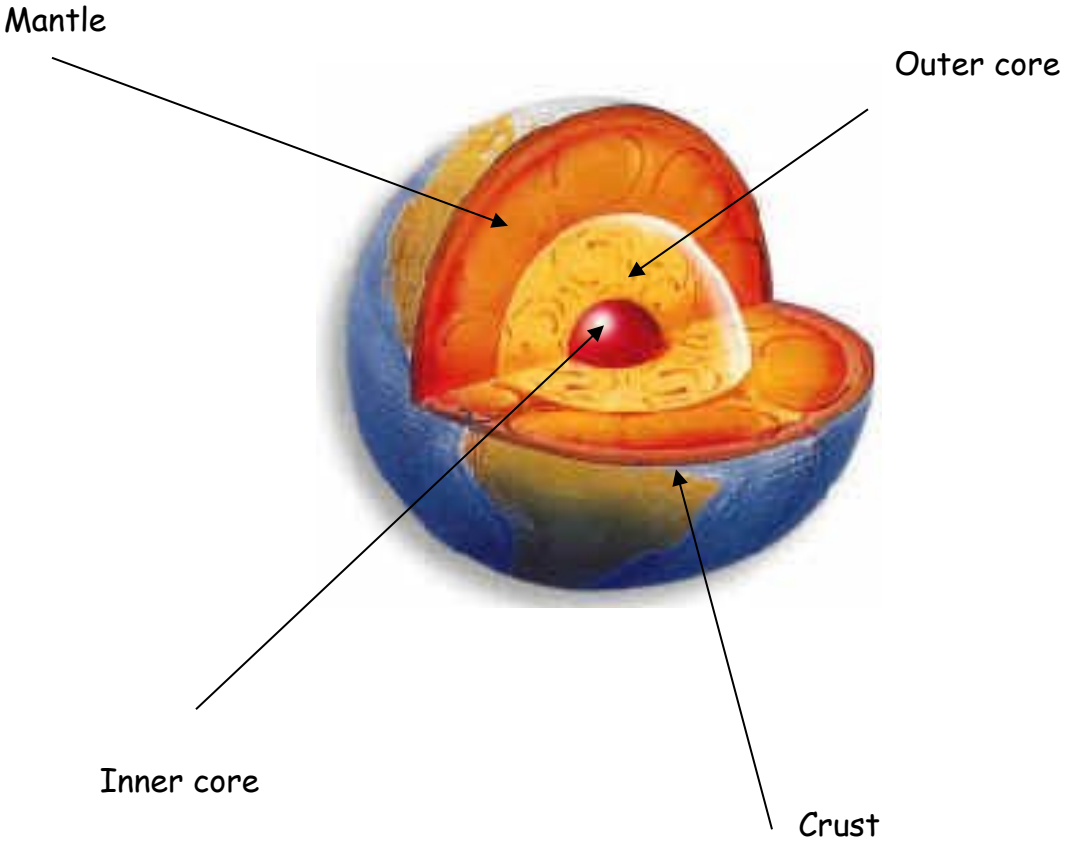
3: Earthquakes and volcanoes

Key learning objective	Sub learning objective	Understanding before unit	Example of learning to cover this syllabus point	Understanding at end of unit
Describe the main types and features of volcanoes and earthquakes	I can define the word volcano and distinguish between active, dormant and extinct volcanoes			
	I can identify the key features of a composite volcano			
	I can identify the key features of a shield volcano			
	I can identify the key features of and earthquake such as focus and epicenter			
	I can identify how earthquakes are measured by the Richter and Mercalli scales			
Describe and explain the distribution of earthquakes and volcanoes.	I can describe the distribution of volcanoes and earthquake zones			
	I can identify the layers of the earth			
	I can differentiate between the two types of crust			
	I can explain what happens at a divergent/ constructive plate margin			
	I can explain what happens at a convergent/ destructive plate margin			
	I can explain what happens at a conservative plate margin			
Describe the causes of earthquakes and	I can explain why volcanoes happen at hotspots			
	I can explain the long and			

volcanic eruptions and their effects on people and the environment	short term effects of a volcanic eruption			
	I can describe and explain the causes and effects of a named volcano: Montserrat			
	I can explain the long and short term effects of an earthquake			
	I can describe and explain the causes and effects of a named earthquake: Haiti			
Demonstrate an understanding that volcanoes present hazards and offer opportunities for people	I can describe the different volcanic hazards such as lava, ash, pyroclastic flows, mudflows, etc. and a describe the likely hazards of each for people.			
	I can explain the benefits of living in volcanic regions.			
Explain what can be done to reduce the impacts of earthquakes and volcanoes	I can explain how volcanoes can be predicted along with any equipment that is used			
	I understand the importance of the importance of evacuation and warning systems			
	I can describe the measures taken to reduce the impact of volcanoes			
	I can explain why people live in earthquake zones			
	I can explain what can be done to manage the risk in earthquake zones			

