



LECTURE # 1

In this lecture we will learn about:

- Structure Of Earth
- Earthquake
- Terminologies
- Earthquake Waves
(Seismic Waves)
- Types of E-Q
- Magnitude & Intensity

Course Name:

“Introduction To Earthquake Engineering”

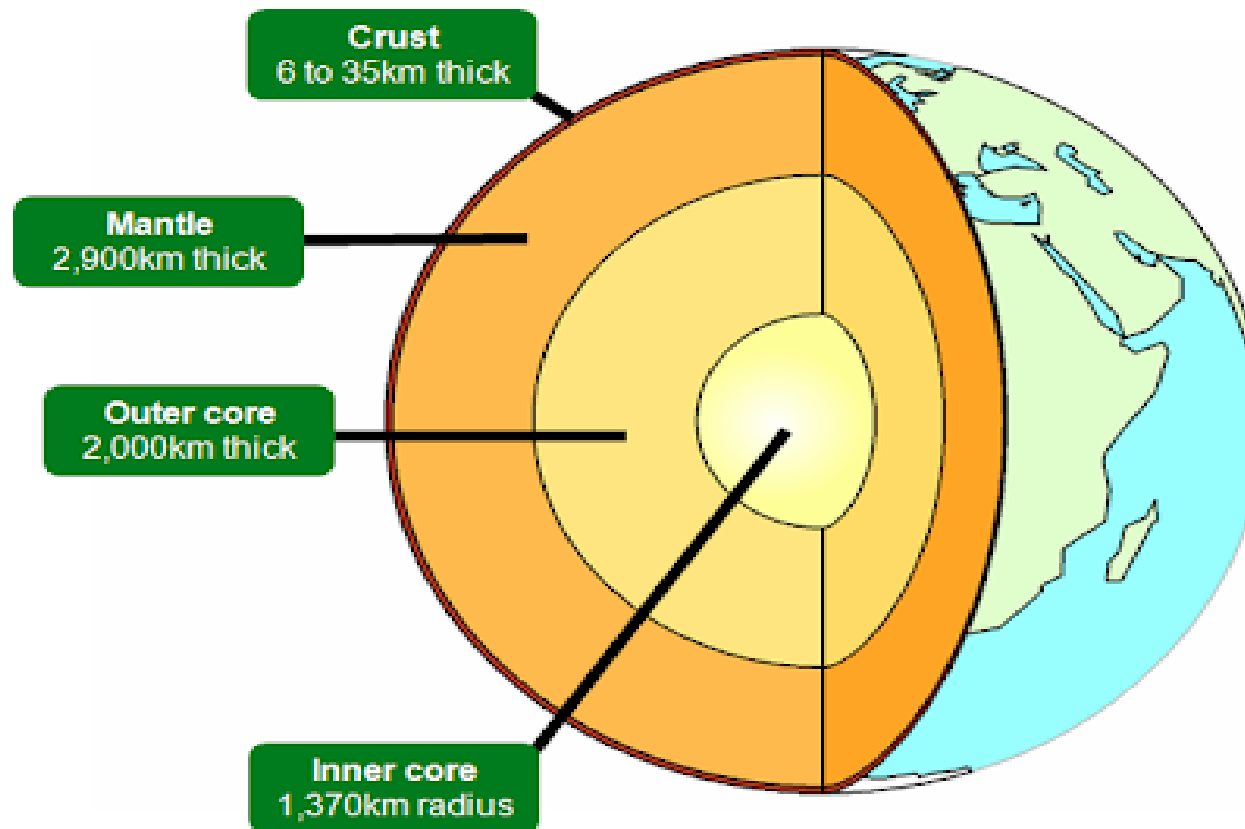
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STRUCTURE OF EARTH



