# Competitive Exams: Earthquake geography notes on causes and implications of earthquake

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The earthquake is a form of energy of wave motion transmitted through the surface layer of the earth in widening circles from a point of sudden energy release, the focus. The point within the earth where earthquakes are generated is called focus or hypocenter. The point on the earth's surface directly above the focus is called the epicenter.

Four types of earthquake waves are found: three discovered by R D Oldham and one later, by Augustas E. H. Love

Basically, they may be divided into two chief kinds of seismic waves:

1. Body waves and

2. Surface waves.

Body Waves: The fastest seismic waves, move through the earth. Slower surface waves travel along the surface of the earth. Body waves tend to cause the most earthquake damage. There are two kinds of body waves:

1. Compressional waves and

2. Shear waves.

As the waves pass through the earth, they cause particles of rock to move in different ways. Compressional waves push and pull-the rock. They cause buildings and other structures to contract and expand. Shear waves make rocks bend or slide from side to side, and buildings shake. Compressional waves can travel through solids, liquids, or gases, but shear waves can pass only through solids. Compressional or longitudinal waves are the fastest seismic waves, and they arrive first at a distant point. For this reason, compressional waves are also called primary (P) waves. ie they have shortest wavelength among the four. Their velocity is 5 to 8 km per second. They can travel through liquids and solids but travel faster in denser solid media. These waves are like sound waves and cause any rock in their path to compress and then expand in the same direction as the waves are travelling. Primary waves undergo refraction and reflection at the margin of earth's outer lighter shell and inner dense core. Secondary or S waves which are of medium wavelength, are also called Shake or Shear waves. Shear waves, which travel slower and arrive later, are called secondary (S) waves. Body waves travel faster deep within the earth than near the surface. For example, at depths of less, than 25 kilometers, compressional waves travel at about 8 kilometres per second, and shear waves travel at J.8 kilometres per second. At a depth of 1,000 kilometres, the waves travel more than 11/2 times that speed.

Surface Waves: are long, slow waves. They produce what people feel as slow rocking sensations and cause little or no damage to buildings. There are two kinds of surface waves: Love waves and Rayleigh waves. Love waves, named after AEH Love in 1911, travel through the earth's surface horizontally and move the ground from side to side. Rayleigh waves, named after Lord Rayleigh in 1885, makes the surface of the earth roll like waves on the ocean. Typical Love waves travel at about 4.4 kilometers per second, and Rayleigh waves, the slowest of the seismic waves, move at about 3.7 kilometers per second.

### Damage by Earthquakes

(1) Fault Slippage: Near a fault, both the shifting of large blocks of the earth's crust, called fault slippage, and the shaking of the ground due to seismic waves cause destruction. The rock on either side of a fault may shift only slightly during an earthquake or several meters.

(2) Liquefaction: In areas with soft, wet soils, a process called liquefaction may intensify earthquake damage. Liquefaction occurs when strong ground shaking causes wet soils to behave temporarily like liquids rather than solids. Anything on top of liquefied soil may sink into the soft ground. The liquefied soil may also flow toward lower ground, burying anything in its path.

(3) Tsunamis. An earthquake on the ocean floor can give a tremendous push to surrounding seawater and create one or more large, destructive waves called tsunamis, also known as seismic sea waves, other horizontally.

### Causes of Earthquake

1. Continental Drift

2. Sea-floor Spreading

3. Plate Tectonics

4. Isostasy and Faulting

5. Hydrostatic Pressure and Anthropogenic Causes: The introduction of additional artificial superincumbent load through the construction of large dams and impounding of enormous volume of water in bog reservoirs behind the dams cause disequilibrium of already isostatically adjusted rocks below the reservoirs or further-augment the already fragile structures due to faults and fractures underneath.

6. Volcanicity Measuring Instruments:

(1) Seismograph: The first electromagnetic seismograph was constructed by Italian scientist in 1855. But the first modern seismograph was devised by John Milne-in 1880, the author of the book 'Earthquake and Other Movements'. It is based on the principle of pendulum.

(i) Seismoscope is a qualitative device to indicate the arrival of an earthquake with human perception may not register if the

acceleration is less than 1 cm/s the minimum acceleration felt by human beings.

(ii) Seismograph, on the other hand, records an earthquake and this piece of recording is called a seismogram. A telegraph is what a seismogram to seismograph is.

(iii) Seismometer lies between a Seismoscope and a seismograph. The movements of the device are calibrated with known earthquake parameters. Oldham's array of wooden cylinders is a Seismoscope:

(2) Accelerographs: are specifically designed to measure, the direction and intensity of ground motions during an earthquake for application to earthquake engineering.

(3) Inverted Pendulum: are used in the seismograph.

(4) Chronograph: the paper component of a seismograph is called a chronograph which consists of a drum rotating at a controlled constant speed around which a time-marked paper moves like a conveyor belt, just touching the stylus.

**Measurement of Earthquake**

1. Richter scale: Probably the best-known gauge of earth-quake intensity is the local Richter magnitude scale, developed in 1935 by United States seismologist Charles Francis Richter. This scale, commonly known as the Richter scale, measures the ground motion caused by an earthquake.

2. It is a logarithmic scale that runs from 1 to 9, though no upper limit exists; a magnitude 7 quake is 10 times more powerful than a magnitude 6 quake, 100 times more powerful than a magnitude 5 quake, 1000 times more powerful than a magnitude 4 quake, and so on. An estimated 800 quakes of magnitudes 5 to 6 occur annually worldwide, in comparison with about 50,000 quakes of magnitudes 3 to 4, and only about one earthquake of magnitudes 8 to 9. Until 1979 an earthquake of magnitude 8.5 was thought to be the most powerful possible; since then, however, improvements in seismic measuring techniques have enabled seismologists to refine the scale, and 9.5 is now considered to be the practical limit. Every increase of one number in magnitude means the energy release of the quake is 32 times greater. For example, an earthquake of magnitude 7.0 releases 32 times as much energy as an earthquake measuring 6.0. An earthquake with a magnitude of less than 2.0 is so slight that usually only a seismometer can detect it. A quake greater than 7.0 may destroy many buildings. There are about 10 times as many quakes for every decrease in Richter magnitude by one unit. For example, there are 10 times as many earthquakes with magnitude 6.0 as there are with magnitude 7.0.

3. The largest earthquake ever recorded on the moment magnitude scale measured 9.5. It was an interplate earthquake that occurred along the Pacific coast of Chile in South America in 1960. The largest intraplate earthquakes known struck in central Asia and in the Indian Ocean in 1905, 1920, and 1957. They range between about 8.0 and 8.3.

4. Mercalli Scale: It was introduced in 1800s by the Italian seismologist Giuseppe Mercalli, measures the intensity of shaking with gradations from I to XII. Because seismic surface effects diminish with distance from the focus of the quake, the Mercalli rating assigned to the quake depends on the site of the mea-surement. Intensity I on this scale is defined as an event felt by very few people, whereas intensity XII is a catastrophic event that causes total destruction. Intensities II to III on the Mercalli scale are roughly equal to magnitudes 3 to 4 on the Richter scale, and XI to XII to 8 to 9.

5. Rossi-Forel Scale: It is a scale for rating the intensity of earthquake shocks, devised in 1878. It was modified by the Mercalli Scale.