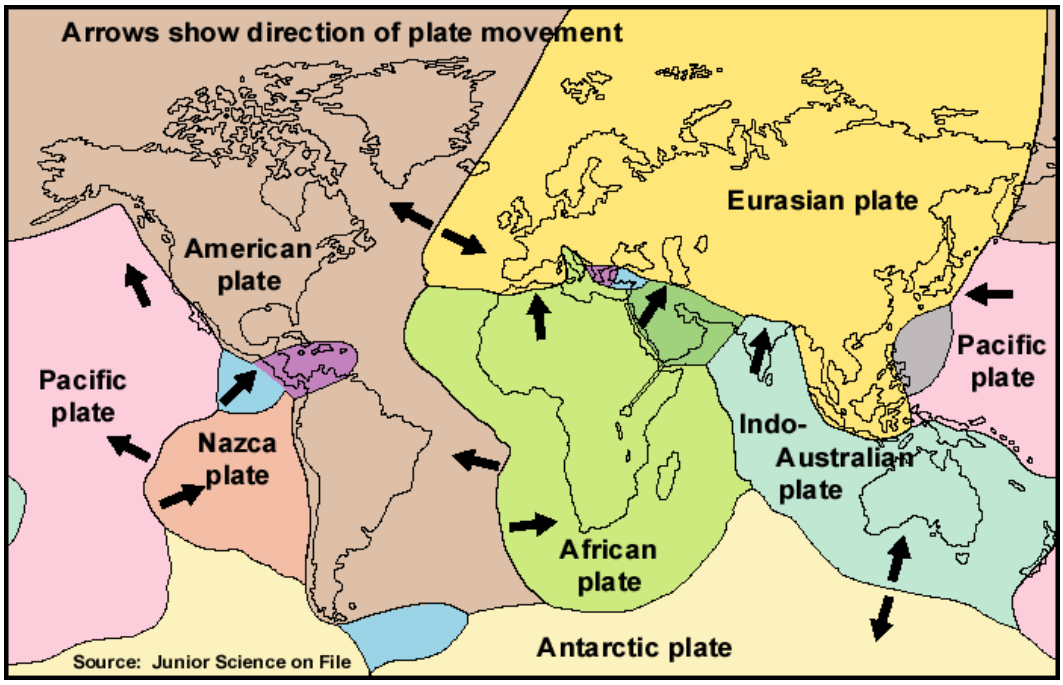
Plate Tectonics Revision Notes

Structure of the earth



- **Crust** A relatively thin layer of solid rocks around the outside of the earth. Continental crust has an average depth of 5km and is mainly composed of Granite. Oceanic crust has an average depth of 70 km and is mainly composed of Basalt. The average temperature of both is 10 0C
- **Mantle** A layer of melted rock 2900 km beneath the crust. Very hot with a temperature of 375 0C and solid, but has the consistency of treacle. The main rock type is Peridotite.
- **Outer core** A layer of molten rock 2900 – 5000 km below the crust. Average temperatures of 3000 0 C and an iron / nickel composition.
- **Inner core** - The centre of the earth with a radius of 1400 km and temperature of about 2700oC and an iron / nickel composition.

Major plates



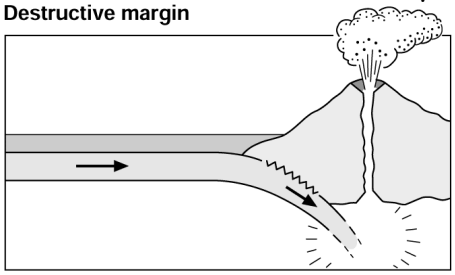
There are 7 major plates:

- The Pacific
- The Eurasian.
- The African
- The American
- The Indo Australian
- The Nazca Plate
- The Antarctic plate.

Plates are sections of very thin crust; they float like rafts on the semi-molten material that makes up the earth's mantle. These plates move on top of the mantle by a series of heat (**convectional**) currents. The movement is very small at less than 1 cm per year, but it can result in volcanic eruptions and earthquakes. This is how plate boundaries cause tectonic hazards. Earthquakes and volcanoes are found near plate boundaries. They can happen on the seabed as well as on land.

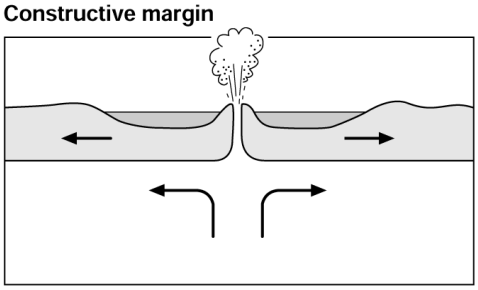
Plate movement

There are 4 ways in which the plates can move from the convectional currents:



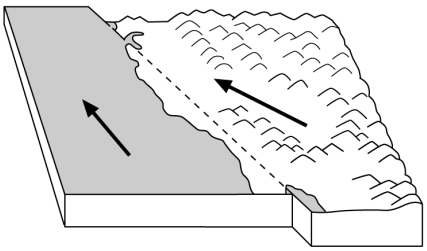
- **Destructive:** This happens when oceanic and continental plates move together. The oceanic plate is denser (heavier) than the continental one and is forced down into the mantle. Here it melts and is released as magma (volcano). The continental plate is forced up (Fold Mountains) and earthquakes occur due to the movement of the plates. E.G. Montserrat.

Constructive margin

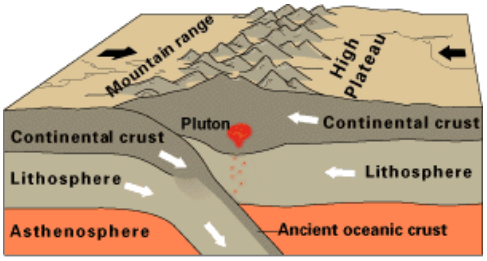


- **Constructive:** New crust forms in undersea valleys in mid – ocean. Oceanic plates move apart causing magma to rise up as a volcanic eruption, and once cooled new land is formed. The new crust gradually pushes the older crust sideways, and away from the ridge. A mid-ocean ridge (undersea mountain chain develops). Minor earthquakes occur. E.G Mid Atlantic Ridge.

Conservative margin



- **Conservative:** Two plates move past one another. Pressure builds up as the plates move causing a massive earthquake. No crust is created or destroyed and no volcanic eruptions take place. E.G. Haiti Earthquake 2010.



- **Collision:** Continental plates converge (move together). They are buckled and pushed up to form Fold Mountains (e.g. Himalayas. No eruption, but violent earthquakes occur. E.G. Nepal Earthquake 2015.

Volcanic Hotspots

Volcanoes do not only occur at plate boundaries, they also happen at hotspots.

- Hotspots are areas in the lithosphere (crust/upper mantle) that are underlain by unusually hot magma.
- This heat causes partial melting of the lithosphere, eventually leading to volcanic activity.
- The Hawaiian Islands are a classic example of a volcanic grouping formed over one hot spot.
- Over thousands of years, as the Pacific Plate inched its way in a northwest direction, the stationary hot spot underneath the plate successively created volcanoes above it.
- Several of these volcanoes reached the ocean's surface, forming the Hawaiian Islands.

Types of volcano

They are classified as:

- **Active** – if they have erupted recently.
- **Dormant** – if they have erupted in the past 2000 years

- **Extinct** – if they have not erupted for many thousands or millions of years

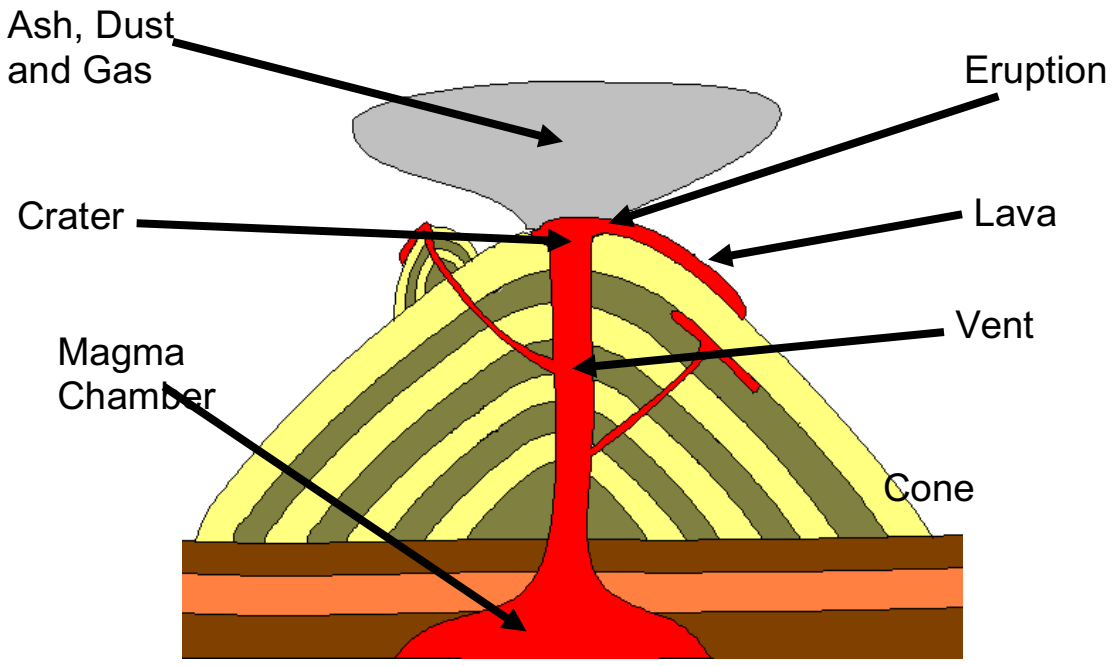
2 types of volcanoes described:

