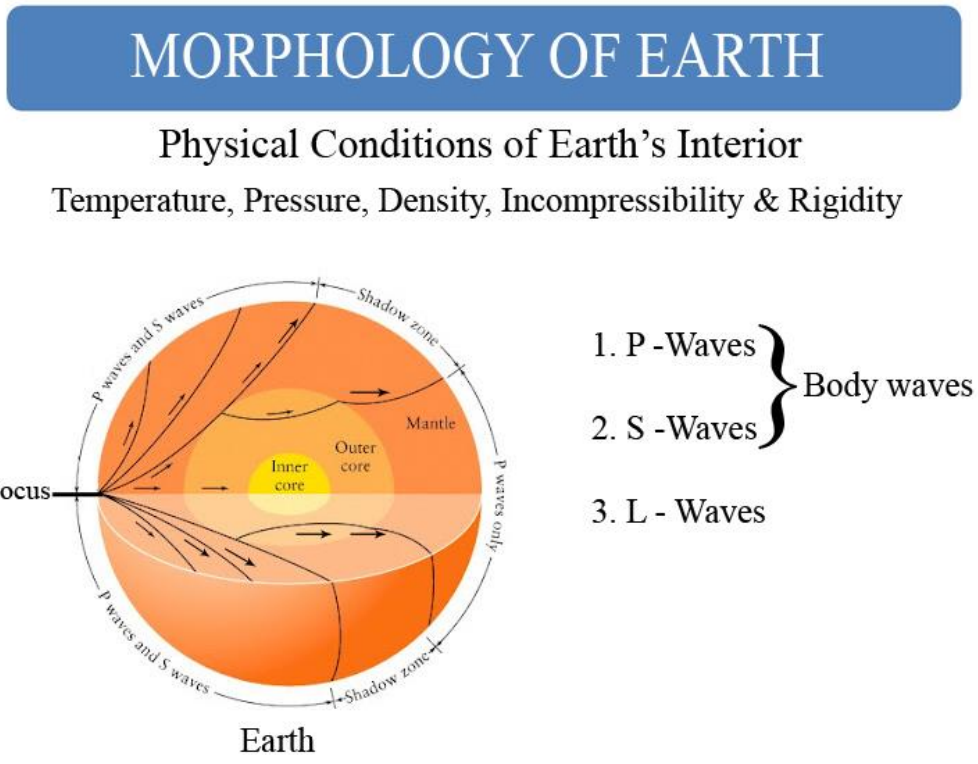
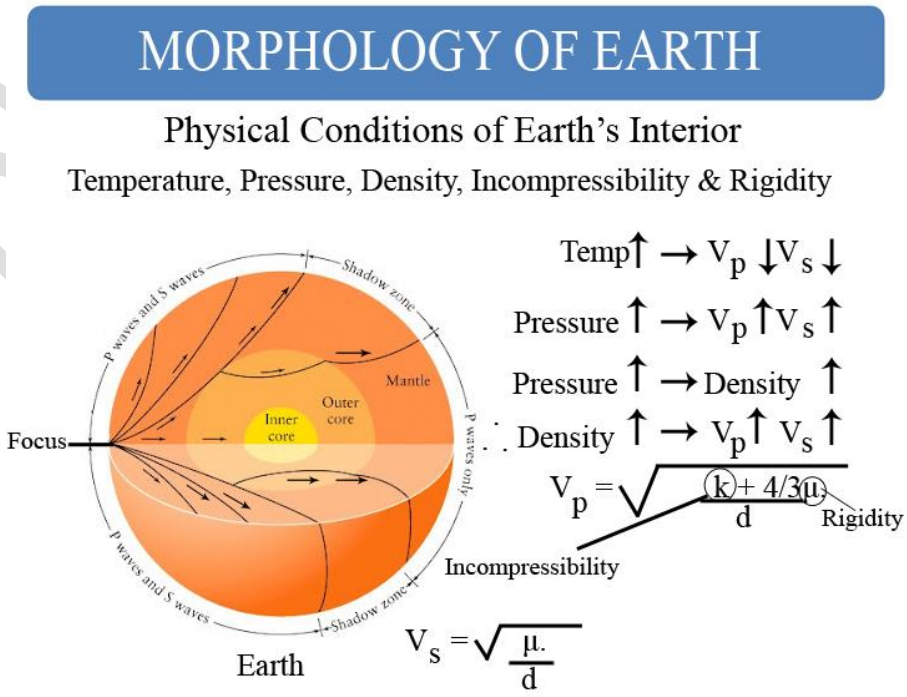
MORPHOLOGY OF EARTH

