

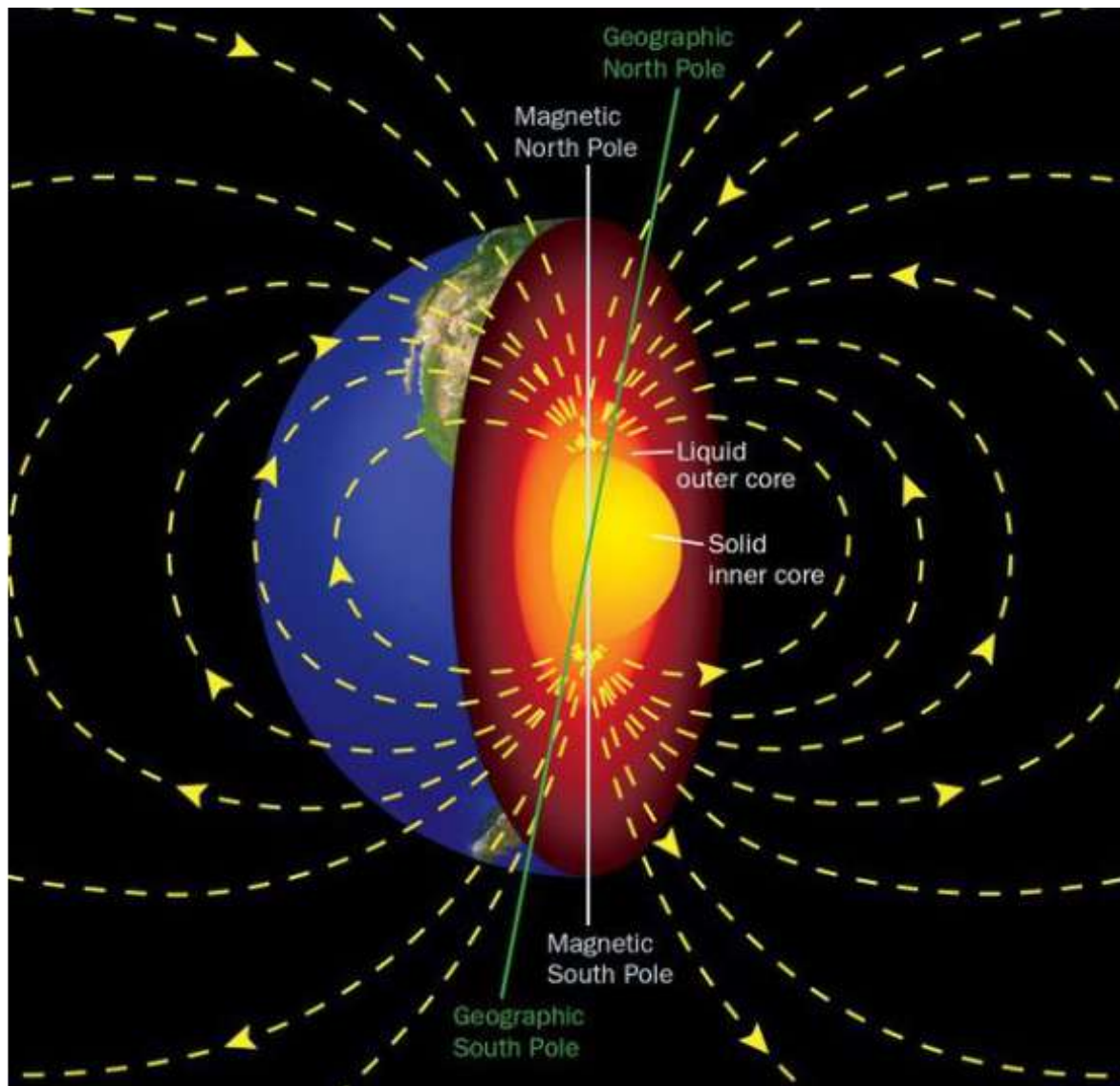
Geography Class 15

REVISION OF THE PREVIOUS CLASS (9:18 AM)

- Volcanism includes all the phenomena associated with the movement of molten material from the interior of the earth to the surface.
- Volcanism involves **three processes**:
- **Generation of magma:**
- It includes processes like-
- Increase in heat.
- Decrease in pressure.
- It is facilitated by the presence of water which lowers the temperature.
- **The intrusion of magma:**
- The magma proceeds into the lithospheric layers.
- **Extrusion of magma:**
- When sufficient pressure builds up in the lithospheric chamber, the magma erupts onto the surface.
- There are mainly two types of magma- Granitic (acidic) and Basaltic (basic).
- Major types of extrusive volcanic features/volcanoes- Shield, Strato, Cinder-Cone, Caldera, Flood basalt province, etc.
- Some other volcanic landforms are Geyser, hot spring, mud-volcano, etc.
- Major types of intrusive volcanic features- Batholith, Lacolith, Lopolith, Sil, Dyke, etc.

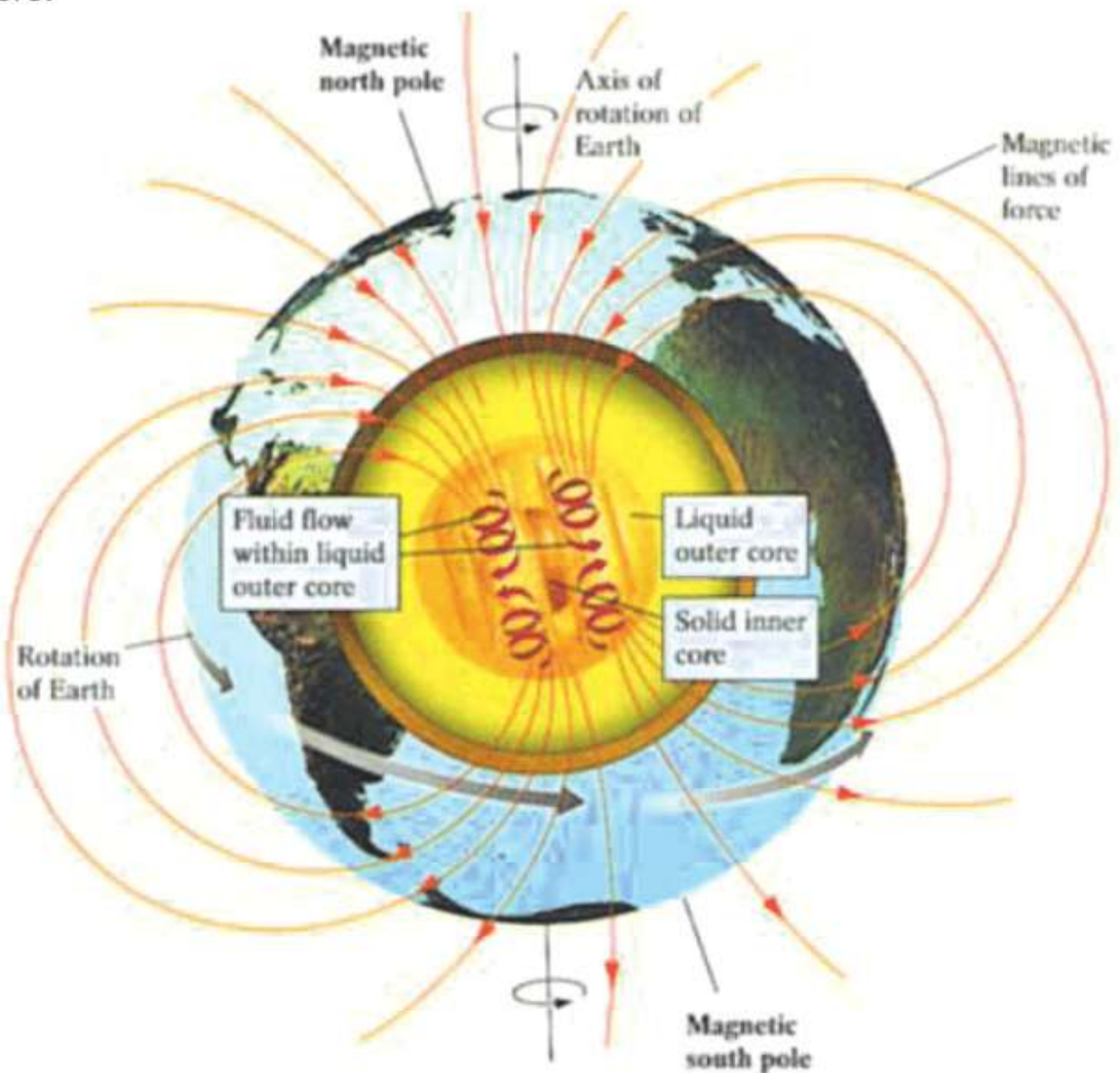
Geomagnetism:

- Simply speaking, the magnetism/magnetic field of the earth is called geomagnetism.
- The earth behaves like a huge bar magnet.
- The earth's magnetic field also has a north & a south pole.
- The earth has a rocky mantle, below which there is a liquid outer core that surrounds the solid inner core.
- It is considered that the motion of charges in the liquid outer core generates a magnetic field.
- The liquid outer core of the earth sees the continuous motion of charged iron particles.
- This is the cause of geo-magnetism.



