



Earthquakes

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Section 1: Causes and Distribution of Earthquakes

• What is an earthquake?



A house collapsing in the 1906 San Francisco earthquake

Energy can build up along faults within the Earth, particularly those close to tectonic plate boundaries. Eventually this build-up of energy must be released, either as heat, as movement along faults, or as seismic waves, and when this energy is released suddenly an earthquake occurs. Although earthquakes generally originate within the Earth, their energy can be transmitted to the surface, resulting in shaking and sometimes displacement of the land surface. A global network of seismometers – instruments that detect and record the earth’s movement – track the seismic waves generated by earthquakes.

Extension Questions

Q1. Can people cause earthquakes?

Yes. Although major earthquakes are related to geological faults, the word ‘earthquake’ can be applied to any event that generates seismic waves, including minor earthquakes triggered by mine blasts, nuclear explosions, or the drilling of wells for oil.

In December 2011, low-frequency geological tremors were measured in Auckland, New Zealand, during a concert by the band Foo Fighters as the crowd jumped up and down during the songs.

Q2. Does a small earthquake mean that a larger earthquake is coming?

Not necessarily. Although small earthquakes, known as ‘foreshocks’, may precede a larger earthquake, many small earthquakes occur in isolation without any larger earthquakes following them.

Q3. Which countries have the largest and most frequent earthquakes?

Approximately 75% of all seismic energy is released around the margins of the Pacific plate, an area which encompasses countries such as the USA, Canada, Chile, Japan, China, Indonesia and the Philippines.

• Suggested Film

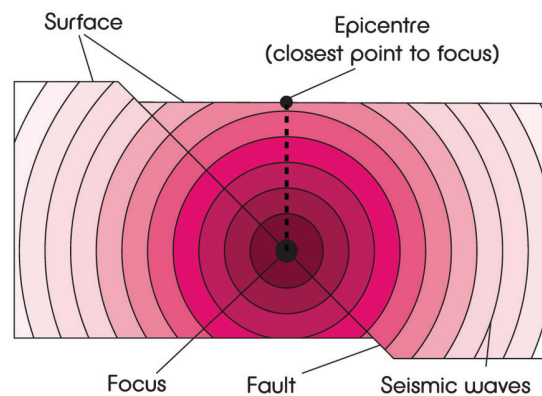
- What Is An Earthquake?

DIAGRAM 01:



Anatomy of an Earthquake

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• Why do earthquakes occur?



The San Andreas Fault in California is monitored by seismologists

The occurrence of earthquakes is often related to activity along geological faults relating to tectonic plate boundaries. Irregularities along the edge of faults lock the surfaces together and increase friction. Although the surfaces may be locked together, the tectonic plates continue to move relative to each other, and strain energy continues to build up. Once the stress in the plate becomes greater than the strength of the rock, the energy must be released. Earthquakes can also occur in relation to other events, including volcanic activity and activity induced by humans, such as mine blasts.

- Suggested Film
- Plate Tectonics

• Where in the world do earthquakes occur?

Earthquakes can occur all over the world, but most occur on active faults related to the boundaries of the major tectonic plates. Around 90% of earthquakes occur along these plate boundaries. One of the most active regions is the Pacific Ring of Fire, which encircles the Pacific Ocean and so affects the west coast of North and South America and large parts of eastern Asia. Earthquakes also tend to occur alongside volcanic eruptions.

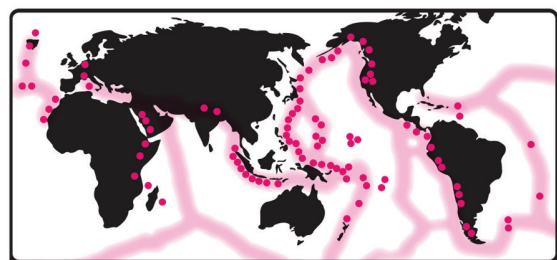
- Suggested Film
- Plate Tectonics
- Christchurch Earthquake

DIAGRAM 02:



Global Distribution of Earthquakes and Volcanoes

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Global Distribution of Volcanoes ●●●

Global Distribution of Earthquakes —

Section 2: Impact of Earthquakes

• What is earthquake magnitude and intensity?