- **Shield** – Shield volcanoes have very runny lava (they are non-viscous); because of this they do not have an 'explosive' eruption. Lava spreads quickly across the landscape. With each eruption a new layer of rock is built on the previous one. Gradually a wide dome of rock is built up. It is called a shield volcano because it looks like a curved shield lying on the ground (or an upside down dinner plate). The slopes of a shield volcano are very gentle. The Hawaiian islands are a chain of shield volcanoes

- **Composite** - Composite volcanoes are the most common type of volcano. When you think of a volcano you are probably picturing the classic shape of the composite volcano. They are formed by hardened layers of lava and ash from successive eruptions. The lava is viscous (therefore thicker than with shield volcanos) and it cools and hardens before spreading very far, therefore the volcanoes are steep sided. The eruptions tend to be very violent, capable of producing deadly pyroclastic flows. Chances Peak, Montserrat is an example of a Composite Volcano.

Volcanic eruptions effect people living in the area. For each case study ensure you know the causes, effects and the management issues involved.

Features of a volcano



Volcanic example in an LEDC (Montserrat)

Location: Montserrat in the Caribbean.
Volcanic area: Soufriere Hills.
Date of eruption: July1995
Eruption lasted: 5 years
Chances Peak Volcano had been dormant for over 200 years.
Emergency plans: Evacuating people to nearby islands or Britain. People had to get emergency aid from Britain in order to rebuild island.
Nos evacuated: 6,000 (over half the population)
Numbers killed: 23 – people who stayed to watch over their crops.
Things destroyed: - farmland covered by lava.

- 2/3 of the homes destroyed covered in ash and mud.
- Pyroclastic flow (rivers of hot gas, ash, mud and rock moving at very high speeds at temperatures of about 500°C) covered large areas of the island.
- Tourist industry destroyed

Prediction

Volcanic eruptions can destroy people and the environment. We need to predict and plan for the eruption. This helps reduce the loss of life and damage. Some of the methods scientist use to predict are;

- Lasers to detect the physical swelling of the volcano
- Chemical sensors to measure the increases in sulphur levels
- Seismometers to detect the large number of earthquakes that occur due to the magma rising up
- Ultrasound, which can monitor low-frequency waves within the magma as the surge of gas and molten rock moves upwards
- Satellite images to record the warming of the ground surface as the magma edges towards the 'breaking through point'.

Some of the methods scientists and local authorities use to plan are:

- Have an evacuation plan, e.g. supplies of food and water, medical facilities, face mask to prevent inhaling ask and temporary homes (tents).

- We ready to establish exclusion zones if needed. For example in Montserrat in 1997 an exclusion zone covering 2/3 of the island was established to protect lives.
- Government agencies such as the police organise the evacuations. These need to be practiced and publicized.
- Have plans to manage lava flows if they threaten valuable areas e.g. in Sicily Mount Etna regularly produces lava flows, the authorities may use powerful jets of water to attempt to divert the flow away from valuable areas.

More on Montserrat Case Study:

Montserrat is located in the Caribbean islands. The volcano, chances peak is located in the south of Montserrat, in the range of Soufriere Hills.

Montserrat Volcanic Eruption (1995-97)

Causes of the eruption:

- The Caribbean island of Montserrat is located at a destructive (convergent) plate boundary.
- At this boundary convection currents pull the North American Plate towards the Caribbean plate.
- The denser North American plate is forced (subducted) under the Caribbean plate.
- Convection currents pull the plate into the mantle causing the rock to melt.
- The molten rock is lighter than the surrounding rock which causes it to rise through the cracks towards the earth's surface.
- Strato-volcanoes, such as the Chances Peak volcano, tend to produce sticky andesitic lava (thick lava).
- The lava is so thick it created a dome on the side of the Chances Peak.
- The dome suffered serious collapse in August 1997 and led to ash fall and pyroclastic flows engulfing significant portions of the south of the island.

Effects of the eruption:

Environmental:

- The landscape of the island has changed dramatically – with valley floors such as the Belham Valley being covered in up to 10 metres of volcanic debris.
- Habitats of animals such as the mountain chicken frog have been destroyed.
- When the eruption occurred farmers were told to let their animals run free so that they would be able to find food. These former farm animals e.g. cows, sheep and donkeys are now feral and in competition with wild animals for food. This is causing further declines in species such as the chicken frog.
- The huge amount of material ejected has also had an impact on Montserrat's coastline. A 2km stretch of deposited material has been added to the coastline, covering fragile coral reef ecosystems in ash and debris.
- The volcano is still releasing gases such as sulphur dioxide – this leads to acid rain which limits the growth or kills vegetation – this impacts other species as their source of food is diminished.

People:

- The eruption has caused long-term damage to Montserrat's economy. For example, it decimated much of the country's most productive farmland.
- The capital city of Plymouth was destroyed by the eruption and is now covered in volcanic debris. Most of Montserrat's businesses were located here and this has led to a substantial decline in employment.
- Montserrat's government buildings were also located in Plymouth and have had to be relocated elsewhere. Finding satisfactory accommodation for these functions has been a problem.
- People who did not evacuate the island had to stay in shelters in the north of the island; here the living conditions were very poor.

- As a result of a loss of job opportunities and poor living conditions Montserrat's population has reduced by 75%, it is now under 2,500. The population structure of the island has completely changed – people of a working age have left to find work in countries like the USA, Canada and the UK – dependents such as children and the elderly have been left behind. This situation has caused emotional strains for families as many have been broken up as relatives migrate.
- However, the future is starting to look up for Montserratians – new opportunities for work are being developed based on the legacy of the eruption – for example plans are in place to improve accessibility to Plymouth so that tourists can enter with guides.

