

## MORPHOLOGY OF EARTH

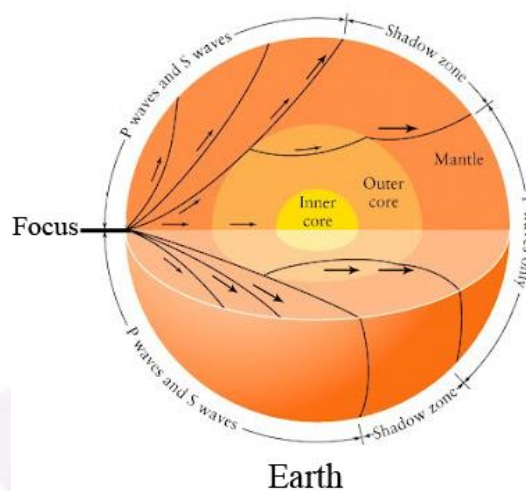
Physical Conditions of Earth's Interior

- Temperature, Pressure, Density, Incompressibility & Rigidity
- Crust, Mantle, Core

## MORPHOLOGY OF EARTH

Physical Conditions of Earth's Interior

Temperature, Pressure, Density, Incompressibility & Rigidity

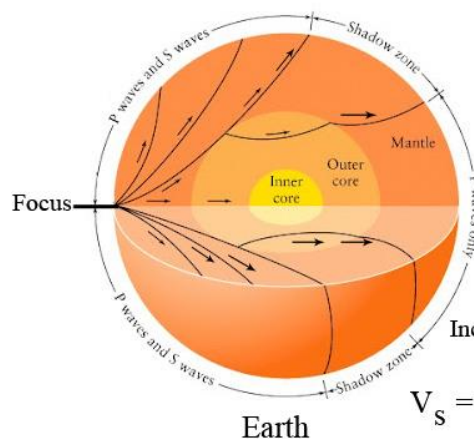


1. P - Waves
  2. S - Waves
  3. L - Waves
- } Body waves

## MORPHOLOGY OF EARTH

Physical Conditions of Earth's Interior

Temperature, Pressure, Density, Incompressibility & Rigidity



$$\begin{aligned} \text{Temp} \uparrow &\rightarrow V_p \downarrow V_s \downarrow \\ \text{Pressure} \uparrow &\rightarrow V_p \uparrow V_s \uparrow \\ \text{Pressure} \uparrow &\rightarrow \text{Density} \uparrow \\ \therefore \text{Density} \uparrow &\rightarrow V_p \uparrow V_s \uparrow \\ V_p &= \sqrt{\frac{k + \frac{4}{3}\mu}{d}} \end{aligned}$$

Incompressibility

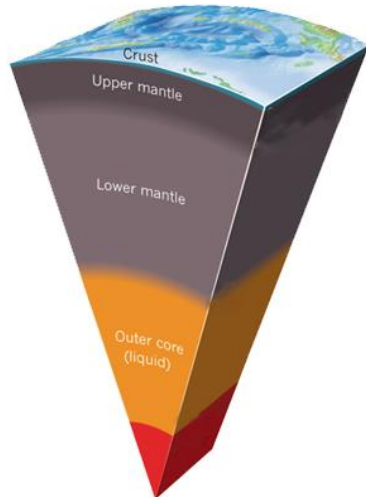
Rigidity

$$V_s = \sqrt{\frac{\mu}{d}}$$

Physical Conditions Prevailing Inside the Earth's Interior

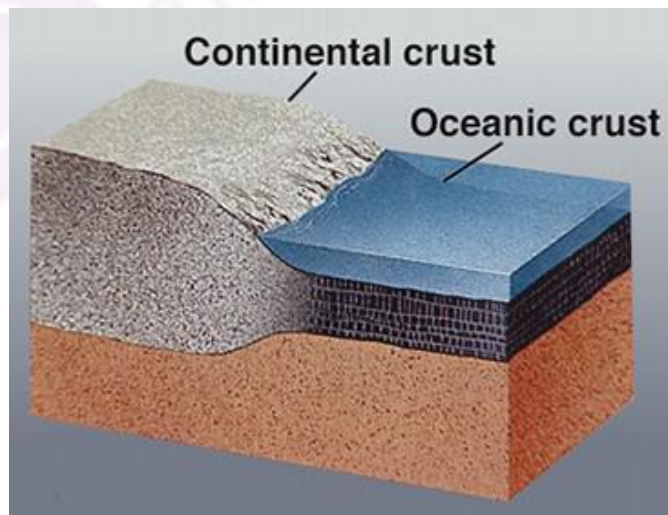
## MORPHOLOGY OF EARTH

Physical Conditions Prevailing Inside the Earth's Interior



- Crust is divided into two Parts
  - i) Continental Crust ( Sial)
  - ii) Oceanic Crust ( Sima)