The reasons behind this continuous motion are :

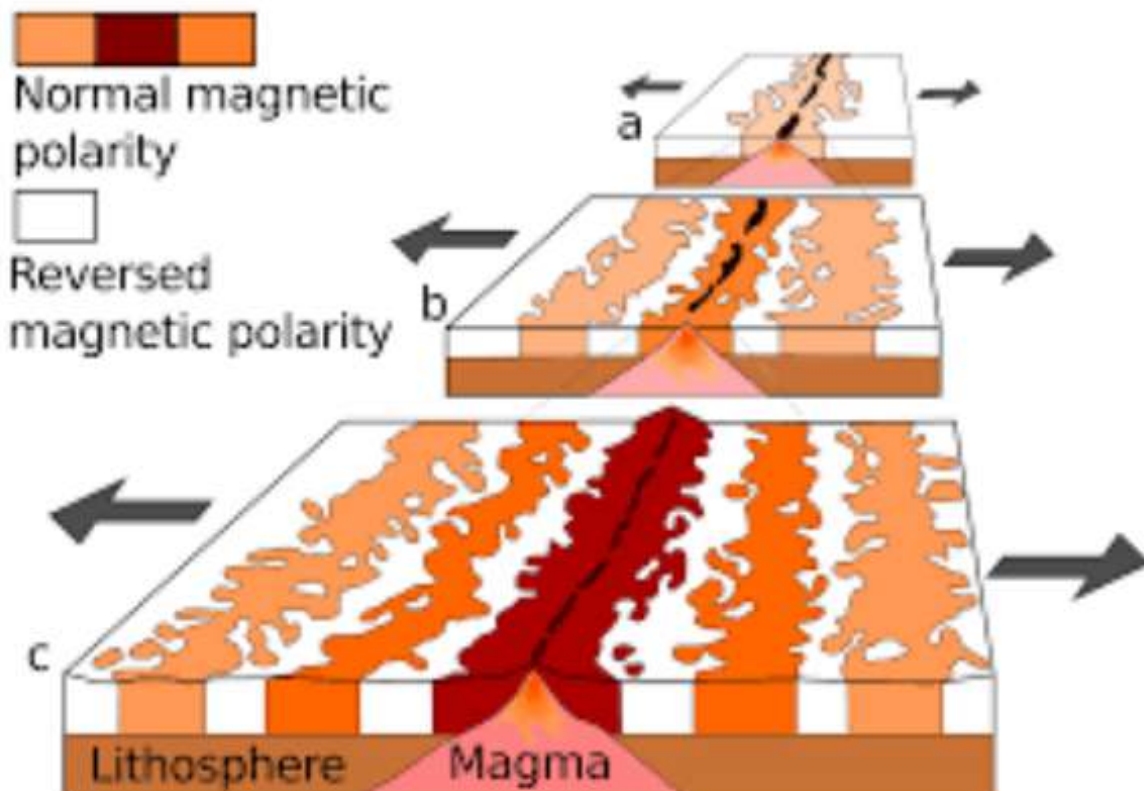
- I. Rotation of the earth.
- II. Convectional currents of the molten material due to the heat generated in the core.



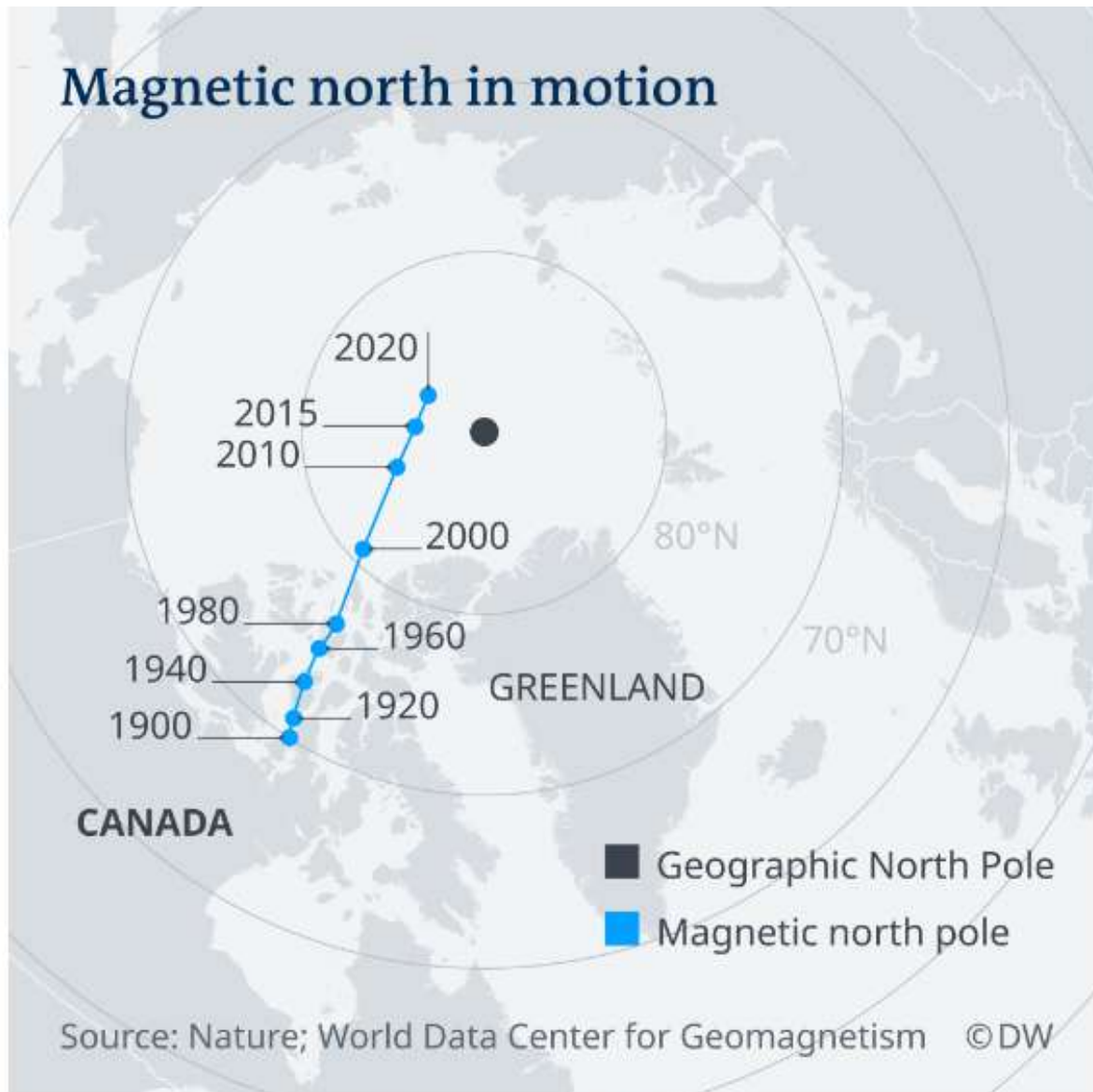
- The convection currents in the mantle are large-scale and slower.
- This motion of charged materials creates an electric current through the earth's core.
- This electric current results in a magnetic field around the earth through **electromagnetism**.
- The above is the most widely accepted theory, and research is still going on.