Management:

Prediction:

The Monserrat Volcanic Observatory (MVO) employs a range of methods to monitor volcanic activity so that accurate predictions can be made. For example:

- Gas sampling: changes in gas composition indicate the activity levels of magma underground.
- GPS technology: is used to monitor any significant changes on the volcano so that the risk of activity e.g. pyroclastic flows can be assessed.
- Seismic monitoring: any minor earthquake activity is detected using seismographs and is recorded. Rising blobs of magma can cause earthquake activity and so this may be a sign of an eruption.
- Geologists on Montserrat have become very good at looking out for signs of volcanic activity and this has saved many lives on the island.

Prevention:

- Some of the effects of Montserrat's 1995-97 eruption could be dealt with relatively easily. For example people cleared the ash fall from their roofs to prevent them from collapsing.
- Other type of volcanic activity that occur on Montserrat e.g. lahars and pyroclastic flows are not so easy to manage. During the eruption an exclusion zone covered 2/3 of the island as this was the only way to safeguard lives. Property and farmland had to be sacrificed.
- Today, the south of the island is zoned. People are not allowed to live in the most risky zones, siren warning systems and evacuation routes are in place so that other safer zones can be evacuated when there is the threat of activity.
- In volcanic areas in other parts of the world prevention management might be different. For example, on the island of Sicily in Europe volcanoes are prone to lava based eruptions. Lava flows can be prevented from damaging property by dropping concrete blocks, digging trenches or even by setting off explosions to aim to divert the flow of the lava.

Why do people live in Montserrat, despite the risk?

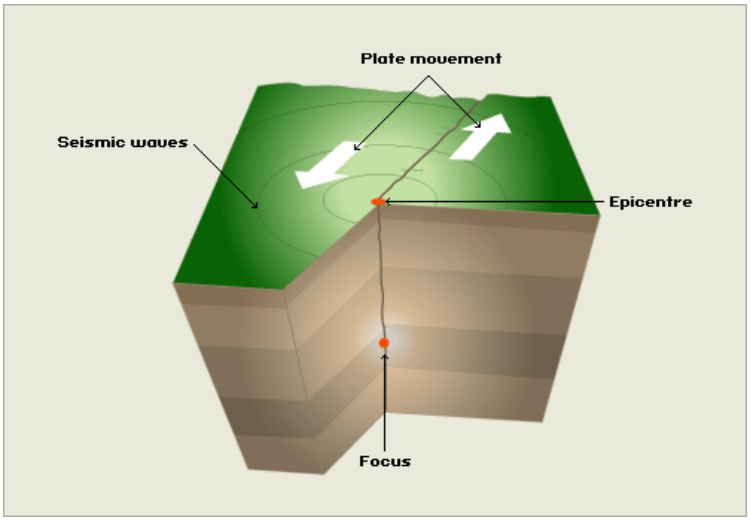
- Traditionally the south of Montserrat has been the more heavily populated part of the island as it contains fertile farmland as a result of deposits of nutrient rich material from previous eruptions.
- Many people in Montserrat are beginning to feel that it is once again safe to settle in the south of the island as the volcano is so carefully monitored by the MVO (Monserrat Volcano Observatory). Volcanic activity is monitored on a daily basis, for example GPS technology is used to monitor any significant changes on the volcano so that the risk of activity e.g. pyroclastic flows can be assessed.
- Today, there are a growing number of opportunities for jobs in the tourism industry on Montserrat. Many tourists love to explore the dangerous side of nature and so tourism resorts are being developed in areas such as Little Bay. There are also current plans in place to improve accessibility to Plymouth so that tourists can enter with guides. These opportunities are encouraging people to move back to the island and settle once more as there are job opportunities available to them.

Earthquakes

An earthquake is the shaking and vibration of the crust due to movement of the Earth's plates (plate tectonics). Earthquakes can happen along any type of plate boundary.

Focus: The point inside the earth's crust where the energy is released.

Epicentre: The surface point directly above the focus and is where the effects of the earthquake may be felt most strongly.



It is measured using the **Richter scale**, which works logarithmically. The higher the number the stronger the quake.

Case study of an Earthquake: Haiti

Haiti is part of a large Caribbean island called Hispaniola. The Dominican Republic is located to the east of Haiti and covers over half of the island.

Cause of the earthquake

Haiti lies right on the *boundary* of the Caribbean and North American plates. There was slippage along a *conservative plate boundary* that runs through Haiti.

On 12 January 2010, a magnitude 7 earthquake hit Haiti at 16:53 local time. The earthquake's epicenter was 25 km west of Port-au-Prince, the capital. Most people, businesses and services were located in the capital.

Social impacts of the earthquake (effects on people)

3 million people affected.
Over 220,000 deaths.
300,000 injured.
1.3 million made homeless.
Several hospitals collapsed.

Economic impacts of the earthquake (effects on money and jobs)

30,000 commercial buildings collapsed.
Businesses destroyed.
Airport and port damaged.

Many of the effects were **immediate** or **primary**, e.g. injuries from falling buildings. Some **secondary** effects didn't happen until many months later, e.g. cholera outbreaks. The effects of this earthquake were particularly bad because of the following reasons:
There were very few earthquake-resistant buildings.
Buildings and other structures were poorly built.
The *epicenter* was near to the capital.
There were few resources to rescue or treat injured people.

Response to the earthquake

Haiti is a very poor country without the money and *resources* to redevelop. It is one of the least developed countries in the world with most Haitians living on $2 or less per day, about £1.30.
Because there were few *earthquake-resistant buildings*, the devastation was massive. Many buildings simply collapsed or were damaged beyond repair.

Primary responses

Neighbouring Dominican Republic provided **emergency water** and **medical supplies** as well as heavy machinery to help with search and rescue underneath the rubble, but most people were left to dig through the rubble by hand.
Emergency **rescue teams** arrived from a number of countries, e.g. Iceland.
Medical teams began treating the injured – **temporary field hospitals** were set up by organisations like the International Committee of the Red Cross.
GIS was used to provide satellite images and maps of the area, to assist aid organisations.
People from around the world watched the news from Haiti on TV and through social networks. Many **pledged money** over their mobile phones.
United Nations troops and police were sent to help distribute *aid* and keep order.

Secondary responses

Money was pledged by organisations and governments to assist in rebuilding, but only slow progress had been made after one year.
After one year, there were still 1,300 camps.
'Cash for work' programs are paying Haitians to clear rubble.
Small farmers are being supported – so crops can be grown.
Schools are being rebuilt.

More on Haiti Case Study:

Haiti Earthquake Case Study (LEDC):

- **GDP per capita–** 819.90 USD
- **Life expectancy at birth –** 62.70 years
- **Total fertility rate –** 3.21 births per woman
- **Literacy rate –** 61%

Causes of the earthquake:

- The earthquake occurred at a transform/conservative plate boundary between the **North American and Caribbean plates**).
- The North-American and Caribbean plates are sliding past each other, tension had been building up for some time.
- Friction between the plates stops them moving, however, when tension builds up they can jolt past each other, sending out shockwaves. Tension was released when the Enriquillo Plaintain Garden fault ruptured.
- The epicenter of the earthquake closest to the settlement of Leogane, which was 10 miles from the capital city Port-au-Prince.
- The earthquake measured **7.0** on the Richter scale – a moderately strong earthquake.