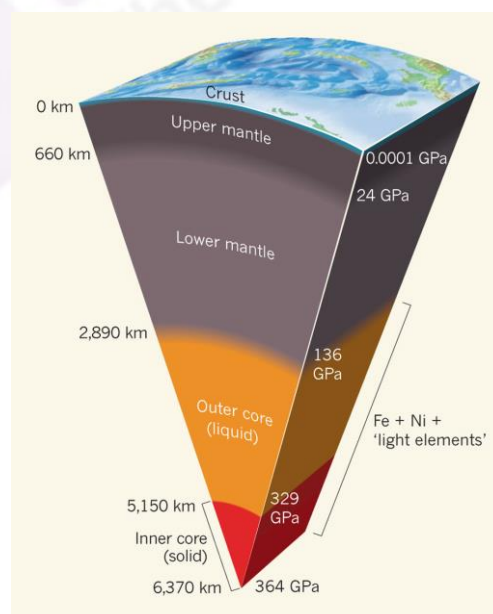
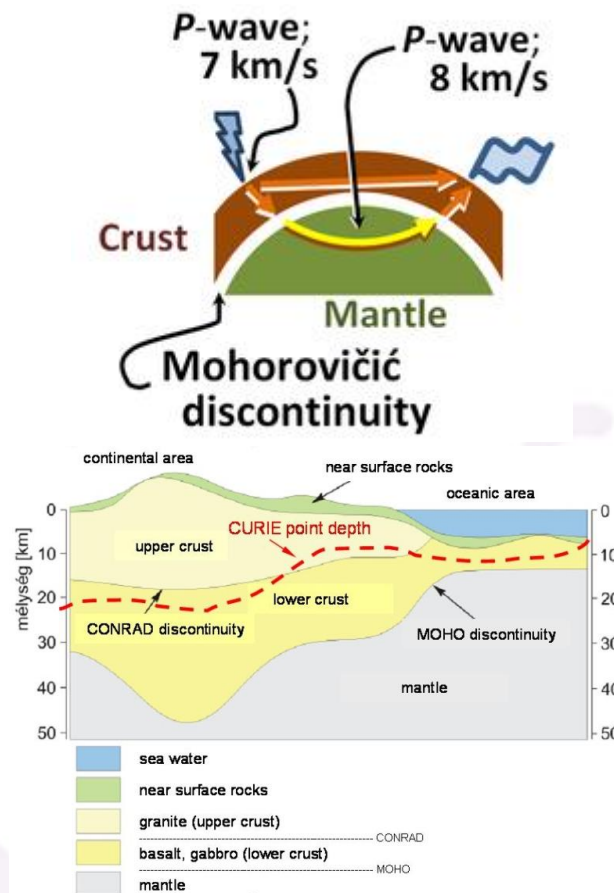
- Continental Crust is made up of Graniatic & Andesitic Rocks
- Dominant mineral present in this rock is Feldsphur
- Density of the Continental crust is 2.6 gm. / Cm<sup>3</sup>
- Thickness of the Continental crust is 40 km
  - Under mountainous area thickness of Continental crust reaches up to 100km



### Oceanic Crust

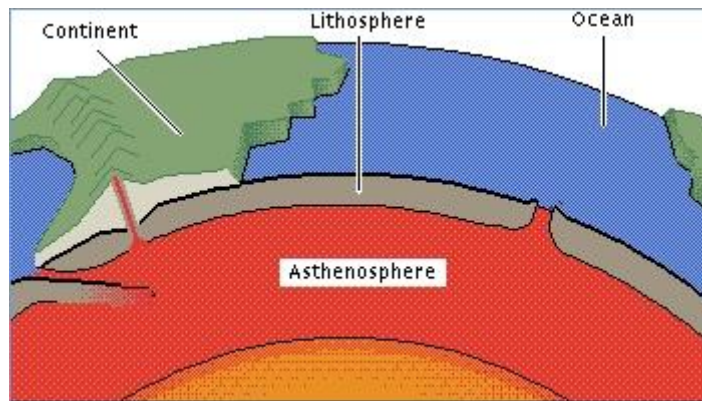
- Oceanic crust is made up of Basaltic Rocks
- Minerals composing the Oceanic crust is Ferro magnesia
- Density of the Oceanic crust is 3.0gm. / Cm<sup>3</sup>

- Thickness of the Oceanic crust is much less variable up to 5-10 km



- Mantle is made up of more denser rocks it has more of Calcium, Iron and Magnesium compared to that of crust
- Mantle comprise 80% volume of the earth
- Temperature the density of the rocks goes on increasing towards interior
- Mantle is divided into Upper mantle & Lower mantle

- Upper mantle is made up of rocks called Pyrrhotite & gabbro
- Pyrrhotite rocks are present in the upper part of the upper mantle
- Gabbro rocks are present in the lower part of the upper mantle
- Density of the upper mantle is 4.5 gm./Cm<sup>3</sup>
- Temperature prevailing in the upper mantle is 1100° C
- Asthenosphere extends from 100-400km depth
- Upper part of the asthenosphere is partially molten state