PALAEOMAGNETISM (9:40 AM):

- This means "Old magnetism".
- It is the historical study of the earth's magnetism through rocks.
- When magma crystallizes, the crystals of ferromagnetic minerals such as iron, manganese, titanium, etc. acquire a stable magnetism.
- They later get frozen as the magma cools down.
- This acquired magnetism is called **fossil magnetism**.
- Such rocks will have ferromagnetic minerals aligned in the same direction as that of the geomagnetic field at the time of its consolidation.
- When palaeomagnetic pieces of evidence for a given region are observed over a long period, a gradual change in the direction can be detected.



- This shows that the position of magnetic poles has moved steadily over time.
- This movement is called **polar wandering**.



- During the study of oceanic surfaces, the study of ferromagnetic minerals revealed the opposite polarity of geomagnetism.
- Such reversal of magnetic field can be brought by the reversal of convection currents in the outer core.
- The magnetic field reversal is observed once every 2-3 lakh years.
- The last such reversal happened around 8 lakh years ago.
- Presently, the north magnetic pole is near **Queen Elizabeth Island, Canada.**
- Presently, the south magnetic pole is near the **Dumont d'Urville, Antarctica.**



- By analyzing their positions we can say that unlike the geographical north and south poles, the magnetic north and south poles are not symmetrical.
- This can also be presented as the magnetic north and south poles are not **Antipodal**- lying on the same line.

Antipodal means lying on same line

AURORA (10:15 AM):

- Light is emitted from the interaction between the charged solar particles and the Earth's atmosphere.
- The earth's magnetic field either neutralizes or deflects the charged solar particles.
- Some charged particles can interact with the earth's atmosphere and give us bright light.



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- It is mainly visible in winter, but it can happen in summer too.
 - It is most visible in the night skies of the poles.
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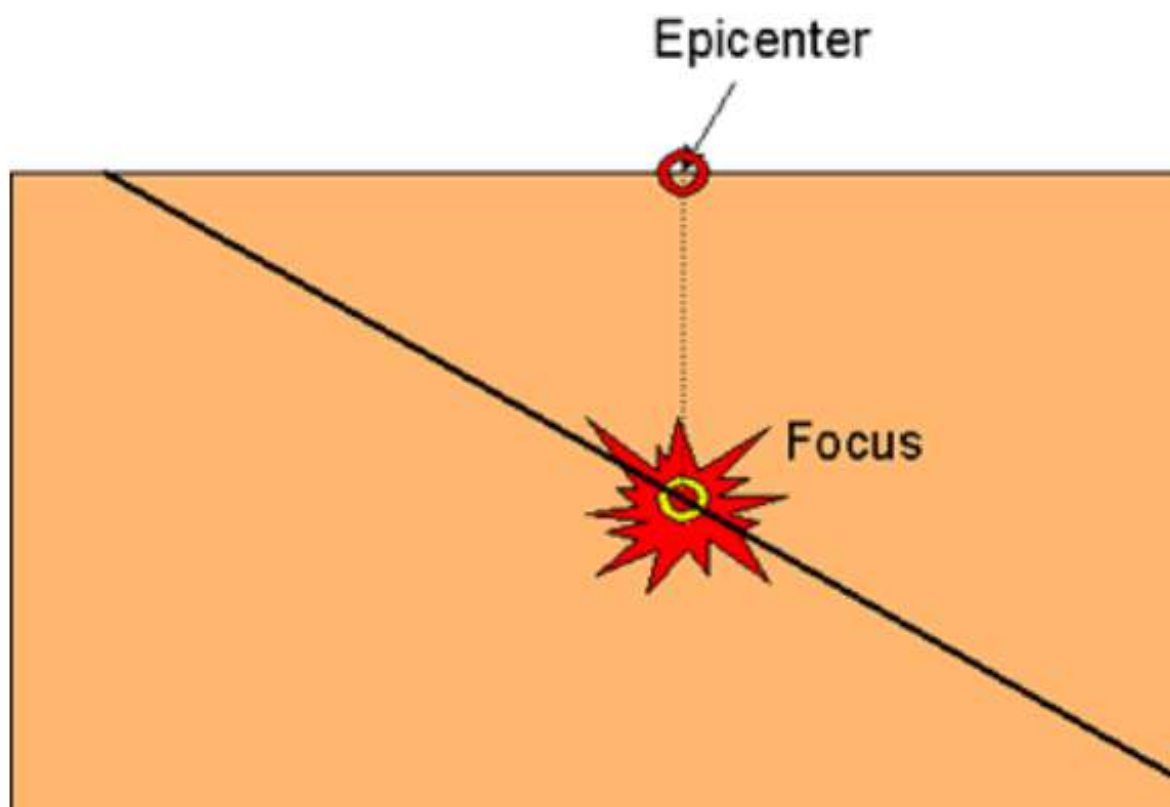
- **Aurora Borealis** is seen at the north pole.
- **Aurora Australis** is seen at the south pole.

Magnetic Anomaly:


- This is a situation where the magnetic field at any region is weaker than it must have been.
- Recently, there were cases of aurora lights being visible in some parts of the USA.
- This points to magnetic anomaly at certain portions where the solar-charged particles can reach the earth's atmosphere without getting deflected or neutralized.

Earthquakes:

- The vibration or oscillation of the earth caused by transient disturbances of the elastic or gravitational equilibrium, at or beneath the surface of the earth.
- The scientific study of earthquakes is called **seismology**.
- The point where the energy is released below the surface is called **Focus**, or **Hypocenter**.
- The point on the surface nearest to the focus is called **Epicenter**.



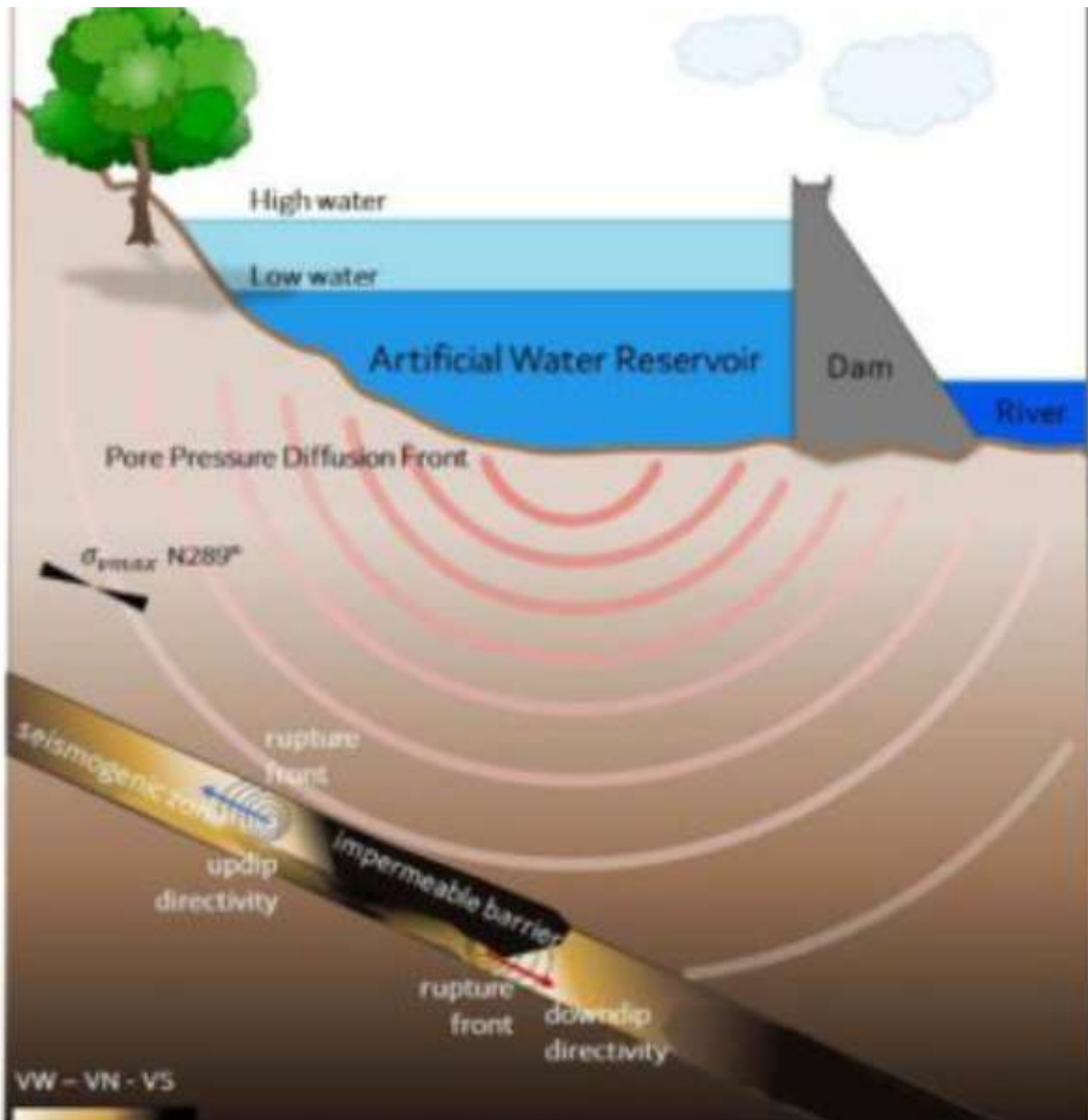
CAUSES OF THE EARTHQUAKE(10:40 AM):