Background

- **12th of January 2010 (4.53pm)**, an earthquake measuring 7.0 on the Richter scale struck the Caribbean island of Haiti.
- Over 220,000 people lost their lives, 250,000 people injured and 1.3 million people were homeless communication, government, police and buildings were wiped out. Also one third of the buildings collapsed in Haiti's capital Port-au-Prince
- The epicenter of the earthquake was at Leogane, 10 miles from Haiti's capital, Port-au-Prince

Why was the earthquake so bad?

- Haiti is one of the poorest countries in the world, so it lacked the capacity to cope with the disaster.
- Haiti hadn't had an earthquake in the past 200 years; therefore, they were not prepared.
- Haiti is a multi-hazard location - it also experiences hurricanes, flooding and landslides. These happen far more frequently than earthquakes. In 2010 Haiti was still recovering from two hurricane events that had occurred in 2008.
- Poor building quality and widespread poverty meant most people were very vulnerable to the damage of the earthquake.
- Lack of building regulations meant that the buildings were not designed to withstand earthquakes. A lot of the houses didn't have support and were constructed on slopes.
- Half of the people were living below the poverty line; they had little or no resources to help themselves recover from the disaster.
- The government had very little money, and therefore was unable to independently cover the damage caused or provide all of the necessary supplies.

Short-term impacts and responses:

- NGO's from around the world tried to meet needs of as many people as possible as they had been separated from families and roaming on the streets.
- Distributing food was a major challenge as the first few trucks were robbed. There were no systems for the disposal of sewage therefore with millions of people living on the streets, sanitation was poor, and diseases spread quickly .
- Oxfam delivered supplies; it was hard as most of the roads were damaged.
- Rain comes into the makeshift tents; many of the buildings were unstable and therefore could not house people anymore, as they were too dangerous.
- Made major camps at the edge of the city to house more than a million homeless people.
- Moving people to camps made it easier to provide services to people. Land ownership was hard to determine who owned lands; therefore, it was hard to find sites to set up camps, as the government doesn't have enough resources to find this information.
- Aid agencies were reluctant to spend money to create these temporary services without getting permission from the landowners. Some of the camps were built on rubbish dumps and low-lying lands, thus susceptible to flooding. A Latin American company created a well in the caps to allow people to access fresh water as most of the people were relying on emergency handouts.

- Yele Haiti and World Vision also gave out hot meals with rice and beans to allow people to have access to nutritious food so they could survive. They also built toilets and showers, but these services were very basic. By April 2010, all the victims in the camps had access to fresh water, basic housing and sanitation.

Medium term impacts and responses:

- Social effects – sleeping on streets next to victim of earthquake, lots of children died and severe injuries occurred.
- After 3 years, people still lived in cramped conditions in the tents.
- Lots of people lost their jobs – losing their stock and most of them don't have any money to start a new business, as they need to provide food for their family. This lead to domestic violence and theft.
- More than 300,000 are still living in the camps because they don't have means of making an income.
- 1000's was injured, thus reducing their ability to be employed, and became dependent on others, creating a greater social impact.
- 30,000 schools and businesses were destroyed.
- NGO's tried to regenerate the economy using existing business to meet the needs of the people living in the camps.
- People set up 85 canteens and set up food stalls by providing people equipment to provide food to the people in the camps. Lots of the skilled workforce was employed to try and make more permanent housing but majority of the people still didn't have jobs leading to social unrest
- Cholera appeared 9 months after the earthquake in October, due to unsanitary conditions. To combat the disease, NGO's set up clinics for emergencies and people in rural areas who were far from clinics, were provided tablets to be dissolved and drunk with water.
- Sewage was not treated properly, which ended up getting into the water supply, contaminating water resource which was drunk by Haitians, making them sick.
- Many camps have clinics of their own and safe drinking water lead to lower death rates from cholera.

Long-term impacts and reponses:

- Prepare people for future events. Earthquake simulation exercises have then evaluated the coordination of international and national emergency services.
- Impacts of earthquake are never the same on everyone, with the greatest effects on the poor. Before the earthquake 10 50% of Haiti's population were living below the poverty line – it was 80% after the quake.

Community, national and international responses:

International – PeePoo bags by Oxfam;

- In Haiti thousands of people were left without sanitation, often camping in tight compacted and concreted areas where no latrines could be dug.
- So, Oxfam tried various solutions - such as peepoo bags. These are bags that allow people to safely dispose of their toilet waste.
- To use a peepoo bag, a person must attach the bag to a seat on a modified commode.
- There is urea at the bottom of the bag, which helps breakdown the waste.
- The peepoo bag is then disposed of in large bins, which are continually taken away.

Short-term community responses:

- Rescue efforts began in the immediate aftermath of the earthquake, with able bodied survivors extricating the living and the dead from the rubble, of the many buildings which had collapsed. However, treatment of the injured was hampered by the lack of hospital and morgue facilities.

Long-term international responses:

- There was a peak of 22,000 US military personnel in Haiti in February 2010 ,when large numbers were dispatched to help in aid effort. The US military ended its disaster relief mission in Haiti in June 2010, nearly 6 months after the massive earthquake struck. Some 500 National Guard troops and reservists remained in Haiti to help aid workers.
- The US secretary of state co-chaired a conference of about 120 countries and international organisations at the United Nations in New York to help to co-ordinate the aid response. The conference drew $9.9bn of donations to help rebuild Haiti.

Building resilience and future capacity:

- Ensuring people have people have quake resistant housing
- Improving heath and sanitation

- People living in camps don't have enough money to rebuilt organisations but NGO's such as Oxfam started offering financial support for rent.
- Oxfam trained people to build structures that are more resistant to earthquakes.
- Some neighborhoods have been constructed in dangerous areas, NGO's bought the land and rehoused people in the outskirts of Port Au Prince. The new houses have a clean water supply and 1 toilet among 5 families, but there are no jobs in the area. Therefore people need to travel long distances to find work and earn a living. These houses are also rent free, thus attracting people out of the camps and into the outskirts of the city. Transport connections are also weak so people living here are cut off from the rest of the city, thus spending a proportion of their income on transport.
- Many people have now become economically independent due to micro credit schemes from Oxfam, which have allowed people to rent spaces and stock up their businesses.
- Oxfam funded research project is started to research how to increase crop yields and reduce dependence on expensive imports. Improving food security is also about enabling that farmers get better return for their crops. Farmers have to transport their crops over large distances. Oxfam has made small processing rice mills, which allows farmers to process their rice at lower prices and a better profit in the market.

