MBC-MRIDUL BHAIYA CLASSES

B.SC GEOLOGY PART-01

GEOLOGY NOTES FOR 1ST YEAR STUDENTS

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MBC – Mridul Bhaiya Classes

B.Sc 1st NOTES

GEOLOGY NOTES

UNIT - 01

GEODYNAMIC AND GEOMORPHOLOGY PART - 01

- ✓ Detailed notes
- ✓ PYQs with answers
- ✓ Graphics included

UNIT – 01 (SEMESTER 1ST)

TOPICS TO BE COVERED

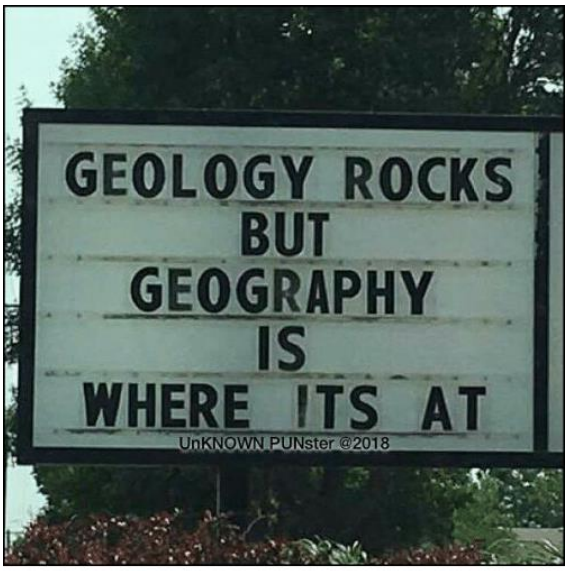
A. Introduction to Geology and its branches and it's importance
B. Introduction to solar system : Star, Planet, Satellite, Asteroid, and Meteorite. Earth in Solar system ; Size, Shape, Mass, And Density.
C. Origin of Earth
D. Internal Structure of Earth, Crust, Mantle, and Core
E. Age of Earth : Various methods of determination of age of the Earth.

GENERAL INTRODUCTION :

There is difference in geology and Geography.

Geology :

- Deals with the study of earth. The science of geology tells us about the **origin, structure** and **history** of the earth and its habitat, as recorded in the rocks.
- It includes the study of the evolution of organisms which inhabit our planet.
- It mainly focus on **nature.**



Geologists accept the earth as it is even with all its faults.

Geography :

- Deals with the study of earth. It is **all about the world** in which we live and on which we depend. Geography is mostly dealing with mapping, the extent of landscapes, people, place and the environment.
- It focus on **nature** as well as **people.**

Now since you know the difference between Geology and Geography. Let's study **GEOLOGY.**

SCIENCE OF GEOLOGY

Geology : *It is a branch of Science devoted to the study of the Earth.*

It deals with :

→ Origin and Processes operating on the surface and beneath the surface of earth. (i.e all features of earth)

→ Composition and constituents

→ Structure and Inhabitants of the Earth

→ Evolution of Life

→ History of Rocks etc.

BRANCHES OF GEOLOGY

The field of geology is divided into several branches

(i) Physical Geology : Work of natural processes which brings changes upon earth's surface.

(ii) Petrology : Discussion of different kinds of Rocks is known as Petrology.

It deals with :

→ Study of composition, Structure and origin of rocks.

(iii) Mineralogy : Study of mineral composition, structure, appearance, stability, occurrence and associations.

(iv) Structural Geology : Study of structure of rocks in earth's crust.

(v) Stratigraphy : The description, correlation and classification of strata in sedimentary rocks.

Strata : A layer or series of layer of rocks in the ground.

(vi) Palaeontology : Science of fossils of ancient life forms and their evolution.

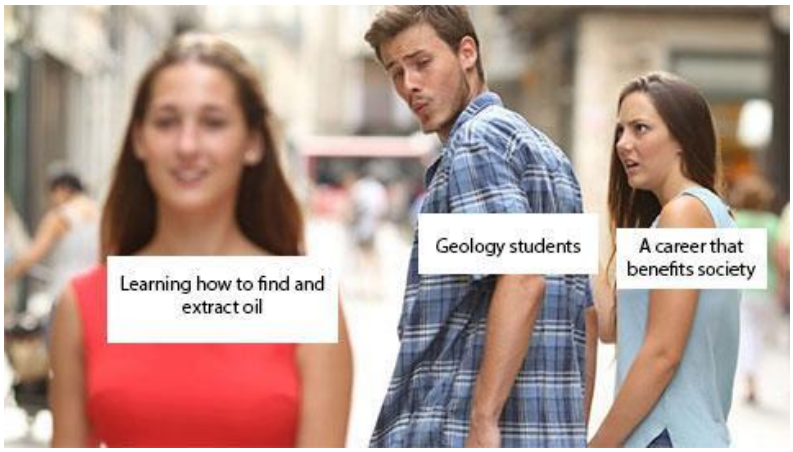
(vii) Historical Geology : Study of stratigraphy and palaentology included under the historical geology.