Natural Causes	Anthropogenic causes
<ul style="list-style-type: none">◦ Plate movements along all three plate margins.◦ Volcanic eruption.◦ Landslide.◦ Land subsidence.  <ul style="list-style-type: none">◦ Meteoritic impact.	<ul style="list-style-type: none">◦ Mining.◦ Large-scale construction.◦ Nuclear construction.◦ Dams & Reservoirs-Reservoir-Induced Seismicity.

- Even earthquakes can cause landslides.

Reservoir-Induced Seismicity:

- This refers to the seismic movements that got triggered due to the impoundment of large quantities of water in the dam's reservoir.
- The filling up of the dam's reservoir rapidly increases the pressure exerted on the land.
- Also, the increases and decrease and decreases in the reservoir water levels also increase and decrease the pressure felt by the land respectively.
- This fluctuation can hamper the balance of the tectonic plates and rick layers underneath and can cause earthquakes.

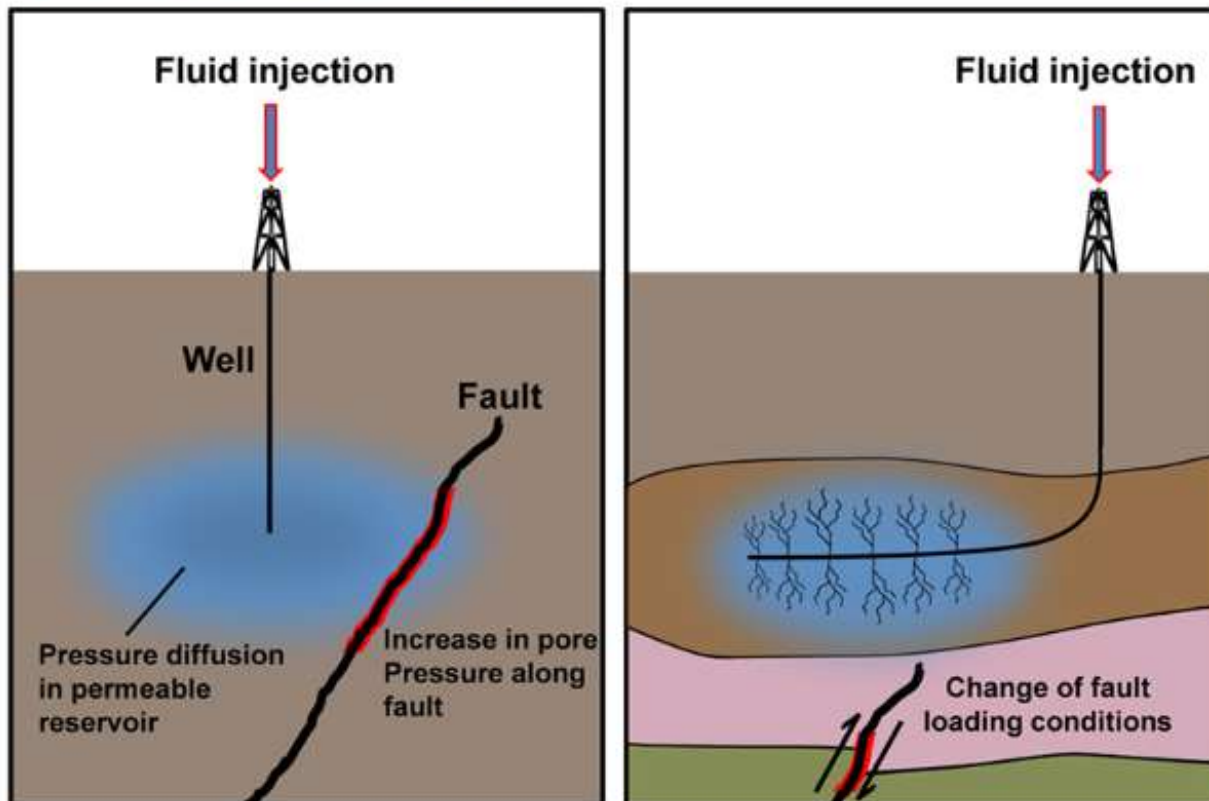


- **For example-** the Koyna River, a Krishna tributary has a dam built on it at Sangli Maharashtra, which sees frequent earthquakes of such nature.

Fracking-induced seismicity:

- Fracking is a method of oil & gas mining that involves fracturing the bedrock by the impact of highly pressurized liquid.
- The mechanical impacts on deeper rock structures can cause seismic movements.

INDUCED SEISMICITY



EARTHQUAKE WAVES (11:10 AM):

- An earthquake generates two types of waves- body waves and surface waves.

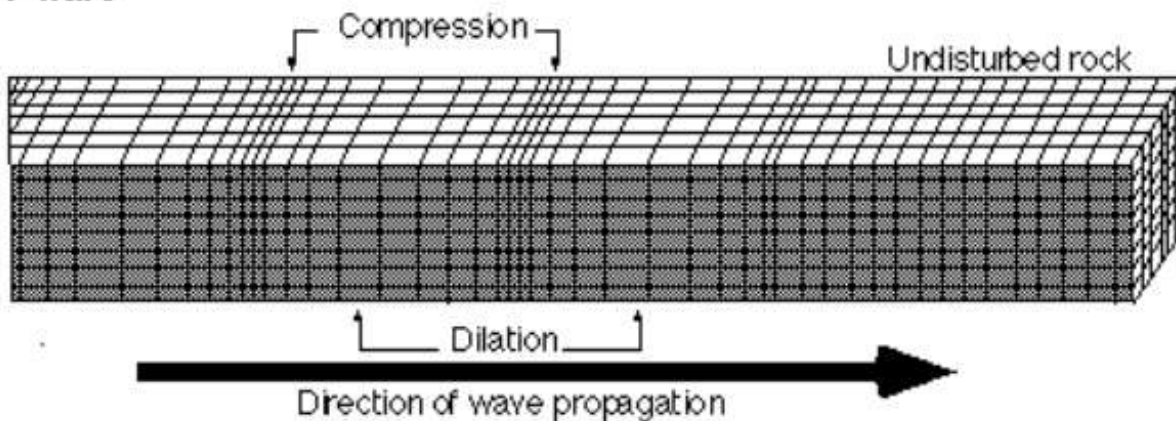
Body waves:

- They are generated from the focus and they move through the interior of the earth.
- There are two types of body waves:

I. P Waves:

- They are **primary, compressional, and longitudinal waves.**
- They oscillate back and forth in the direction of propagation.

