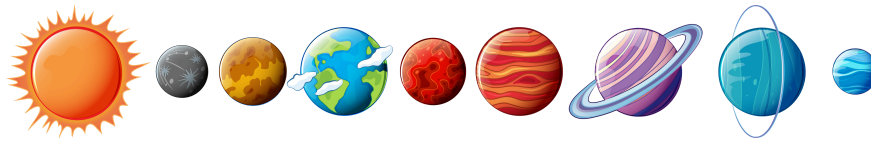


# SOLAR SYSTEM

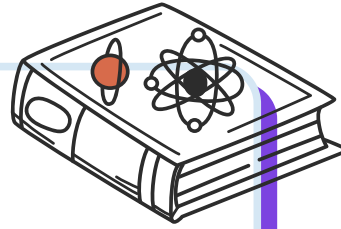


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## Cosmology

Study of Universe.



Universe > Galaxy > Solar System



## Galaxy



- A massive collection of stars, gas, dust and dark matter held together by gravity.
- Our Galaxy is Milky Way.
- Andromeda is the nearest galaxy to Milky Way.

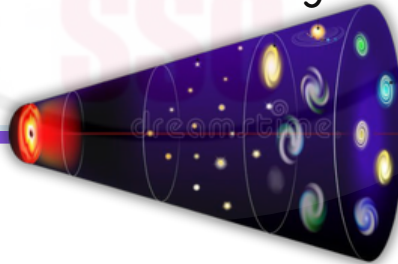
## Big Bang Theory



- Given by George Lemaitre in 1927 and published in 1931.
- It was an explosion of concentrated matter in the universe that occurred 13.8 billion years ago.
- It led to the formation of Galaxies, Stars and other heavenly bodies.

## Steady State Theory

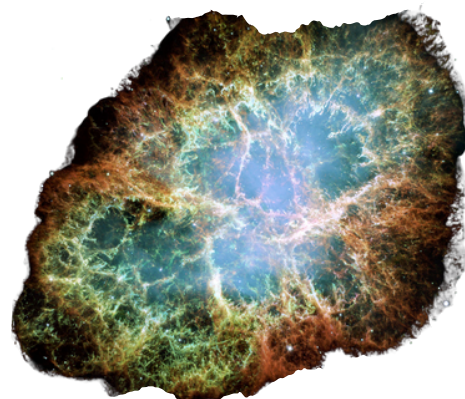
- Given by Fred Hoyle, Hermann Bondi, and Thomas Gold.
- It proposes that the universe is constantly expanding, but its average properties remain unchanged.



○○○

## Origin of Solar System

- Began 4.8 Billion Years ago.
- The Process started when a cloud of gas and dust collapsed, forming a spinning disk called Nebula



# THEORIES



## Planetesimal Theory

- Proposed By :  
**Thomas Chowder Chamberlin** and  
**Forest Ray Moulton** in **1905**

## Nebular Hypothesis

- First proposed by **Immanuel Kant** in **1755** and Independently expanded by **Pierre-Simon Laplace** in **1796**
- Age of Earth : **4.5 Billion Years Old**

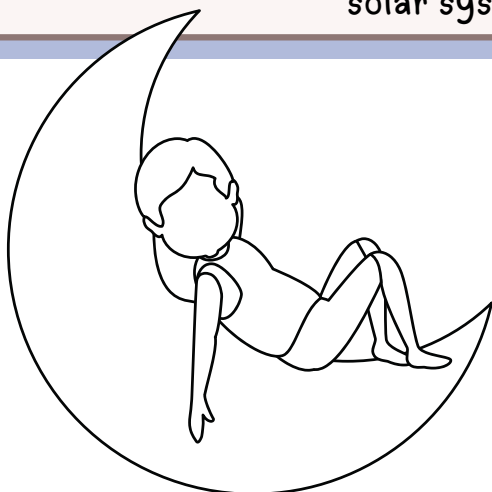
## Copernicus Theory

- It Predicted that the Sun is at the center of the universe, with the Earth and other planets orbiting around it.
- It is also known as **Heliocentric Model**

## Solar System



- Our Solar System has 8 planets and 5 Dwarf Planets
- The Sun is at the center and Only star of our Solar System.
- It makes up for about 99.86% of the total mass of solar system.



## Celestial Bodies

### Object that glows in night Sky

- Luminous** : Emits their own light.  
Ex: Stars, Candle, Firefly, Bulb etc.
- Non Luminous** : Do not emit their own light.  
Ex: Moon, Comets, Asteroids, Meteorites, Meteor, Meteoroid.

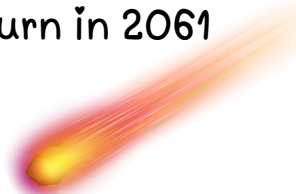
## Comets



- Comets are large ice objects that orbits the sun.
- Made of Dust, Rock & Frozen Gases like Water, Carbon Dioxide, Ammonia, Methane.

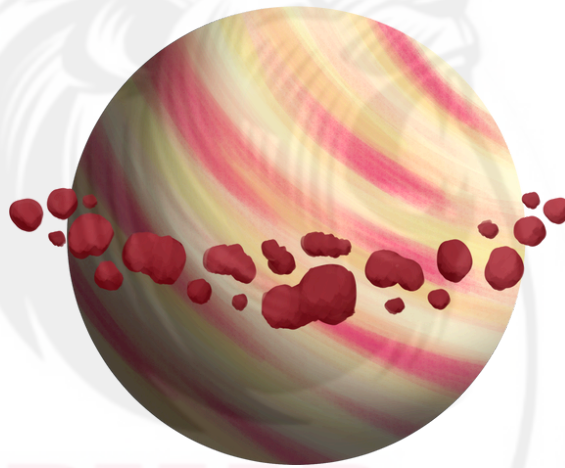
## Halley's Comet

- It is seen every 76 years. It was last seen in 1986 and is expected to return in 2061



## Asteroids

- A rocky, metallic or icy object that orbits the sun.



## Meteoroid



Smaller than Asteroids, Rocky or Metallic space rock, orbits around the Sun.

## Meteor



Meteoroid enters earth's Mesosphere, Burns up and Creates a streak of light, called Meteor

## Meteorite



If meteoroid hits the ground, it is called Meteorite.

Meteor shower Quadrantids is visible in the early month of January





# Constellation

A group of star that appears to form a pattern or shape in the night sky.