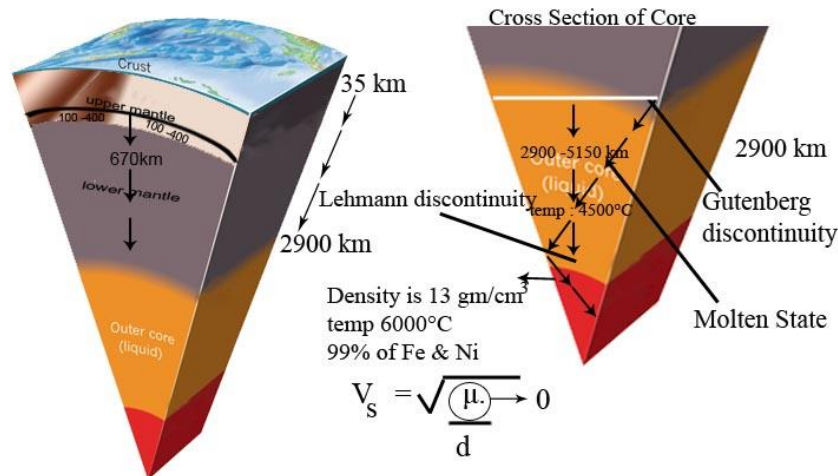


- From surface, density, temperature & pressure goes on increasing towards centre of Earth
- Below solid asthenosphere between 400-670 km depth lies the Mantle transition zone
- Upper mantle avg. temperature: 1100° C
- This temperature increases as we move down
- The rocks are still solid because the pressure is increase at a faster rate
- The discontinuity is known as Rapetti Discontinuity
- Velocity of seismic wave is recorded as maximum in the lower mantle even more than the Inner core
- Focus will not occur below the depth of 670 km
- Lower mantle mostly in the forms of minerals so rocks does not exist in this part
- Important minerals like Olivine, plagioclase, orthoclase.
- Only in upper part of the lower mantle Gabbro rocks can be found
- In Lower mantle temperature ranges from 2000° C at a depth of 670 km to 3500° C at depth of 2900 km
- Density of lower mantle is 6.5gm/Cm<sup>3</sup>



## MORPHOLOGY OF EARTH

### Physical Conditions Prevailing Inside the Earth's Interior



- Outer core is in molten state and inner core is in solid state.
  - When Earth rotates from west to east Earth's magnetism is created along the Lehmann discontinuity because of the Churning up action of the outer core and the inner core
- Lehmann Discontinuity: It separates Inner core from Outer Core

### Plate Tectonics Theory

- Concept of Uniformitarianism  
Assumption that the same natural laws and processes that were operating in the universe in the past are operating today and will operate in the future
- Concept of Plate Tectonics (Synthetical concept)  
Continental drift + Sea floor spreading + Paleo-magnetism
- Gist of Continental Drift Theory:
  - Oceanic floor represents top of the Sima
  - Continents (Sialic) masses are drifting over Sima
  - Sialic masses are well embedded in Sima and are floating over it
  - Continents are mobile but Sima (Oceanic floor) is static
- Forces responsible for CDT according to Wegnar:
  - Tidal force of moon (westward movement of the continents)
  - Gravitational force of earth (northward movement of continental masses)
- Theory of Thermal Convection Current
  - Put forward by Holmes in 1928
- Gist of Theory of Convection Current

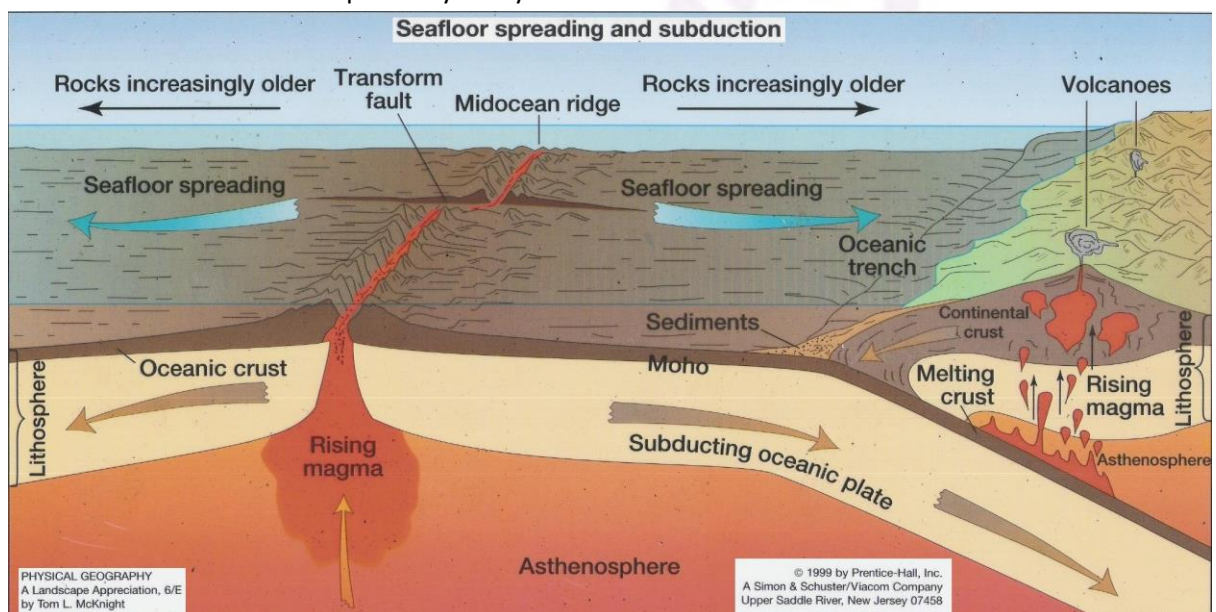
- Earth's core is very hot
- Heat is dissipated by convection current
- This current is responsible for driving the plates

### Continental Drift Theory + Theory of Convection Current

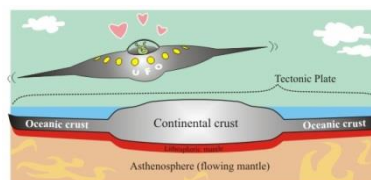


#### **Evidence for Continental Drift**

- Sea Floor Spreading
  - Proposed by Harry Hammond Hess in 1960's



- According Harry Hess:
  - Continents are static
  - Oceanic crust is mobile
- Morgan & Wilson

