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# **Earthquake and the Causes of its Creation**

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# What is an earthquake?

The Earth's crust consists of seven large lithospheric plates and numerous smaller plates. These plates move towards each other (a convergent boundary), apart (a divergent boundary) or past each other (a transform boundary).

Earthquakes are caused by a sudden release of stress along faults in the earth's crust. The continuous motion of tectonic plates causes a steady build-up of pressure in the rock strata on both sides of a fault until the stress is sufficiently great that it is released in a sudden, jerky movement. The resulting waves of seismic energy propagate through the ground and over its surface, causing the shaking we perceive as earthquakes.

An earthquake is the sudden release of strain energy in the Earth's crust, resulting in waves of shaking that radiate outwards from the earthquake source. When stresses in the crust exceed the strength of the rock, it breaks along lines of weakness, either a pre-existing or new fault plane. The point where an earthquake starts is termed the focus or hypocentre and may be many kilometres deep within the earth. The point at the surface directly above the focus is called the earthquake epicentre.

## The Four Layers

The Earth is composed of **four different layers**. Many geologists believe that as the **Earth cooled** the heavier, **denser materials sank to the center** and **the lighter materials rose to the top**. Because of this, the crust is made of the lightest materials (rock- basalts and granites) and the core consists of heavy metals (nickel and iron).

The crust is the layer that we live on, and it is the most widely studied and understood. The mantle is much hotter and has the ability to flow. The Outer and Inner Cores are hotter still with pressures so great that you would be squeezed into a ball smaller than a marble if you were able to go to the center of the Earth!!!!!!

# The Crust

The Earth's Crust is like the skin of an apple. It is very thin in comparison to the other three layers. The crust is only about 3-5 miles (8 kilometers) thick under the oceans(oceanic crust) and about 25 miles (32 kilometers) thick under the continents (continental crust). The temperatures of the crust vary from air temperature on top to about 1600 degrees Fahrenheit (870 degrees Celcius) in the deepest parts of the crust. You can bake a loaf of bread in your oven at 350 degrees Fahrenheit , at 1600 degrees F. rocks begin to melt.

The crust of the Earth is broken into many pieces called plates. The plates "float" on the soft, plastic mantle which is located below the crust. These plates usually move along smoothly but sometimes they stick and build up pressure. The pressure builds and the rock bends until it snaps. When this occurs an Earthquake is the result!

Notice how thin the crust of the Earth is in comparison to the other layers. The seven continents and ocean plates basically float across the mantle which is composed of much hotter and denser material.

The solid crust and top, stiff layer of the mantle make up a region called the **lithosphere**. The lithosphere isn't a continuous piece that wraps around the whole Earth like an eggshell. It's actually made up of giant puzzle pieces called **tectonic plates**. Tectonic plates are constantly shifting as they drift around on the **viscous**, or slowly flowing, mantle layer below.

This non-stop movement causes stress on Earth's crust. When the stresses get too large, it leads to cracks called **faults**. When tectonic plates move, it also causes movements at the faults. An **earthquake** is the sudden movement of Earth's crust at a fault line.

- An **earthquake** is what happens when two blocks of the earth suddenly slip past one another. The surface where they slip is called the **fault** or **fault plane**. The location below the earth's surface where the earthquake starts is called the **hypocenter**, and the location directly above it on the surface of the earth is called the **epicenter**.
- Sometimes an earthquake has **foreshocks**. These are smaller earthquakes that happen in the same place as the larger earthquake that follows. Scientists can't tell that an earthquake is a foreshock until the larger earthquake happens. The largest, main earthquake is called the **mainshock**. Mainshocks always have **aftershocks** that follow. These are smaller earthquakes that occur afterwards in the same place as the mainshock. Depending on the size of the mainshock, aftershocks can continue for weeks, months, and even years after the mainshock!



# How Do We Measure Earthquakes?

The energy from an earthquake travels through Earth in vibrations called **seismic waves**. Scientists can measure these seismic waves on instruments called seismometer. A seismometer detects seismic waves below the instrument and records them as a series of zig-zags.

Scientists can determine the time, location and intensity of an earthquake from the information recorded by a seismometer. This record also provides information about the rocks the seismic waves traveled through.

# Top 10 Causes of Earthquake

An earthquake can be both a man-made and natural disaster. It is difficult to control the magnanimity and fierceness of such an attack when an earthquake comes. The recent Nepal example is in itself a testimony of how necessary it has become to be aware of some of the earthquake preventive measures. But before that one must know how an earthquake is caused. Read up:-

# 1. Seismic Waves

This is one of the major causes of an earthquake. There are several types of earthquake waves including primary waves and also secondary waves. However, Surface waves consist of several major types and are known as long waves. These waves then cause heavy disruption when they flow as they are affected by changes in the density and also the rigidity of the material through which they pass. Major examples of such an earthquake were in Assam, India (1897 and 1950).