## Ursa Major

- Also known as Great Bear and Saptarishi.
- Big Dipper asterism is seen in ursa major

## Cassiopeia

- It is a W-shaped constellation.
- The brightest Star of Cassiopeia is Schedar.

## Cygnus

- A prominent northern constellation known for its distinctive Cross Shape

## Orion

- Known as Hunter.
- Brightest Star of Orion is Rigel



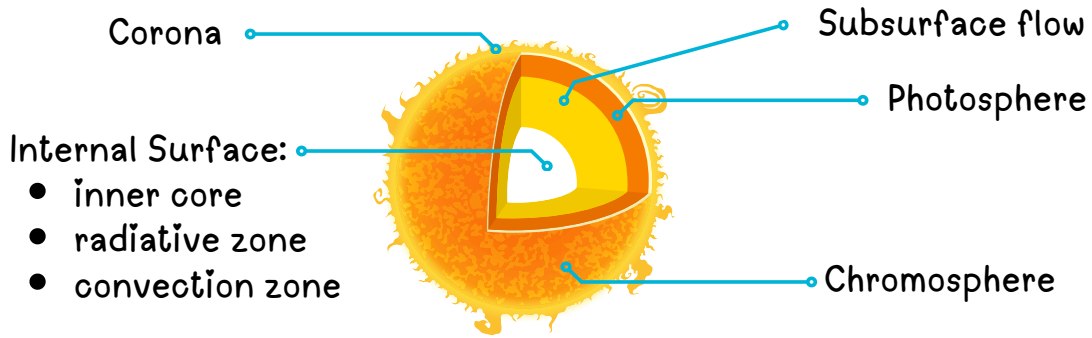
## The Sun

- Only Star of our solar System
- Composed of Hydrogen (73%), Helium (25-28%) and other gases.
- Approx 15 crore KM ( 149.6 Million KM) away from the earth.
- Light takes 8 minutes 20 seconds to reach earth from Sun.
- Temperature at Surface : 5800 K or 5600° C.
- Temperature at Center : 15.7 million Kelvin (K).

## Light Years

- It is a unit of length used to measure distance between two astronomical objects.
- It is the distance that light travels in a vacuum in one Julian year (365 Days)
- $1 \text{ LY} = 9.461 \times 10^{12} \text{ KM}$

# Layers Of Sun



1

**Photosphere**

The only visible surface of the Sun.

2

**Chromosphere**

Visible as a dim red ring just above the photosphere.

3

**Corona**

The Outermost layer of the sun, which is extremely hot, and only visible during Solar Eclipses.



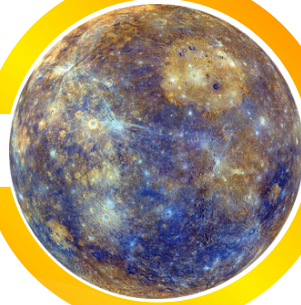
## Planets

### Classification of planets

Terrestrial Planets	Jovian Planets
<ul style="list-style-type: none"> <li>• They are relatively very small</li> <li>• They are made of Rocky material</li> <li>• Their surface is solid.</li> <li>• They are nearer to sun</li> <li>• They have few or No Moons.</li> <li>• They do not have rings</li> <li>• Eg : Mercury, Venus, Earth, Mars</li> </ul>	<ul style="list-style-type: none"> <li>• They are Immense in size.</li> <li>• They are made of gaseous material.</li> <li>• They do not have solid surface</li> <li>• They are far away from sun</li> <li>• They have multiple moons.</li> <li>• They support ring system.</li> <li>• Eg : Jupiter, Saturn, Uranus, Neptune</li> </ul>

## Mercury

- Closest planet to Sun.
- Smallest Planet in Solar System, with diameter of 4900 Km.
- Fastest planet to revolve around the sun in 88 days.
- Only planet that has no atmosphere.



## Venus

- Hottest planet in Solar System
- Known as 'Earth's Twin'
- Brightest Planet in the Solar System
- Slowest Rotation (243 Earth Days)
- Has Clouds of Sulphuric Acid



## Earth

- Only Planet that supports Life.
- Also known as 'Blue Planet' (70% of water)
- Natural Satellite : Moon
- It has the highest density (5.5 g/cm cube)
- Closest Planet to Earth is Venus.



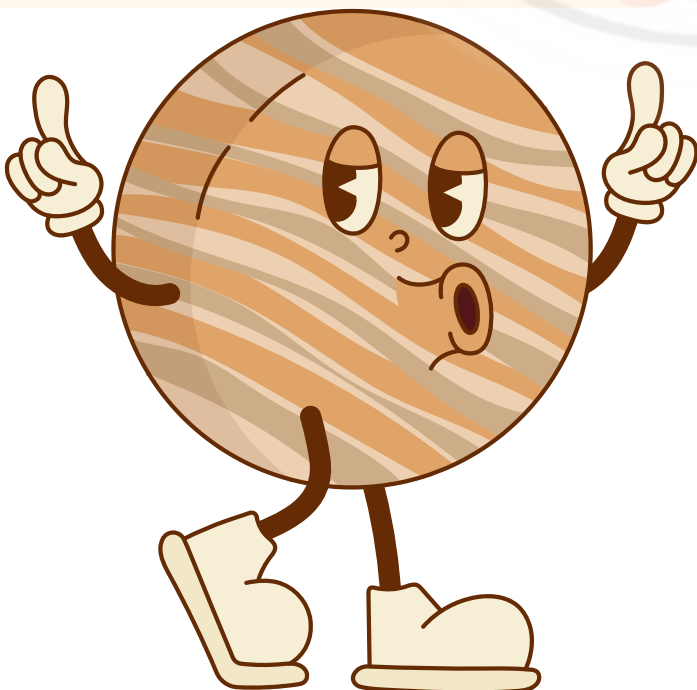
## Mars

- Known as Red Planet because of Iron-rich red soil.
- second smallest planet.
- Phobos and Deimos are two natural moons.
- Olympus Mons (height: 22-25 KM) is the largest volcano and Tallest mountain in the solar system lies in Mars.
- Length of day : 24 hrs 37 minutes.
- Asteroid belt is found between orbits of Mars and Jupiter.
- Asteroid Bennu studied by Nasa's OSIRIS-REx mission .



## Jupiter

- Largest planet of solar system
- Shortest rotation time : 9 hrs 55 minutes
- It is the 3<sup>rd</sup> brightest star in night sky after Moon and Venus.
- It has 95 Moons including 'Io, Europa, Ganymede and Callisto"
- Ganymede is largest among them.
- It has unclear ring around it.
- Great Red spot, a giant storm in the solar system exist on this planet.