(viii) Economic Geology : Study of minerals, ores and fossils fuels of economic importance.

(ix) Mining Geology : Study of application of geology to mining engineering.

(x) Engineering Geology : Study of application of geology to civil Engineering.

(xi) Field Geology : It is concerned with the study of application of geology to mining.



SCOPE OF GEOLOGY OR IMPORTANCE OF GEOLOGY

It plays a very useful part in the search of coal, petrolium and minerals used as atomic fuels.

(a) **In civil Engineering :** Provides necessary information about the site of construction, material used in construction of building, dams, tunnels, tanks, reservoirs, highways, and bridges.

(b) **In mining Engineering :** Geology is useful to know the method of mining of rocks and deosits on earth surface and sub-surface.

SOLAR SYSTEM

The Solar System comprises 8 planets, approximately 170 natural planetary satellites (moons), and countless asteroids, meteorites and comets.

Our Solar System

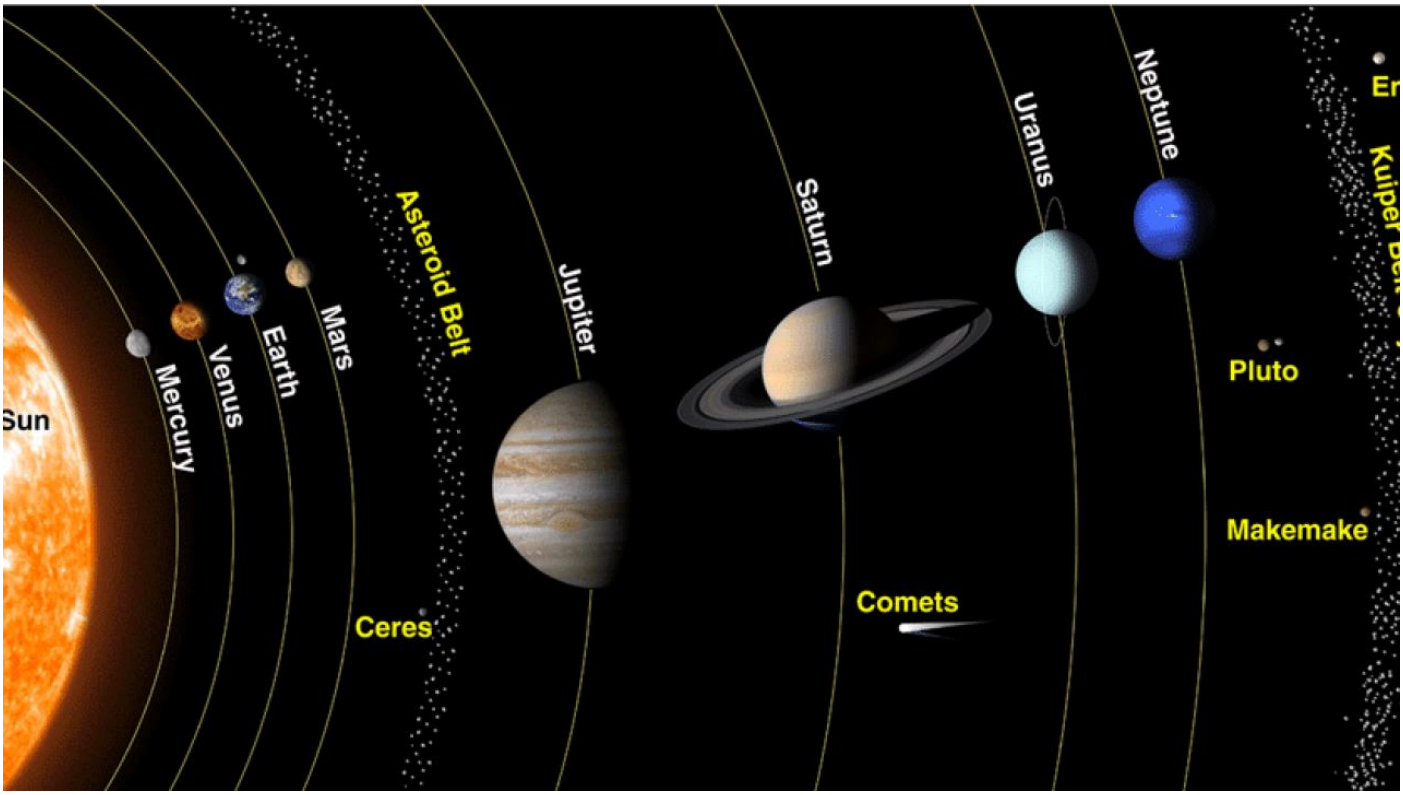
Why is it called the Solar System ?

