CHAPTER-2 THE ORIGIN AND EVOLUTION OF THE EARTH

This chapter deals with

1. Origin of the earth 2. Early theories 3. Modern Theories 4 .Big Bang theory 5. The star formation 6. formation of planets 7. Our solar system 8. The moon 9 Evolution of the earth 10. Development of lithosphere 11. Evolution of Atmosphere and hydrosphere 12. Origin of life

7.NEBULA

Nebular hypothesis: There is evidence that the nebular hypothesis was first proposed in 1734 by Immanuel Kant, who was familiar with Swedenborg's work, developed the theory further in 1755.[4] He argued that gaseous clouds—nebulae, which slowly rotate, gradually collapse and flatten due to gravity and eventually form stars and planets. A similar model was proposed in 1796 by Pierre-Simon Laplace. It featured a contracting and cooling proto solar cloud—the proto solar nebula. As the nebula contracted, it flattened and shed rings of material, which later collapsed into the planets. While the Laplacian nebular model dominated in the 19th century, it encountered a number of difficulties. The main problem was angular momentum distribution between the Sun and planets. The planets have 99% of the angular momentum, and this fact could not be explained by the nebular model. As a result this theory of planet formation was largely abandoned at the beginning of the 20th century.

8ANGULAR MOMENTUM

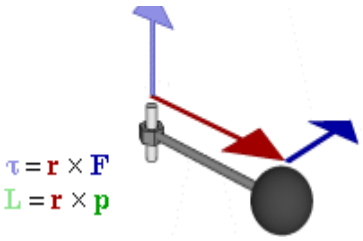
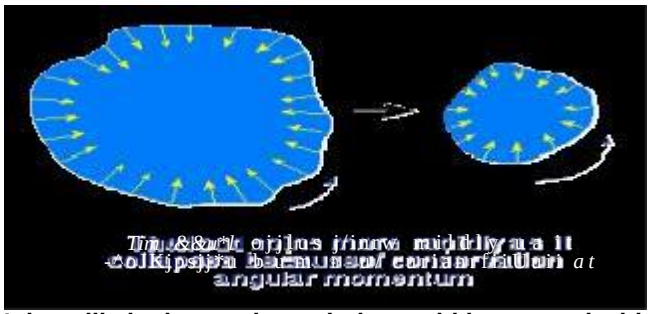
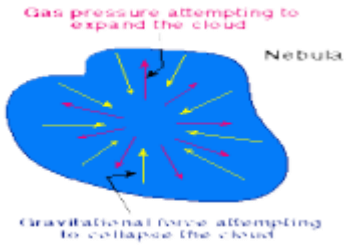


Figure 6angular momentum

The fall of the Laplacian model stimulated scientists to find a replacement for it. During the 20th century many theories were proposed including the *planetesimal theory* of Thomas Chamberlin and Forest Moulton (1901), *tidal model* of Jeans (1917), *accretion model* of Otto Schmidt (1944), *proto planet theory* of William McCrea (1960) and finally *capture theory* of Michael Woolfson. In 1978 Andrew Prentice resurrected the initial Laplacian ideas about planet formation and developed the *modern Laplacian theory*.[4] None of these attempts was completely successful and many of the proposed theories were descriptive. Sir Horald Jeffery **Nebular Hypothesis in its original form was proposed by Kant and Laplace in the 18th century.**

The initial steps are indicated in the following figures .Collapsing Clouds of Gas and Dust-A great cloud of gas and dust (called a *nebula*) begins to collapse because the gravitational forces that would like to collapse it overcome the forces associated with gas pressure that would like to expand it (the initial collapse might be triggered by a variety of perturbations---a supernova blast wave, density waves in spiral galaxies, etc.).



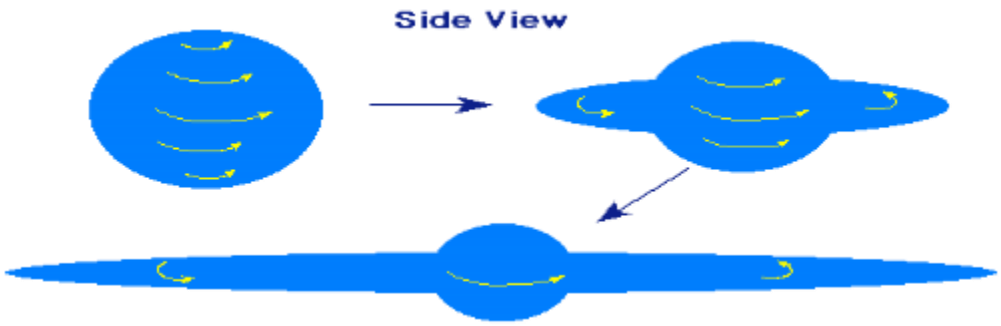


It is unlikely that such a nebula would be created with no angular momentum, so it is probably initially spinning slowly. Because of conservation of angular momentum, the cloud spins faster as it contracts.

The Spinning Nebula Flattens Because of the competing forces associated with gravity, gas pressure, and rotation, the contracting nebula begins to flatten into a spinning pancake shape

In the Nebular Hypothesis, a cloud of gas and dust collapsed by gravity begins to spin faster because of angular momentum conservation

with a bulge at the center, as illustrated in the following figure.



The collapsing, spinning nebula begins to flatten into a rotating pancake

Condensation of Proto sun and Proto planets As the nebula collapse further, instabilities in the collapsing, rotating cloud cause local regions to begin to contract gravitationally. These local regions of condensation will become the Sun and the planets, as well as their moons and other debris in the Solar System.

MODERN THEORIES Origin of the universe

The Big Bang Theory, also called as expand universe hypothesis.
Edwin Hubble in 1920 provided the evidence that the universe is expanding. The galaxies move farther as the time passes.

Laboratory The Expanding Balloon

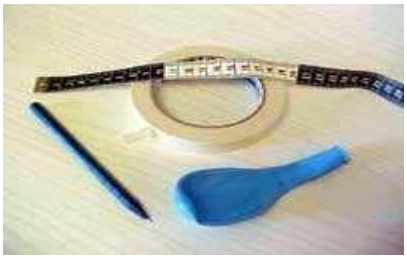
In **The Expanding Universe**, Charles Jenkins tells us that galaxies are moving away from each other.

The universe appears to be growing larger.
We can use a balloon to help us understand what is going on in the cosmos. In this activity, the balloon represents the universe. Bits of tape on the surface of the balloon represent some of the galaxies located throughout the universe.

Tools & Materials

Create your own expanding universe with these simple materials

- round balloon
- masking tape
- tape measure
- pen or pencil
- clothespin (optional)



The Experiment

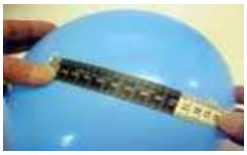
Here's what to do:

1. Blow up the balloon part way. The partially-inflated balloon represents the universe. Imagine that there are many galaxies both inside the balloon universe and on its surface. Have someone hold the mouth of the balloon closed so that it doesn't deflate, or use a clothespin to clamp the rolled-up mouth closed.

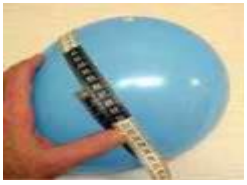
2. Tear off three small bits of masking tape, each about the size of your little fingernail. Draw a round dot in the middle of each bit of tape to represent a galaxy. Label each galaxy as A, B, or C.

3. Place the three bits of tape on the balloon so that the distances between them are all different. These represent three of the many galaxies in the universe.

4. Use your tape measure to find the distance from each masking tape galaxy to each of the others. Also measure the circumference of the balloon at its widest part. This gives you an indication of the size of your balloon universe at this time. Record these measurements for Round 1. (See chart below.)



5. Blow the balloon up a bit more, to represent the expanding of the universe. Measure and record the balloon circumference and the distances between the masking tape galaxies for your next round.



Repeat Step 5 a few more times until the balloon is about as big as it can get without popping. (Try to avoid a Big Bang!

Use a chart like the one below to record your results.

	Changes in Distances between Galaxies as the Universe Expands			
Balloon	Circumference	From A to B	From B to C	From C to A
Round 1				
Round 2				
Round 3				
Round 4				

Observe how the distances between the galaxies changed as the balloon universe expanded. Do you see any pattern or trend?

Stages of Big Bang theory

(i) In the beginning, all matter was in the form of tiny ball(singular atom) with unimaginable small volume , infinite temperature and infinite density

(ii) About 13.7 billion years ago the tiny ball exploded violently. The expansion continues even today. As a result some energy was converted into matter Within fraction of second there was rapid

(iii) expansion

(iv) The expansion slowdown after three minutes and first atom formed

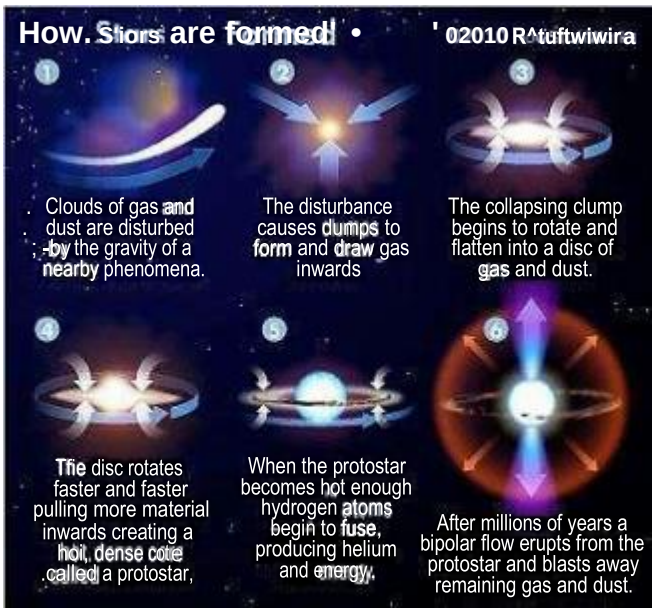
(v) After 300000 years the temperature dropped down to 4,500 K and gave rise to atomic matter.

***(vii)** The universe became transparent.*

Steady State Theory

The Big Bang Theory is the standard model of cosmology; however, there have been several other models for the universe. One such model, which gained a large following in the 1950 and 60 (before becoming obsolete in the early 70), is the Steady State Model. This model asserts that the general character of the universe is not changing over time (hence, a steady state).