# Saturn

- Second largest planet in the solar system
- it has Bright and concentric rings around it, which are made up of tiny rocks and pieces of ice.
- Saturn has least density (0.69 g/cm cube), it can float in water.
- It has 274 moons and "Titan" is the largest among them.
- Satellites : Titan, Enceladus show possibility of life on it.
- In 1655 : Huygenes discovered Saturn rings.
- In 1665 : Cassini discovered the Gap between them.
- Rotation time : 11 hours

## Uranus

- Known as Green Planet due to Presence of Methane gas in it.
- Discovered by : William Herschel in 1781.
- Atmosphere composed of Hydrogen and Helium, Ammonia and Water
- It has at least 27 moons ( Miranda, Ariel and Umbriel)
- It is tilted to  $98^\circ$  on its axis, hence known as Rolling Planet.
- Rotation time : 17 hours

## Neptune

- Slowest Revolution of 165 years
- Rotation time : 16 hours
- Windiest Planet, Atmosphere of Hydrogen & Helium
- Bluish in colour because of Methane.
- Discovered by : Johann Galle and Urbain Le Verrier in 1846
- Only planet found by Mathematical Prediction.
- Triton is famous satellite among 14 Satellites.

# Moon

- The Moon is Earth's only natural Satellite.
- It is Non-Luminous.
- Radii =  $1.74 \times 10^6$  m.
- Moon's light takes 1.26 Seconds to reach Earth.
- Distance Between Earth and Moon : 3,84,000 KM.
- Gravity on moon =  $1/6^{\text{th}}$  on Earth.
- Only one side of moon is visible because rotation and revolution time of Moon is same.
- The Highest point on Moon : Mt. Leibniz (Known as Mons Huygens)



## Dwarf Planets

### Kuiper Belt

It is a ring of bodies beyond Neptune containing a number of asteroids, rocks and comets.

### Characteristics

1. To be around the Sun.
2. To have nearly Spherical Shape
3. Not able to clear their orbit of Debris.

# Pluto

- Pluto has been omitted from the list of planets in 2006.
- Pluto is considered as dwarf planet and now it is a member of Kuiper Belt
- Charon is the largest moon of Pluto out of its 5 Moons.
- 1 revolution of Pluto = 248 earth years
- Pluto's Oblong orbit overlaps with that of Neptune.
- It is the largest and Brightest Dwarf Planet.

## Other Dwarf Planets

- Eris : Second largest dwarf planet
- Makemake : Third largest and it orbits in 310 years
- Haumea : Fastest rotating dwarf planet in Kuiper Belt
- Ceres : This dwarf planet is present in Asteroid Belt

## Solar & Lunar Mission

### Sun

- Aditya-L1 : India's 1<sup>st</sup> solar observatory mission launched by ISRO.
- L1 refers to 1<sup>st</sup> Lagrange points on the sun. (Total-5)

### Moon

- Chandrayaan 3 : It is the third lunar-exploration mission of ISRO.
- Lander : Vikram
- Rover : Pragyaan
- Point : Shiv Shakti Point
- Chandrayaan-3 landed on near side of moon (South Pole)



## Terms to Understand

- **Supernova** : Explosion of Stars
- **Pulsar** : A neutron Star
- **Black Hole** : A place in space with immense gravity.
- **Van Allen Radiation Belt** : These are two concentric rings of charged particle that surrounded the Earth.

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# LATITUDE & LONGITUDE



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## EARTH

The shape of Earth is Geoid or Oblate spheroid. A little flat from top and bottom and bulged at the centre.

### Reason

Centrifugal Force (Due to Rotation of Earth)



### Radius of Earth

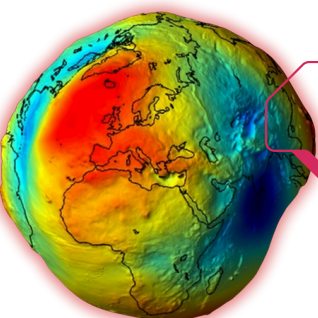
- Equatorial Radius : 6378 km
- Polar Radius : 6357 km
- Mean Radius : 6371 km

### Circumference of Earth

- Polar : 40,007.863 km
- Equatorial : 40,075 km
- Mean : 40,040 km

- Equatorial radius > Polar radius
- Equatorial circumference > Polar circumference
- Equatorial speed > Polar speed

(All because the Earth is bulged at the equator and flattened at the poles)



### Actual Shape Of Earth

**Geodesy** is the science of accurately measuring and understanding the earth's geometric shape, orientation in space and gravity field



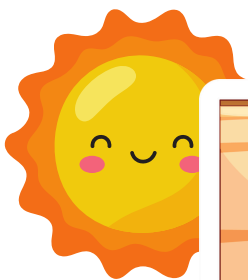
## Rotation Of Earth

- Earth rotates on its axis from west to east (Anticlockwise.)
- One rotation of Earth = 23 Hours 56 Minutes 4 Seconds
- The phenomenon of day and night is caused by earth's rotation .
- Rotational Speed is maximum at the equator and minimum at the poles.



## Revolution Of Earth

- Earth Revolves around the sun in elliptical orbit.
- 1 Revolution = 365 days 6hr & 9min
- Orbital Speed = 29.8 km/sec
- Mercury has the maximum Orbital Speed
- Neptune has the minimum orbital speed.
- The phenomenon of seasons is due to the revolution of earth around the sun and the tilt of its axis..



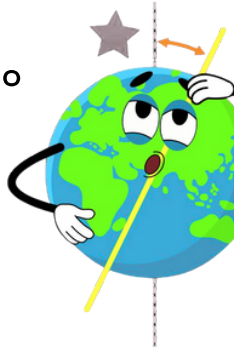
### Distance of Earth From the Sun & Moon.



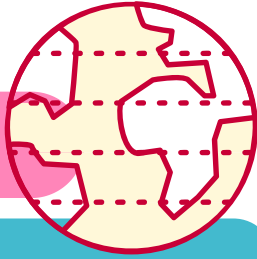
Sun	Moon
<ul style="list-style-type: none"> <li>• The point in the planets orbit when it is closest to the Sun is called Perihelion. On January 3<sup>rd</sup> the earth is closest to the Sun. (147 Million KM)</li> <li>• When Earth is farthest from the Sun, it is called Aphelion. On July 4<sup>th</sup> the earth is farthest from the Sun. (152 Million Km)</li> </ul>	<ul style="list-style-type: none"> <li>• The point in the moon's orbit when it is closest to Earth is called Perigee, The moon appears large in the sky.</li> <li>• When Moon is farthest from the earth, it is called Apogee. At Apogee The moon's tide raising force is smaller and the tidal ranges are less than average.</li> </ul>

# Inclination of Earth's Axis

- **Axial Inclination** = Inclination of Earth on its axis is  $23.5^\circ$
- **Orbital Inclination** = Inclination of Earth on its orbital plane is  $66.5^\circ$ .