Our planetary system is called "the solar system" because we use the word "solar" to describe things related to Sun. (Latin Word = "Solis")

The planets in order of increasing distance from sun.

Mercury, Venus, Earth, Mars — **"Inner planets" (Terrestial Planets)**

Jupiter, Saturn, Uranus, Neptune — **"Outer planets" (Gas Giants)**



What is a Planet ?

Planet must do three things

- ✓ It must orbit a star (the Sun)
- ✓ It must be big enough to have gravity to force it into a spherical shape.
- ✓ It must be big enough that gravity cleared away any other object of a similar size near its orbit around the Sun.

Planets – 8 (eight)
Dwarf Planet – (5) five
Moons – 200+
Asteroids – 1,113,537

99.85 % of mass contained within "sun", while remaining 0.15 % collectively by "Planets

What is Dwarf Planet ?

The key difference between planet and Dwarf Planet is the kinds of objects that share its orbit around the sun.

'Tisre point ko follow nahi karta isliye dwarf planet bolte hai'

SOME MORE DEFINITIONS :

Satellite : A satellite can be of two types, though both have the overlapping parameters of **revolving around a planet in a specific orbit**.

a. **Artificial Satellite**
b. **Natural Satellite**

Asteroids (Planetoids) : An asteroid is a celestial object with diameter ranging few hundered to few thousands of kilometers.

Location : Between Mars and Jupiter, (Mostly) in Asteroid belt

Comets : A comet appears generally as a bright head with a long tail.

→ They revolve around the sun in elliptical orbits
→ Period of revolution is very high

- Halley's comet (Most periodic – 76 years)
- Hale-Bopp

Meteors : A meteor is usually a small object that ocassionally enters the earth's atmosphere

→ Also known as **Shooting Star**

Meteroites : Some meteors are large, they reach the earth before getting evaporate completely.

→ " The body that reaches the earth is called **meteorites** "

Size : Inner Planets Small
Outer Planets Large (Giants)

Density : Inner – generally dense
Outer – less dense

NOTE : Saturn has density less than Water

Composition : Inner – Silicates and metals
Outer – Hydrogen, Helium, Water, Ammonia and Methane.

Rate of Rotation : Mercury – Fastest (88 days)
Pluto – (248 years)

EARTH IN THE SOLAR SYSTEM

→ Blue Planet
→ Only Planet having Water on surface and life.
→ Third Planet
→ Slightly tilted responsible for season change

Size :

- Radius – 3,959 miles (6,371km ≈ 6400km)
- Biggest of terrestial Planets
- Fifth largest planet
- 8 minutes for light from Sun to Earth

Shape :

"**Oblate Spheroid**"

Density : 5.6 g/cc

Rotation : 23.9 ≈ 24 hours ; Prograde ; West to East

Tilt : 23.4 °

Revolution : 365 days

Moon : 01 (Our Moon)

Mass : 6×10^{24} kg

ORIGIN OF THE EARTH

In general the theories of origin of the Solar System can be divided into two groups :

i. Evolutionary theories
ii. Catastrophic theories

(a) Evolutionary theories : The theories which suggest that Planets are formed during the evolution of Sun are called "Evolutionary Theories"

Ex : Nebular Hypothesis

(b) Catastrophic theories : Those theories which imagine that planets are formed by some special accident or Catastrophe.

Ex : Planetesinal and Gaseous tidal Hypothesises.

NOTE :

Since the stars are so far apart in galaxy, the possiblity of a catastrophe is extremely rare.