P wave

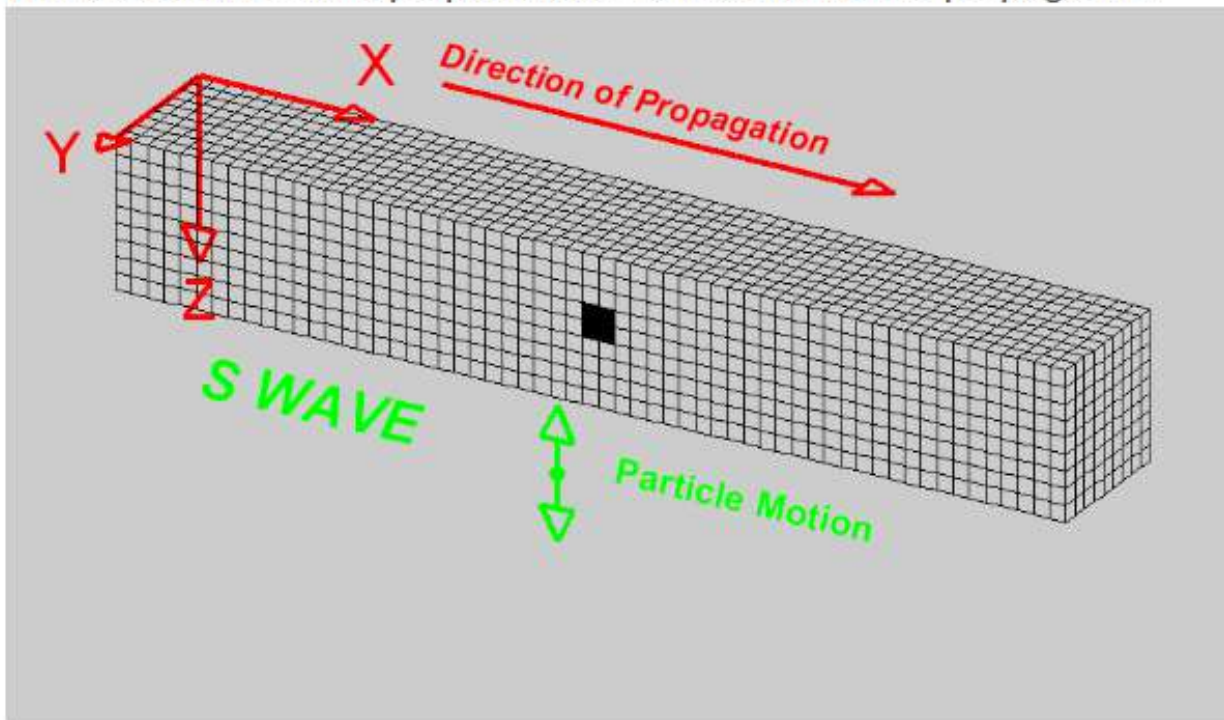


(Modified from Bruce A. Bolt, *Earthquakes: A Primer*, W H. Freeman & Company, 1978.)

- They are the **first earthquake waves to be detected** during an earthquake.
- They depend on the **density and compressibility** of materials.
- They can pass through solid, liquid, and gas mediums.

II.S/ Secondary/ **Transverse waves:**

- The oscillation occurs perpendicular to the direction of propagation.



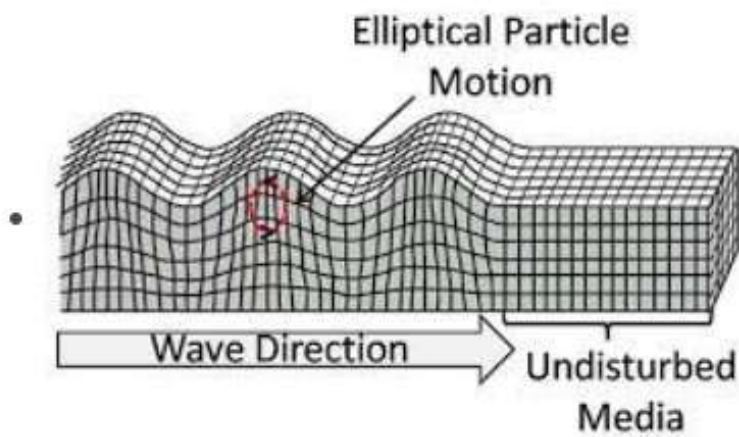
- They depend upon the density and rigidity of the material.
- S waves can travel only through solids and not liquids and ~~solids~~ gases.

Surface Waves:

- They are generated from the surface of the earth itself.
- They are formed due to the interaction of body waves with the surface.
- They are confined to the surface of the earth.
- They are much slower than body waves and they can cause more damage.
- There are two types of surface waves- Rayleigh waves and Love waves.

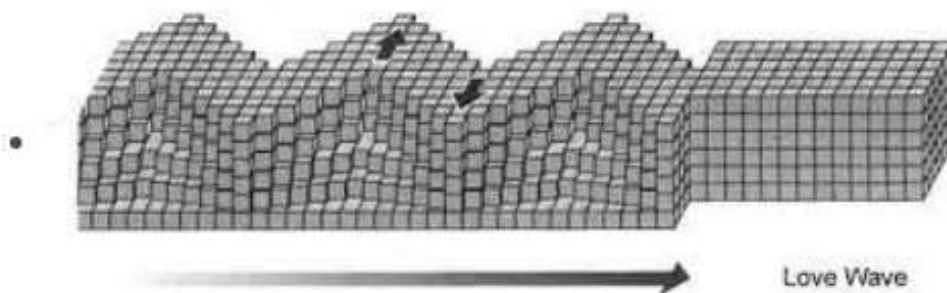
Rayleigh waves:

- A Rayleigh wave is a seismic surface wave causing the ground to shake in an elliptical motion, with no transverse, or perpendicular, motion.
- They move in a wave-like pattern as observed on the ocean surface.



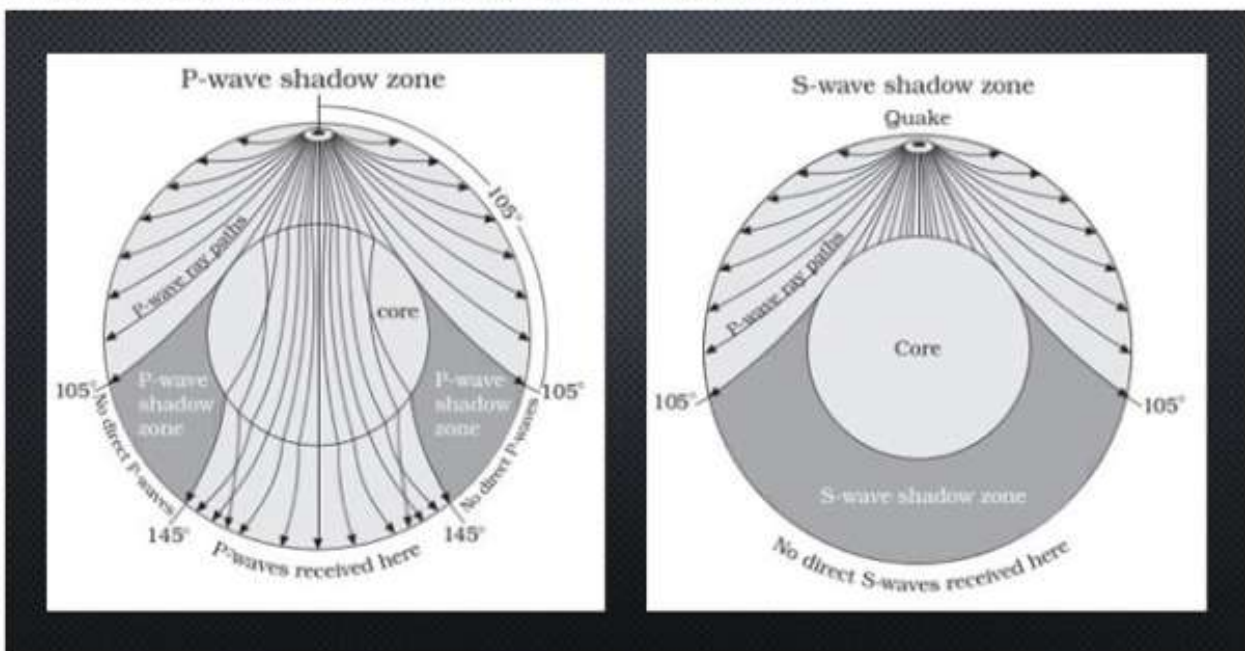
Love waves:

- They are also a type of transverse wave which along with the perpendicular displacement have a movement like a crawling snake.
- This makes it highly destructive.
- It can be said that S waves only put things up and down, while the love waves also shake things horizontally.