## Latitudes



- They are Imaginary Horizontal Lines on the globe that run from East to West
- It is the Angular Distance of a place from the Equator
- Distance between each latitude is same.
- Total latitudes: 181
- $1^\circ$  of Latitude is Approx equal to 111 km.
- Latitude Circles: 179
- All parallel circles from equator to poles are called "Parallel of Latitudes"

### Important Latitudes

- Largest Latitude- Equator
- Smallest Latitude- Poles
- Tropic Of Cancer=  $23.5^\circ\text{N}$
- Tropic of Capricorn =  $23.5^\circ\text{S}$
- Arctic Circle=  $66.5^\circ\text{N}$
- Antarctic Circle :  $66.5^\circ\text{S}$
- Radius of earth at equator is 6378 Kms.



## Longitude

- **Important Longitudes**
- International Date Line-  $180^\circ$  Longitude
- Prime Meridian-  $0^\circ$  longitude (Also called Greenwich mean time , passes through : Burkina Faso, Spain, France, Ghana, Algeria, Mali, Togo, UK)

- They are Imaginary Vertically lines over the globe that run from North to South.
- Least distance at Poles & Maximum distance at Equator - 111.32 km
- Total Longitudes: 360
- The Part between 2 longitude is called 'Gore'

- The Difference between Polar Diameter and Equatorial Diameter of earth is 42 or 44 km

# Greenwich Mean Time



- GMT Passes through 3 continents; Europe, Africa, Antarctica
- Also known as Prime Meridian.

# Indian Standard Time



It is 82.5° longitude. IST passes through 5 states of India.

Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Odisha, and Andhra Pradesh



- USA has 6 time Zones.
- India and China has only one time zone.
- Russia has 11 time Zones.
- France has maximum number of time zones; that is 13.

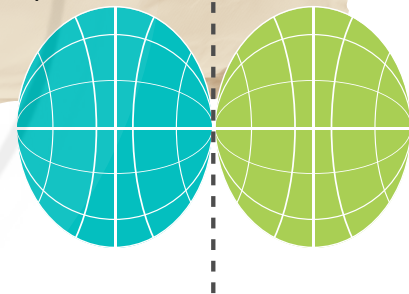


## International Date Line

- It is the imaginary zig zag line passing through the Pacific Ocean from where the date changes.
- While crossing international date line eastbound that is from east to west (like: Japan to USA), date is subtracted by 1 or in other words, the person gains a day and vice versa.

## Concept of Great Circle

- A great Circle is the largest possible circle that can be drawn around a sphere.
- It divides the Earth into two Equal Parts called Hemispheres (Northern and Southern)
- All longitudes are considered great circles, but only one latitude is considered a great circle and that is Equator ( $0^\circ$  latitude)
- It is the shortest distance between two points

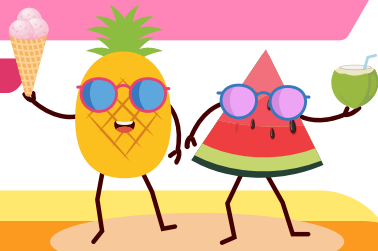


## Hemisphere

- Equal Division of earth in two parts.
- Equator : It divides the globe horizontally into 2 equal parts, i.e. Northern and Southern Hemisphere
- Prime Meridian : It divides the globe into two equal parts i.e. Eastern & Western Hemisphere
- Our India is located in North Eastern Hemisphere



# Solstice



A Solstice is an astronomical event that occurs twice a year when the sun reaches its highest or lowest point in the sky, resulting in the longest day or shortest day of the year

## Summer Solstice

- It Occurs on 21st June.
- It is the longest day of the year in Northern Hemisphere
- The vertical rays of sun are directly overhead on Tropic of Cancer
- Northern Hemisphere gets more heat.
- Continuous sunrise fall on the North Pole for 6 months.



## Winter Solstice

- It Occurs on 22nd December.
- It is the shortest day of the year in Northern Hemisphere
- The vertical rays of sun are directly overhead on Tropic of Capricorn.
- Southern Hemisphere gets more heat.
- Continuous sunrise fall on the South Pole for 6 months.

## Equinox



An Equinox is a time when the Sun's apparent path in the sky crosses the equator, making day and night approximately equal in length.

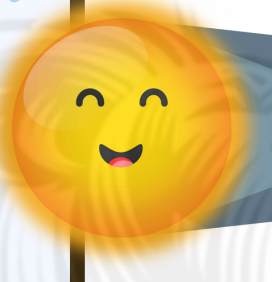
- Vernal Equinox : 21<sup>st</sup> March
- Autumnal Equinox : 23<sup>rd</sup> September

## Solar Eclipse

- It occurs when the Moon passes between the Earth and the Sun, casting a shadow on Earth. This can only happen during a new moon (Amavasya)

## Lunar Eclipse

- It occurs when the Earth passes between the moon and the sun, casting a shadow on Moon. This can only happen during a full moon.(Purnima)



## Red Moon

When Earth blocks the Sun's light (light refraction), it causes blue colour (scatters more) light to vanish and red light to reach moon (scatters less)

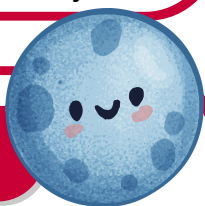


## Super Moon

A supermoon occurs when the Moon's orbit is closest to the Earth during a full/new moon. The Moon appears bigger than its normal size.

## Blue Moon

Occurs when there are two full moons within a single calendar month.



When the Sun, Moon and Earth, all are aligned in a straight line, the alignment is known as

**Syzygy.**

Two Types of Syzygy are:

1. Syzygy Conjunction
2. Syzygy Opposition



1

## Torrid Zone

Receives direct overhead rays of the Sun due to which it is the hottest zone. It is located between Tropics.



2

## Temperate Zone

Region between Tropic of cancer and Arctic circle or Tropic of Capricorn and Antarctic circle. It receives slanting rays of Sun.