Physical Conditions of Earth's Interior

- Temperature, Pressure, Density, Incompressibility & Rigidity

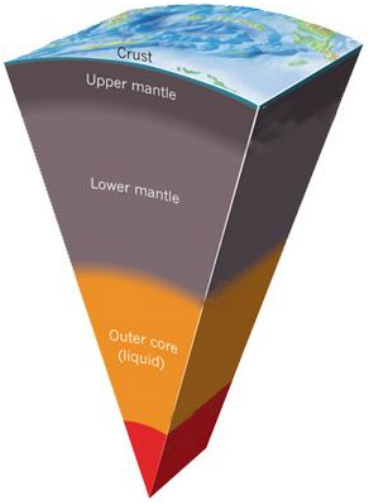
- Crust, Mantle, Core





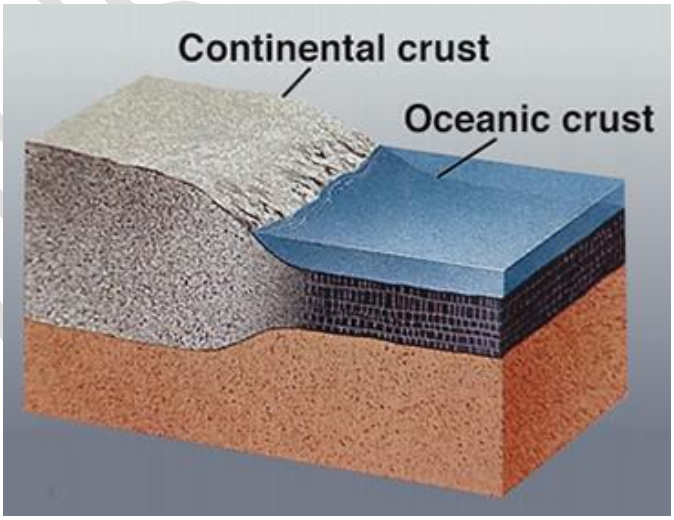
MORPHOLOGY OF EARTH

Physical Conditions Prevailing Inside the Earth's Interior



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

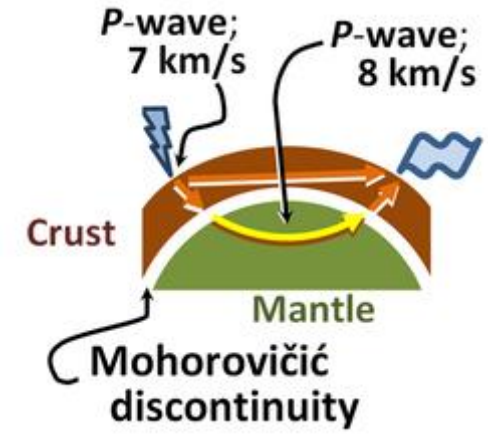
- Continental Crust is made up of Graniatic & Andesitic Rocks
- Dominant mineral present in this rock is Feldsphur
- Density of the Continental crust is 2.6 gm. / Cm3
- Thickness of the Continental crust is 40 km
    - Under mountainous area thickness of Continental crust reaches up to 100km

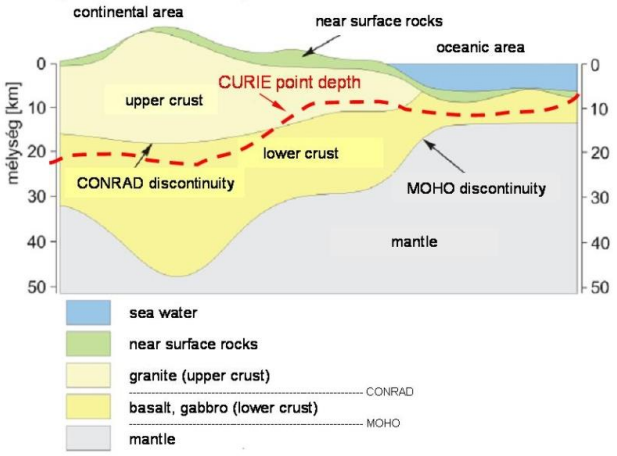


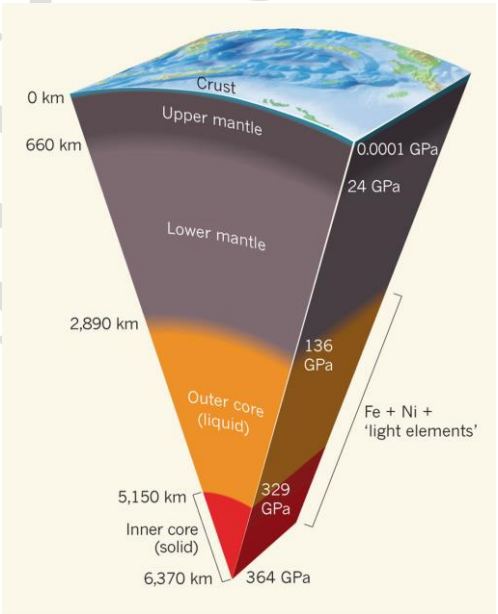
Oceanic Crust

- Oceanic crust is made up of Basaltic Rocks
- Minerals composing the Oceanic crust is Ferro magnesia
- Density of the Oceanic crust is 3.0gm. / Cm3