Steady State theory propones the idea that the universe looks the same no matter the viewpoint and that the universe has always looked like this; essentially,the theory states that the universe is uniform throughout both time and space. The advantage of Steady State theory over some other theories is its simple and aesthetic explanations of certain troublesome topics. For example, since the universe is unchanging throughout time, the universe needs no convoluted explanation of its beginning. In addition, to account for the decrease in density that would result from expansion, steady state theory claims new matter constantly must be created in order to maintain a constant density (and therefore a static appearance).



The Demise of Steady State

The Steady State theory offered simple solutions to the way the universe worked, but as observatories looked farther back into the early eras of the universe, astronomers started to see contradictions to the theory. Astronomers found that the universe actually evolves over time. For example, cosmologists discovered different types of stars are more common during different ages of the

State theory came in the late 1960's with the discovery of the Cosmic Microwave Background. Steady State Theory could offer no convincing explanation for the CMB and as such, most contemporary cosmologists feel this theory is wrong

The star formation

1. *The distribution of matter and energy was uneven in the universe.*
2. *The density difference gave rise to differences in gravitational forces It caused the matter to get*
3. *drawn together.*
4. *This is the base for the formation of galaxies Galaxy contains large number of stars*
5. *The distance between the start is measured with light years.*
6. *One light year is equal to the distance covered by the light in one year when it travels at the speed*
7. *of 3 lakh km/hour*
8. *The average diameter of the stars is 80,000 km to 1,50,000 light years 9.*
   It starts forming by accumulation of hydrogen gas in the form of cloud

10. The denser gases were condensed into stars. 11. The formation of star was about 5-6 b y a.

12. One light year is 9.461 x km

13. The mean distance from the Sun to the earth is 8.311 minutes

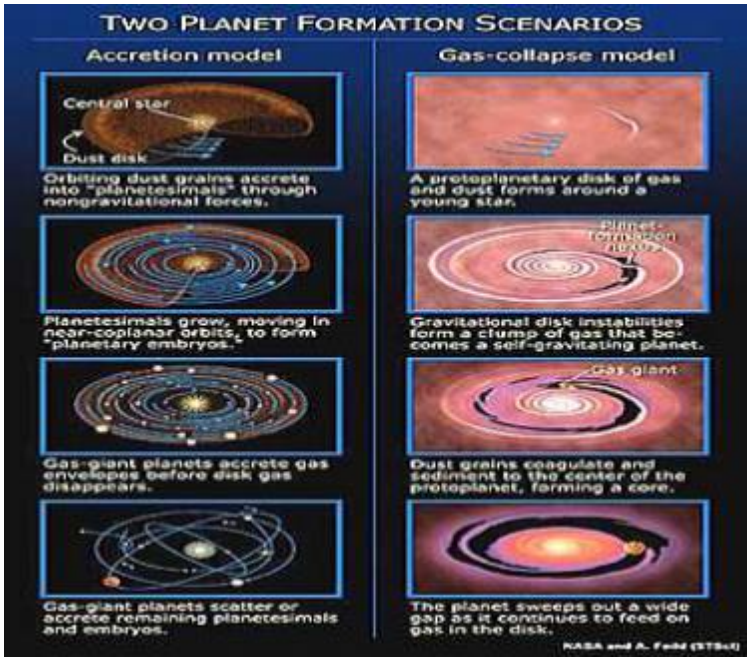
*Formation of planets -**Stages in the development of planets***

(i) The stars are localized lump of gases found in nebula The gravitational force led to the formation of the core

(ii) The huge rotating gas disc and dust develops around the gas core

(iii)

(iv) in the next stage the gas cloud starts getting condensed and the matter around the core develops into small rounded objects.

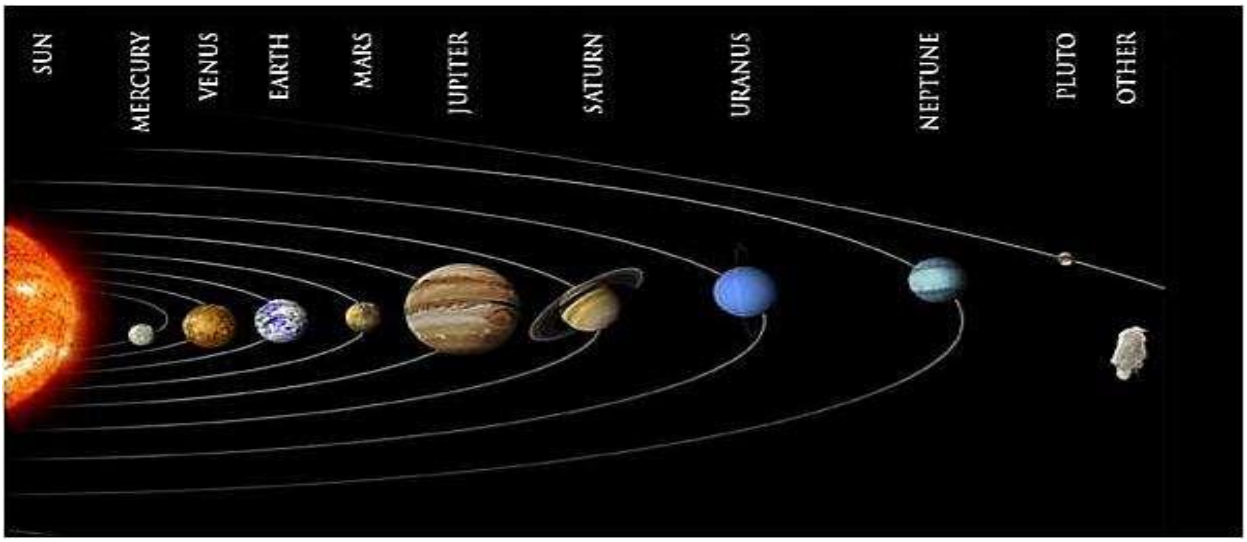


(v)The small rounded objects developed into planetesimals due to the process of cohesion.

(vi)Larger bodies started forming due to collision and attraction.

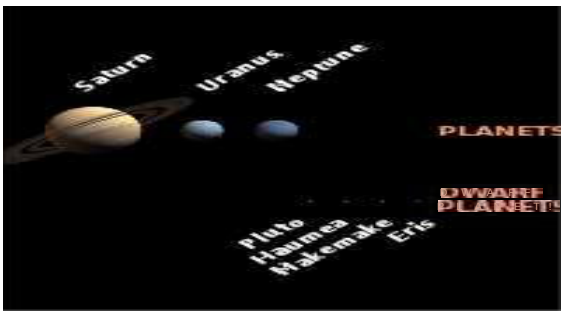
(vii)At the final stage, the small planetesimals accrete to form large bodies in the form of planets.

Our Solar system



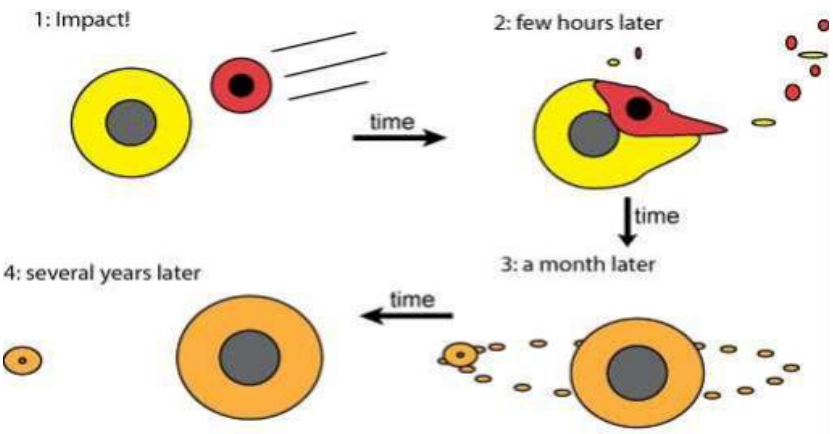
1. Our solar system consists of eight planets
2. The nebula of our solar system started collapsing around 5-5.6 b. y. a 3. The planets were formed about 4.6 b. y .a
4. Our solar system consists of 8 planets, 63 moons, millions of asteroids comets ,huge quantity of gas and dust.
5. There are two types of planets inner planets and outer planets.

THE DIFFERENCE BETWEEN INNER PLANETS AND OUTER PLANETS



THE MOON : THE EARLIER EXPLANATION

In 1838, Sir George Darwin suggested that initially the earth and the moon formed a single rapidly rotating body. The whole mass became a dumb-bell shaped body and eventually it broke. The material separated from the earth was formed as Moon and the place became the pacific ocean. It is not accepted now. the present theory is the giant impact theory./big splat theory. A large size body of Mars collided with the earth and that portion was separated from the earth. The same portion became as a moon which revolves around the earth. The Moon was formed about 4.4 b y a.



A long time ago in a planet system close to home...
A giant impact made the Moon . The Moon is mantle material from the Earth and impactor Earth today is mantle+core from early Earth + impactor.