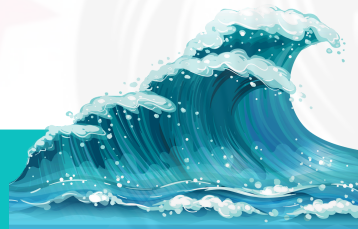


3

## Frigid Zone

Coldest Region on earth which experiences daylight for 6 months and 6 month of night (due to tilt of earth).

## Tides



### Spring Tide

They Occur when the Earth, Sun and Moon are aligned along a straight line.

### Neap Tide

They Occur when the Earth, Sun and Moon are in perpendicular alignment.

### Ebb or Flood Tide

The change from low to high tide is called the 'flood tide' or flow. The change from high to low tide is called 'ebb tide'

Tides are the periodic rise and fall of the ocean's water levels. They are caused by gravitational Pull of the moon and the Sun on the Earth's Oceans.

- Diurnal Tides : One High tide and One low tide in a day.
- Semi-Diurnal Tides: Two high tide and Two low tide in a day.
- Time gap between two high & two low tides is 12 hrs 25 minutes.
- Time gap between one High tide and One low tide is 6 hrs 12 minutes.

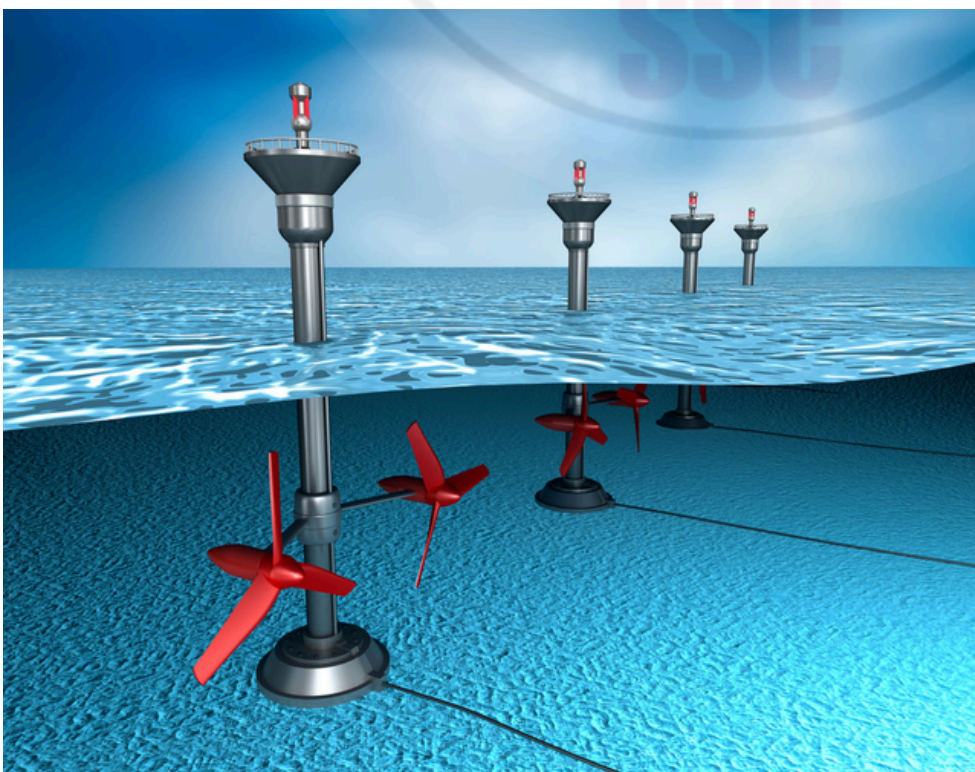
# Tidal Energy



- Tides are high where continental shelves are wide.
- Tides are also high where geographical feature is like funnel shape.



- Harnesses the predictable, powerful rise and fall of ocean tides, caused by the gravitational pull of the moon and sun, to generate electricity



# EARTH'S INTERIOR & PLATE TECTONICS



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## Methods to know about Earth's Interior

### Indirect Sources

Temperature



Meteorites



Earthquake

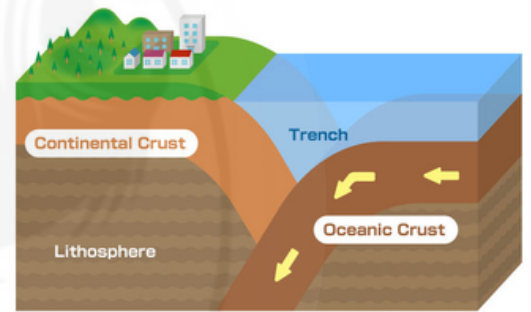


### Direct Sources

Volcanoes



Rocks

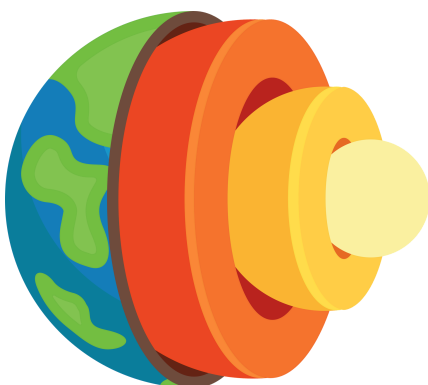


### Layers of Earth

Crust

Mantle

Core



### Crust has two divisions

#### Continental Crust

- It is the land part of the crust, the outermost layer of the Earth that makes up the Continents & Continental Shelves.
- It is thick (30 Km)
- It is lighter
- It is made of Granitic Rock

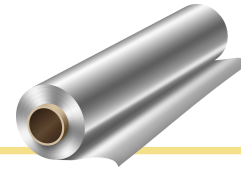
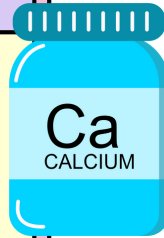
#### Oceanic Crust

- It is the water part of the crust, the solid layer Earth's crust that lies beneath the Ocean.
- It is thin (5 Km)
- It is Denser
- It is made of Basaltic Rock.