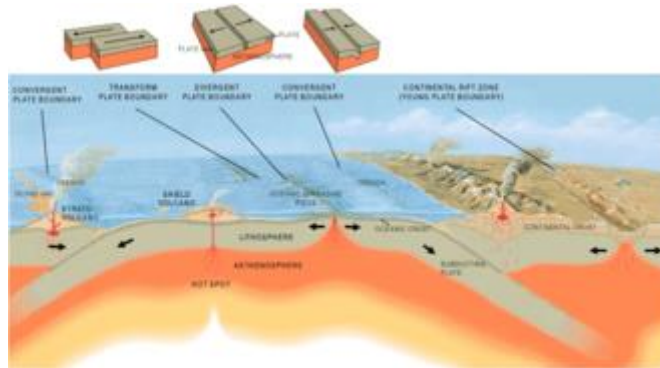


- Continents and oceans are located on a plate

- The entire plate is moving

Plate tectonics : Study of plate interaction & deformation of plates along their boundaries

Plates: Rigid lithospheric slabs



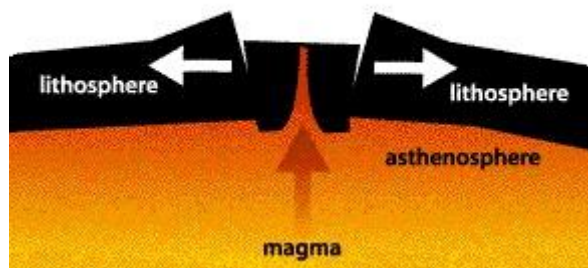
Lithos → Crust + upper most mantle

Lithosphere



Major plates    Minor plates

- Plates are floating over partially molten but denser asthenosphere
- When plates are moving away, divergent plate boundaries

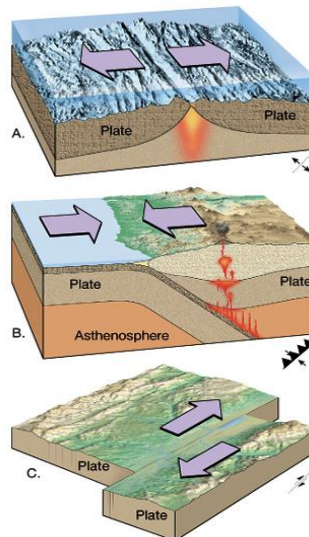


- According to basic postulates of plate tectonic theory
-

crustal material created at divergent plate boundary = crustal material destroyed at subduction zones

### The crustal material of Earth remains constant

- Lithospheric plates are sliding over the underlying mantle
  - Lithospheric plates are divided into major and minor plates
  - Along diverging plate boundaries, high energy flow is found
  - Along converging plate boundaries, low energy flow
  - Crustal material is fixed
- According to Geometric part, there can be three types of plates
    1. Purely Continental Part
    2. Purely Oceanic Part
    3. Partly Continental & partly Oceanic



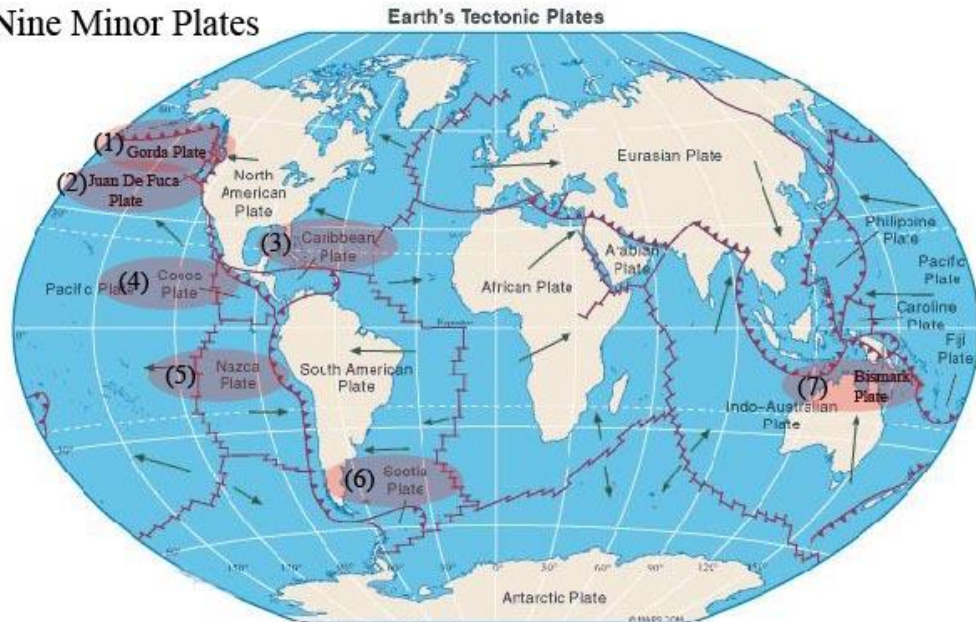
- No major plate is purely continental
- Only pacific plate is purely oceanic
- All the other major plates are continental and oceanic
- Number of plates
  - 7 major plates
  - 9 minor plates
  - 6 sub plates