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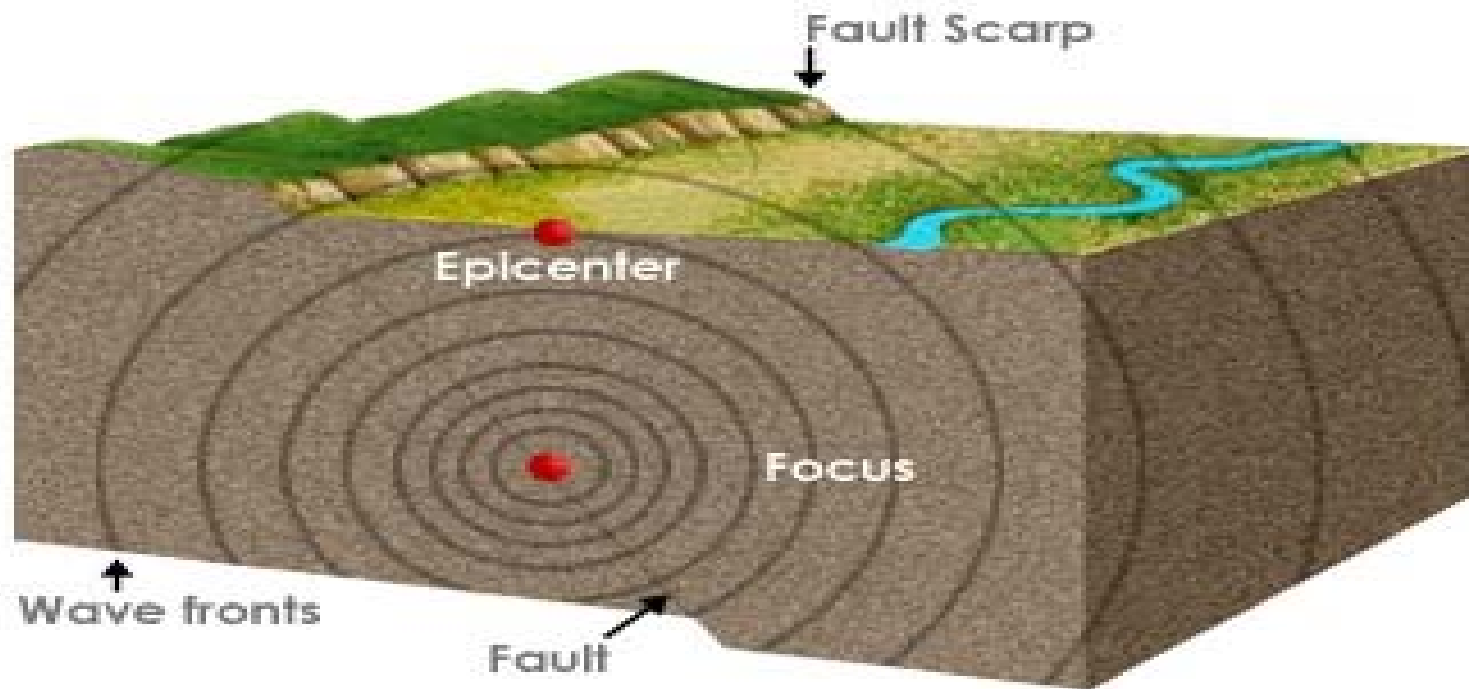


EARTHQUAKE

DEFINITION

Earthquake, any sudden shaking of the ground caused by the passage of [seismic waves](#) through [Earth](#)'s rocks. Seismic waves are produced when some form of energy stored in Earth's crust is suddenly released, usually when masses of rock straining against one another suddenly fracture and "slip." Earthquakes occur most often along geologic [faults](#), narrow zones where rock masses move in relation to one another. The major [fault](#) lines of the world are located at the fringes of the huge tectonic plates that make up Earth's crust.

ANATOMY OF EARTHQUAKE



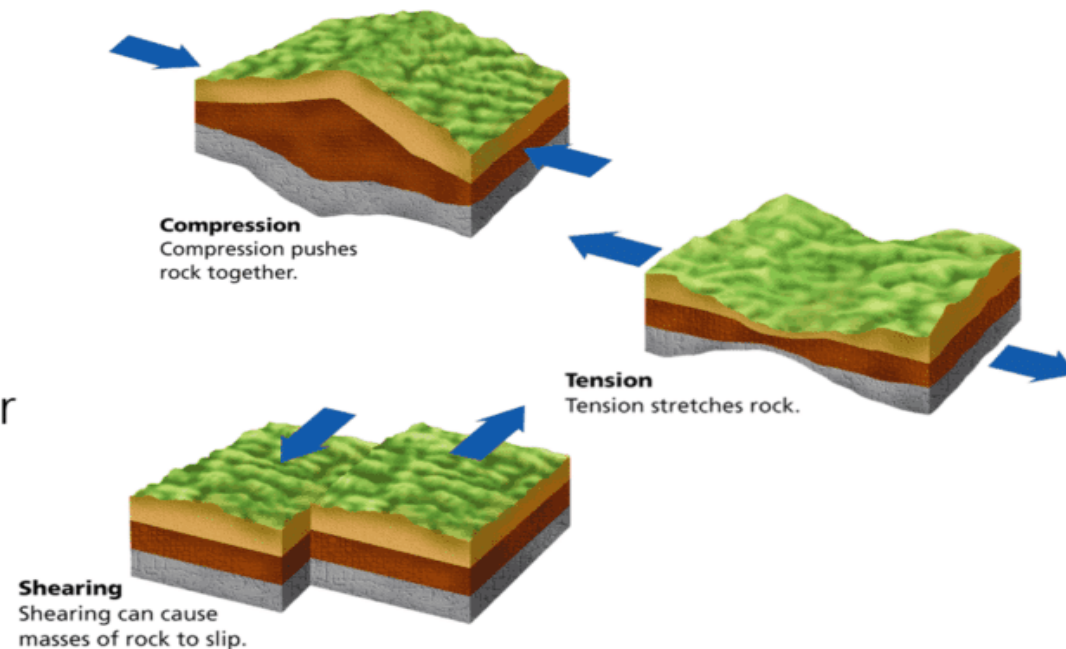
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STRESS ON ROCKS