## Composition of Earth

### Crust

- Oxygen : 46.6%
- Silicon : 27.7%
- Aluminum : 8.1%
- Iron : 5%
- Calcium : 3.6%
- Sodium : 2.8%
- Potassium : 2.6%
- Magnesium : 2.1 %
- Others : 1.5%



Most abundant metal found in earth's crust is Aluminum

### Mantle

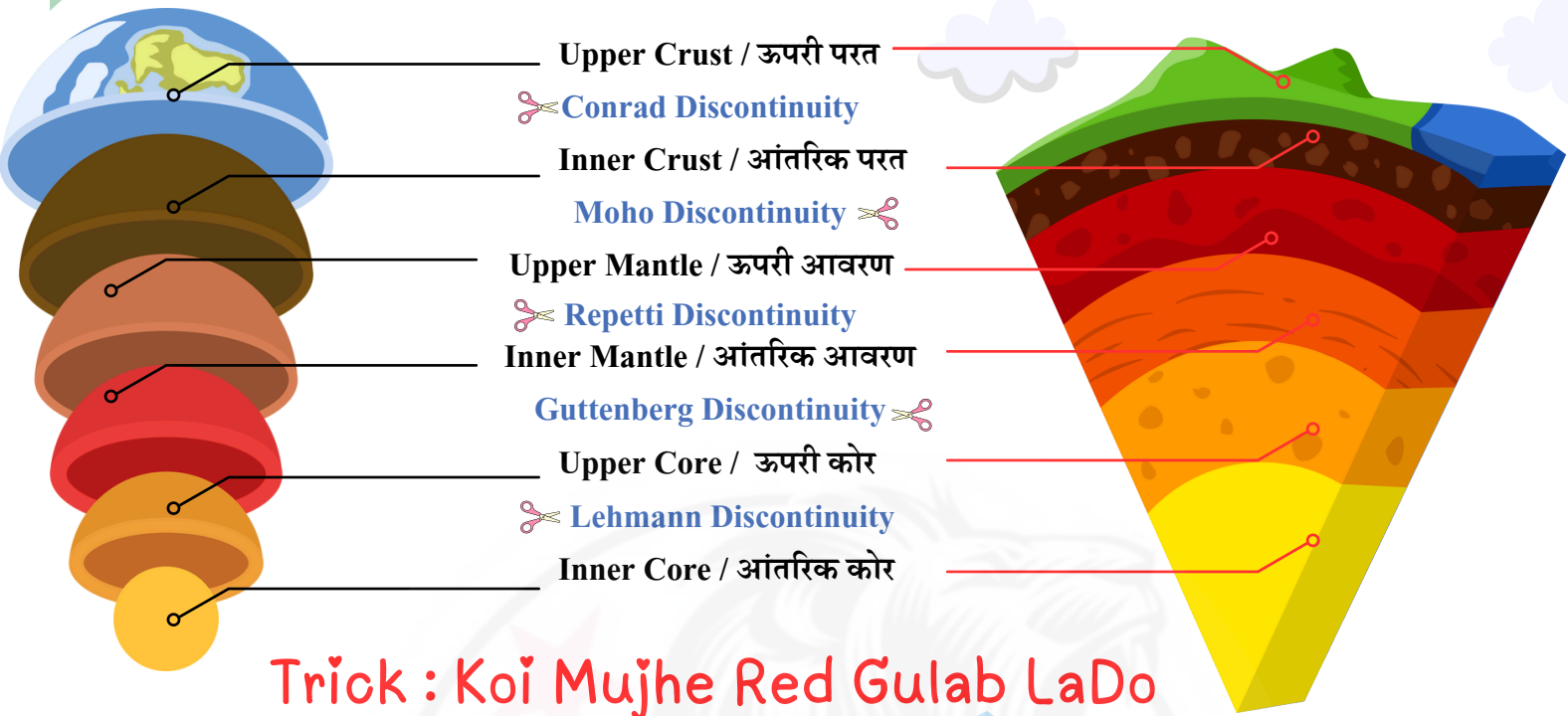
- It is made of Silica and Magnesium (SiMa)
- Thickness : 2900 Km.
- Mantle Has Two Divisions:  
1. Upper Mantle 2. Lower Mantle
- Asthenosphere : It is a Semisolid / semi-molten layer of earth's upper mantle that is mechanically weak and Ductile. It lies beneath the lithosphere ( the rigid outermost layer of earth made up of crust and upper solid mantle with 10-200 km of thickness).
- Asthenosphere is a not a part of Lithosphere.
- Asthenosphere is a source of Magma / lava.

### Core

- It is made of Nickel and Iron (NiFe)
- It has two divisions
1. **Inner Core** : It is in solid form (2200 Km)
  2. **Outer Core** : It is in liquid form and shows magnetic properties (1300 Km)

	By Volume	By Mass
Crust	1%	1%
Mantle	84%	68%
Core	15%	31%

# Earth's Discontinuity



## Force Of Drifting

### Theory of Plate Tectonic

- Given by McKenzie and Parker in 1967. This theory suggests that the Earth's lithosphere is broken into large, rigid plates that move and interact with each other, driving various geological phenomena.

### Convection Current Theory

- Given by Arthur Holmes. Holmes theorised that convection current move through mantle, the same way heated air circulate through a room and radically reshape the Earth's surface in the process.



# Earthquake

- An earthquake is an intense shaking of Earth's surface, which caused due to shifting of Earth's plate. It is a sudden release of energy along the fault lines in the form of waves (also known as Seismic Waves).



1

## Epicentre

It is the point on the Earth's surface directly above earthquake's focus (also known as Hypocentre), where the earthquake originates underground.



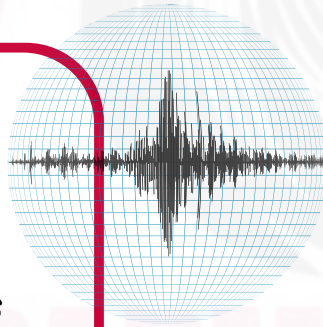
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## Hypocentre

It is the point within the Earth where the earthquake begins.