SHADOW ZONE (11:35 AM):

- It is a zone in the interior of the earth where earthquake waves are not reported.
- P waves are not reported between 105-145 degrees from the focus.
- S waves are not reported beyond 105 degrees.



- The P wave shadow zone is caused due to deflection and **slowing down** of the P waves as they enter the outer core which is liquid.
- The S wave shadow zone is due to the inability of S waves to pass through the liquid outer core.
- Through the analysis of the shadow zones ~~analysis~~ and the nature of earthquake waves, we can conclude about the earth's interior.

because outer core is liquid and hence density is high and compressibility is low.

Types of earthquakes:

Type of earthquake	Depth of focus
Shallow	up to 70 km
Intermediate	70-350 km
Deep-Seated	Beyond 350 km

- Deep-seated earthquakes are mainly seen in trenches, but they can also be seen in intra-plate regions, the reason for which is unknown.

Distribution of earthquakes:



Main regions of earthquakes:

- The belt sees ocean-ocean convergent boundary along the west, and ocean-continent belt convergence along the east.



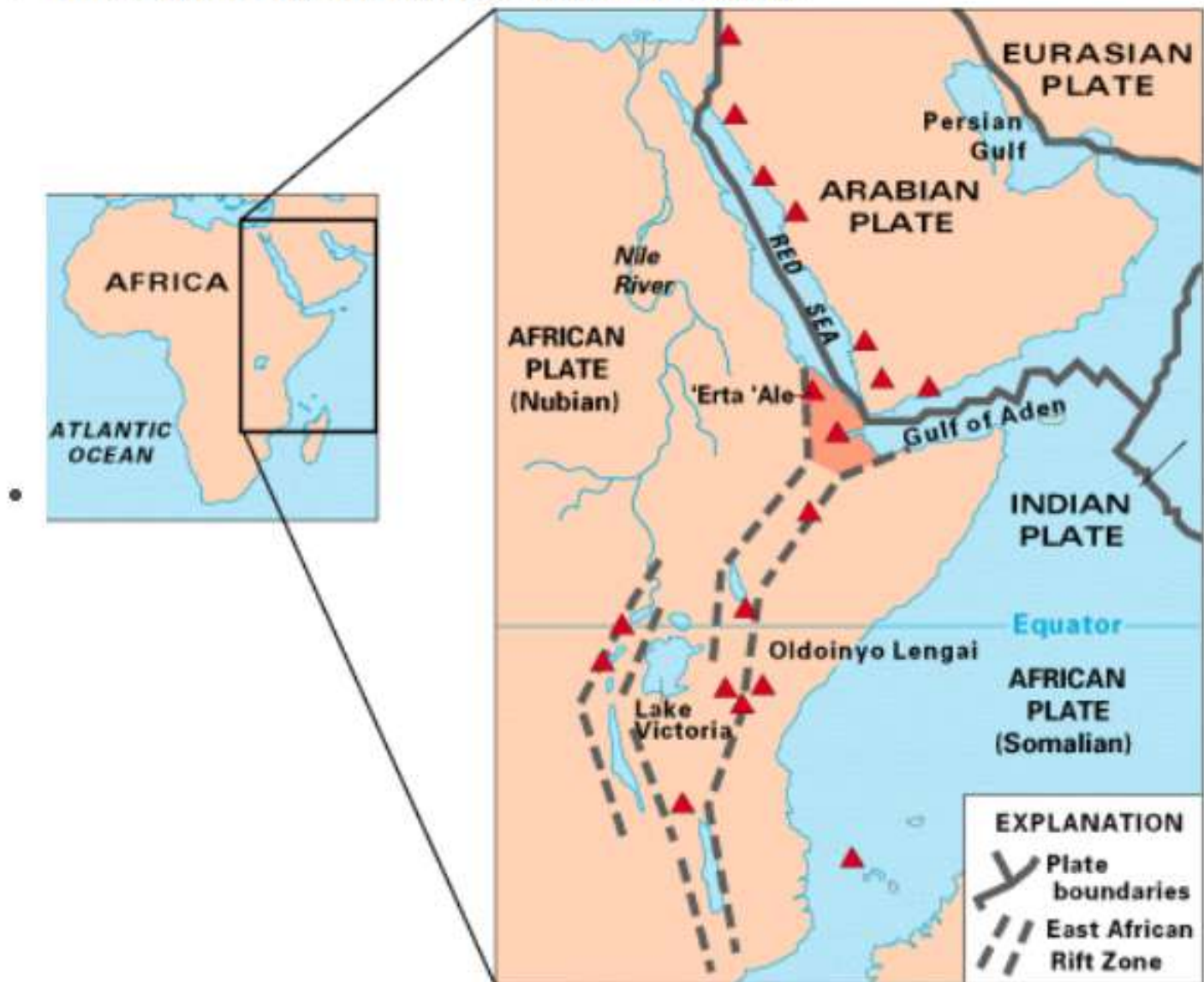
2. Mediterranean and Trans Asiatic belt:

- The earthquakes happen here due to the movement of African and Indo-Australian plates towards the Eurasian Plate.



- Along Mid-oceanic ridges.
- The regions of the East African rift valley.

- 3• Along Mid-oceanic ridges.
- 4• The regions of the East African rift valley.



Measurement of the earthquakes:

- A **seismograph** is used to measure earthquakes.
- The record hence produced is **Seismogram**.

• The intensity of the Earthquake	The magnitude of the Earthquake
The visible damage caused.	The energy is released at the focus.
It decreases away from the epicentre.	It remains constant everywhere.
It is a subjective measure	It is an objective measure.
It is measured with a Modified Mercali scale	It is measured with a Richter scale.

Modified Mercalli Scale	Richter Scale
It has a range of 1-12.	Technically speaking, there is no upper limit to the Richter scale, but it is kept at a 1-10 range.
It is a normal scale.	It is a logarithmic scale, which means an earthquake of magnitude 4 is ten times stronger than an earthquake of magnitude 3; and an earthquake of magnitude 5 is 100 times stronger than an earthquake of magnitude 3.

Highest ever recorded earthquake is 9.5 Richter Scale in Chile in 1960.

Some major earthquakes in India:

- **I. Bhuj earthquake 2001:** (Gujrat)
 - It was 7.7 on the Richter scale.
- **II. Indonesia earthquake:**
 - It was 9.1 on the Richter scale.
 - The impact was felt in India as Tsunami.
- **III. Nepal earthquake 2015.**
 - It was 7.8 on the Richter scale.
- **IV. Latur earthquake 1993:** (Maharashtra)
 - It was 6.2 on the Richter scale.
 - Just like Bhuj, even Latur is not along the plate boundary.
 - They were caused due to active faultlines under the crust.
- **V. 2005 Kashmir earthquake:**
 - It was 7.6 on the Richter scale.
 - It was felt in the Pakistan-Occupied Kashmir region and saw around 80,000 deaths.
- **VI. Uttarkashi earthquake 1991:**
 - It was 6.1 on the Richter scale.
- **VII. 2011 Sikkim earthquake:**
 - It was 6.9 on the Richter scale.
 - There was very less casualty because it was in a region of less habitation.

Impacts of earthquakes:

- Destruction of infrastructure.
- Triggering of landslides, tsunamis.
- Loss of biodiversity.
- Urban fires, etc.

The topic for the next class is tsunamis.