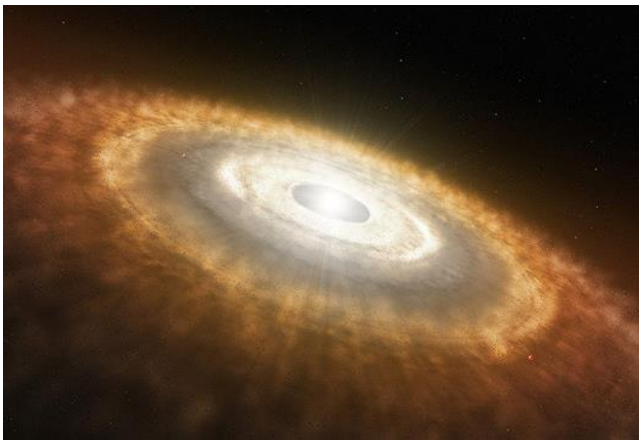
* Collisions of two stars

The best known hypothesis for origin of the Earth and Other planets of the Solar system are :

1. Nebular Hypothesis
2. Planetesimal Hypothesis
3. Gaseous tidal Hypothesis
4. Binary Star Hypothesis
5. Gas dust Hypothesis

NEBULAR HYPOTHESIS

- Given by Kant, the german Philospher and Laplace French Mathematician
- This hypothesis suggest that "the Sun and planets, including earth have formed from a disc-shaped rotating Nebula".
  → A vast cloud of hot gas is called "Nebula".



THE HYPOTHESIS :

1. Originally there was a large, hot, gaseous nebula which rotated along its axis.
2. - As the gas lost enegy by radiation, it became cooler
   - The nebula contracted and its speed of rotation increased to conserve angular momentum.
   - Due to this centrifugal force at equatorial zone increased thereby causing the nebula to bulge out.
3. The cooling and contraction of nebula continued and stage came when centrifugal force became greater than gravitational attraction acting inwards.
4. The above process was repeated and successive rings of gaseous material were thrown off from central mass.
5. In final stage, the rings condensed into planet. Planetoids were formed when one such ring broke into many small fragments.

6. The central mass of Nebula continued to Shrink and finally formed the Sun.

Drawback of Nebular Hypothesis :

(i) Could not explain the energy distribution whithin Solar System.
(ii) There was not enough mass in the rings to provide the gravitational attraction for condensation into individual planets.

PLANETESIMAL HYPOTHESIS

- Given by Chamberlin and Moulton

THE HYPOTHESIS :

1. The sun existed before the formation of planets. A large passing star approached very close to sun.
2. Due to the disruptive forces of the Sun and the Strong Gravitational pull of the passing star, giant masses of gas were torn from the surface of pre-existing Sun.
3. The giant masses of gas broke into a large no. of small chunks which on cooling gave rise to solid particles, called “Planetesimals”
4. The planetesimal started flying as cold bodies into orbits around Sun. By collision and gravitational attraction the larger planetesimal swept up smaller pieces and thus planets were formed.

Drawback of Planetesimal Hypothesis :

(i) Most of the material which was ejected by the explosive action of Sun would be so hot that gases would disperse in space rather than condense into planet.
(ii) The amount of angular momentum of planets is less than that observed.

(iii) The space is vast therefore probability of close approach of two stars is extremely rare.