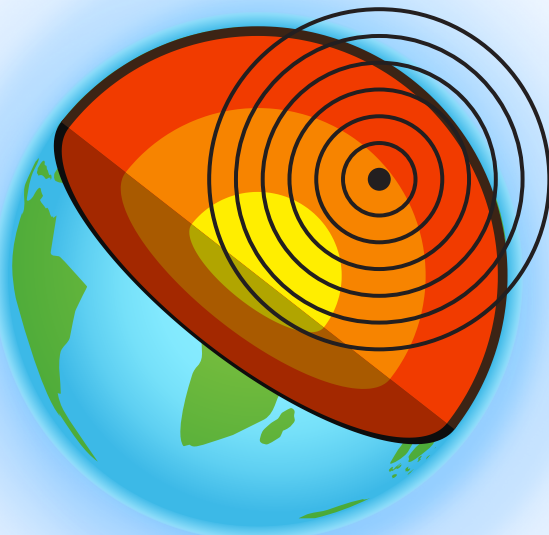
## Body Waves

- These waves travel through the Earth's interior with high speed.
- They are of two types : P-Waves and S-Waves



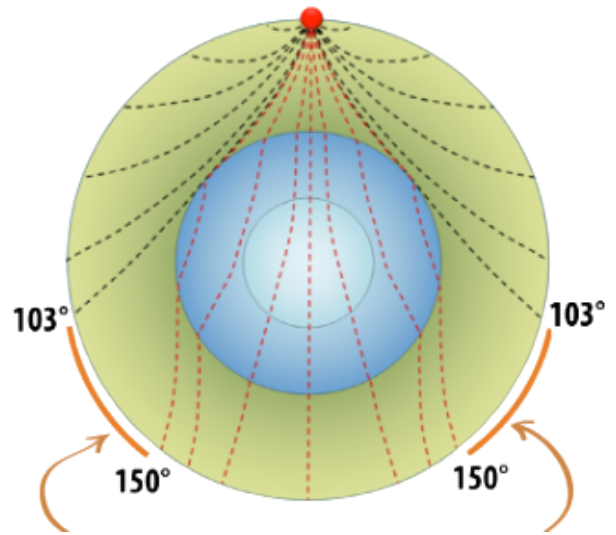
## Earthquake

- All natural earthquake occur in lithosphere.
- Earthquake generates seismic waves, which are vibrations that travels through the earth in the form of body waves and surface waves.
- Shallow focus earthquakes have more intensity than the deeper ones.



## P-Waves

- They are also known as Primary Waves
- They are the fastest Seismic waves (first to record on Seismograph; 7-8 km/s)
- They can travel through all medium (Solid > Liquid > Gas)
- P-waves are longitudinal compression waves, similar to sound waves.
- They create compression and rarefaction and also causing stretching and squeezing

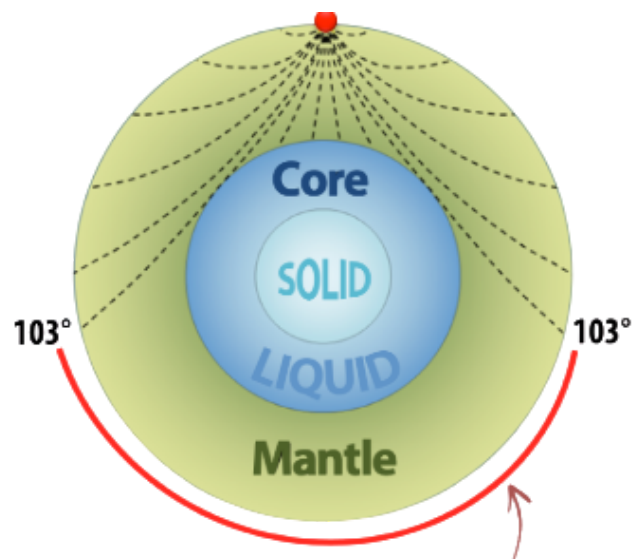


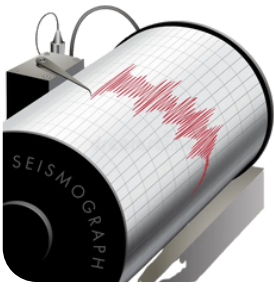
## Surface Waves

- When body waves come in contact with surface rocks, they form surface waves
- They are more destructive in nature.
- Rayleigh waves/Love Waves are type of surface waves
- They are last to record on Seismograph

## S-Waves

- They are also known as Secondary Waves.
- They are the Slow Seismic waves in comparison to P-Waves; 4-6 Km/s.
- They can travel through only Solid.
- S-waves are Transverse waves that causes the ground to vibrate perpendicular to the direction of waves.
- They create Crest and Trough.

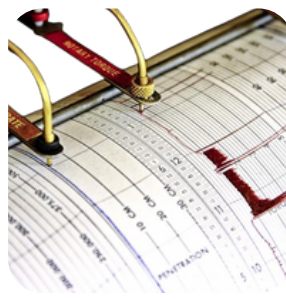




1

### Seismograph

A Seismograph is an instrument that measures and registers seismic waves that travel through the Earth as the outcome of an Earthquake



2

### Richter Scale

- An instrument to measure magnitude of the earthquake
- It measures magnitude from 0 to 10.
- It is a limitless Scale.



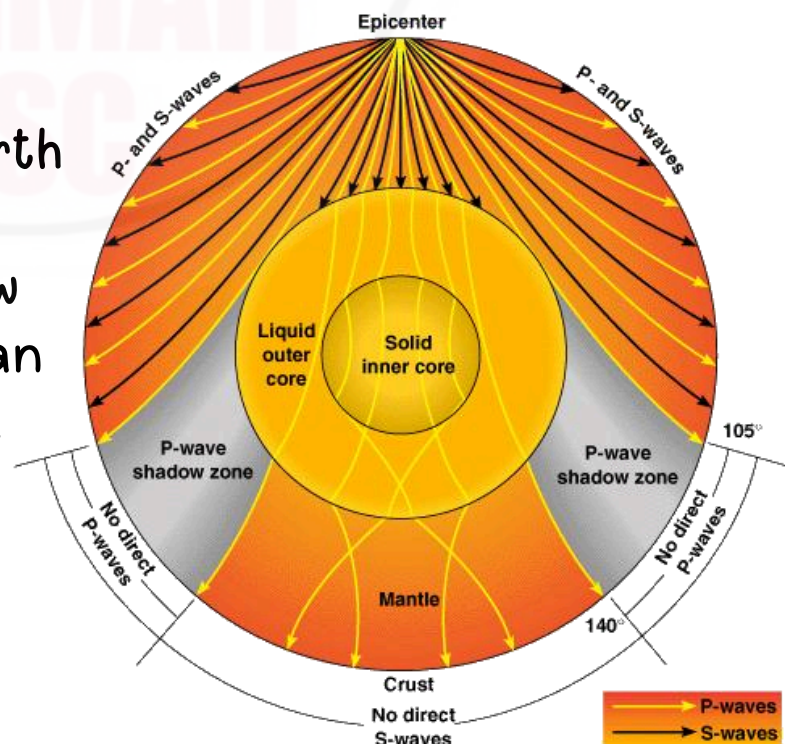
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### Mercalli Scale

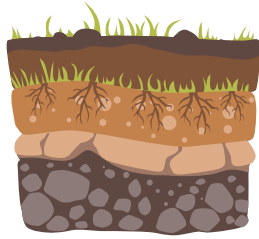
- It is an instrument to measure the intensity of earthquake.
- It measures intensity from 1 to 12.