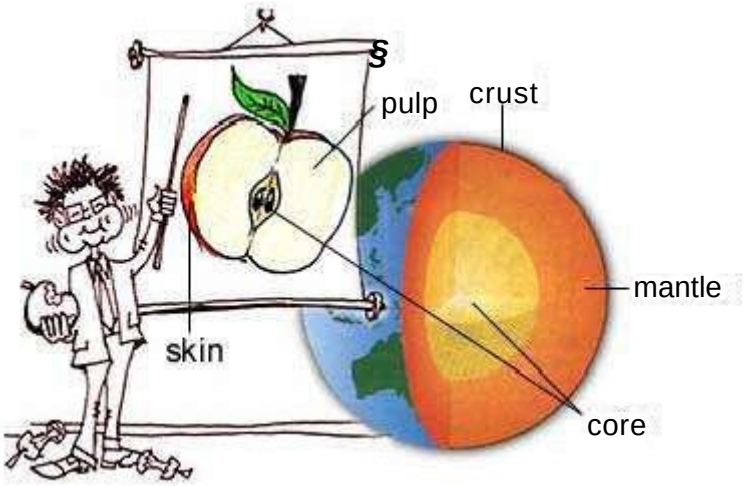
EVOLUTION OF THE EARTH

1. The earth was initially barren rocky and hot Object
2. Hydrogen and helium were present
3. It was formed about 4.6 b y a the earth was Layered structure
4. Lighter layer is formed at the outer surface
5. Density increase to wards inside the core

EVOLUTION OF LITHOSPHERE

1. There was volatile state during its primordial stage 2. Due to high density temperature increased 3. The material started separating depending on their density Light material came out side and heavy material went inside the earth 4. It cooled and condensed into solid which is called lithosphere 5. At the time of formation of the moon the earth again became hot 6. Due to differentiation different layers formed

11. EVOLUTION OF THE EARTH



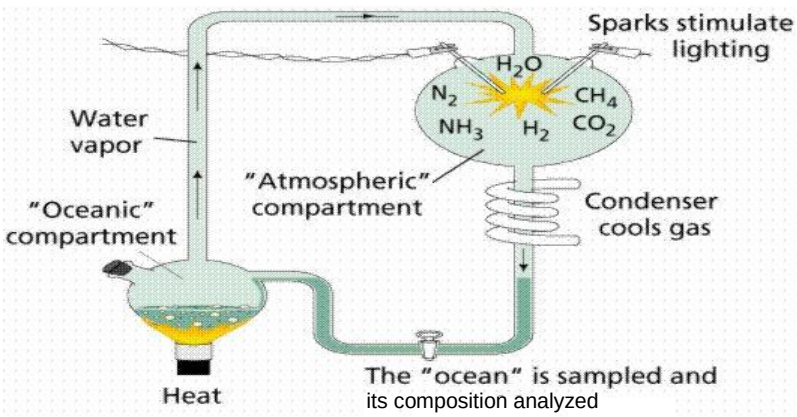
EVOLUTION OF ATMOSPHERE AND HYDROSPHERE

THERE ARE THREE STAGES OF THE FORMATION OF THE ATMOSPHERE

I .IN THE FIRST STAGE : the early atmosphere consist of hydrogen and helium .loss of primordial atmosphere due to solar winds

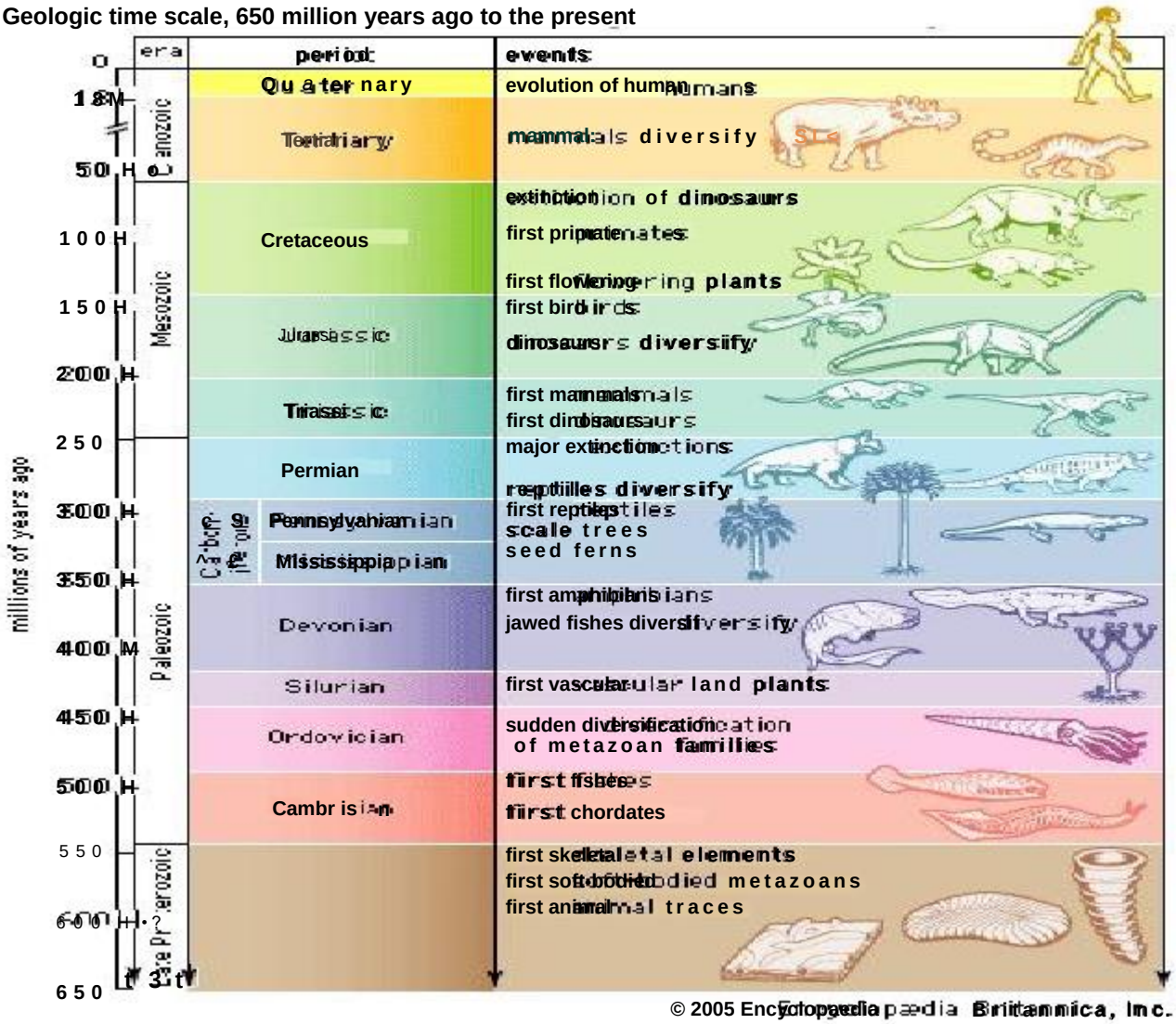
II. IN THE SECOND STAGE: Gases were released from the earth's interior such as Water vapor and other gases. There were water vapor, nitrogen, carbon dioxide methane, ammonia and little free oxygen. The process of outpouring the gases from the interior of the earth is called degassing. Volcanic eruptions contributed the water vapor and . The . Disolved in the rain water and converted into acid rain. Rain water collected into the depressions called oceans. The oceans were formed about 4000 m y a. The life began to evolve about 3.8 b y a. The photosynthesis evolved about 2500 to 3000 m y a oceans began to contribute oxygen to the atmosphere. oceans were saturated with oxygen and flooded into the atmosphere.

III IN THIRD STAGE: Living organisms changed the composition of the atmosphere due to photosynthesis



The last phase of the earth relates to the origin and evolution of life. It is clear that initially the earth or even the atmosphere of the earth was not conducive for the development of life. Modern scientist believes that origin of life is one kind of chemical reaction, took place in the oceans. Due to lightning, the complex organic molecules were combined into a certain form which can duplicate themselves. They are called first single cell animals. They are able to convert inanimate things into animate things. The earliest form of life existed about 3000 m y a . The life began on the earth about 3800 m y a.

Geologic time scale, 650 million years ago to the present



CHAPTER -3 INTERIOR OF THE EARTH

This chapter deals with

1. Sources of information of about the earth interior 2. direct sources 3. Indirect sources 4. earth quake 5. Earth quake waves 6. Propagation of earthquake waves 7. emergence of shadow zone 8. types of earthquakes 9. effects of earthquakes 10. structure of the earth 11. the crust 12. The mantle 13. the core 14. volcanoes and volcanic landforms 15. types of volcanoes 16. shield volcano 17. composite volcanoes 18. caldera 19. flood basalt provinces 20. mid ocean ridge volcanoes 21. volcanic landforms intrusive forms, plutonic rocks ,batholiths, laccoliths, lapolith, phacolith ,sills & dykes

Sources of Information about the Earth‟ s Interior

- There are two sources for information about interior of the earth – a) Direct Sources and b) Indirect Sources:
- Direct Sources: Mining, drilling and volcanic eruption are examples of direct sources. During the process of mining and drilling rocks and minerals are extracted which gives information that there are layer system in the crust. Crust is made of many kinds of rocks and minerals. Volcanic eruption suggests that there is some zone inside the earth which is very hot and in liquid condition. Direct sources are not very reliable because mining and drilling can be done only up to some depth only.
- Indirect Sources: Seismic waves, gravitational field, magnetic field, falling meteors etc are example of indirect sources. They are very important for know about earth‘s interior. Movement of seismic wave suggests that there are three layers in the earth and each layer has different density. Density increases toward the center of the earth.

Movement of seismic wave suggests two things: a) There are three layers in the earth and b) Each layer has different density which increases toward the center of the earth. EARTH QUAKE

It is the shaking of the earth, natural event. It is caused due to release of energy which generates waves that travel to all directions.

WHY DOES EARTH SHAKE?

The release of energy occurs along the fault line

Rocks along the fault tend to move in opposite directions as the overlying strata press them the friction locks them together.

However, the tendency of movement overcome the friction As a result, blocks get deformed

They slide over another: as a result energy releases. Energy waves travel in all directions.

The point where energy releases is called focus/hypocenter Above the focus point on the surface it is called epicenter

EARTH QUAKE WAVES

All earth quakes take place in the lithosphere (200 km depth) An instrument called *Seismograph* records the waves.

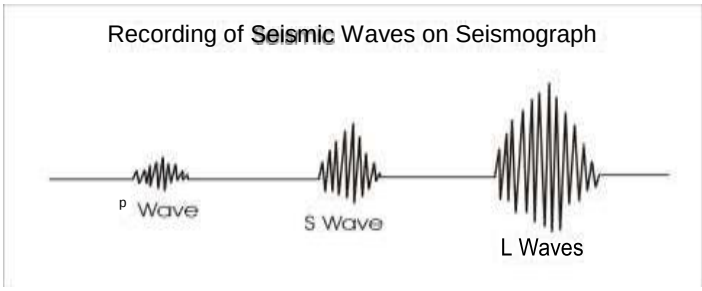
Earthquake and Seismic Waves

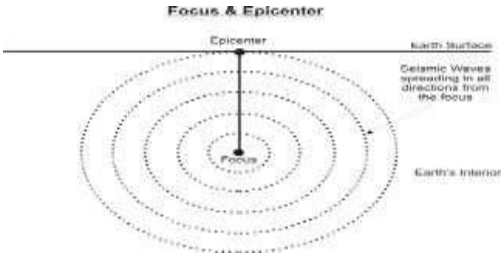
Meaning of Earthquake: Sudden movement or vibration on the earth surface is called earthquake. In other words, sudden release of energy due to tectonic activity is called earthquake. An earthquake may be produced due to: a) movement of plates, b) rising of magma, c) folding and faulting, d) violent volcanic eruption etc. When earthquake occurs, three types of wave are produced called as seismic waves. These are: a) P or Primary Wave, b) S or Secondary Wave, and c) L or Long or Surface Wave.