Aurora

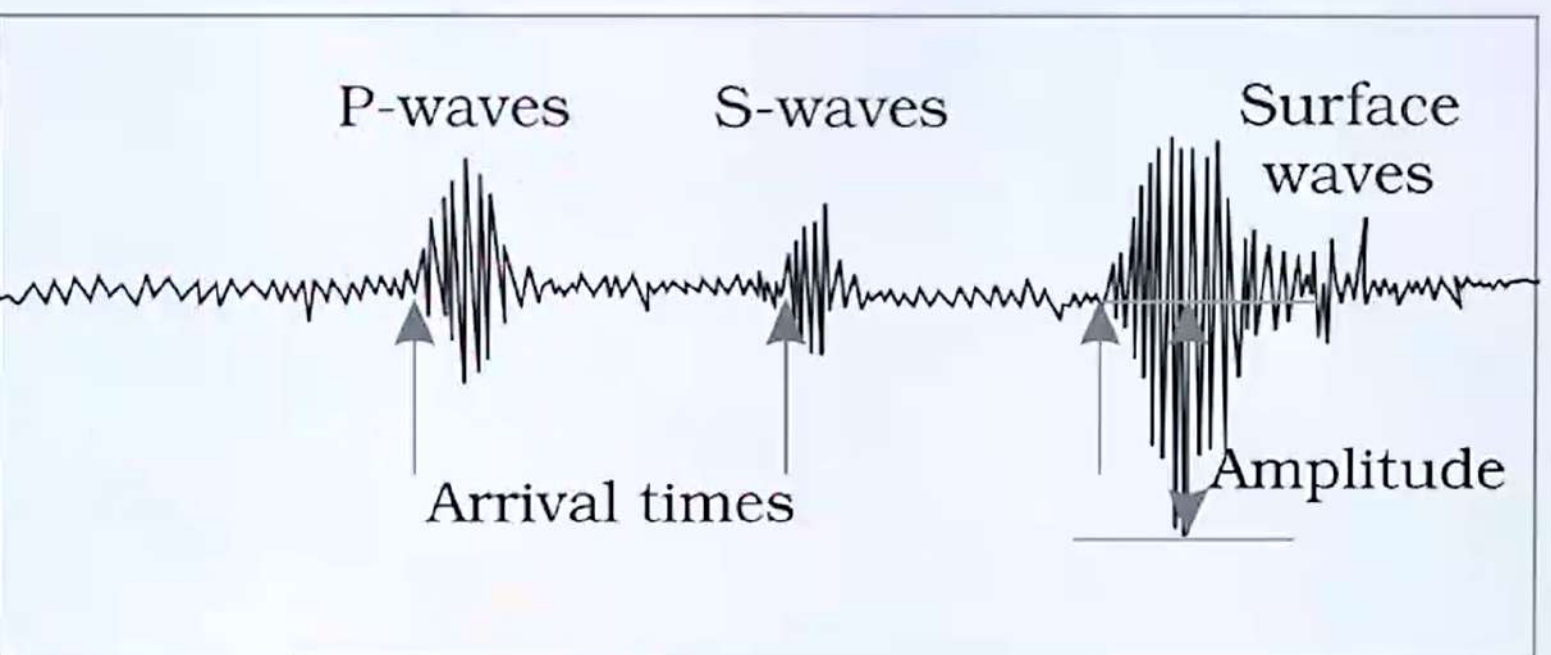
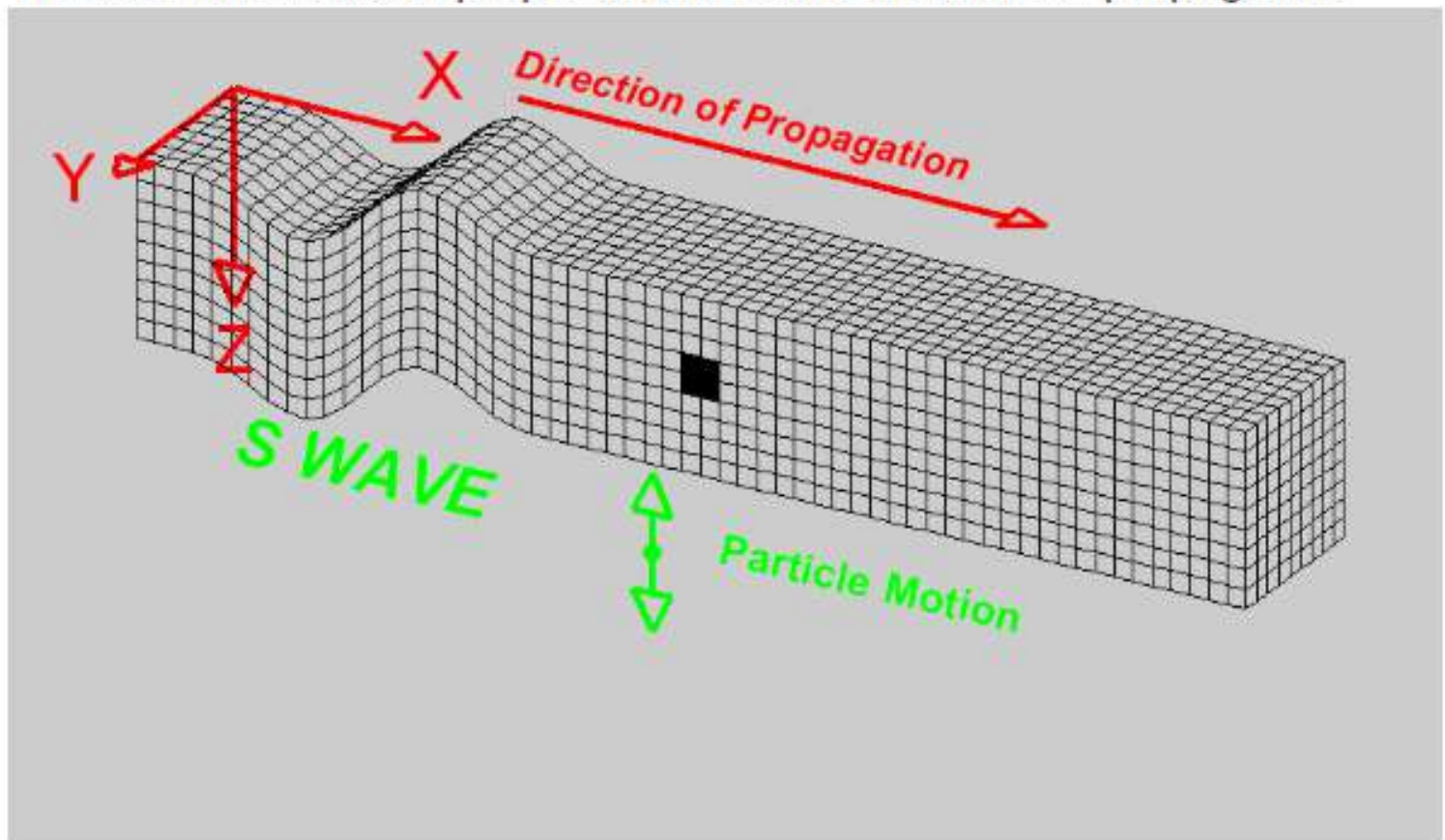