# MORPHOLOGY OF EARTH

## Plate Tectonics Theory

- Nine Minor Plates

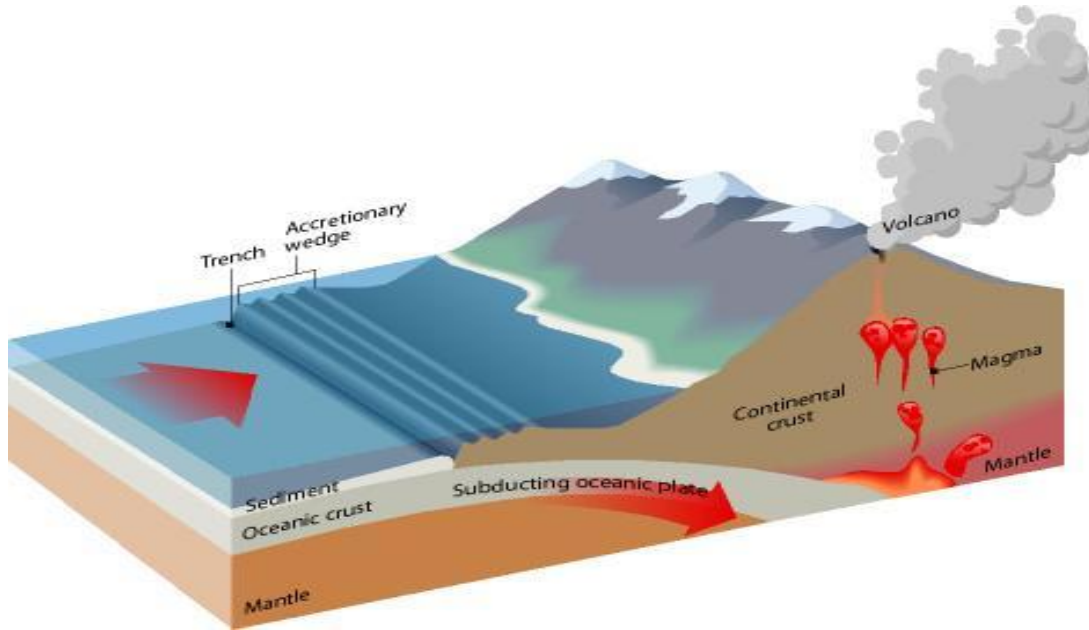


Sub plates: Those plates which have not yet got separated but are still in the process of separation

- Nubian plate



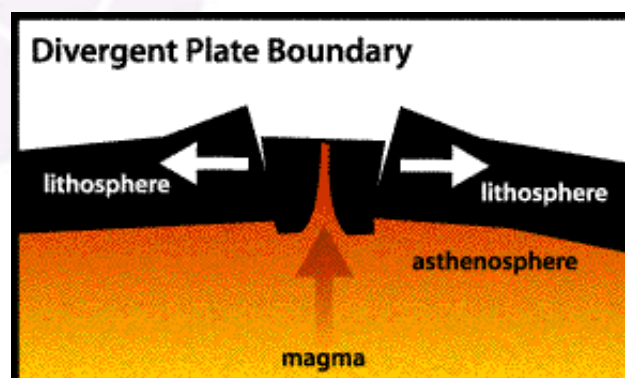
Plate tectonics: Study of plate interaction & deformation of plates along their boundaries



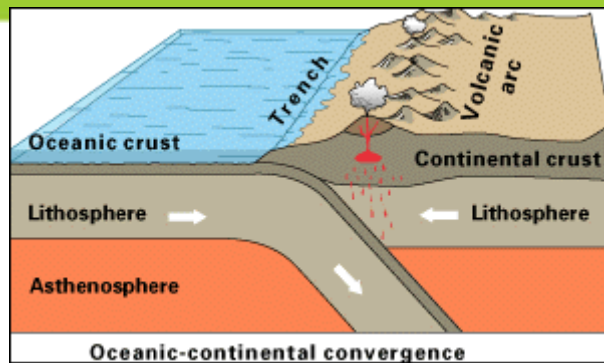
- Plate tectonics theory is studied under 2 parts
  - Geometric part
  - Kinematic parts

Geometric Part: This part deals with shape, size, number & relative location of plates

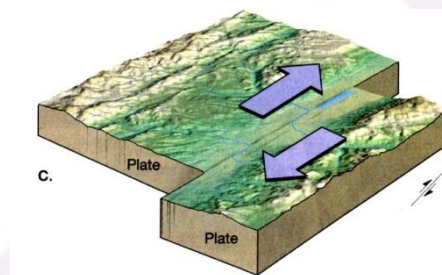
Divergent plate boundaries



Convergent plate boundaries



### Sliding plate boundaries



#### 1. Divergent Plate Boundaries

Origin: a) Divergent plate boundaries can be created both on the oceanic crust & the continental part

#### 2. Sliding Plate Boundaries

#### 3. Convergent Plate Boundaries

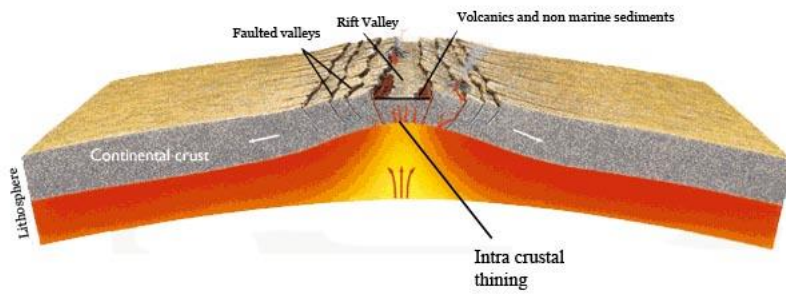
- 1. Ocean oceanic Convergence
- 2. Ocean continental Convergence
- 3. Continental continental convergence