Earthquakes

Stress on Rocks

- Compression – rocks move together
- Tension – rocks move away from each other
- Shearing – rocks slide past each other





TERMINOLOGIES

- **FAULT:** A fracture in the rocks that make up the Earth's crust
- **EPICENTER:** The point at the surface of the Earth above the focus
- **PLATES:** Massive rocks that make up the outer layer of the Earth's surface and whose movement along faults triggers earthquakes
- **SEISMIC WAVES:** Waves that transmit the energy released by an earthquake
- **FOCUS (HYPOCENTER):** The point within the Earth where an earthquake rupture starts

EARTHQUAKE WAVES (SEISMIC WAVES)



Earthquake shaking and damage is the result of two basic types of elastic waves. They are:

1. Body Waves.
2. Surface Waves.



BODY WAVES

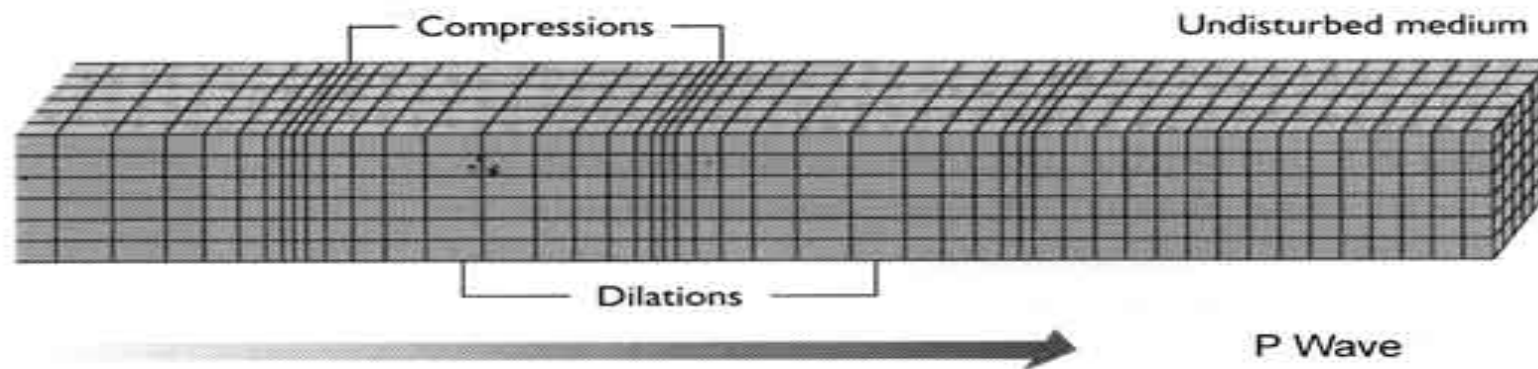
Body waves can travel through the earth's inner layers.