GASEOUS TIDAL HYPOTHESIS

- Given by Jeans and Jeffreys

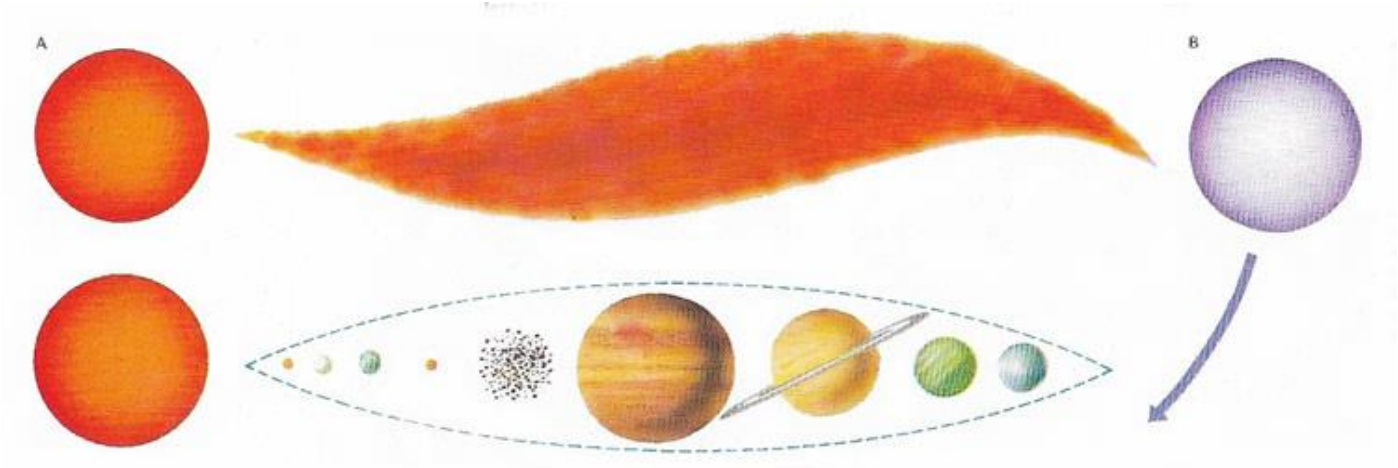
THE HYPOTHESIS :

1. A very large star progressively approached close to the Sun. Due to gravitational pull of Star, a gaseous tide was raised on the Surface of the Sun.
2. When the Star began to move away, the gaseous tide was detached from the Sun. Its shape was like a spindle being thickest in the middle.
3. This spindle-shaped gaseous mass soon broke into ten pieces, nine of which condensed into planets and remaining one broke into small pieces, formed Planetoids.

Drawback of Gaseous-tidal Hypothesis :

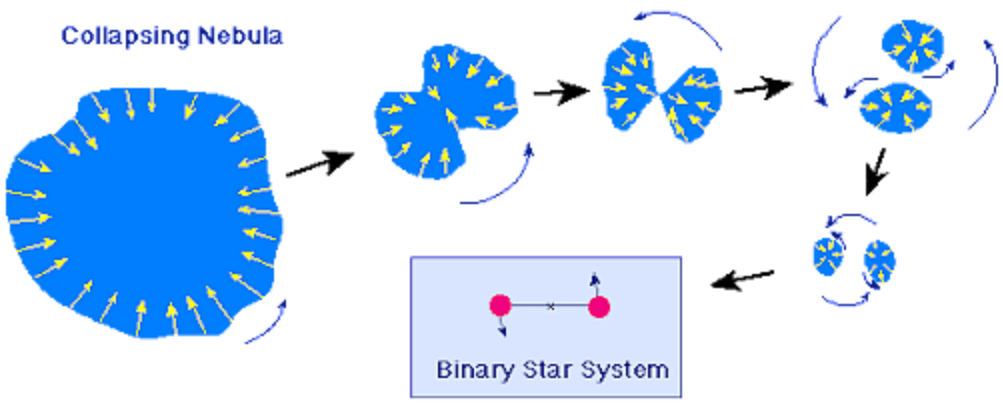
(i) The passing star is unable to impact the proper angular momentum to the detached gaseous masses.

(ii) The hot gaseous mass pulled away from the sun would not form solid planets but would dissipate into space.



BINARY STAR HYPOTHESIS

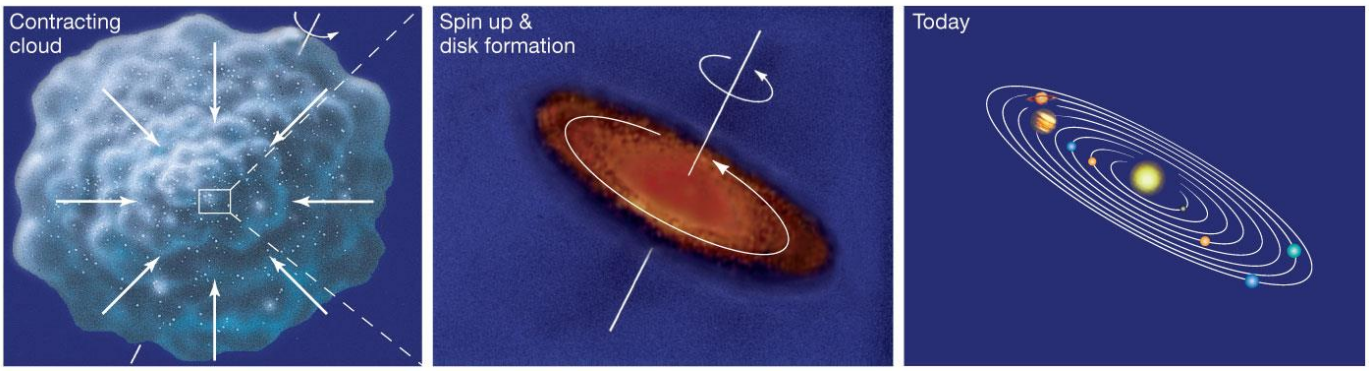
- Given by Lyttleton
- Before the formation of planets, the Sun had companion star
- Another star approached close to these double stars and dragged the companion star away.
- A gaseous filament was torn from the companion star and it remained close to the sun.
- The planets were originated from this gaseous filament in the same way as described in the gaseous tidal hypothesis.