# MORPHOLOGY OF EARTH

## Plate Tectonics Theory

### Plate boundaries

#### 1. Divergent Plate Boundaries

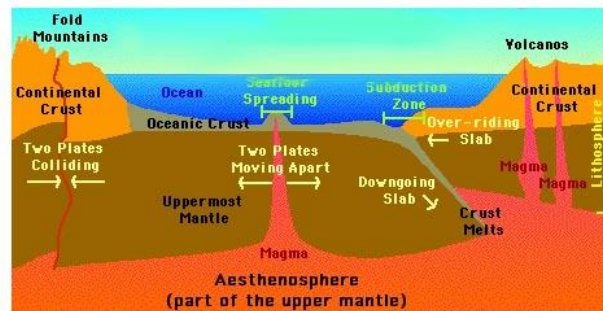


# MORPHOLOGY OF EARTH

## Plate Tectonics Theory

### Plate boundaries

#### 1. Divergent Plate Boundaries





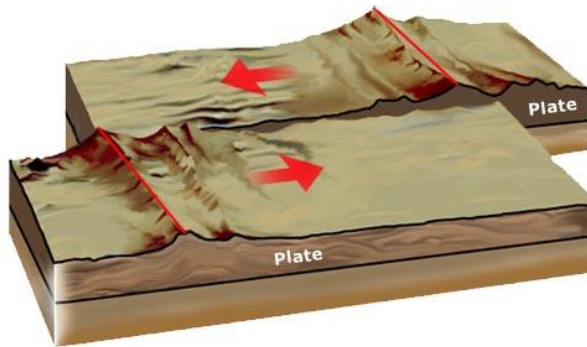
## MORPHOLOGY OF EARTH

### Plate Tectonics Theory

#### Plate boundaries

#### 2. Sliding Plate Boundaries

- Sliding plate boundaries result in intense shallow focus earthquakes

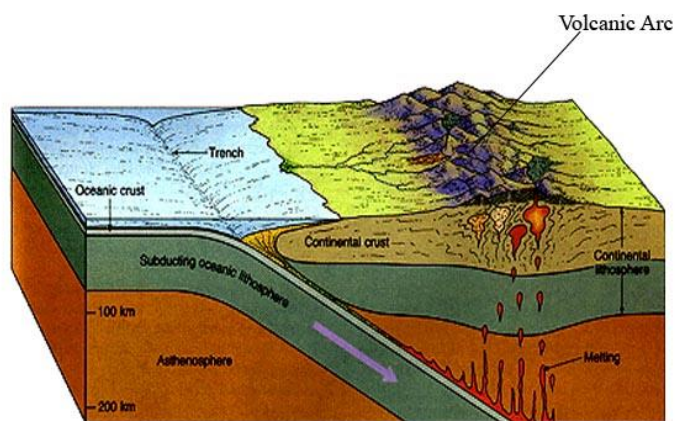


## MORPHOLOGY OF EARTH

### Plate Tectonics Theory

#### Plate boundaries

#### 3. Convergent Plate Boundaries





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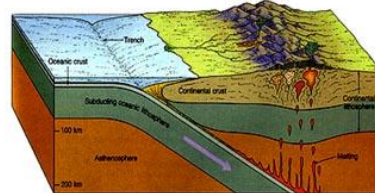
### Plate Tectonics Theory

#### Plate boundaries

#### 3. Convergent Plate Boundaries

- Four phenomenon can take place:

1. Formation of Trench
2. Formation of Volcanic Arc
3. Earthquakes
4. Formation of Tectonic Arc (Fold Mountains)



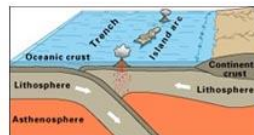
## MORPHOLOGY OF EARTH

### Plate Tectonics Theory

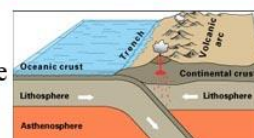
#### Plate boundaries

#### 3. Convergent Plate Boundaries

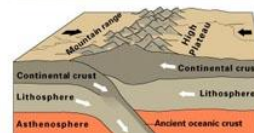
##### 1. Oceanic oceanic convergence



##### 2. Oceanic continental convergence



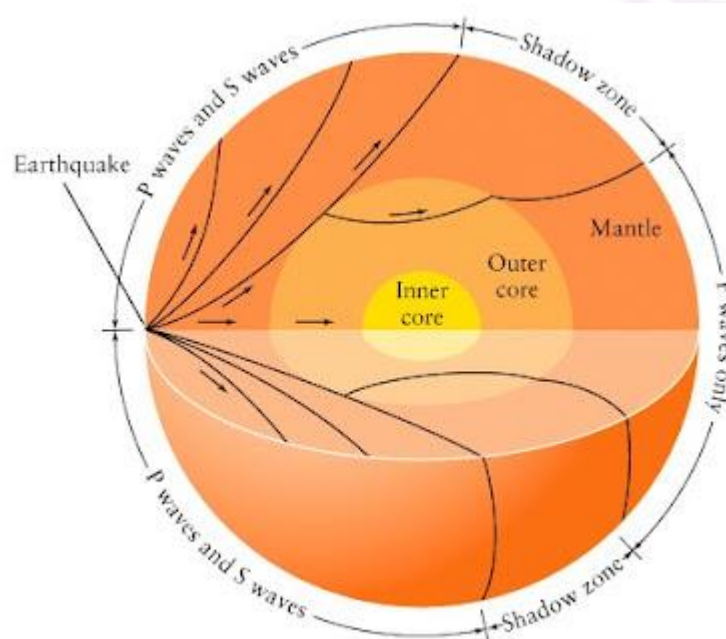
##### 3. Continental continental convergence