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

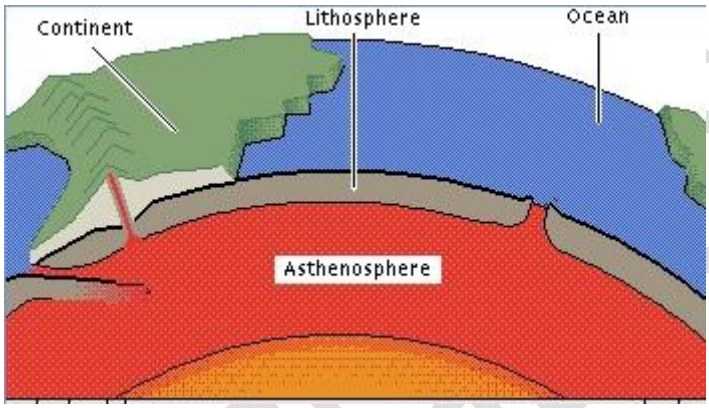




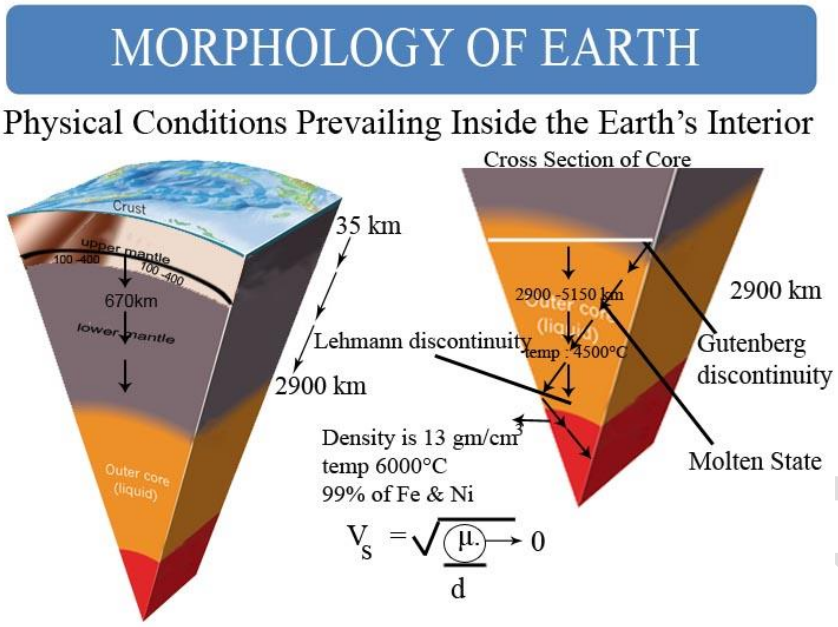


- Mantle is made up of more denser rocks it has more of Calcium, Iron and Magnesium compared to that of crust
- Mantle comprise 80% volume of the earth
- Temperature the density of the rocks goes on increasing towards interior
- Mantle is divided into Upper mantle & Lower mantle

- 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. /Cm3
- Temperature prevailing in the upper mantle is 1100^{o} 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^{o} 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 ^{o} C at a depth of 670 km to 3500^{o} C at depth of 2900 km
- Density of lower mantle is 6.5gm/Cm3



- 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

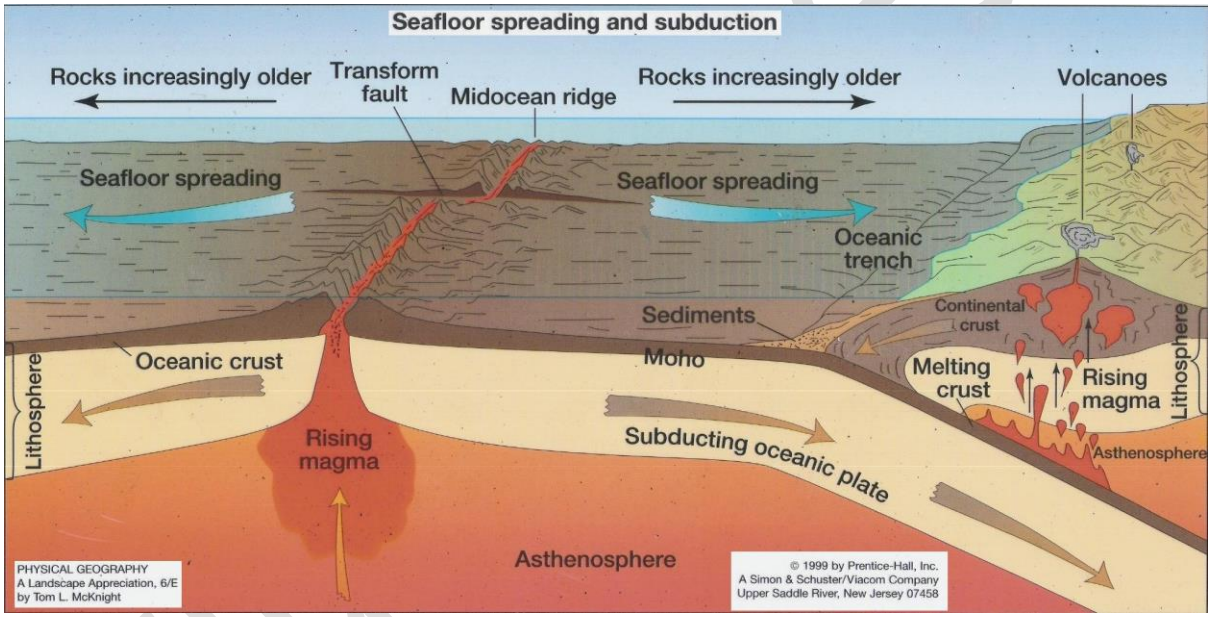
<u>Continental Drift Theory + Theory of Convection Current</u>