GAS DUST HYPOTHESIS

THE HYPOTHESIS :

1. There was a disc-shaped cloud of gas and dust around the sun.
2. The planets were formed by gradual aggregation of the disappear matter in cloud.
   (i) Those materials which have high melting point like metals and rock condensed near Sun making inner planet.
   (ii) Volatile materials such as water, methane and ammonia were blown away making Outer Planet.
3. Primitive Sun acted as rotating magnet and accelerated the hydrogen ions present in dust cloud. Due to this acceleration gases moved outwards carrying dust and leaving large solid mass which slowed down the Sun's rotation.

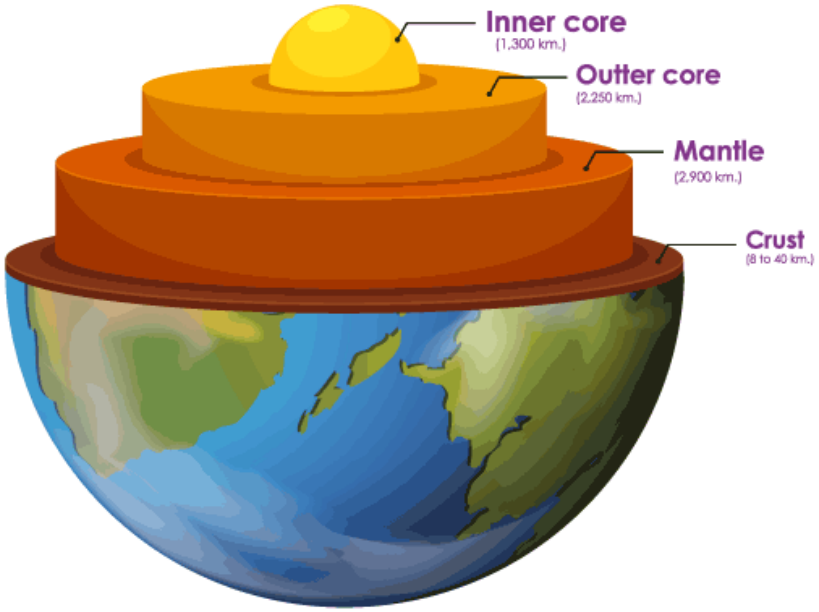


INTERIOR OF THE EARTH

On the basis of seismic investigations, the earth can be divided into three major layers

i. Crust
ii. Mantle
iii. Core

THE LAYERS OF EARTH



CRUST :

- The outer superficial layer of the earth is called the "**crust**'.

  Or

  The uppermost layer over the earth's surface is called the 'Crust'
- It Is very thin as compared to the other three layers.
- It extends down to **30 to 40 km beneath continents** and to about **10 km beneath ocean basin**.
- The crust mantle boundary is known as the "**Mohorovincic discountinuity"**
- The crust of earth is broken into many pieces called Plates
- In continental regions, the crust can be divided into two layers
  (a) Sial (b) Sima

i. Sial (Si + Al) [silica + aluminium] : The upper layer ; Less dense and granitic in character.

ii. Sima (Si + Mg) [silica + magnesium] : The lower layer ; and basaltic in character.