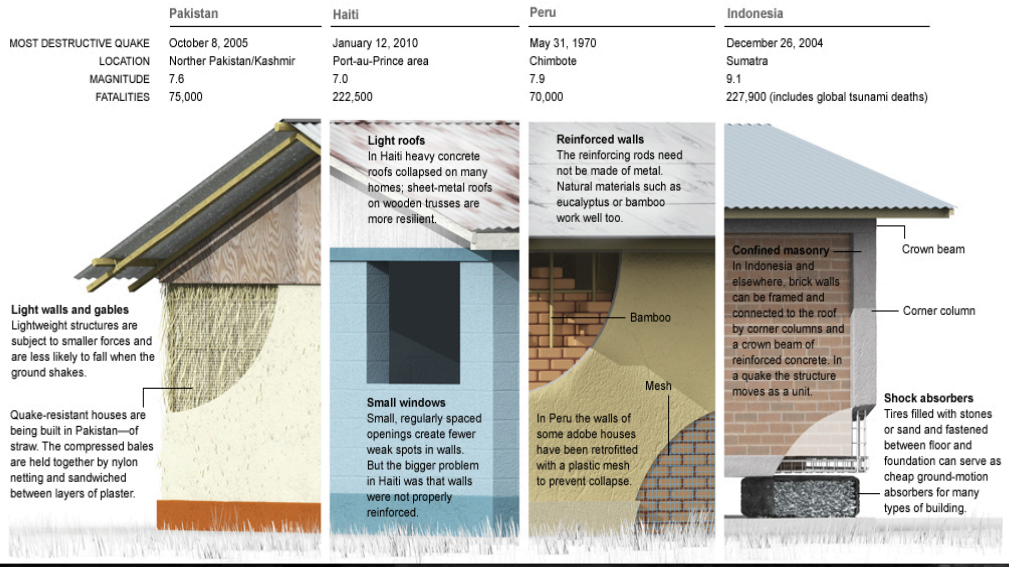
Management in Haiti:

Prediction:

- A 2006 study team presented a hazard assessment of the Enriquillo-Plantain Garden fault system to the 18th Caribbean Geologic Conference in March 2008, noting a large strain on the fault.
- The team recommended "high priority" historical geologic rupture studies, as the fault was fully locked and had recorded few earthquakes in the preceding 40 years.
- An article published in Haiti's Le Matin newspaper in September 2008 cited comments by geologist Patrick Charles to the effect that there was a **high risk of major seismic activity for Port-au-Prince.**

Prevention:

- There are many ideas for cheap earthquake proofing but the Haitian government has never enforced building codes.
- The devastation in Haiti wouldn't happen in a developed country," Yet it needn't happen anywhere. Cheap solutions exist.
- Researchers in India have successfully tested a concrete house reinforced with bamboo.
- A model house for Indonesia rests on ground-motion dampers: old tires filled with bags of sand. Such a house might be only a third as strong as one built on more sophisticated shock absorbers, but it would also cost much less—and so be more likely to get built in Indonesia.
- In northern Pakistan, straw is available. Traditional houses are built of stone and mud, but straw is far more resilient.



Preparedness of the population:

- Haiti only has 2 fires stations and no army (this was demolished in 1995)- it was powerless to do anything itself

- The Health service was already bad but many hospitals were also destroyed in the quake

Aid in Haiti after the earthquake:

- The neighboring Dominican Republic was the first country to give aid to Haiti – hospitals also made available
- 7 days after the quake there was only enough food to feed 200,000 people
- Help was pledged from various countries e.g. Britain, Cuba, France, Germany
- Crews of Dominicans including engineers and telecoms technicians were the first to join the relief effort
- The world bank gave a $100 million from its emergency fund
- EU pledged $13.7 million most aid arrived too late for those trapped under the rubble or awaiting treatment

Months after the disaster: (more notes before)

- Building shelter robust enough to support heavy rains and hurricanes
- 550 000 were in makes shift camps and equal were sleeping rough.
- Many people were too scared to go back to their homes due to aftershocks
- For many proper housing is years away

Prediction of earthquakes

Whereas volcanic activity is often the end result of a slow build up of magma pressure within the earth's crust, an earthquake is a sudden, violent event. Although the pressure gradually builds as two plates temporarily 'lock together', its release is not a slow or steady movement but rather a sudden lurch forward.

Some methods of prediction are –

- Historical records can be used to assess the level of frequency of large earthquakes e.g. southern California experiences a large earthquake once every 150 years on average.
- Using GPS technology to monitor the stress build up on faults
- Monitoring an increase in the escape of radon gas, which may suggest the approach of an earthquake
- Checking water levels in wells, which may fall before a earthquake as the water seeps into small tension cracks
- Using seismographs to detect small fore shocks

Earthquake Prevention

Some of the methods scientists and local authorities use to plan are

- Construct buildings and infrastructure (bridges, roads etc.) that can withstand the earth shaking (examples from California e.g. No. 1 Rincon Hill/Trans American Pyramid in San Francisco).
- Plan for rescue, restoring essential services and arranging for temporary evacuations.
- Evacuation routes must be practiced and individuals need to have emergency kits with things like food, water, torches etc.
- Doing emergency drills e.g. in schools. Earthquake prone cities have also practiced city wide earthquake drills e.g. in Port Au Prince following the 2010 Haiti earthquake and in cities such as Los Angeles, San Francisco and Tokyo.

The Impact of Tectonic Activities

There are variations in the effects and responses to tectonic activity between

1. MEDCs and LEDCs, and
2. Rural and urban.

The variations occur mainly due to the differences in

a, Population Density
b, Building Materials
c, Emergency services
e. Quality of the communication network
f. Relative wealth

	MEDCs	**LEDCs**
Building Materials	a. Quality materials b. Enforcement of planning regulations	a. Poor in general but better in the city. b. Little enforcement
Emergency services	Good and available to help	Virtually none existence
Medical facilities	Usually readily available	Mostly in the cities and very limited in the countryside
Quality of the communication network	Good throughout the country, and easy to reach the affected areas	Poor especially in the countryside and sometimes impassable roads during the raining seasons
Relative wealth	Can provide most of the resources themselves and other rich countries are willing to help	Cannot provide the resources themselves and helpers are slow to act and may respond when it is too late.

	Urban (City)	**Rural (countryside)**
Population Density	High and a lot of damage caused by electricity, gas and pipes etc	Sparse and usually fewer loss of lives
Building Materials	Good to withstand weak force even	No difference in MEDCs but big difference in the LEDCs
Medical facilities	Relatively good in the urban areas.	very limited in the countryside
Emergency services	Better to deal with the situation than in the rural areas	very limited in the countryside

Why do people live in tectonic zones?

Volcanoes

- People live close to volcanoes because they felt that the advantages outweighed the disadvantages.
- Most volcanoes are perfectly safe for long periods in between eruptions
- Today, about 500 million people live on or close to volcanoes.
- We even have major cities close to active volcanoes. Popocatapetl is a volcanic mountain less than 50 miles from Mexico City in Mexico.
- In short, the main things that attract people to live near active volcanoes are minerals, geothermal energy, fertile soils and tourism.