↓

Evidence for Continental Drift

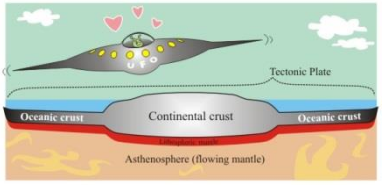
- Sea Floor Spreading

  - Proposed by Harry Hammond Hess in 1960's



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

- Morgan & Wilson

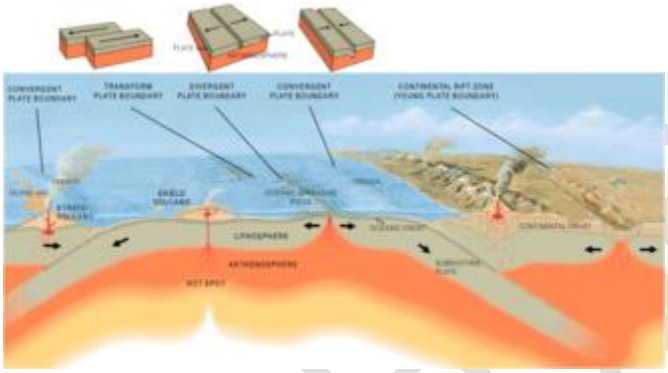


  - Continents and oceans are located on a plate

- The entire plate is moving

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

Plates: Rigid lithospheric slabs

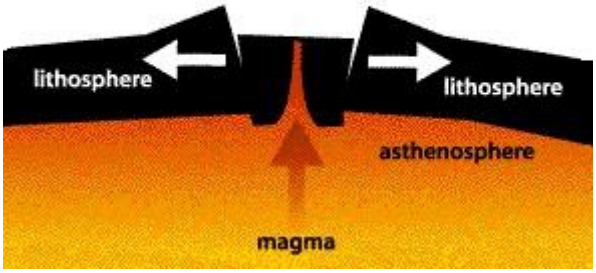


Lithos → Crust + upper most mantle

Lithosphere

Majorplates Minor plates

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



- According to basic postulates of plate tectonic theory
-

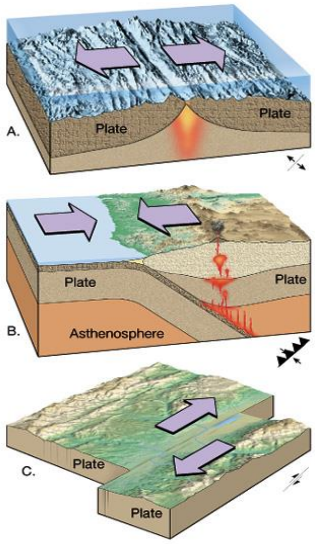
crustal material created at divergent plate boundary = rustal material destroyed at subduction zones

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

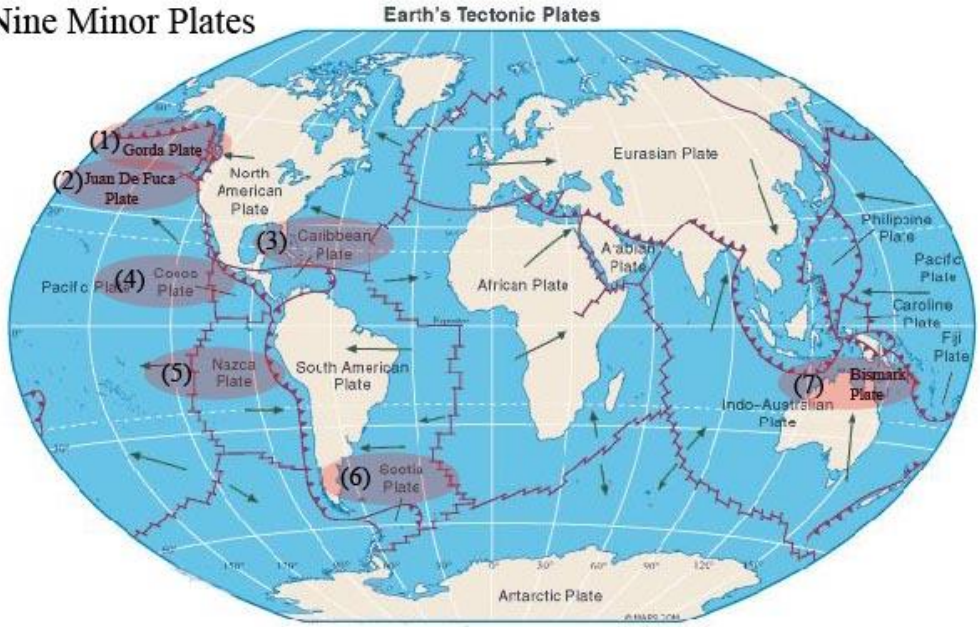


- No major plate is purely continental
- Only pacific plate is purely oceanic
- All the other major plates are continental and oceanic
- Number of plates
  - 7 major plates
  - 9 minor plates
  - 6 sub plates