A seismograph can measure the magnitude of an earthquake

Both intensity and magnitude describe the severity of an earthquake, but they are expressed in different ways. The magnitude is related to the energy released by an earthquake in absolute terms. The intensity measures the effects that earthquakes produce at the Earth's surface, through their effects on humans, animals, buildings and natural objects, and represents the severity of shaking at the surface. Any given earthquake can have many intensities, but only one magnitude. Intensity tends to decrease with distance from the source, or epicentre, of the earthquake. Earthquake magnitude is commonly reported as the moment magnitude; an earthquake with magnitude 3 or less will barely be noticed, and magnitude 7 or over will cause extensive damage. The extent of the damage caused by an earthquake can vary greatly, depending on its location.

• Suggested Film

- Predicting Earthquakes

Extension Question

Q4. Is there a maximum magnitude for an earthquake?

Theoretically, there is no limit to earthquake magnitude, but since the tectonic plates have a limited size, there is only so much energy that can build up to be released as an earthquake. It is believed that the physical limit corresponds to the greatest moment magnitude yet recorded of 9.5, recorded by the Chilean earthquake in 1960.

• What are the secondary effects of the earthquake hazard?

In addition to the shaking and displacement of the ground that is caused by earthquakes, the motion can lead to slope instability and trigger landslides. Earthquakes can also damage infrastructure, such as power or gas lines, leading to fires. When earthquakes are located offshore, displacement of the seabed can generate tsunamis, large waves produced by the sudden movement of huge volumes of water. These waves can travel long distances across the ocean and can overrun coastal areas very rapidly. Only large magnitude earthquakes cause tsunamis, for example, the 9.0-magnitude earthquake which caused devastation in Japan in March 2011.

• Suggested Films

- Tsunami
- Santorini: Looking for Atlantis

• Suggested Activity

- Ask the students to research the Japanese tsunami, which took place in March 2011, and write a 500-word report.

• What factors affect the impact of an earthquake?

The magnitude of an earthquake has an effect on its intensity, but does not always directly relate to the impact it causes at the surface. The local geology can amplify or reduce the earthquake's effects. The impact will tend to decrease the further it is measured from the earthquake's epicentre. The impact can also be affected by building regulations and the density of population in the vicinity of the earthquake. Sometimes housing is built on reclaimed land, which can be unstable.

Extension Questions

Q5. What is a seismograph?

A seismograph is an instrument that measures the shaking of the earth, and produces a series of waves known as a seismogram, allowing scientists to record information about earthquakes.

Q6. At what depth do earthquakes occur?

Most earthquakes occur within a few tens of kilometres of the Earth's surface, although they can occur up to 700km deep. Earthquakes can be termed shallow-focus, mid-focus or deep-focus depending on the depth at which they originate.

• Suggested Film

- Living On the Edge

• Suggested Activity

- Ask the students to research earthquake-proof architecture and design an earthquake-proof building, annotating the diagram with all the special features.

Section 3: Earthquakes and People

• Are we able to predict earthquakes?



The study of how rocks crack may help earthquake prediction in the future

It is not yet possible to predict the time, date or location of earthquakes with any accuracy, although collecting data on past earthquakes can provide some useful information to suggest where and when they might occur. Scientists are currently concentrating more on reducing the risk associated with earthquakes, and introducing measures such as earthquake warning systems can provide some notification of an earthquake once it is in progress.

• Suggested Film

- Predicting Earthquakes

• What can people do to reduce the impact of earthquakes?

The impact of earthquakes can be reduced by introducing warning systems, and by ensuring that people in zones prone to earthquakes are informed of the risks and ways to deal with these. The improvement of infrastructure, whether making buildings more resistant to shaking or ensuring sufficient provision of support services, will also reduce the impact. Buildings can be made more resistant by reinforcing the structure itself, and by ensuring it is built on a solid foundation; both of these have the main objective of preventing collapse. Using light and flexible building materials allow structures to move with the motion of the earthquake rather than collapsing, and there are many ways to damp or dissipate earthquake energy reaching a building.