Geothermal energy

- Geothermal energy means heat energy from the earth.
- The heat from underground steam is used to drive turbines and produce electricity, or to heat water supplies that are then used to provide household heating and hot water.
- Where steam doesn't naturally occur it is possible to drill several deep holes into very hot rocks, pump cool water down one hole and extract steam from another hole close by.
- Countries such as Iceland make extensive use of geothermal power, with approximately 26% of Iceland's electricity coming from steam powered turbines. Reykjavik is said to be "the most unpolluted capital in Europe."
- Iceland has over 200 volcanoes and 800 hot springs

Other uses of geothermal energy:

- Geothermal energy is also used for recreational purposes. For example, the Blue Lagoon in Iceland. The Blue Lagoon is a natural hot spring in the middle of a huge lava field, the water is naturally heated by the geothermal activity below the surface. It is very popular with tourists who visit Iceland, who enjoy bathing in the warm waters in the scenic surroundings.

Fertile soils:

- Volcanic rocks are rich in minerals, but when the rocks are fresh the minerals are not available to plants.
- The rocks need thousands of years to become weathered and broken down before they form rich soils.
- When they do become soils though, they form some of the richest ones on the planet.
- The Naples area, which includes Mount Vesuvius, has such rich soils thanks to two large eruptions 35,000 and 12000 years ago. Both eruptions produced very thick deposits of ash and broken rocks which have weathered to rich soils.

Tourism

- Around the volcano may be warm bathing lakes, hot springs, bubbling mud pools and steam vents.
- Geysers are always popular tourist attractions, such as Old Faithful in the Yellowstone National Park, USA. Old Faithful is such a popular tourist feature that it even has its own 24 hour Old Faithful webcam.
- Iceland markets itself as a land of fire and ice, attracting tourists with a mix of volcanoes and glaciers, often both in the same place.
- The wild, raw and barren volcanic landscapes also attract tourists who want to see what the early planet may have looked like.
- Locals economies can profit from volcanism throughout the year, whereas skiing, for example, has only a limited winter season.
- In Uganda, a country trying hard to increase its tourist industry, the volcanic region around Mt Elgon is being heavily promoted for it's landscape, huge waterfalls, wildlife, climbing and hiking and its remote 'get away from it all' location.

Earthquakes

The main reasons why people continue to live in earthquake zones are:

- Large earthquakes do not occur that frequently and so people are not aware of the risk or they do not believe it will happen to them.
- People feel protected against earthquakes due to disaster preparedness measures e.g. earthquake resistant buildings, earthquake drills, disaster preparedness education and advice.
- The benefits of living in earthquake zones may outweigh the risks e.g. due to employment opportunities or it being a pleasant place to live.

Mini case study: Why do people continue to live in California despite the risk?

In high-income countries, people may choose to live in areas that are tectonically active for economic reasons. In California, for instance, there is a significant concentration of high-tech industry, and people are attracted to work there because high-income jobs are available in companies such as IBM and Apple. With 23,000 factories, the industry employs over 700,000 people. All of this is despite the fact that the area is on the conservative plate boundary between the North American and Pacific Plates. Small earthquakes are a daily feature of life, and there were major events in 1989 and 1994.

People are attracted to live and work in this area by the attractive landscape and the pleasant climate. The coast provides beautiful beaches and opportunities for surfing at places such as Half Moon Bay. Summer temperatures can reach 30°C and winters are mild at around 10°C. Rainfall is low, typically 300–400 mm per year, with very little falling in the summer. The standard of living is high, with people enjoying high quality services such as education and medical care.

Examples of tectonic landscape questions

Explain the processes at a Divergent Plate Boundary (4 marks)

Remember - here the focus needs to be on processes:
1 - Show understanding of what a Divergent Boundary is (what happens to the plates)
2 - try and name an example
3 - focus on the processes - i.e. divergence, magma rising, new crust being created, volcanism and earthquakes.

Possible Answer
At a divergent plate boundary the plates are moving away from each other as a result of convection currents which operate in the mantle. Here hot magma rises to the surface and spreads out pulling the plates apart, forming a ridge. Magma fills the gap in the ridge, creating new crust and causes volcanic eruptions. Along a ridge, such as the Mid-Atlantic Ridge, both earthquake and volcanic activity are experienced as a direct result of the plate movement.

Why is volcanic activity occuring in the middle of the Pacific Plate? (4 marks)

The Hawaiian Islands are located in the middle of the Pacific Plate. They are located here due to the presence of a hotspot. This is where a plume of heat rises up from the mantle and melts the overlying plate which is thinner than usual. As the magma is lighter it rises up and erupts onto the surface, forming a volcano. Lava builds up over time, eventually creating an island above sea level. The plate continues to move slowly away from the stationary 'hot spot' due to convection currents in the mantle so the volcano becomes inactive but a new volcano will form above the hotspot, eventually forming a series of volcanic islands.

Explain why people continue to live in areas of volcanic and earthquake activity. Use examples in your answer (5 marks)

Advice:
The question asks examples - if you only give one example you will lose a mark.
Each point you make must include specific points related to an example.

Remember - this question ask for reasons for living in BOTH areas of volcanic and earthquake activity - you must refer to both to access the full marks.

Possible Model Answer (look for the explanation and the example)

Some people continue to live in volcanic areas as they cannot afford to move. Others continue to live in these areas as the potential for economic benefits outweighs the risk. As well as precious minerals like gold being mined in these areas, these areas provide job opportunities due to their popularity with tourists. Major attractions include the Old Faithful geyser in Yellowstone National Park (USA) and the Blue Lagoon (Iceland). In Iceland alone, tourism provides over 5,000 jobs. The fertility of many volcanic soils, due to weathered ash, also provides opportunities for economic gain through farming. Many farms thrive on the slopes of Mt Etna where olives, grapes and citrus fruits are grown. Improvements in technology help to explain why many continue to live in areas of earthquake activity. Many HICs such as Japan and the USA have clear disaster plans in place and carefully designed earthquake proof buildings like the Transamerica Pyramid in San Francisco. In Montserrat the highest population density is in the South of the Islnad because the Chances Peak is located there making for the best farmland in this part of the island. Tourist operators on the island of Montserrat now run ‘disaster tourism’ trips to the devastated capital city of Plymouth.