Body waves are of two types:

1. P-Waves.
2. S-Waves.

P-WAVES

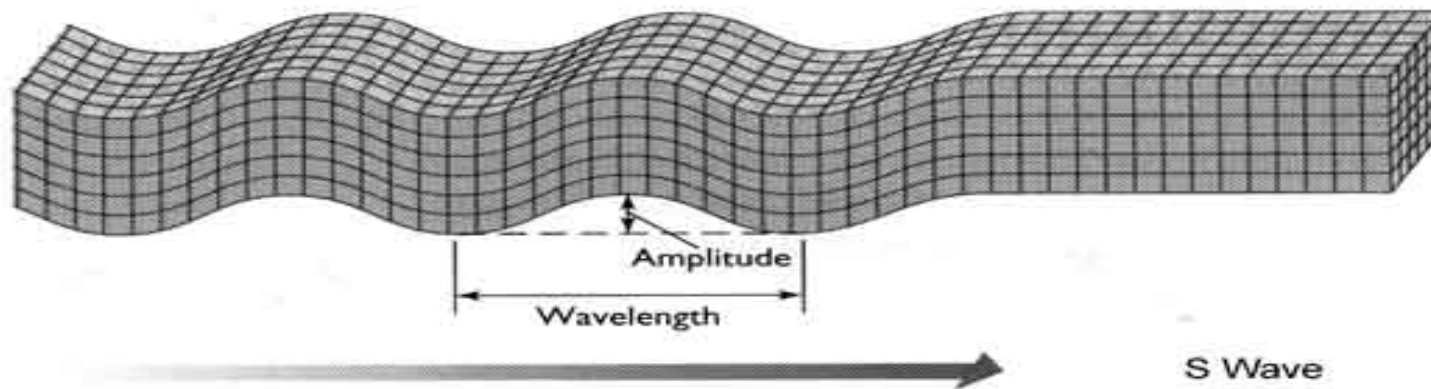
They propagate within a body of rock. The faster of these body waves is called the primary or P wave. Its motion is the same as that of a sound wave in that, as it spreads out, it alternately pushes (compresses) and pulls (dilates) the rock. These P waves are able to travel through both solid rock, such as granite mountains, and liquid material, such as volcanic magma or the water of the oceans.





S-WAVES

The slower wave through the body of rock is called the secondary or S wave. As an S wave propagates, it shears the rock sideways at right angles to the direction of travel. If a liquid is sheared sideways or twisted, it will not spring back, hence S waves cannot propagate in the liquid parts of the earth, such as oceans and lakes.



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BODY WAVES CONTD.

The actual speed of P and S seismic waves depends on the density and elastic properties of the rocks and soil through which they pass. In most earthquakes, the P waves are felt first. The effect is similar to a sonic boom that bumps and rattles windows. Some seconds later, the S waves arrive with their up-and-down and side-to-side motion, shaking the ground surface vertically and horizontally. This is the wave motion that is so damaging to structures.



SURFACE WAVES

Surface waves can only move along the surface of the planet like ripples on water.