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

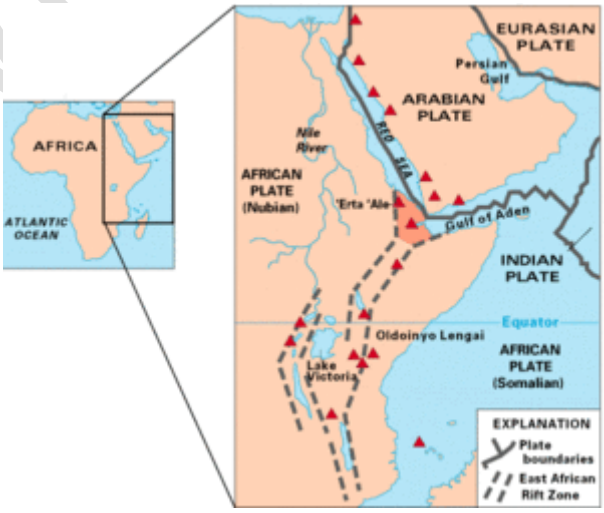
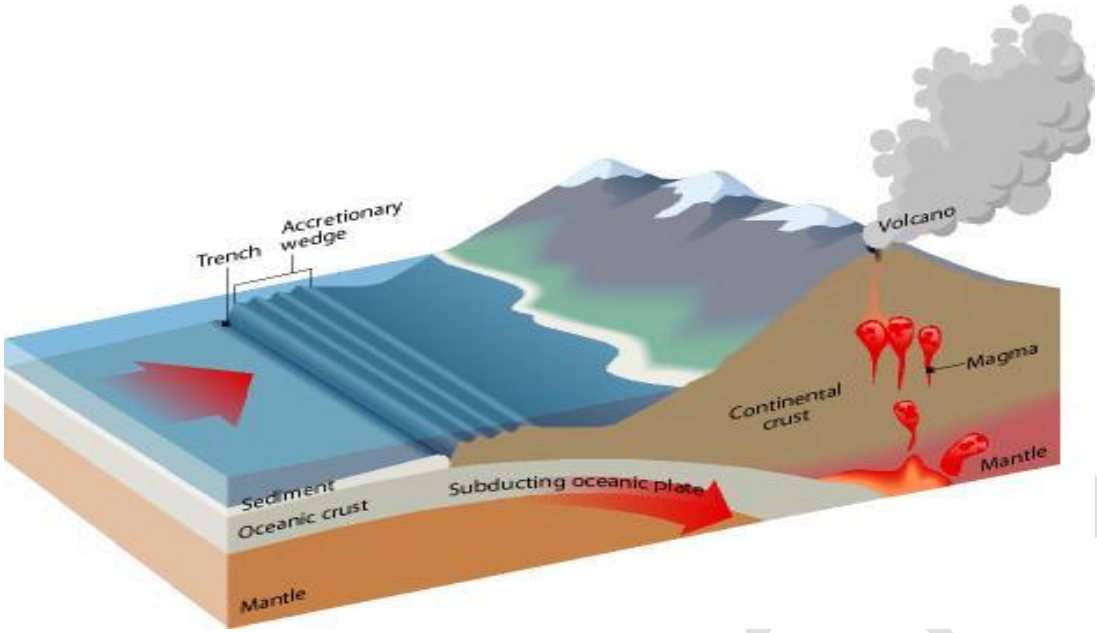


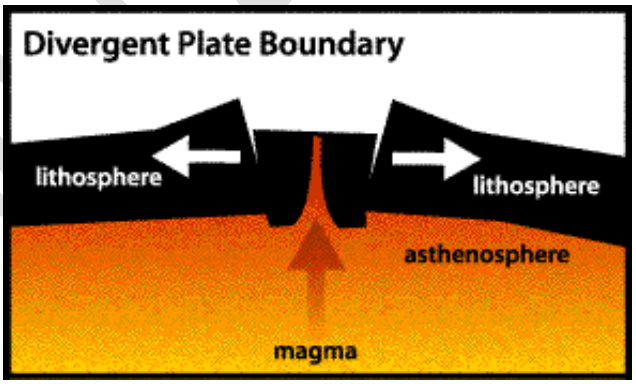
Plate tectonics: Study of plate interaction & deformation of plates along their boundaries



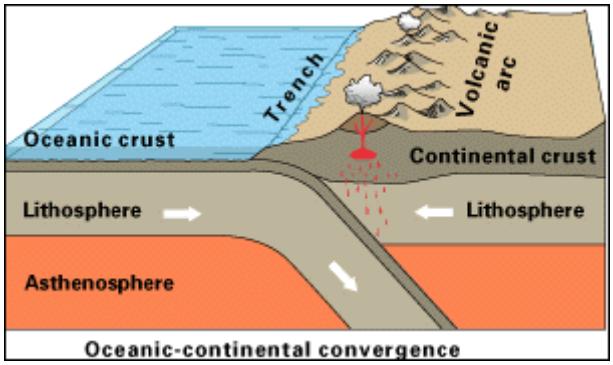
- Plate tectonics theory is studied under 2 parts
    - Geometric part
    - Kinematic parts

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

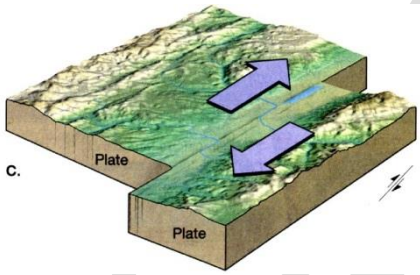
Divergent plate boundaries



Convergent plate boundaries



Sliding plate boundaires



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

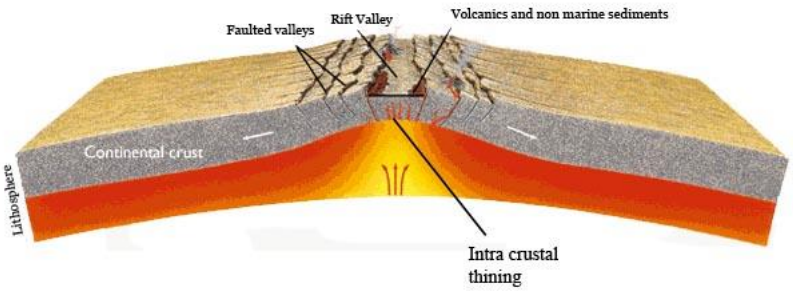
2. Sliding Plate Boundaries
3. Convergent Plate Boundaries
   - 1. Ocean oceanic Convergance
   - 2. Ocean continental Convergance
   - 3. Continental continental convergance