P and S waves are combinely called as _Body Wave‘ as they move inside the body of the earth.

-

- P wave is the fastest wave. It is also called as longitudinal wave. These waves move forth and back. In other words, P waves move parallel to the direction of wave. These waves can move in both solid and liquid.
- S wave is slower than P wave. It is also called as transverse wave. It moves perpendicular to the direction of the wave. These waves move only in solid and disappear in liquid.
- L wave is the slowest wave. It moves on the earth surface. It causes maximum destruction on the earth surface.





- Focus: It is point inside the earth surface from where an earthquake starts. It is always hidden inside the earth. Focus of an earthquake may be found at the depth of 100-200 km.
- Epicenter: It is a point on the earth surface which records the seismic waves for the first time. Maximum destruction from an earthquake is caused on the epicenter. Epicenter is located just perpendicular to the focus.
- P and S waves are called as Body Wave.
- P wave can pass through both solid and liquid. But S wave can pass only through solid.
- Seismograph: It is an instrument which record seismic waves on a paper.
- Richter Scale: It is an scale which measures the magnitude of an earthquake. In other words, energy released by an earthquake is measured on Richter Scale. Generally, it is from 0 to 10. An earthquake measuring 6 on Richter Scale is 10 times more stronger than 5 and 100 times more stronger than 4.
- Crust and upper part of the mantle is called ‗lithosphere'.
- The opening through with magma comes out from a volcano is called as ‗mouth' or ‗crater'. When crater is collapsed due to a violent explosion it is called as ‗caldera'.
- Mid-Oceanic Ridge: When plates move away from each other under the water of the ocean and magma rises up, it form a long hill like landform called as mid-oceanic ridge. Mid-oceanic ridge of Atlantic Ocean is the best example.
- Mercalli Scale: It was developed by an Italian seismologist. It measures the destruction caused by an earthquake. It ranges from 1 to 12.

Effects of Earthquake

a) Ground shaking
b) Destruction to houses and buildings
c) Land slide and tsunami
d) Soil liquefaction [solid soil becomes liquid]
e) Damage to dams and reservoirs Fire accidents
f) Destruction to transport and communication lines.
g)

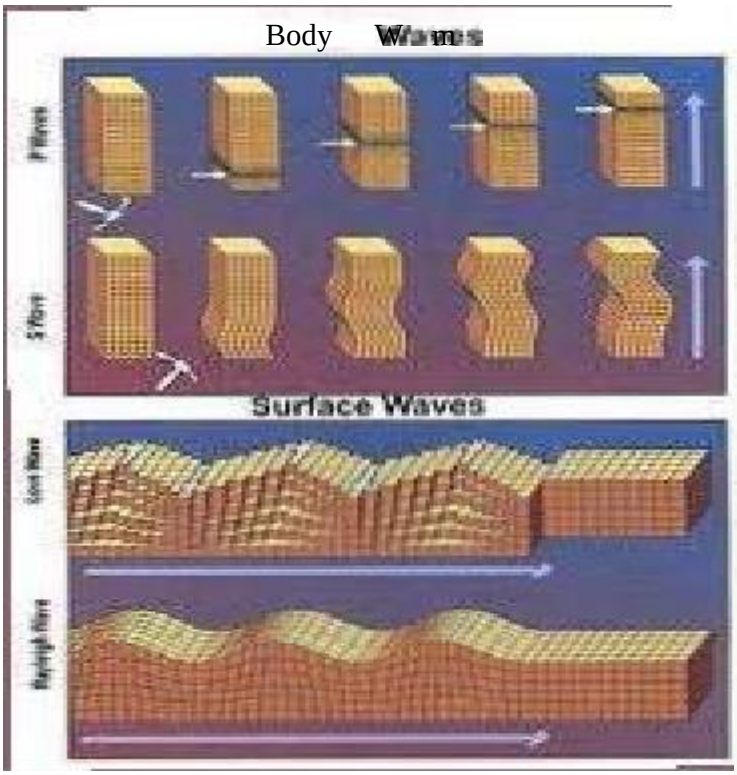
Shadow Zones and Their Formation

Meaning of Shadow Zone: There are some areas where seismic waves [P and S waves] do not reach during an earthquake. It is called as shadow zone. Shadow zones are formed due to two reasons:

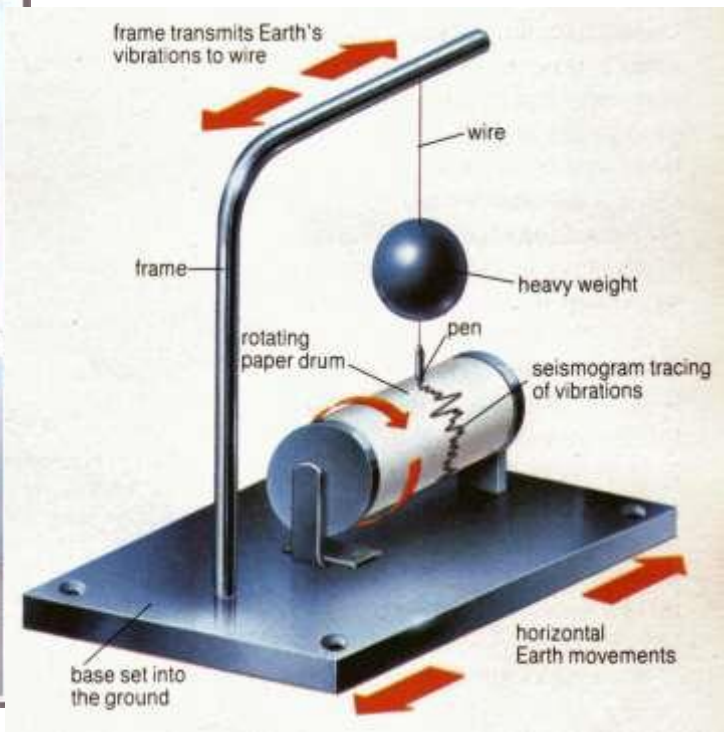
a) Three layers in the earth
b) Varying density of each layer
c) Liquid condition of the mantle

- P Wave Shadow Zone: Ideally seismic waves should move in straight line but due to varying density of layer P wave moves in a curved path. Due to this an area around the earth does not record P wave. This zone is from 105° to 145° from the focus.

- S Wave Shadow Zone: It is larger zone than P wave shadow zone. It developed because S wave does not pass through liquid mantle of the earth. Therefore, the zone from 105° all around the earth from the focus is called as S wave shadow zone.



SEISMOGRAPH



TYPES OF EARTH QUAKE WAVES

- BODY WAVES
  - P'WVES
  - S'WVES
- SURFACE WAVES
  - LOVE WAVES
  - RELEIGH WAVES

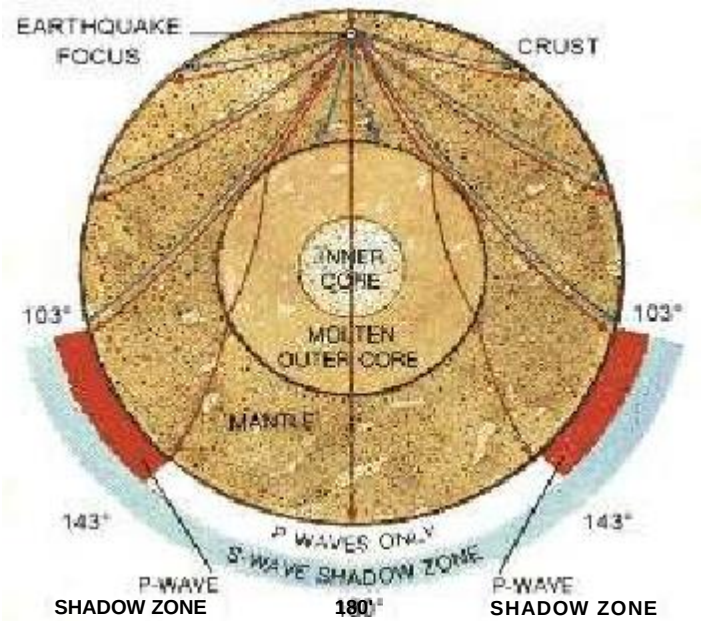
BODY WAVES GENERATED DUE TO ENERGY GENERATED IN THE EARTH'S INTERIOR They interact with the surface rocks and generate other waves called surface waves
The velocity of the waves changes along with the density of material, denser the material higher the velocity
Their direction also changes according to the density of the material

PROPAGATION OF EARTHQUAKE WAVES
When they travel in the body they vibrate the bodies of the rocks P waves vibrate parallel to their direction of the movement

It led to the density difference in the material due to stretching and squeezing
Other three waves vibrate perpendicular to their direction

They create troughs and crests over the surface

EMERGENCE OF SHADOW ZONE



Where earthquake waves are not reported, such zones are called earthquake shadow zones. It is observed that seismographs located beyond 103° from the epicenter do not record the earthquakes.