• Suggested Film

- Living On the Edge

• Suggested Activity

- Ask the students to design a public awareness leaflet to inform the public of what to do in the event of an earthquake. Then ask the students to work in small groups to research, discuss and plan an emergency response drill to practise in the event of an earthquake near the school.



Buildings with steel frames are generally considered more resistant to earthquakes

• How does the response to earthquakes differ between MEDCs and LEDCs?

A key factor in the number of deaths and damage caused by an earthquake is preparedness. If you live in an area prone to earthquakes it is important to know the associated risks and be prepared. This can include ensuring buildings meet the required standards, knowing where is safe to shelter, and having sufficient supplies of food and water.

The people of Haiti (an LEDC) were not able to effectively prepare for or respond to the 7.0-magnitude earthquake that hit the country in January 2010. The undeveloped infrastructure made it difficult to reach those who needed help and as the buildings were not built to withstand earthquake tremors many were destroyed. Services were disrupted in and around the city of Port-au-Prince, where almost 100,000 homes were destroyed. The country lacked the specialist equipment that is needed to rescue people trapped in collapsed buildings, and a cholera outbreak caused further problems.

Japan (an MEDC) is relatively well equipped to respond to the primary and secondary effects of earthquakes. Unlike Haiti, Japan has the resources to mount emergency response teams in the immediate aftermath of an earthquake to deliver much-needed aid to affected areas. As a country prone to earthquakes, Japan also invests heavily in sophisticated warning systems, emergency evacuation procedures and earthquake-resistant construction. But even the most sophisticated of systems can fail to predict the scale of the secondary effects of an earthquake. In March 2011, a 9.0-magnitude earthquake occurred off the east coast of the country creating a powerful tsunami. The deadly surge of water consumed coastal towns in the hour that followed the initial quake, covering almost 561 square kilometres and destroying thousands of homes and buildings. Damage to a nuclear power plant created a major health risk for the area, and huge amounts of debris were created. Over 13,000 people died as a result of the earthquake with an estimated 93% of these having drowned as a result of the tsunami.



Large machinery is often required to clear massive amounts of rubble after an earthquake

• Suggested Films

- Earthquakes: LEDC Response
- Earthquakes: MEDC Response

• Suggested Activity

- Ask the students to research the effects of two contrasting earthquake case studies, one from a more economically developed country (MEDC) and one from a less economically developed country (LEDC).

• Quizzes

What Is An Earthquake?

Basic

• Earthquakes are violent shaking of the Earth's

- A – outer core
- B – crust
- C – mantle
- D – inner core

• The plate boundary where the earthquake occurs is known as the

- A – fall line
- B – faint line
- C – fault line
- D – fjord line

• Inside the Earth's crust, the point where the pressure is released is known as the

- A – focus
- B – slip zone
- C – shake HQ
- D – epicentre

• What scale is used to measure the magnitude of earthquakes?

- A – Richter Scale
- B – Rodgers Scale
- C – Reinhart Scale
- D – Richards Scale

Advanced

• Earthquakes occur along

- A – conservative plate boundaries only
- B – conservative and destructive plate boundaries only
- C – conservative and constructive plate boundaries only
- D – all types of plate boundary

• Which best describes the epicentre?

- A – the point on the Earth's surface directly above the focus
- B – the point inside the Earth's crust where the pressure is released
- C – the point on the Earth's surface that receives most damage
- D – the point beneath the Earth's surface where most slipping of the plates has occurred

• Earthquake energy is released in

- A – volcanic waves
- B – plate waves
- C – seismic waves
- D – geologic waves

• Which is not a secondary effect of earthquakes?

- A – fires
- B – landslides
- C – ground movement
- D – tsunamis

• Answers

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