MORPHOLOGY OF EARTH

Plate Tectonics Theory

Plate boundaries

1. Divergent Plate Boundaries

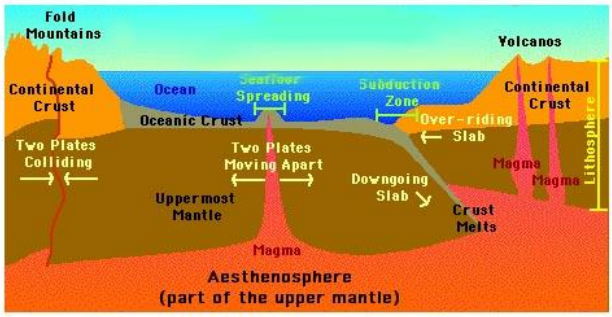


MORPHOLOGY OF EARTH

Plate Tectonics Theory

Plate boundaries

1. Divergent Plate Boundaries



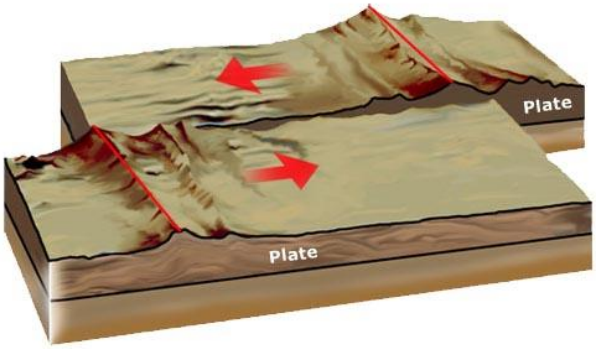
MORPHOLOGY OF EARTH

Plate Tectonics Theory

Plate boundaries

2. Sliding Plate Boundaries

- Sliding plate boundaries result in intense shallow focus earthquakes

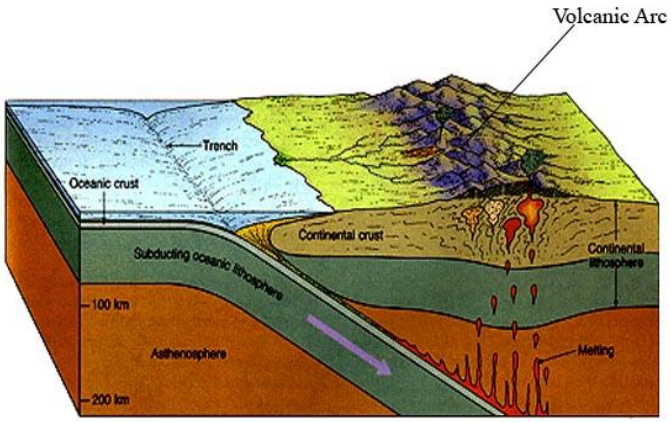


MORPHOLOGY OF EARTH

Plate Tectonics Theory

Plate boundaries

3. Convergent Plate Boundaries



MORPHOLOGY OF EARTH

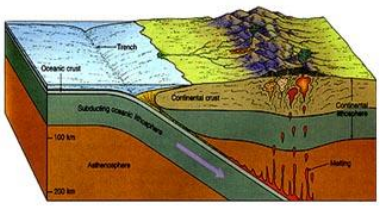
Plate Tectonics Theory

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)