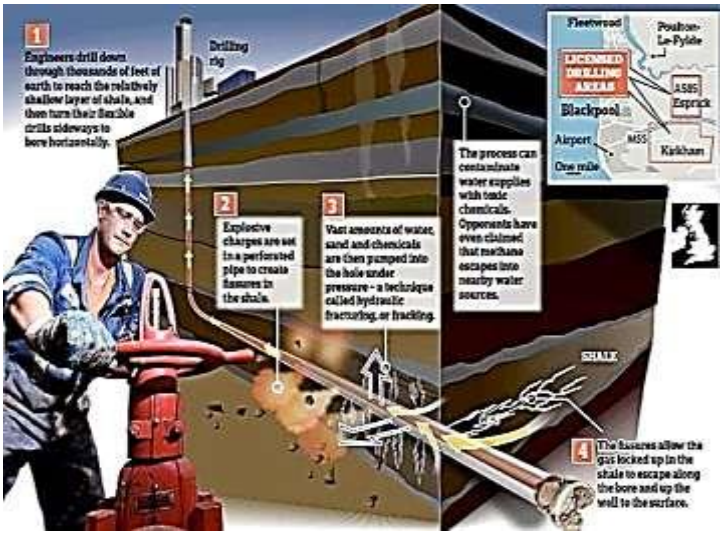
Seismographs located beyond 142° again record _p‘ waves only . The entire zone beyond 142° do not receive _s‘ waves

The shadow zone of _s‘ waves is much larger than the _p‘ waves it is equal to 40% of the earth surface

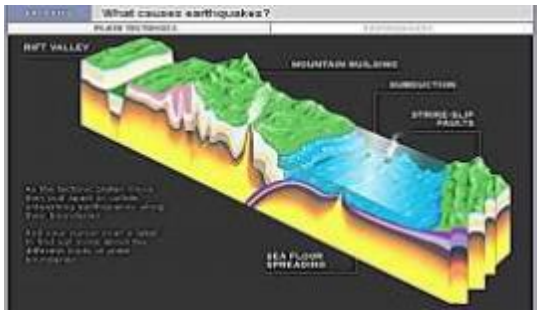
TYPES OF EARTHQUAKES

INDONE

MINING EARTH QUAKE - SOUTH AFRI



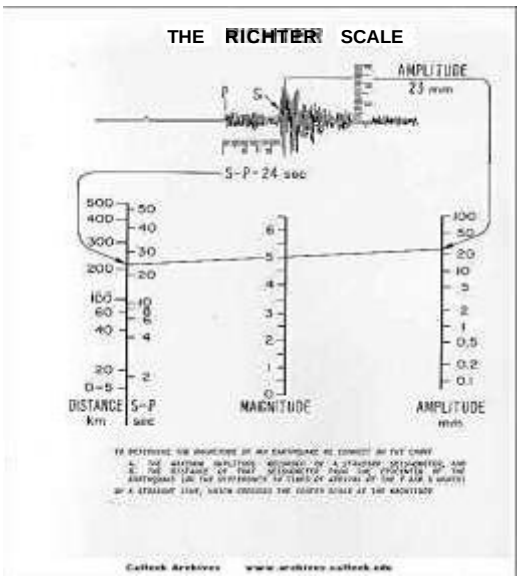
TECTONIC EARTH QUAKE GUJARAT

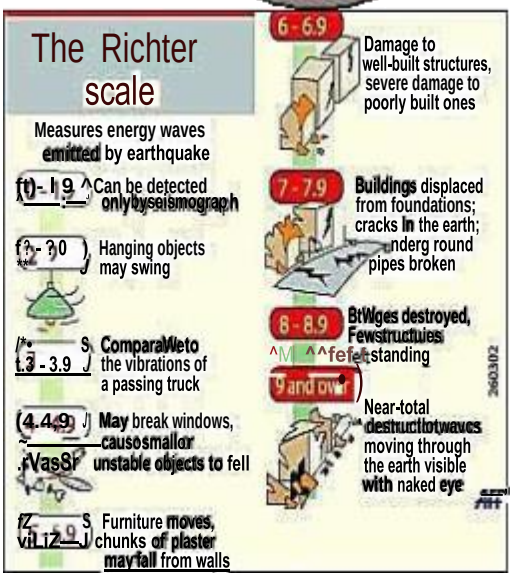


NUCLEAR EXPLOSION EARTH QUAKE JAPAN

RESERVOIR IMPOUND EARTHQUAKE TEHRI DAM

HOW IS EARTH QUAKE MEASURED-RICHTER SCALE





The magnitude of most earthquakes is measured on the **Richter scale,** invented by Charles F. Richter in 1934. The Richter magnitude is calculated from the amplitude of the largest seismic wave recorded for the earthquake, no matter what type of wave was the strongest.

The Richter magnitudes are based on a logarithmic scale (base 10). What this means is that for each whole number you go up on the Richter scale, the amplitude of the ground motion recorded by a seismograph goes up ten times. Using this scale, a magnitude 5 earthquake would result in ten times the level of ground shaking as a magnitude 4 earthquake (and 32 times as much energy would be released). To give you an idea how these numbers can add up, think of it in terms of the energy released by explosives: a magnitude 1 seismic wave releases as much energy as blowing up 6 ounces of TNT. A magnitude 8 earthquake releases as much energy as detonating **6 million tons of TNT**. Pretty impressive, huh? Fortunately, most of the earthquakes that occur each year are magnitude 2.5 or less, too small to be felt by most people.

The Richter magnitude scale can be used to describe earthquakes so small that they are expressed in negative numbers. The scale also has no upper limit, so it can describe earthquakes of unimaginable and (so far) inexperienced intensity, such as magnitude 10.0 and beyond.

Although Richter originally proposed this way of measuring an earthquake's "size," he only used a certain type of seismograph and measured shallow earthquakes in Southern California. Scientists have now made other "magnitude" scales, all calibrated to Richter's original method, to use a variety of seismographs and measure the depths of earthquakes of all sizes.

The Mercalli Scale

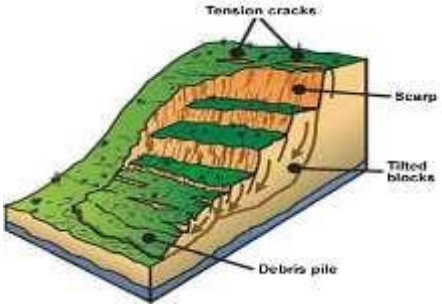
Here's a table describing the magnitudes of earthquakes, their effects, and the estimated number of those earthquakes that occur each year.

	Modified Mercalli Scale	Richter Magnitude Scale
I	Only felt by sensitive instruments	1.5
II	Felt by few persons at rest, especially on upper floors, delicate Suspended objects may swing	2.0
III	Felt indoors, but ray not be recognized as earthquake, vibrations like large passing truck	2.5
		3.0
IV	Felt indoors by many, some outdoors, may awaken some sleeping persons: dishes. windows, doors may move, cars rock.	3.5
V	Felt by most: some windows, dishes break; toll objects may fall.	4.0
VI	Felt by by all, falling plaster and chimneys, light damage but fear.	4.5
VII	Very noticeable, damage to weaker buildings on fill, driving automobiles notice.	5.0
VIII	Walls, monuments. chimneys, bookcases fall: liquifcutMm. driving difficult	5.5
		6.0
IX	Buildings shifted off foundations, cracked and twisted ground is cracked and underground pipes are broken	6.5
X	Most structures Severely damaged to destroyed; ground cracked, rails ore bent, lands) der on Steep Skipes	7.0
XI	Few structures standing; bridges ond roads severely damaged or destroyed. large fissures in ground	7.5
		8.0
XII	Total domage: can see the earthquake wove move through the ground; gravity overcome and objects thrown into the air	

EFFECTS OF EARTH QUAKE

GROUND SHAKING

LAND &MUD SLIDES



AVALANCHES

GROUND LURCHING

SOIL LIQUEFACTION

GROUND DISPLACEMENT

FLOODS FROM DAM

FIRES

STRUCTURAL COLLAPSE

TSUNAMI

First six listed above have some hearings upon landforms while others may be considered the effects causing immediate concern to the life and properties of people in the region.

Tsunami occurs when the epicenter is below the ocean floor with sufficient magnitude. Tsunamis are waves generated by the termers not by the earthquake. The magnitude should be more than 5 in Richter scale.

The earthquakes of magnitude 8+ are rare occurs once in 1-2 years .tiny types occur every minute.

The structure of the Earth

Imagine a Scotch egg.....

1. The outer shell of the Earth is called the **CRUST** (breadcrumbs)
2. The next layer is called the **MANTLE** (sausage meat)
3. The next layer is the liquid **OUTER CORE** (egg white)
4. The middle bit is called the solid **INNER CORE** (egg yolk)

The deepest anyone has drilled into the earth is around 12 kilometers, we've only scratched the surface. How do we know what's going on **deep** underground?

There are lots of clues:

- 1.The overall density of the Earth is much higher than the density of the rocks we find in the crust. This tells us that the inside must be made of something much denser than rock.
- 2. Meteorites (created at the same time as the Earth, 4.6 billion years ago) have been analyzed. The commonest type is called a contrite and they contain iron, silicon, magnesium and oxygen (Others contain iron and nickel). A meteorite has roughly the same density as the whole earth. A meteorite minus its iron has a density roughly the same as Mantle rock (e.g. the mineral called olivine).
- 3. Iron and Nickel are both dense and magnetic.
- 4. Scientists can follow the path of seismic waves from earthquakes as they travel through the Earth. The inner core of the Earth appears to be solid whilst the outer core is liquid (s waves do not travel through liquids). The mantle is mainly solid as it is under extreme pressure (see below). We know that the mantle rocks are under extreme pressure, diamond is made from carbon deposits and is created in rocks that come from depths of 150-300 kilometers that have been squeezed under massive pressures.

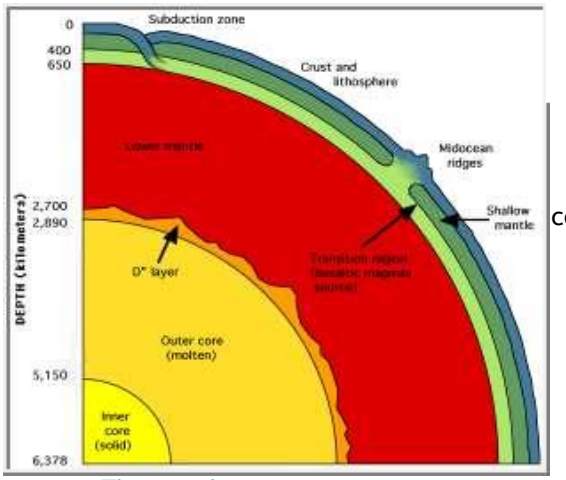
5. The Earth is sphere (as is the scotch egg!) with a diameter of about 12,700 Kilometers. As we go deeper and deeper into the earth the temperature and pressure rises. The core temperature is believed to be an incredible 5000-6000°c.

6. The crust is very thin (average 20Km). This does not sound very thin but if you were to imagine the Earth as a football, the crust would be about ½ millimeter thick. The thinnest parts are under the oceans (OCEANIC CRUST) and go to a depth of roughly 10 kilometers. The thickest parts are the continents (CONTINENTAL CRUST) which extend down to 35 kilometers on average. The continental crust in the Himalayas is some 75 kilometers deep.