NOTE : Under Oceans only Sima is found and Sial is absent

MANTLE :

- This is the second layer of the earth, it lies directly below the crust.
- Located beneath the earth's crust and **has thickness of about 2900 km.**
  → It forms **83% of the earth by Volume** and **68% by mass**.
- It has divided into two layer :
  (a) Upper Mantle
  (b) Lower Mantle
- The **boundary between upper mantle and lower mantle** is at about **700 km** depth (660 km).
- Mantle is the **source-region** of most of the earth's **internal energy** and of forces responsible for ocean-floor spreading, continental drift, orogeny and major earthquake.

i. Upper Mantle :

→ This zone provides lava for oceanic eruptions
→ It contains a most important zone called "asthenosphere"
→ Locaation at depth between 50 to 100 km
→ Consist partly melted rocks
→ Most basalts originate in this zone.

ii. Lower Mantle :

→ Denstity of material increases.
→ It consists of a mixture of periodtite and minerals of higher density.

CORE :

- Core is the innermost of the Earth's layers
- The boundary between the mantle and the core is at depth of about 2900km
- It lies the depth up to 6371 km
- It is mainly made up of nickel and iron and is called **NiFe.**

- The core of the earth is sorce of internal heat because it contains radioactive materials which release heat as they break down into more stable substance.

i. Outer Core :

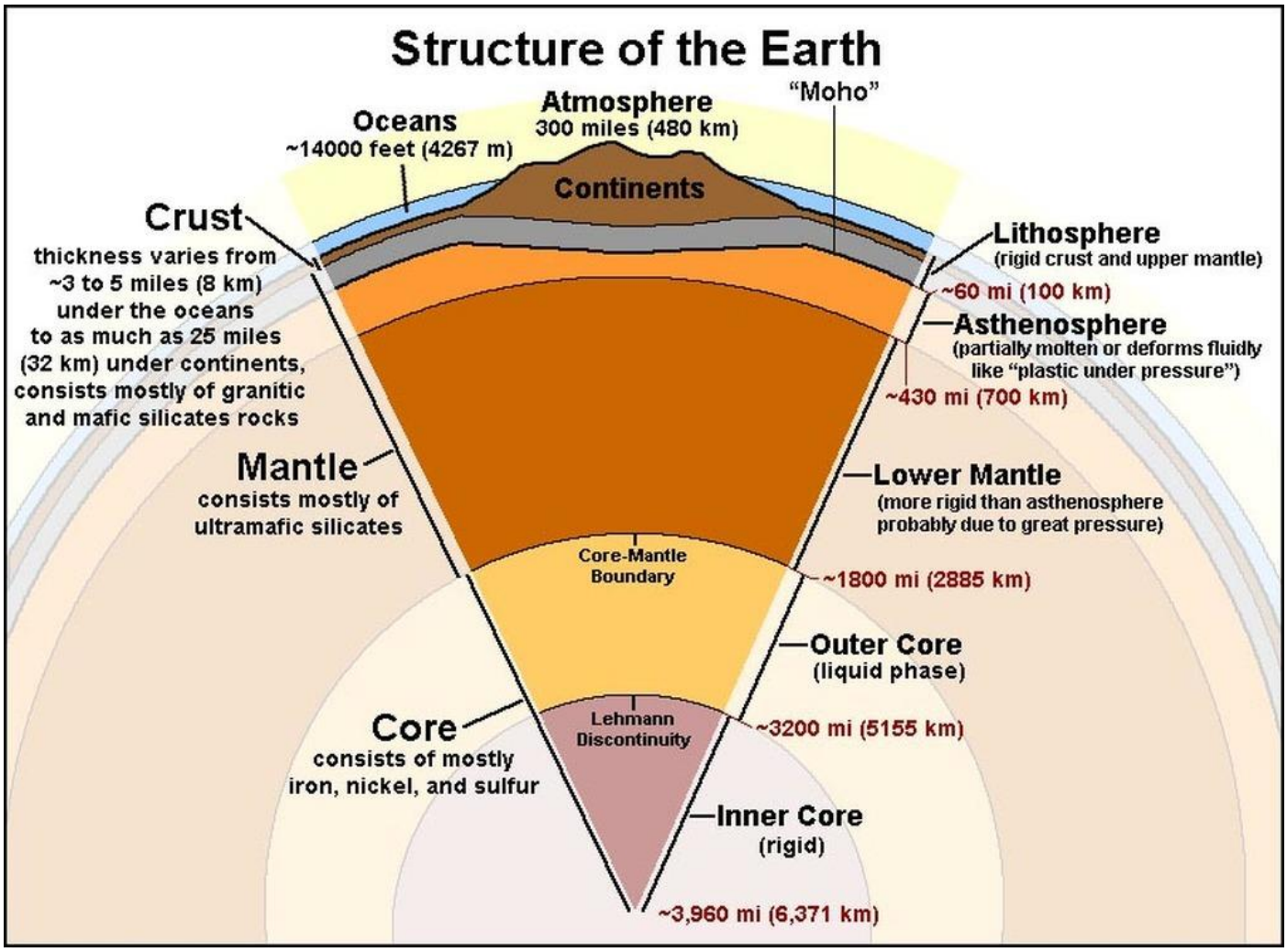
→ Discovered when it was found that P waves were bent inwards there by producing a "shadow zone" at the surface.