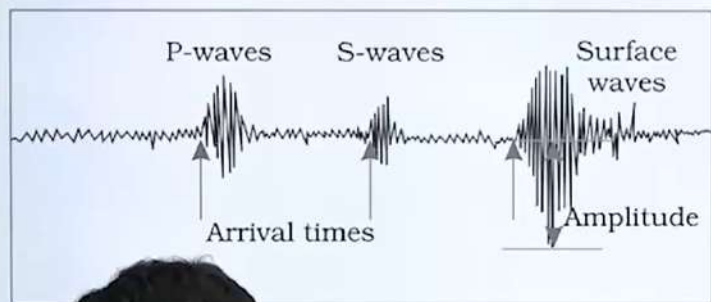
Figure 3.1 : Earthquake Waves

Seismogram recorded by Seismograph

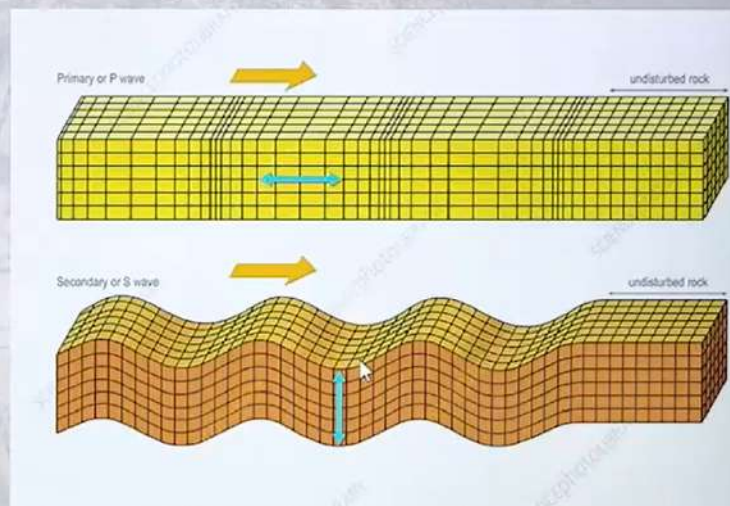
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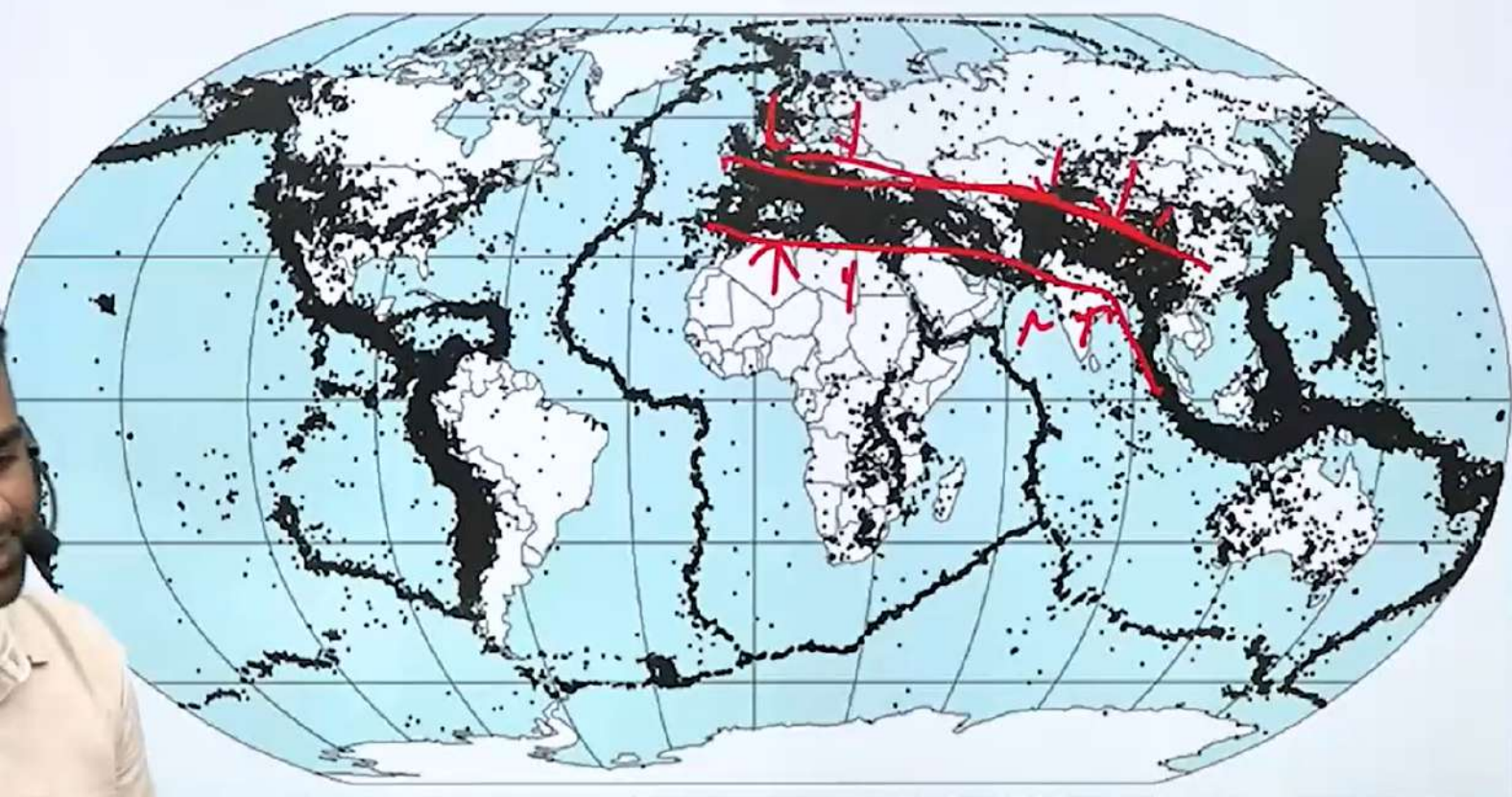


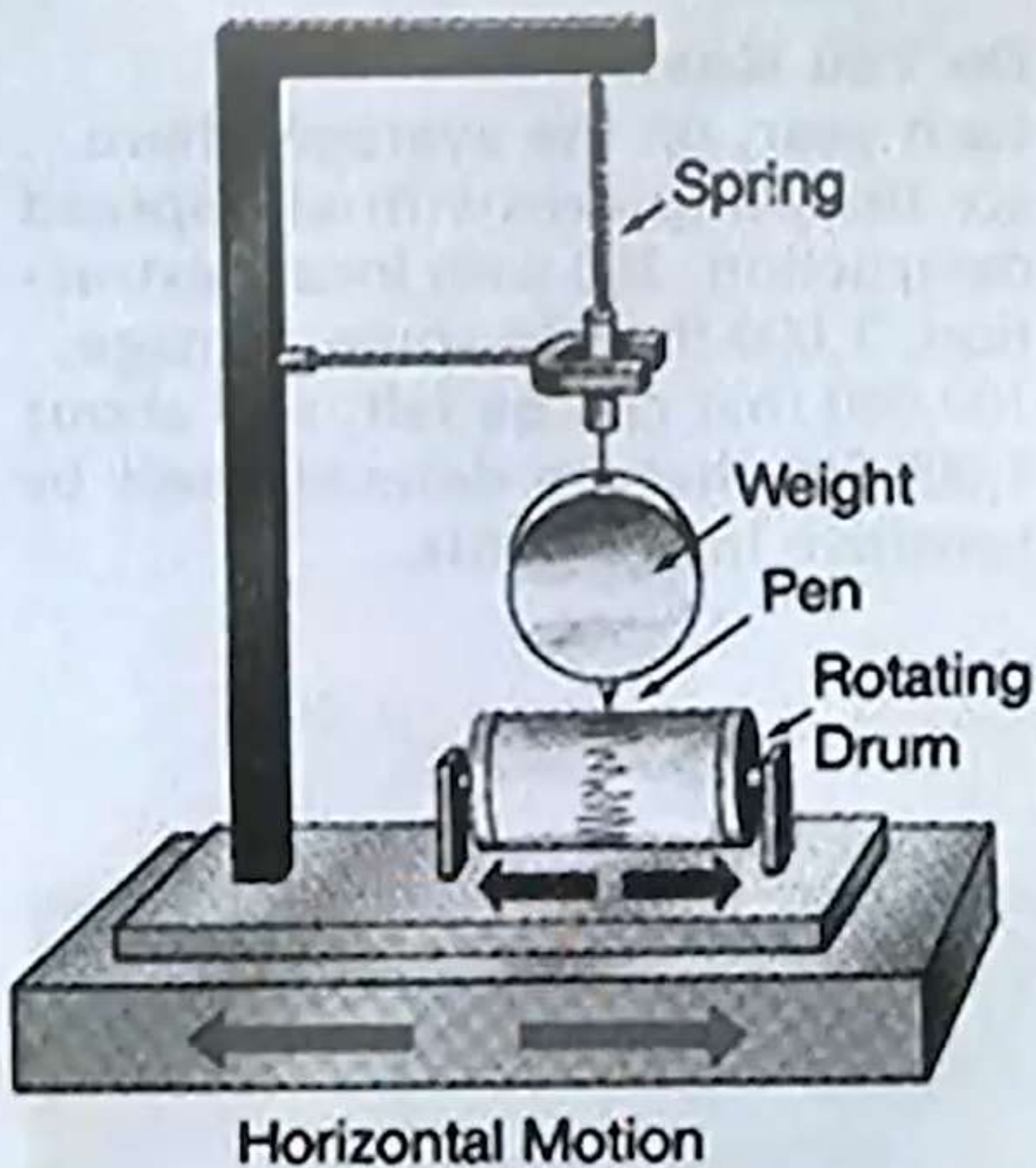


1 : Earthquake Waves



Preliminary Determination of Epicenters 358,214 Events, 1963 - 1998





Seismograph



Region where 80 percent earthquakes come