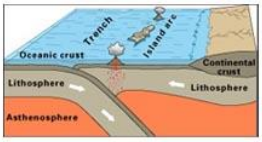
MORPHOLOGY OF EARTH

Plate Tectonics Theory

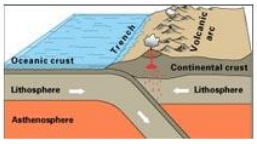
Plate boundaries

3. Convergent Plate Boundaries

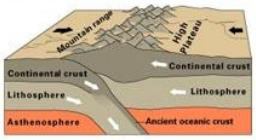
1. Oceanic oceanic convergence



2. Oceanic continental convegence



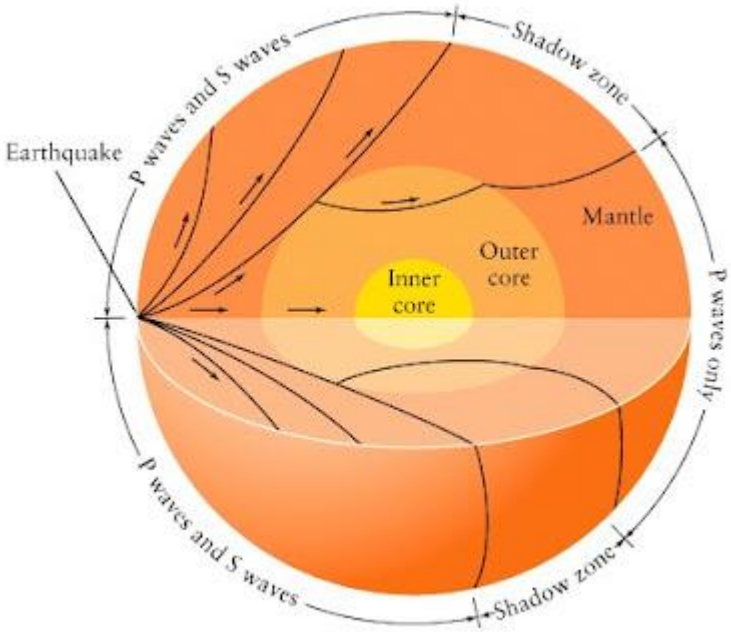
3. Continental continental convergence



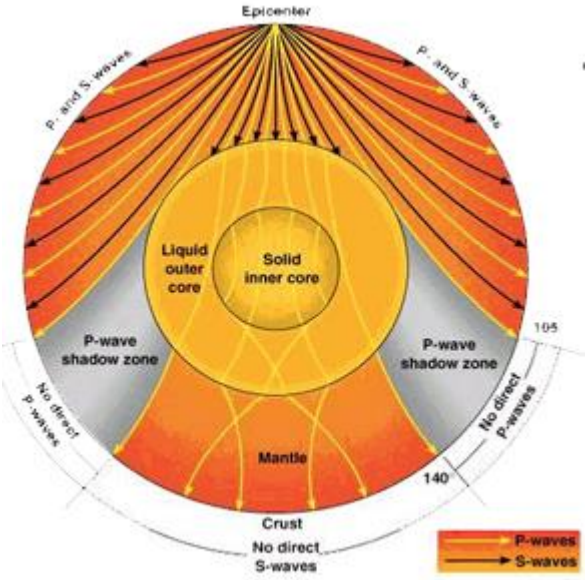
Earthquakes

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)



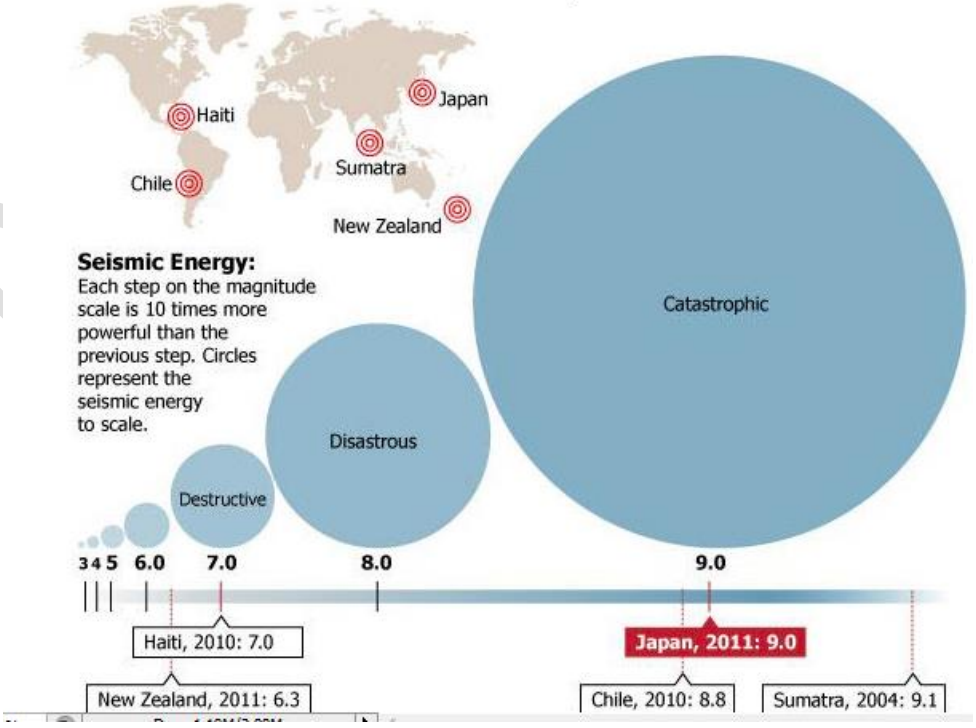
- Vibrations get transmitted in the form of seismic waves