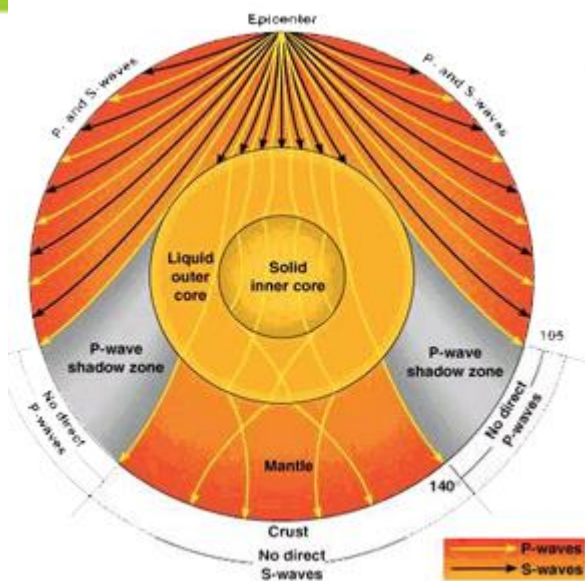
## Earthquakes

Earthquake: An oscillation or vibration of the Earth crust that is caused due to short-lived disturbance in the gravitational equilibrium of the under-lying rocks

- Vibrations get transmitted in the form of seismic waves (P waves & S waves)



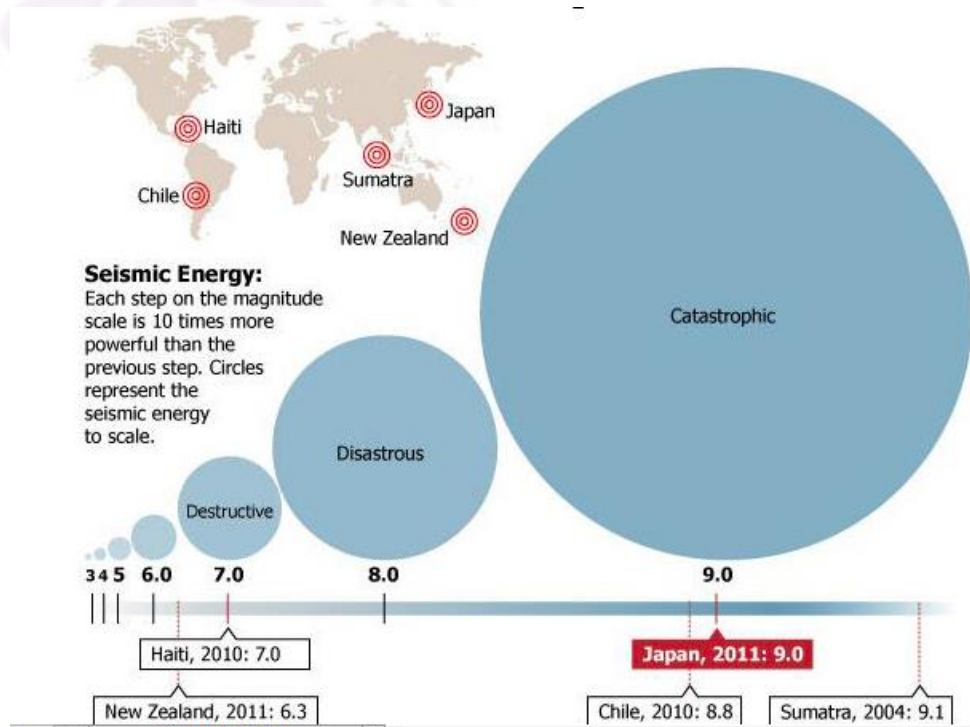
- Vibrations get transmitted in the form of seismic waves



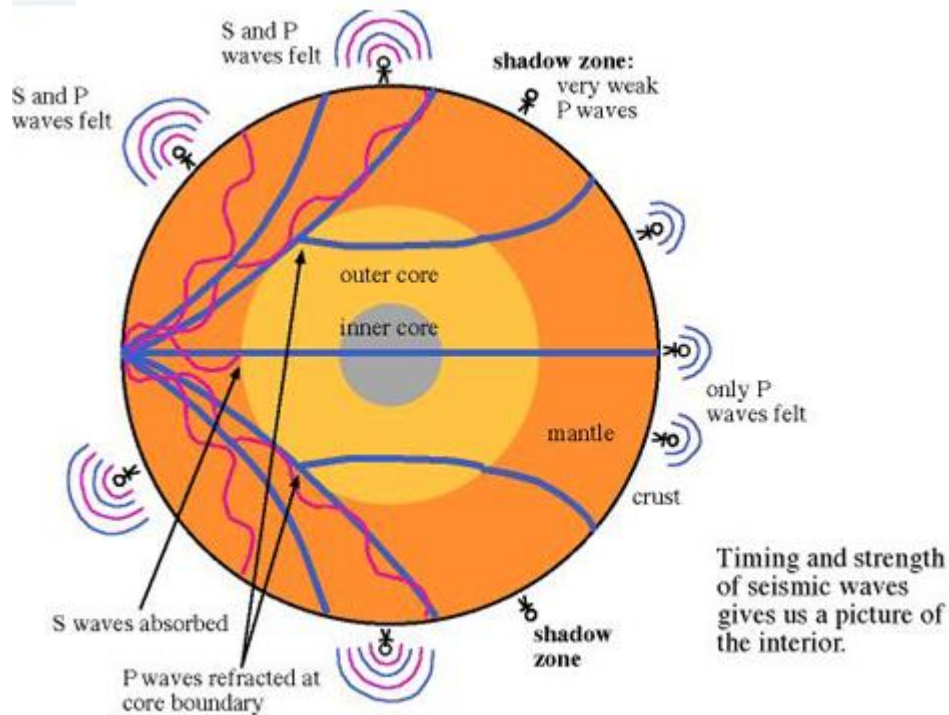
- There are two aspects of earthquake
  - i) Intensity of earthquake
  - ii) Magnitude of earthquake

i) Intensity of earthquake : refers due to the destruction caused by an earthquake

ii) Magnitude of earthquake : refers to the amount of energy release during in earthquake