7. The mantle is the layer beneath the crust which extends about half way to the centre. It's made of solid rock and behaves like an extremely viscous liquid - (This is the tricky bit... the mantle is a solid which flows????) The convection of heat from the center of the Earth is what ultimately drives the movement of the tectonic plates and cause mountains to rise. Click here for more details

The outer core is the layer beneath the mantle. It is made of **liquid** iron and nickel. Complex convection currents give rise to a dynamo effect which is responsible for the Earth's magnetic field.

8. The inner core is the bit in the middle!. It is made of **solid** iron and nickel. Temperatures in the core are thought to be in the region of 5000- 6000° c and it's solid due to the massive pressure.



EARTH STRUCTURE

The crust - the Outer most solid part

1. Brittle in nature
2. Thickness is 5 km. thin under the oceans and thick under the continents
3. 30 km under oceans and 70 km under mountains

Density in the ocean floor is 3g/ (basalt) mean density is 2.7g/

The mantle

Second layer from the top of the earth

1. 2. it extends from Moho-discontinuity to a depth of 2900 km.
3. the upper portion of the mantle is called ASTHENOSPHERE (
3. Astheno= weak it extends up to 400 km)
4. 4. it is the source of magma 5. average density is 3.4g/
6. 6. crust and upper most part of the mantle is called Lithosphere. Its thickness is 10 -200km
7. 7. Lower mantle is in solid state

The core

1. It extends from 2900 km to 6300 km depth
2. 2. Outer core is liquid while inner core is solid
3. 3. Also called as Nife
4. 5. outer core density is 5 g/ inner core is 13 g/
5. made of heavy metals such as nickel and iron

VOLCANOES AND VOLCANIC LANDFORMS

A volcano is place where gases, ashes and or molten rock material lava escape to the ground.

Active volcano Mount Pinatubo, Philippines in 1991.

Lava from Mt. Kilauea pouring into the ocean during the sunset

The Differences between Active, Dormant and Extinct volcanoes

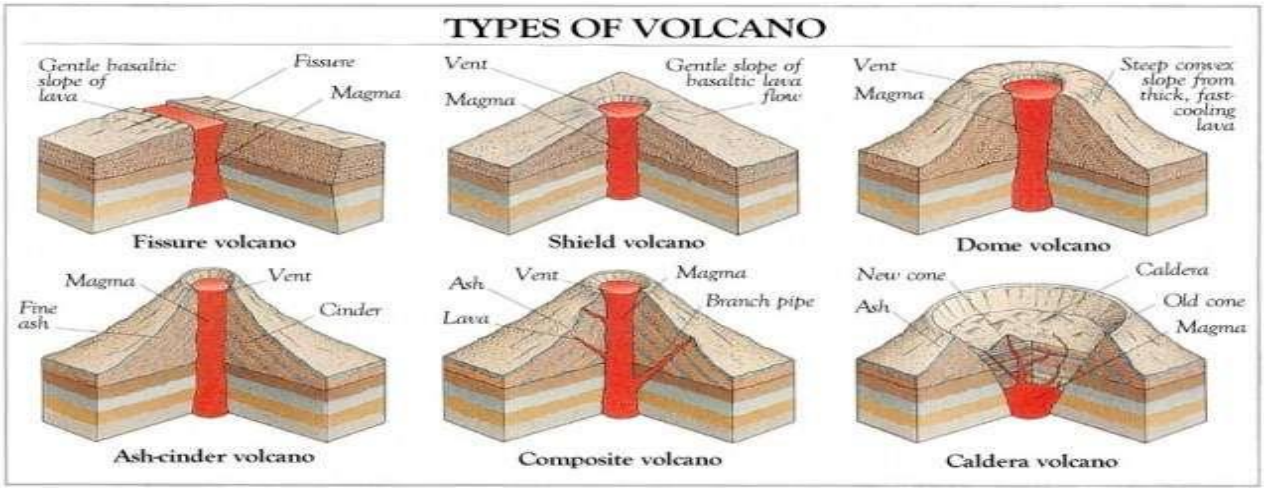
Active Volcano: In volcano that is currently erupting or shows signs of unrest activities, like earthquake activity or significant amounts of gas discharged. It is a volcano that is not presently erupting, but has erupted in the past is considered likely to do erupt in the future again.

One of the dormant volcanoes in the Cascades in the "Three Sister Area."

Dormant: These volcanoes are also called "Sleeping" volcanoes because it is presently inactive, but could erupt again. For example, the majority of the Cascade volcanoes arebelieved to be dormant rather than extinct.

This is an Aerial view of Crater Lake in Oregon.

Extinct: Is a volcano that is presently not erupting, that is unlikely to do so for a very long time in the future.



Classification of volcanoes based on nature of eruption and land forms developed on the surface.

SHIELD VOLCANO

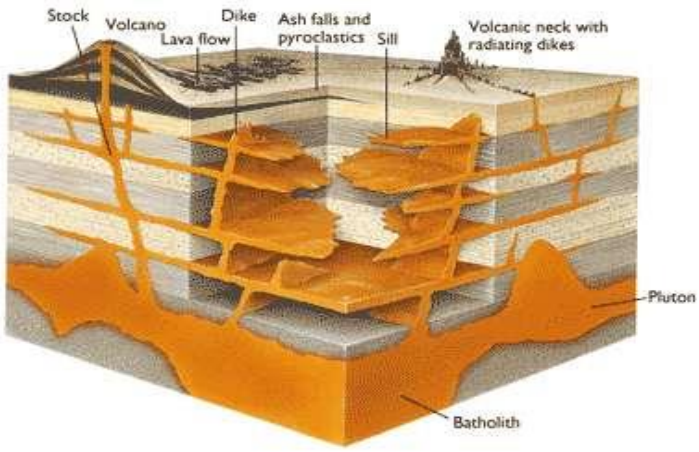
1. Largest of volcanoes
2. Hawaiian islands are best examples Basalt lava flow
3. Lava is very fluid They are not steep
4. They become explosive when water is held in tovent
5. Develops in to cinder cone
6.
7. COMPOSITE VOLCANOES

1Cool and more viscous lava 2.Explosive eruptions
3.They erupt pyroclasitc and ashes along with lava
4.Layers are formed

CALDERA

1.These are the most explosive type of volcanoes

2.They collapse themselves and form into lakes
3.The magma chamber is huge and found nearby



FLOOD BASALT PROVINCES

1. Consists of highly fluid lava
2. Some parts of the world are covered by thousands of sq.km of basalt
3. there can be series of flows
4. Average thickness is more than 50 km
5. Individual flow is 100 of sq.k.m 6. Ex. Deccan plateau

MID OCEANIC RIDGES VOLCANOES

Found in oceanic surfaces

1. More than 70,000 km length
2. Frequent volcanic eruptions
3. Ex. Mid Atlantic ridge
4.

INTRUSIVE VOLCANIC LANDFORMS

1.when volcanic eruption takes place some lava comes out and some settle down in the lithosphere.
2.when lava comes out forms volcanic rocks, some part cools down in the lower portion forms plutonic rocks

INTRUSIVE FORMS OCCUR INSIDE THE CRUST. BATHOLITH:

A large part of the magma material that cools in the deeper depthof the crust. They are dome shaped, cover large areas,

They come out when erosion takes place.they are granite bodies. LACOLITHS: large dome shaped intrusive bodies. Consists of level bodies

Connected through pipe like conduit from below it resembles composite volcanoes found deeper depthsthey are localised source of lava

Ex. Karnataka plateau

LAPOLITHS:concave shaped lava formation phacoliths: wave typed lava formation SILL: horizontal sheet of lava

DYKES: vertical lava formation

Chapter-4 DISTRIBUTION OF OCEANS AND CONTINENTS

GIST OF THE LESSON: CONTINENTAL DRIFT, EVIDENCES TO SUPPORT CONTINENTAL DRIFT, FORCES OF DRIFTING, POST DRIFT STUDIES, OCEAN FLOOR CONFIGURATION, DISTRIBUTION OF VOLCANOES AND EARTHQUAKES, CONCEPT OF SEA FLOOR SPREADING, PLATE TECTONICS, MAJOR AND MINOR PLATES, TYPES OF PATE BOUNDARIES RATES OF PLATE MOVEMENT, FORCES OF PLATE MOVEMENT& MOVEMENT OF THE INDIAN PLATE.

CONTINENTAL DRIFT: ABRAHAM ORTELIUS a Duchy map maker 1596 first proposed the possibility of joining the continents such as America with Europe and Africa
ANTONIO PELLEGRINI drew the map showing the three continents together.
ALFRED WEGENER a German meteorologist put forth THE CONTINENTAL DRIFT THEORY. According to him,
All continents formed a single continental mass called PANGAEA All oceans formed a single universal ocean called PANTHALASSA
AROUND 200 mya THE PANGAEA BEGAN TO SPLIT INTO TWO LARGE MASSES CALLED LAURASIA and GONDWANA LAND
By further splitting Laurasia formed northern continents and Gondwana land formed southern continents.

EVIDENCES TO SUPPORT THE CONTINENTAL DRIFT

1. The matching of continents (jig-saw fit)

A. the shorelines of S. America and Africa have remarkable match

B. a map was produced by Bullard in 1964 to show the jigsaw fit of these two continents.

C. it was fit around 1000 fathom line of the shoreline

2. ROCKS OF SAME AGE ACROSS THE OCEANS

A.the belt of ancient rocks of 2000 my from Brazil coast matches with those of Western Africa
B. Marine deposits of South America and Africa belong to Jurassic age.