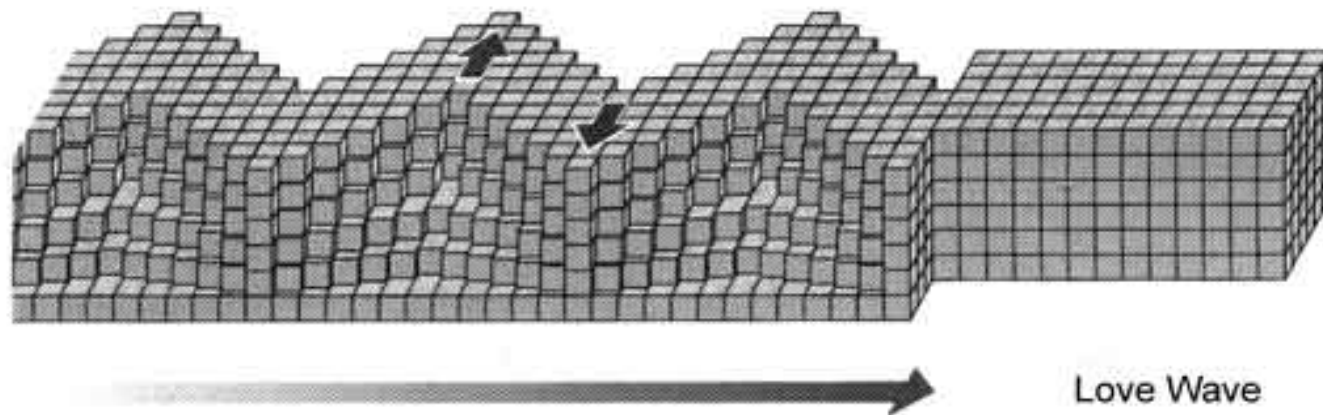
Surface waves are also of two types

1. Love Waves.
2. Rayleigh Waves.



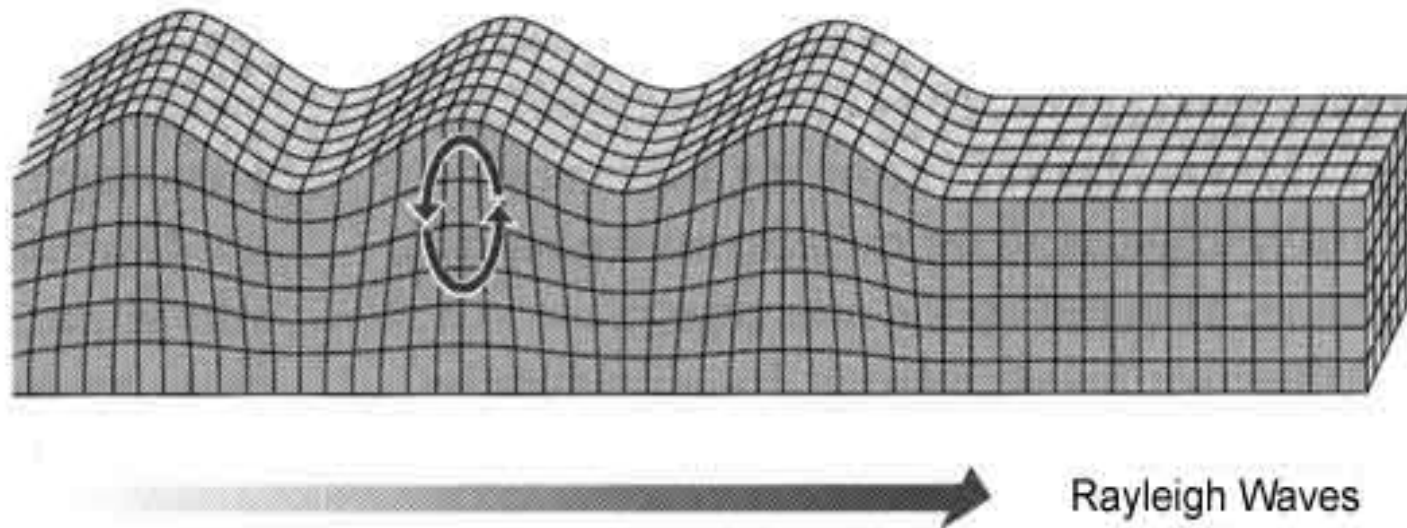
LOVE WAVES

Its motion is essentially that of S waves that have no vertical displacement; it moves the ground from side to side in a horizontal plane but at right angles to the direction of propagation. The horizontal shaking of Love waves is particularly damaging to the foundations of structures.



RAYLEIGH WAVES

Like rolling ocean waves, Rayleigh waves wave move both vertically and horizontally in a vertical plane pointed in the direction in which the waves are travelling.





SURFACE WAVES CONTD.

Surface waves travel more slowly than body waves (P and S); and of the two surface waves, Love waves generally travel faster than Rayleigh waves. Love waves (do not propagate through water) can effect surface water only insofar as the sides of lakes and ocean bays pushing water sideways like the sides of a vibrating tank, whereas Rayleigh waves, because of their vertical component of their motion can affect the bodies of water such as lakes.



TYPES OF EARTHQUAKE

Tectonic Earthquakes

- Occurs when rocks in the earth's crust break due to geological forces created by movement of tectonic plates.

Volcanic Earthquakes

- Occurs in conjunction with volcanic activity.

Explosive Earthquakes

- Results from the explosion of nuclear and chemical devices.

Collapse Earthquakes

- Are small earthquakes in underground caverns and mines.



MAGNITUDE AND INTENSITY OF EARTHQUAKE

- Rossi-Forrel's Scale
- Mercalli Scale
- Richter Scale



ROSSI-FORREL'S SCALE

The 1873 version of the Rossi–Forel scale had 10 intensity levels:

1. Micro seismic tremor
2. Extremely feeble tremor.
3. Feeble tremor.
4. Slight tremor
5. Moderate tremor
6. Strong tremor
7. Very strong tremor.
8. Damaging tremor.
9. Devastating tremor.
10. Extremely high intensity tremor.