## Seismic waves



Seismic waves are of 3 types

- i) Primary waves
- ii) Secondary waves
- iii) Surface waves

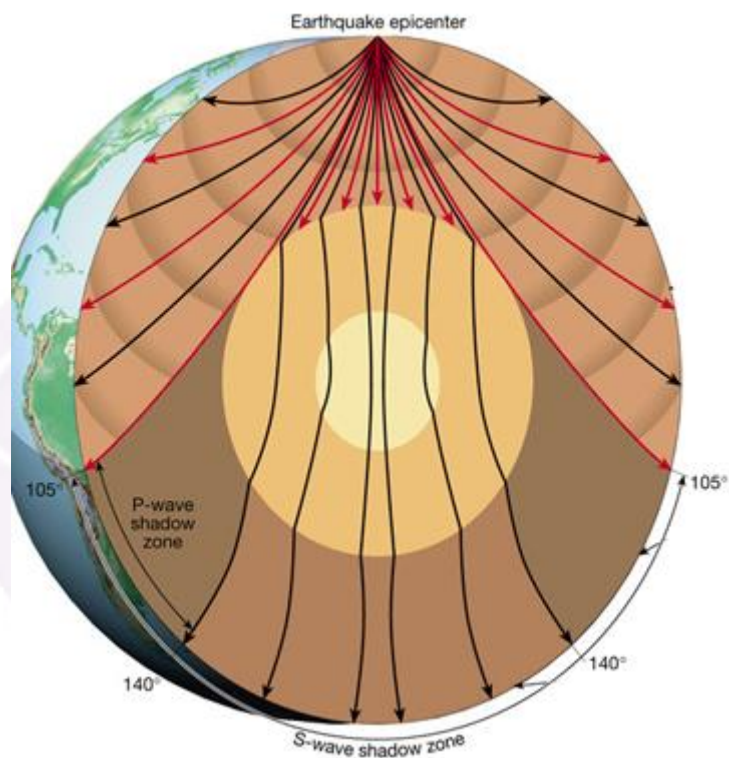
Primary waves : These waves are said to be longitudinal waves

$$V_p = \sqrt{\frac{k + \frac{4}{3}\mu}{\rho}}$$

Incompressibility
Rigidity
Density

- P waves are pass through all solid liquid & gas
- Velocity of p waves goes on decreasing
- Velocity of p wave is 1.7 times of s waves
- P waves are first to reach the surface
- S waves are share waves or transverse waves
- S waves are passes through solids

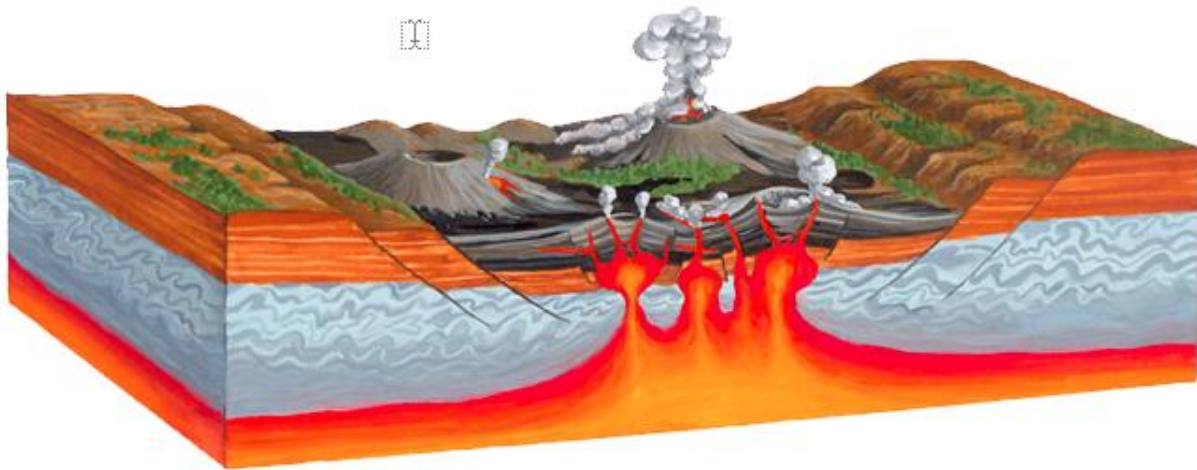
- Due to its horizontal & vertical movements they can cause destruction
- Surface waves are the slowest waves but they can cause maximum destruction
- Surface waves made up of two waves
  - i) Love waves
  - ii) Rayleigh waves
- Love waves have movements in horizontal direction
- Love waves cannot pass through liquid medium
- Rayleigh waves have both movements of horizontal & vertical direction
- Rayleigh waves is responsible for maximum destruction



## Causes of Earthquake

### 1. Volcanism





- Harry Fielding Reid put forward the Elastic-rebound theory
- According to this theory the underground rocks are elastic like rubber and expand when stretched and pulled.
- The broken rock blocks try immediately to occupy their previous position

#### Anthropogenic cause

- Pumping of ground water
- Deep underground mining
- Blasting of rocks by dynamite
- Nuclear explosion
- Storage of huge volume of water in big reservoirs