3.TILLITE

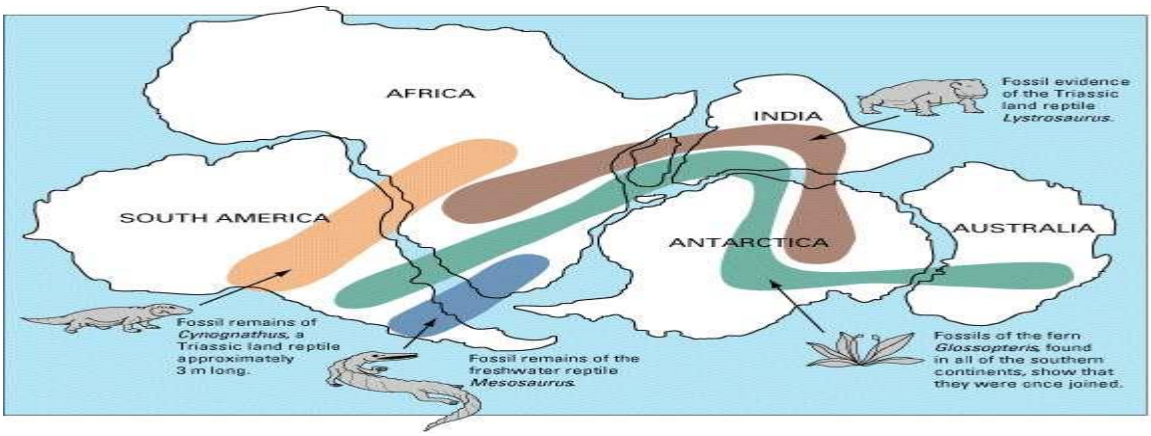
A. sedimentary rock formed out of glacial deposits
B. sediments from India have similar counter parts at different continents of south. C.tillile indicates prolonged glaciations
D.The same glaciations is found in Africa, Falklands, Madagascar, Antarctica and Australia E. the glacial tillite indicates that unambiguous evidence of palaeo climates and drifting of continents. 4.PLACER DEPOSITS
a. Formation of placer deposits of gold in Ghana coast has no source rock. a. The gold bearing veins of rocks are found in Brazil
5.DISTRIBUTION OF FOSSILS

- **Identical species of animals and plants are found along the coastal regions of the different continents.**
- **lemurs occurs in India , Madagascar and Africa.**
  The contiguous land mass was called LEMURIA
- **the fossils of mesosaurus were found in only South Africa and Brazil.**

LEMURIA

MESOSAURUS

DIS



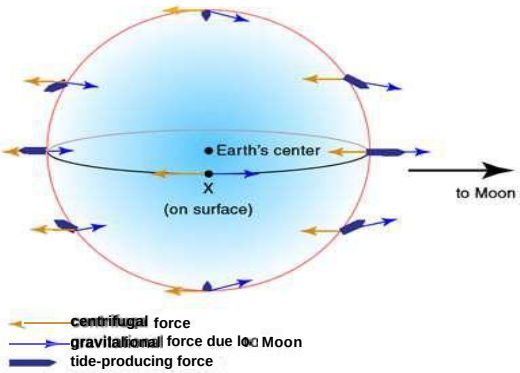
FORCES FOR DRIFTING THE CONTINENTS

1. **Wegner suggested that the movement responsible for the drifting of the continents was caused by**

A. POLAR FLEEING FORCE **B. TIDAL FORCE**

Possible driving forces for plate tectonics:

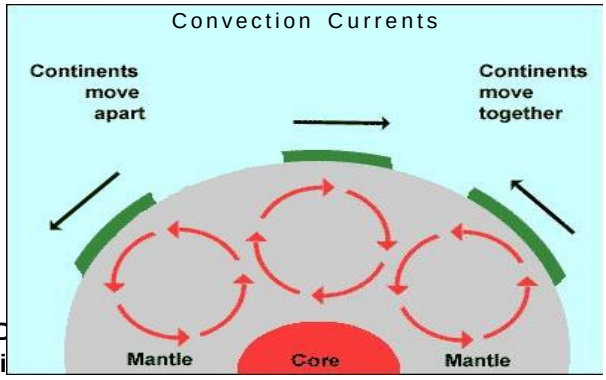
2. bottom lithosphere tractions by convection currents.
3. trench pull (covered earlier).
4. ridge push (sliding off a high, crust in compression).
5. trench suck (rollback).
6. global expanding or contracting forces.
7. membrane forces on spinning ellipsoid (e.g. variants of polar fleeing forces).



TIDAL FORCE

Wegener suggested that these two forces are responsible for the movement of plates.

Most of the scholars consider that these forces are not sufficient to move the plates.

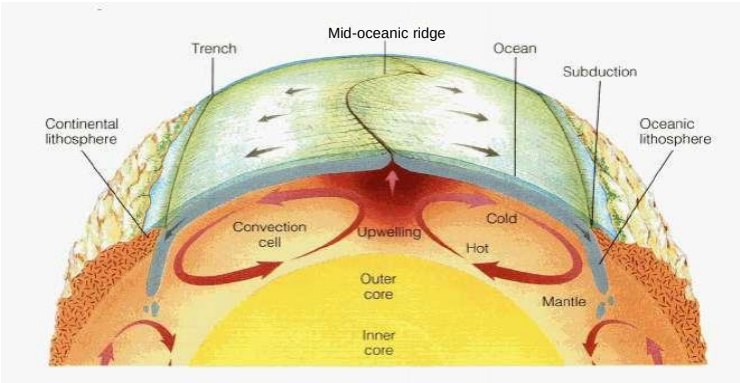


POST DRIFT STUDIES

Information collected from the ocean mapping is more useful to study the continental drift

Convectional current theory

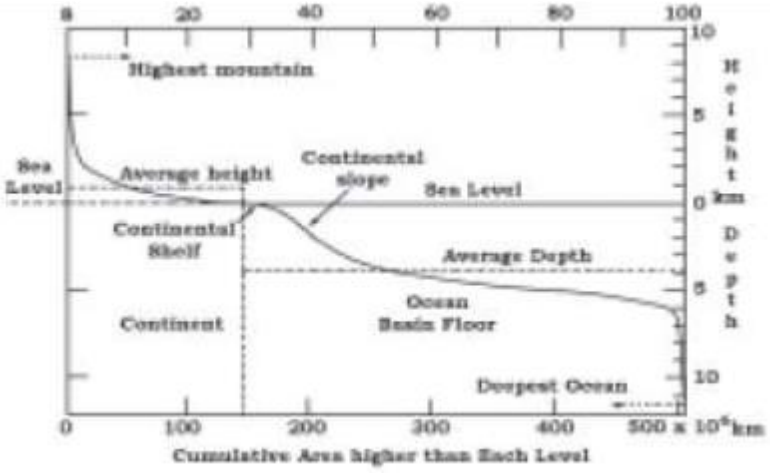
It was proposed by ARTHUR HOLMES IN 1930 D
currents are formed due to disintegration of radi
These currents are found entire mantle portion



MAPPING OCEAN FLOOR

1. Existence of ridges and deep trenches nearby continental margins Mid oceanic
2. ridge is the most active for volcanic eruptions
3. The ocean floor is much younger than the continents
4. Rocks of equal distance of the ridge have similar chemical composition and age

OCEAN FLOOR CONFIGURATION



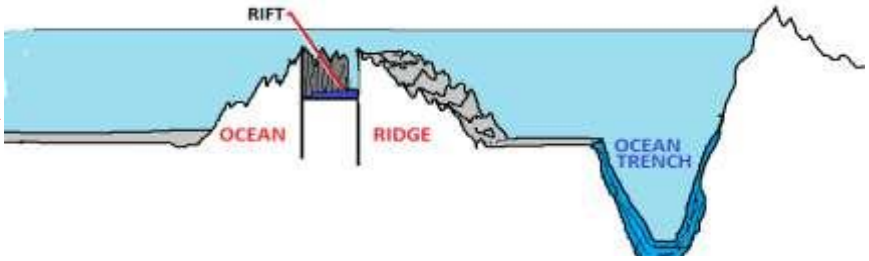
OCEAN FLOOR CONFIGURATION

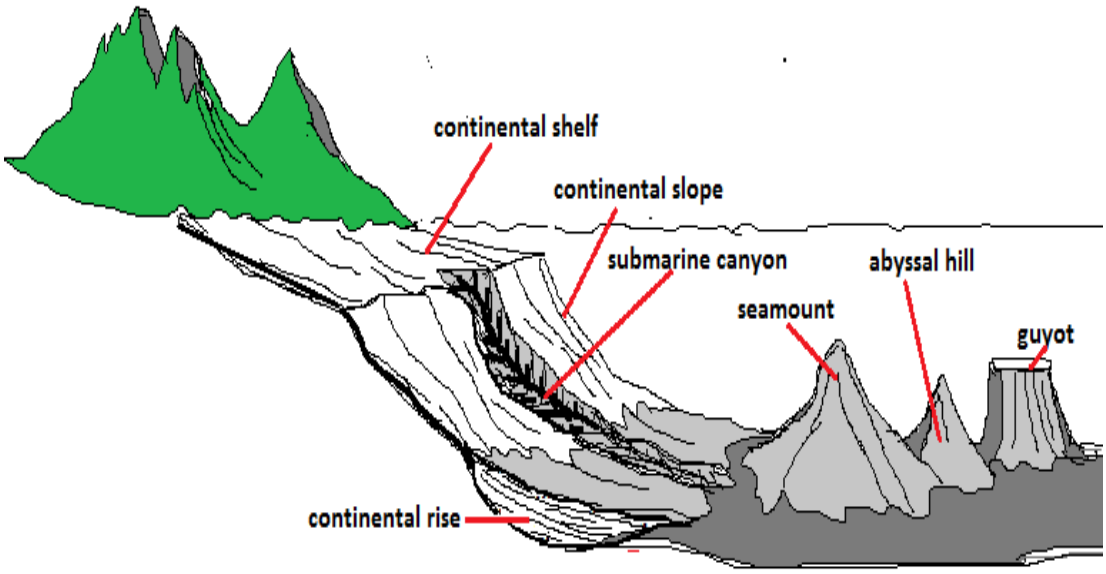
The ocean floor is segmented into three major divisions
Based on depth and configuration

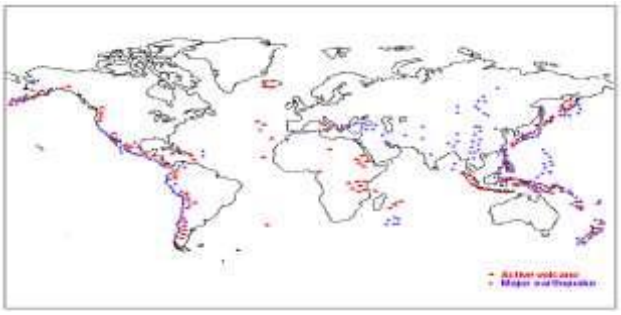
1. **Continental margins**
   a.Form transitional zone between continental shore and deep sea basins
   b.They include continental slope , shelf, continental rise and deep oceanic trenches
   ABYSSAL PLAINS