## 2. Compression in the earth's crust

There have been many examples of Earthquakes in Australia being caused because of the movements along faults. This could be a result of the compression in the Earth's crust. You can determine the size or magnitude of earthquakes by measuring the actual amplitude of the seismic waves which gets recorded on a seismograph.

# 3. Dams and reservoirs

This can be one of the major causes. The rupture in the million tons of water would have hastened the earth's shaking. No geological process can actually come up with such a huge concentration of mass in such a small area except for a volcano. It is history which has proved how large reservoirs of water created by dams have caused earthquakes. Examples include from Zambia to Greece to India. Example: – 2008 Sichuan, China earthquake- killed nearly 70,000 people. It is believed that it was triggered by the construction of the Ziping Dam nearby.

## 4. Groundwater extraction

Taking water out of ground is another example through which earthquakes have been necessarily initiated. The act causes the water table to drop thus destabilizing an existing fault. For example: – 2011 Lorca earthquake. This 2011 earthquake in Lorca, Spain caused a huge amount of destruction for its 5.1 magnitude as was recorded in the Richter scale. It was also because the epicenter of the mountain was located so close to the surface. Its shallow epicenter could have had a relation with that of the act of groundwater extraction near Lorca. Since 1960, water extraction has been one of the main reasons as to why the region's water table dropped by an incredible 250 meters.

## 5. Geothermal power plants — Salton Sea Geothermal Field and The Geysers Geothermal Field

According to a 2011 study published, it was clear that researchers at the University of California had discovered that seismic activity had increased around the Salton Sea as geothermal field operations around the area had ramped up. While these earthquakes in themselves may not be the main cause of damage but the other interaction with bigger faults like San Andreas could be one. Earthquake swarms include bursts of dozens of small quakes prevailing below magnitude 6 or so—happen regularly along the Salton Sea. Example of such an earthquake include: – Salton Sea Geothermal Field and The Geysers Geothermal Field

## 6. Tracking and injection wells — 2011 Oklahoma earthquake

The process of hydraulic fracturing, or fracking is not actually the main cause of earthquakes. It is when the waste fracking liquid is injected back underneath into the deep wells that cause rupture. The fluid caused due to the extraction of liquids can seep out and also lubricate faults. This can cause them to slip more easily. For example:- 2011 Oklahoma earthquake- A study had pointed out that Seismic activity in Oklahoma has shot up along with the rise of fracking. Earthquake swarms have become a regular occurrence in the region. The number of earthquakes had shot up from a dozen in 2008 to over 1,000 in 2010.



## 7. Big skyscrapers

Big skyscrapers and buildings can put immense pressure on the earth's surface. It can cause the rudimentary rocks to even crack. As a study points out, Taipei 101's especially huge mass of 770,000 tons is presently putting too much pressure on the soft sedimentary rock below. It comes because of the extra steel and concrete which is being used to make the skyscraper solid enough to withstand earthquakes. Since construction began on the building of Taipei 101, the region began to receive several micro-earthquakes and even two larger earthquakes which went directly underneath the building.

## 8. Tectonic movements of the earth

Tectonic Earthquakes are caused when the crust becomes subjected to strain, and eventually starts moving. The theory of plate tectonics explains how when the crust of the Earth is made of several plates, there are large areas of crust which float on the Mantle. Since these plates are small and are free to slowly move, they undergo a lot of movement. Many of these earthquakes which we feel are may be located in the areas where these plates could collide can even slide past each other.

Example: – Due to tectonic movements, San Francisco has noticed many small shakes.

# 9. Volcanic eruptions

Volcanic earthquakes are very less likely than Tectonic ones. They are triggered when there is an explosion of an explosive volcano. It depends from volcano to volcano. If they are quite, chances are less. For example: – In the case of Mt Pele, the lava has solidified before it flew down the sides of the volcano. At least around 20 miles of the area around is affected when a volcano explodes. However for a tectonic earthquake, effects may be felt around the globe.

The table below briefly describes earthquake effects corresponding to various magnitude levels and also gives an estimated number of earthquakes of different magnitudes that happen in the world each year. It can be observed from this table that a large majority of earthquakes (900,000) are of magnitude 2.5 or less (very minor earthquakes, usually not felt). Great, catastrophic earthquakes (magnitude 8 or greater) happen once in 5 to 10 years.