Outline the economic reasons for people continuing to live in areas prone to volcanic activity (4 marks)

Advice
The command word is outline and often these questions are marked out of 4. Each point with gain a mark. However you must include specific points about an example, if not you will only gain two marks In the suggested answer below make sure you can identify (i) the economic gain (ii) the example

Possible Answer:
Areas prone to volcanic activity can bring many economic gains which attract people. Precious minerals such as gold, diamonds and sulphur are often found in abundance in these areas such as the Philippines (Mt Pinabubo) and Sicily (Mt Etna), where farmers make a living from crops such as olives, grapes and citrus fruits. The attraction of volcanic environments to tourists, for example the geysers and boiling mud pools of Iceland, provide many job opportunities in the tourism industry. Other economic benefits of volcanic areas includes the provision of a source of cheap geothermal energy (28of Iceland's electricity comes from these sources). Finally, a lack of money can explain why many poor people in LICs still live in volcanic prone areas as they cannot afford to move.

Damage caused by earthquakes and volcanoes can be prevented by adequate building design, planning and education. How true is this statement, use examples in your answer (6 marks)

Advice:
The question asks about damage caused by BOTH earthquakes and volcanoes - so you must make sure you address both in the answer.
How true is this statement? - you need to be able to give an opinion and back it up using examples
The question ask for examples - therefore unless more than one example is used you will lose marks.

Possible Answer:
Although it is not possible to ensure that earthquakes cause no damage, it is certainly true that adequate building design, planning and education can be used to significantly limit the damage caused by earthquakes (1). Techniques include the use of rubber shock-absorbers between the foundations and the building structure to absorb earth tremors (1), as well as computer controlled counter-weights on roofs to reduce movement. The TransAmerica building in San Francisco has been designed with a wide stable base and a steel frame, enabling the building to sway with the movement (1). Automatic shut off switches for electricity and gas can also help to prevent problems of fire following an earthquake (1). Training and education of emergency services and people in earthquake drills (e.g. Japan's 1st Sept disaster prevention day) help people to prepare for the event of an earthquake.(1). Damage caused by volcanoes is harder to prevent through building design but roofs with an angled design can encourage ash not to accumulate which would otherwise cause the roof to collapse (1).

Other points you could have included:
Earthquakes - Strict planning regulations can ensure buildings in earthquake prone areas are not built on unstable land (helping to prevent problems of liquefaction e.g. San Francisco)
Volcanoes - lava flows in Mt Etna (Sicily) and Eldfell volcano (Iceland) have been successfully diverted - e.g. by use of water sprays and the use of explosives.

Choose a volcanic eruption or earthquake you have studied. Explain the causes of the volcanic eruption or earthquake. (6)

Haiti is located on a conservative plate margin between the North American and Pacific Plate. As the two plates move past each other, pressure builds up due to friction. The earthquake occurred at 4.53pm on 12th January 2010, when the built up pressure on the Enriquillo Plantain Garden Fault was suddenly released. Conservative plate margins often result in shallow earthquakes, this was this being the case in 2010 where the focus was only 8 miles deep. Violent shaking at the epicenter occurred, which was only 16 miles east of Haiti's capital, Port Au Prince. The 2010 earthquake measured 7.0 on the richter scale and was the largest earthquake to have hit Haiti in more than 150 years.

Choose a volcanic eruption or earthquake you have studied. Explain the effects of the volcanic eruption or earthquake. (6)

Your chosen case study must be CLEARLY LOCATED (place specific detail is important - e.g. names of plates and clearly defined geographical location).

You also need to ensure that you explain the cause of the earthquake (i.e. talk about what is happening at, in the case of Haiti, a conservative / transform boundary.

Mark-scheme:
Level 1 (1-2) - a basic answer with descriptive statements
Level 2 (3-5) - a clear answer with level 2 being reached by there being an explanation or a specific point. The top of the level requires a range of specific points or a number of explanations or a specific point and an explanation.
Level 3 (6-7) - an explicit answer with a range of specific and explained points.

The questions clearly asks for EFFECTS (so you will not be credited for talking about the cause in this question) and it is also asks for effects on PEOPLE AND the ENVIRONMENT - you must mention both to ensure access to full marks.

You MUST also ensure that there is clear PLACE SPECIFIC DETAIL - or you will not be able to access the highest marks.

Chosen case study: Haiti Earthquake, 2010

The magnitude 7.0 Haiti earthquake epicenter was shallow and very close to the capital city Port au Prince. This had an impact on the devastation being more serve. This is coupled with the fact that the country is the poorest in the Western hemisphere and so the building quality was very poor making meaning it was easily damaged in the earthquake. Because of the this approx. 220,000 people were killed and 1.5 million more were made homeless. For years after the quake people had to live in make shift tents. Additionally, the economic basis of the country was destroyed (30,000 businesses buildings collapsed) meaning that people lost the income needed to rebuild their lives. In the longer term there were outbreaks of cholera.

Or.....

Montserrat was devastated by *pyroclastic flows*. The small population of the island (11,000 people) was *evacuated* in 1995 to the north of Montserrat as well as to neighbouring islands and the UK. Despite the evacuations, 19 people were killed by the eruptions as a small group of people chose to stay behind to watch over their crops. Volcanic eruptions and *lahars* have destroyed large areas of Montserrat. The capital, Plymouth, has been covered in layers of ash and mud. Many homes and buildings were destroyed, including the only hospital, the airport and many roads. In the longer term there have been some positive effects new roads and a new airport were built, Services in the north of the island were expanded. The presence of the volcano

resulted in a growth in tourism.

Explain how the effects of volcanic eruptions are reduced through prediction and prevention. Use examples in your answer.

Explain the methods used before and after a natural disaster to limit its effects (6 marks)

Methods that can be used Before:
Emergency drills and evacuation procedures set up and practiced (e.g. Japan 1st - emergency drill day)
Fully train emergency teams and have proper rescue equipment available with emergency people trained in use
Earthquake proof buildings and major infrastructure (e.g. bridges - Golden Gate, San Francisco and Transamerica Building, San Francisco)
Seismic monitoring

Methods that can be used after the disaster:
A well-coordinated relief effort (but relies on prior planning)
LICs need to welcome help from HIC's and Charites as soon as possible
Government needs to co-ordinate a response plan (following Kobe earthquake, government were slow to respond - and effect were worse than could have been)

Outline 3 techniques we can use for monitoring volcanoes (6 marks)

1. Earthquake activity often increases before an eruption due to rising magma forcing its way to the surface (1). Seismometers can be used to measure increasing earthquake activity in volcanic areas and therefore help predict an eruption (1).
2. As magma rises to the surface, it often causes changes in the shape of a volcano (1). Tilt meters or GPS technology can be used to indicate and measure the growth of a bulge on the sides of a volcano (such as that at Mt St Helens - 1980) (1).
3. Rising magma is accompanied by an increase in the gas Sulphur dioxide (1). Gas sampling can be used to monitor levels of Sulphur dioxide, a sudden increase in which may indicate the increased likelihood of a volcanic eruption (1).

Could also talk about:
(i) Geothermal Monitoring - monitoring increasing heat indicating rising magma
(ii) Patterns of past eruptions - can help look at regularity in eruptions to help with prediction.