1. EXTENSIVE PLAINS
2. FOUND BETWEEN CONTINENTAL MARIGN AND MID OCEANIC RIDGE
3. CONTINENTAL SEDIMENTS GET DEPOSITED

MID OCEANIC







DISTRIBUTION OF VOLCANOES AND EARTHQUAKES

1.all volcanoes and earthquakes are paralle to the coast
2.this line also coinsides with mid- atalantic ridge
3.alpine hymalayan system
4.around the pacific ocean it is called **ring of fire** Mid oceanic ridges

1. Interconnected mountain system within the ocean
2. Longest mountain chain in the ocean floor
3. Consist of central rift system at the crust
4. Intense volcanic activity is found

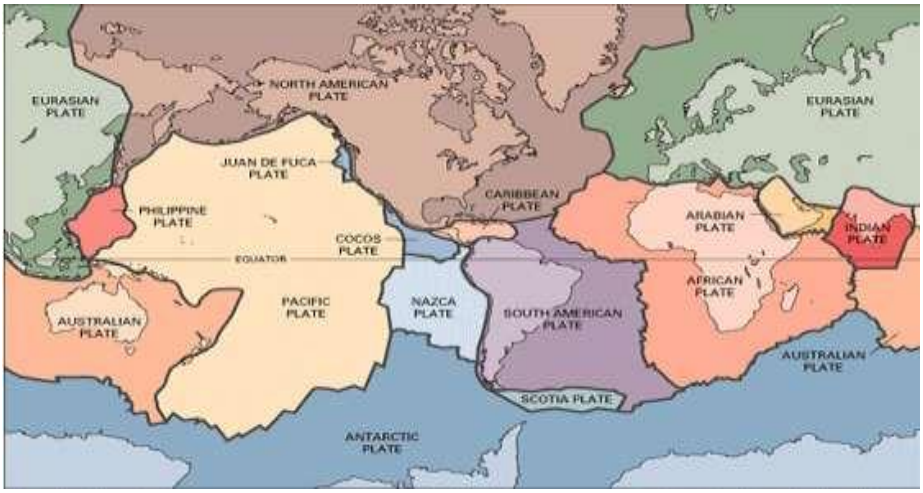
CONCEPT OF SEA FLOOR SPREADING

1.it was proposed by Hess in 1961
2.he believed that new lava pushes out the plates from the mid oceanic ridge 3.palaeo magnetic studies of the ocean floor reveals that
A.along the mid oceanic ridge there is intense volcanic eruption B.huge amount of lava comes out along the mid atlanticn ridges
C.the equidistant rock formations have similar age and chemical compositions & magnetic properties
7.rocks closer to the mid oceanic ridges are young and normal polarity
8. The age of rocks increases as the distance increases from the mid oceanic ridge 9. Oceanic crust is much younger(200my) than continental crust (3200my)
10. The sediments of ocean floor is very thisn
11.earth quakes are common along the deep sea trenches Positions of continents through geological past

PLATE TECTONICS

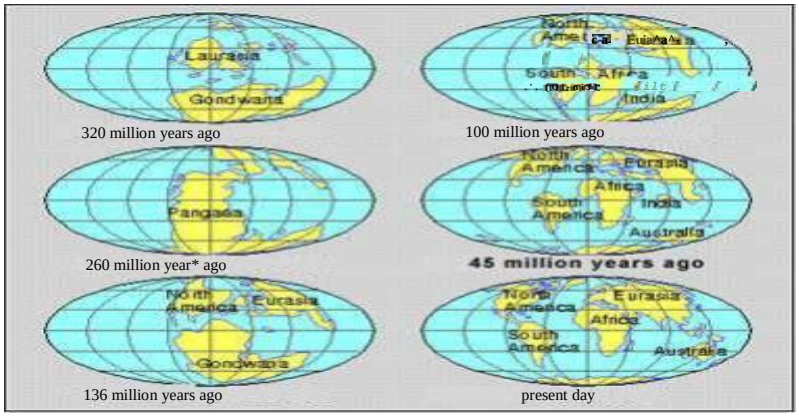
1. **The theory of plate tectonics was introduced by** McKenzie, parker and Morgan in 1967 **2. A tectonic plate is also called as lithosphere plate**
3. **It is a massive irregularly shaped slab of solid rock 4. Consists of oceanic and continental sphere**
5. **Plates move horizontally over the Asthenosphere**
6. **Average thickness is 100 km of oceanic part and 200 km continental part 7. It may be oceanic or continental**
8. **Pacific plate is largest oceanic plate where as Eurasian plate is the largest continental plate**

MAJOR PLATES OF THE EARTH CRUST

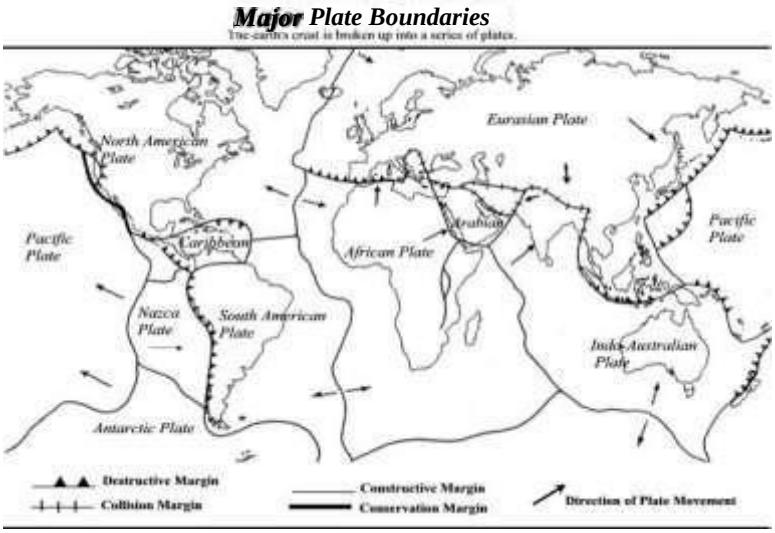


MAJOR PLATES

MAJOR PLATES



1.Antarctica And Surrounding Oceanic Plate 2. North American Plate
3. South American Plate Pacific Plate
India-Australia-New Zealand PLATE
6.African Plate Eurasian Plate



MINOR PLATES

1. Cocos Plate 2. Nazca Plate 3. Arabian Plate 4. Philippine Plate 5. Caroline Plate 6 .Fuji Plate

These plates are moving constantly throughout geological time not the continent believed by Wegener Pangaea was the convergent of all the plates
Position of Indian subcontinent is traced with the help of rocks analyzed from Nagpur area

TYPES OF PLATE BOUNDARIES

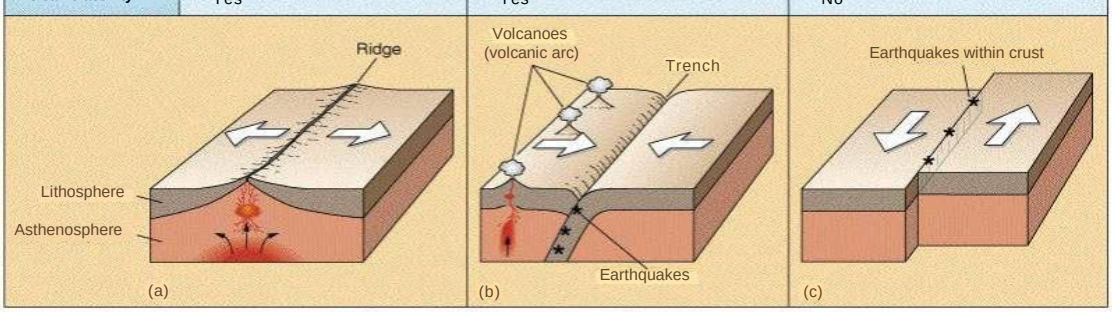
I. DIVERGENT BOUNDARIES

1. **New crust is generated 2. plates move away from each other**
2. **These are called spreading sites 3. Ex. Mid Atlantic ridge**

II.CONVERGENT BOUNDARY

1. Crust is destroyed 2. sinking of plate is called „subduction zone" 3. There are three ways in which subduction occurs
i. Ocean and continent ii. Ocean and ocean iii. continent and continent plates

Type of Margin	Divergent	Convergent	Transform
Motion	Spreading	Subduct	Lateral sliding
Effect	Constructive (oceanic lithosphere created)	Destructive (oceanic lithosphere destroyed)	Conservative (lithosphere neither destroyed)
Topography	Ridge/Rift	Trench	No major
Volcanic activity?	Yes	Yes	No



III TRANSFORM BOUNDARIES

1. Crust is neither produced nor destroyed 2. Plates slide horizontally
3. Perpendicular to the mid oceanic ridges
4. Differential movement of a plate at the same time
5. Rotation of the earth has its effect on this movement

RATES OF PLATE MOVEMENT

1. The strips of normal and reverse magnetic field helped the scientists to study the rate of plate movement
2. Arctic ridge has the slowest rate less than 2.5 cm /year east pacific rise has more than
3. 15 cm/year

FORCES OF THE PLATE MOVEMENT

1. Surface of the earth is dynamic 2. Interior is always mobile
3. Beneath the lithosphere there is always movement of magma horizontally 4. Heated material rises to the top and cooled material sinks down
5. This cycle is repeated over the time and form convection cells

SOURCES OF HEAT

A. Residual heat b. Radioactive decay
6. It was first considered by Arthur Holmes in 1930 7. Later it also influenced Harry Hess

MOVEMENT OF INDIAN PLATE

1. Indian plate includes India and Australia 2. Northern boundary is along the Himalayas
3. It is the place of continental convergence
4. In the east it extends up to Rakinyoma mountains of Myanmar 5. Eastern margin is spreading site
6. Western margin extends along Kirthar mountains, Makran coast red sea rift . 7. The boundary between India and Antarctica is called divergent boundary
8. Till 225 m y a India was separated by Tethys sea
9. About 200 m y a India started its journey towards north
10. India collided with Asia about 40-50 m y a and caused the upliftment of Himalayas 11. About 140 m y a the position of Indian plate is at 50°s latitude
12. During the movement of Indian plate two events occurred in India 13. A. out pouring of lava and formation of Deccan plateau
B. Subsidence of west coast
14. The Himalayas started rising about 40 m y a

STAGES OF MOVEMENT OF INDIAN PLATE TO WARDS ASIAN PLATE AT DIFFERENT AGES