MERCALLI SCALE

| Level of Earthquake | Instrumental | Detected only by seismographs |
|---------------------|-----------------|---------------------------------------------------------------------------------------------------------------------|
| I | Instrumental | Detected only by seismographs |
| II | Feeble | Noticed only by sensitive people. |
| III | Slight | Resembling vibrations caused by heavy traffic |
| IV | Moderate | Felt by people walking; rocking of free standing objects |
| V | Rather strong | Sleepers awakened and bells ring |
| VI | Strong | Trees sway, some damage from overturning and falling objects. |
| VII | Very strong | General alarm, cracking of walls |
| VIII | Destructive | Chimneys fall and there is some damage to buildings |
| IX | Ruinous | Ground begins to crack, houses begin to collapse and pipes leak. |
| X | Disastrous | Ground badly cracked and many buildings are destroyed. There are some landslides |
| XI | Very Disastrous | Few buildings remain standing; bridges and railways destroyed. water, gas, electricity and telephones out of action |
| XII | Catastrophic | Total destruction; objects are thrown into the air, much heaving, shaking and distortion of the ground. |

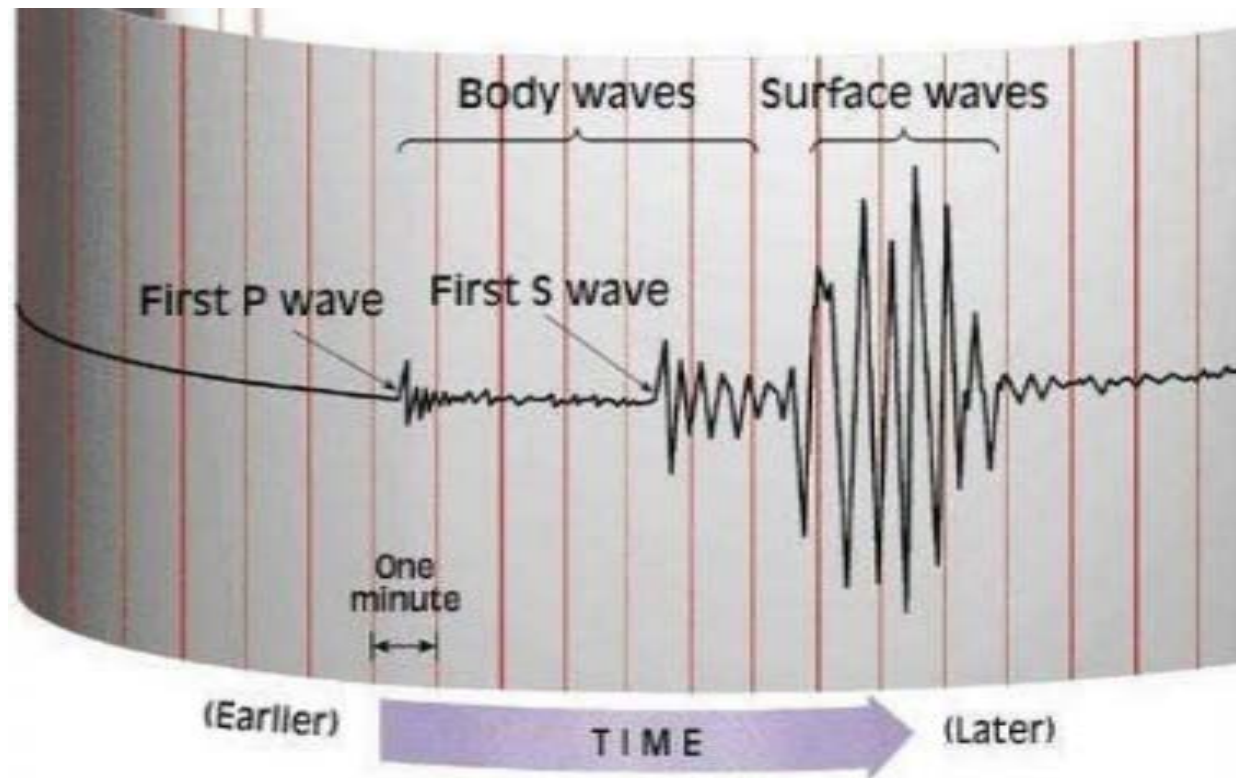


RICHTER SCALE

MAGNITUDE

- Richter scale measures total amount of energy released by an earthquake; independent of intensity.
- Amplitude of the largest wave produced by an event is corrected for distance and assigned a value on an open-ended logarithmic scale.

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ASSIGNMENT - 1

1. Classification of earthquakes on the basis of:
 - Cause of Origin
 - Depth of Focus
 - Intensity & Magnitude of Earthquake

2. Draw a labeled diagram showing the following terminologies
 - Dip.
 - Strike.
 - Normal, Reverse and Strike-Slip Faulting.

NOTE:

Assignments are also included in course for paper

Thank you