→ Since S wave do not pass, it is in **liquid state**.

ii. Inner Core :

→ Extends from 5150 km to the earth's centre at 6371 km.

→ Transmits P-waves at higher velocity i.e it is in **solid state**.

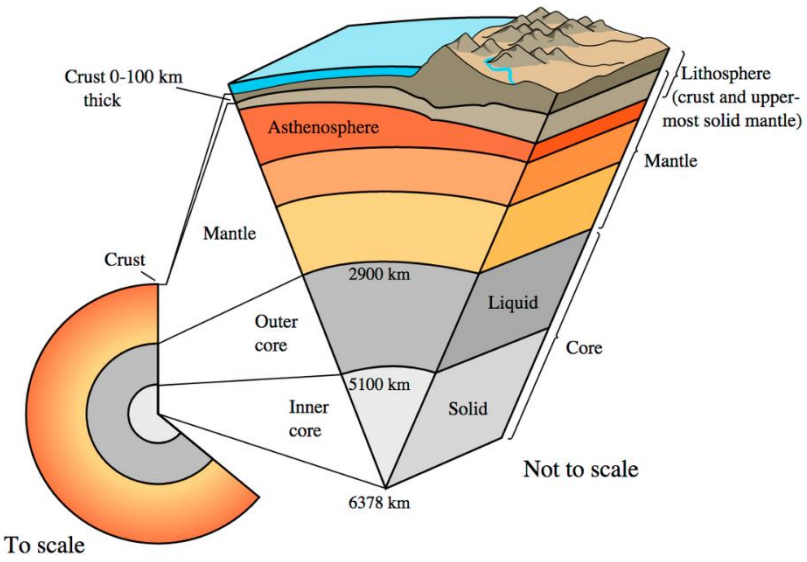


DISCONTINUITY

The zone inside the earth where there is a sudden change in the physical properties of materials, such as the change in velocity of seismic waves, is known as **Discontinuities.**

The discontinuities are located at the boundaries between the Earth's various layers.

1. **CONRAD** → Between Sima and Sial or Upper crust and lower crust
2. **MOHOROVICIC** → Between Crust and Mantle
3. **REPETITE** → Between Upper and Lower Mantle
4. **GUTERBERG** → Between Mantle and Core
5. **LEHMAN** → Between Upper Core and Lower Core.



CONRAD DISCONTINUITY :

- The boundary between the continental and oceanic crust is called as Conrad Discontinuity
-

MOHOROVIC DISCONTINUITY :

- Located at an average depth of 8 km under the ocean and 32 km under the continents.
- The velocity of seismic primary waves across this boundary changes abruptly from 6.7 to 7.2 km per second in the lower crust to 7.6 to 8.6 km per second in the upper mantle.
- Mohorovicic stated that this was because the crust of the earth is made up of less dense material and mantle is much more dense than the crust. Since the mantle is more dense the waves move faster through the mantle rock.
- The boundary is estimated to be between 0.2 to 3 km thick.

GUTENBERG DISCONTINUITY :

- The boundary between the mantle and the outer core is called Guterberg discontinuity.
- It is also been referred to as the Oldham-Gutenberg or Weichhert Guttenberg discontinuity.
- Beno Gutenberg claimed that the outer core of the earth was made up of liquid because secondary waves could not pass through and were sometime bounced off.

Crust is Divided into two Parts :

1. Continental Crust (30-32 km)

- Continental crust Is about 30-32 km thick but under mountains it can be 70 km thick.
- Composition is granitic, silica and aluminium dominantally (Sial)
- Continental crust has a density of about 2.7g/cc and is less dense than the material of the Earth's mantle.

2. Oceanic Crust (32 – 40 km)

- Oceanic crust is about 5-10 km thick, basaltic composition dominated by silica and magnesium (Sima)
- It is thinner than the continental crust
- It is more dense, having a mean density of about 3.3g/cc