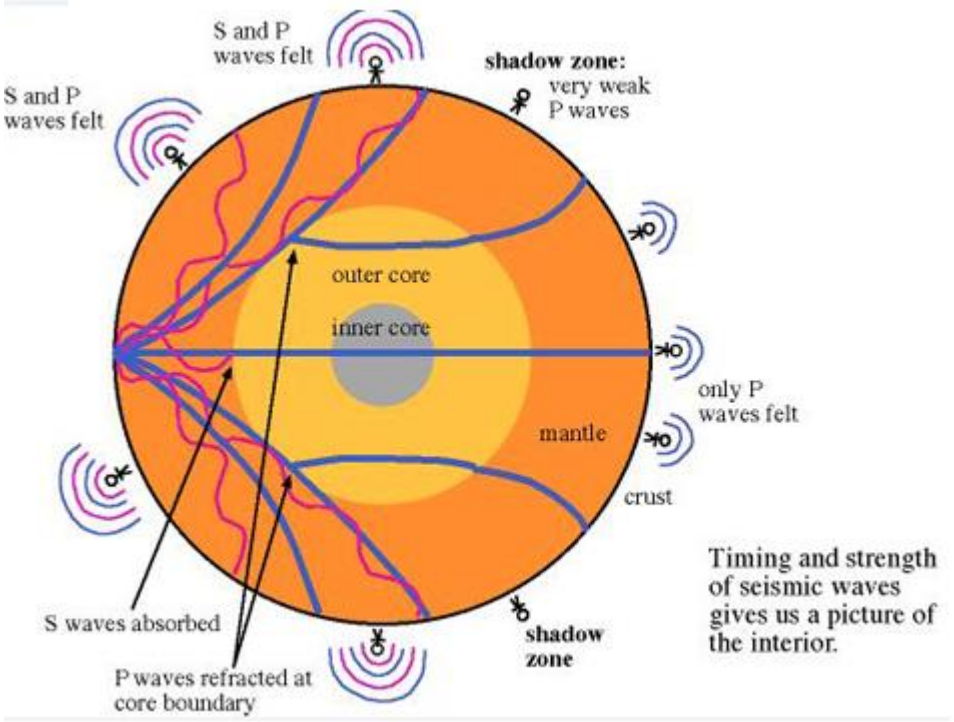
- There are two aspects of earthquake
  i) Intensity of earthquake
  ii) Magnitude of earthquake

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 3types

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

Primary waves : These waves are said to be longitudinal waves

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

μ — Rigidity

d — Density

Incompressbility

- 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

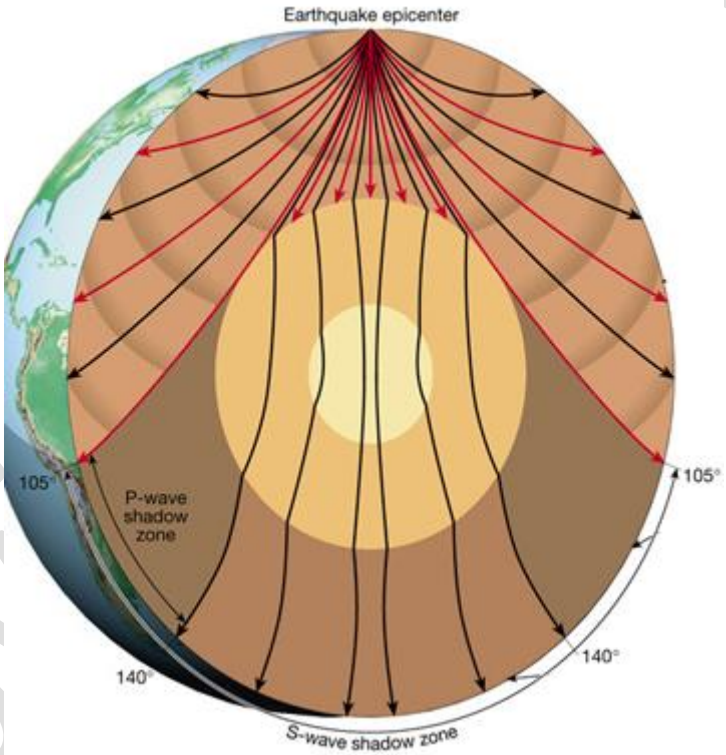
- Surface waves are the slowest waves but they can cause maximum destruction
- Surface waves made up of two waves

i) Love waves

ii) Rayleigh waves

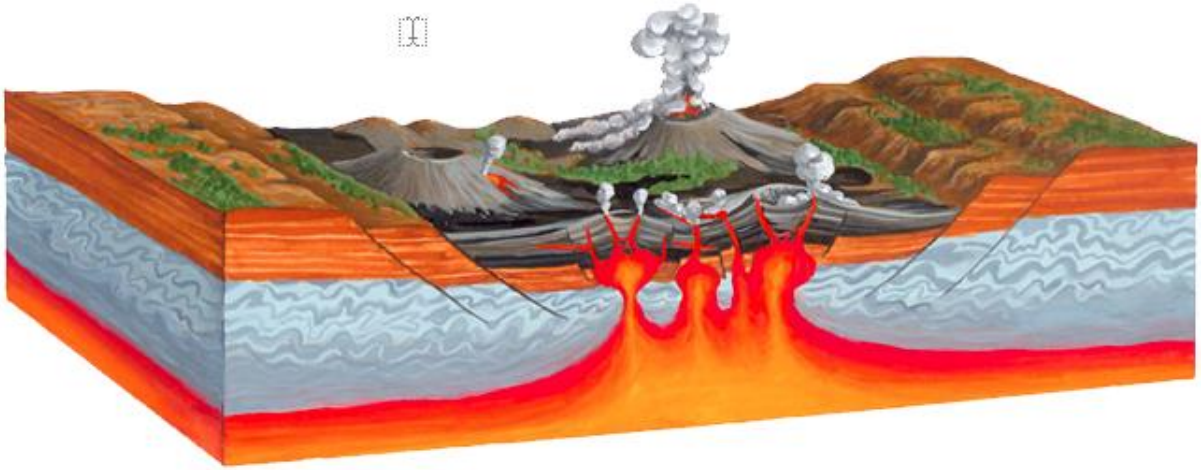
- Love waves have movements in horizontal direction
- Love waves cannot pass through liquid medium
- Rayleigh waves have both movements of horizontal & vertical direction
- Rayleigh waves is responsible for maximum destruction

Shadow zone



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