## Shadow Zone Of Seismic Waves

The Shadow Zone of an earthquake is the area of earth where certain seismic waves are not detected. The shadow zone of S-Waves is larger than the shadow zone of P-Waves.



# Effects of Earthquake



## • Tsunami :

It is a Japanese term. These are harbour waves. It occurs when earthquake occurs at sea floor.

## • Soil Liquefaction

## • Landslide

## • Avalanche

## • Floods

## • Fire

## Types of Earthquake

01

### Collapse Earthquake

These are small earthquake that occur when the roof of underground mine or caverns collapse.

02

### Explosion Earthquake

An Earthquake caused by detonation of a chemical or nuclear device.

03

### Tectonic Earthquake

An Earthquake caused by movement of earth's tectonic plate.

04

### Reservoir Induced Earthquake

An Occurrence of earthquakes caused by construction of large reservoirs. This is human-induced earthquake.

05

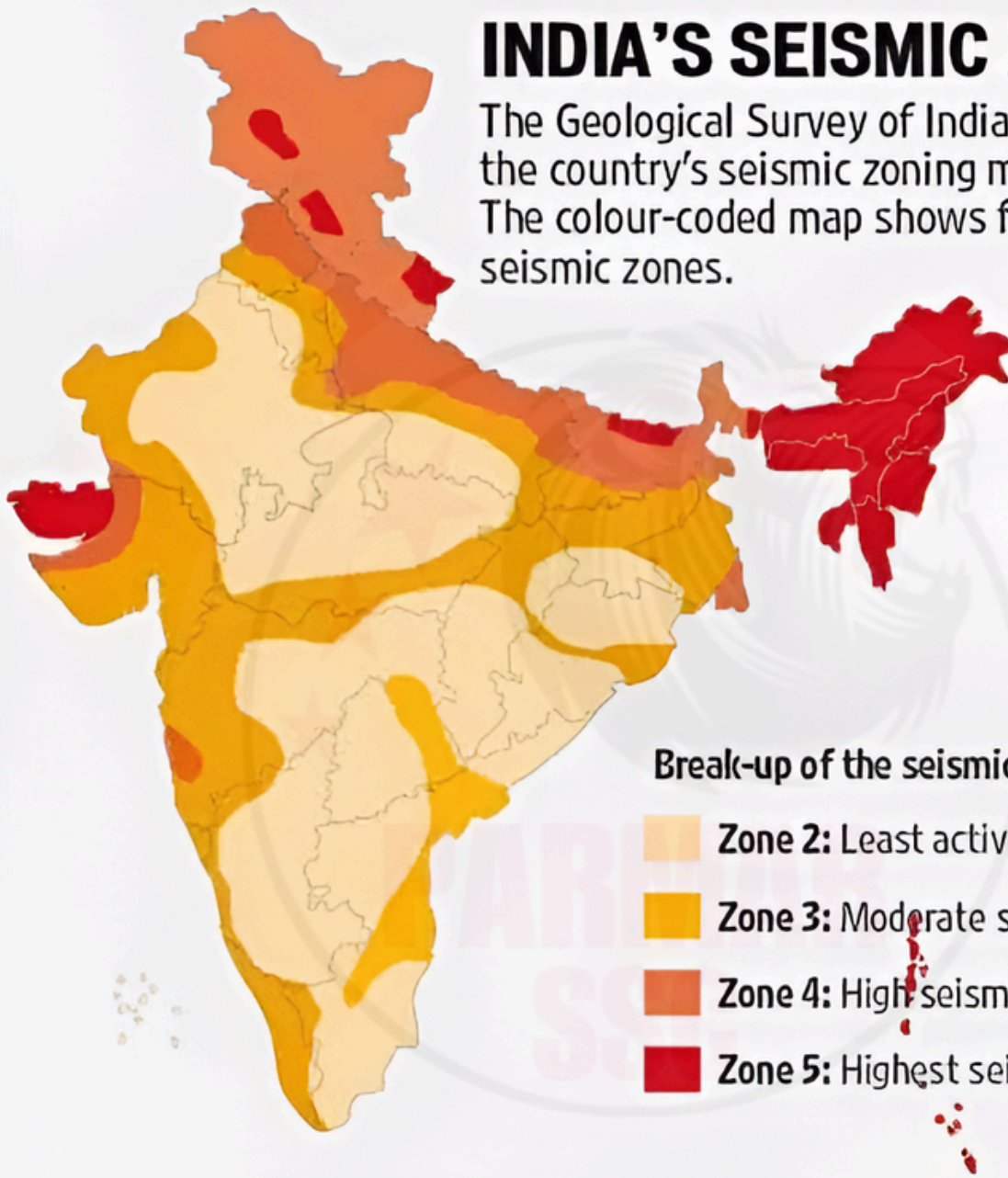
### Volcanic Earthquake

An earthquake that occurs as result of volcanic eruption

## Seismic Zones in India

### INDIA'S SEISMIC ZONES

The Geological Survey of India published the country's seismic zoning map in 1935. The colour-coded map shows four distinct seismic zones.



- Dogs, Cats, cows, elephants, birds, snakes and toads exhibit unusual behavior before earthquake as they are often attributed to their sensitivity to electromagnetic fields, Infrasound.

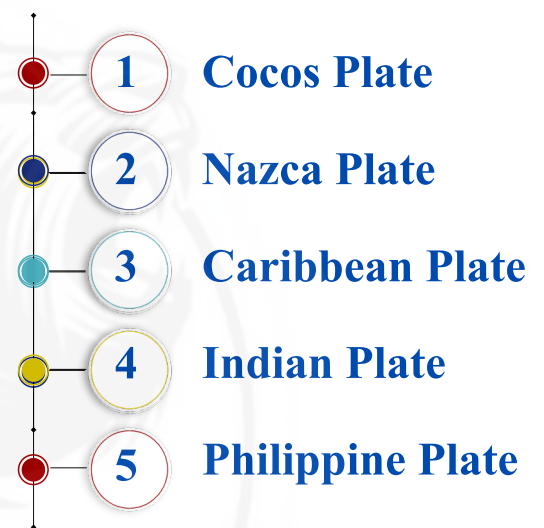
# Tectonic Plates

- Lithosphere makes plates comprising crust and Upper Solid part of Mantle.
- There are seven + Few minor Plates

## Major Tectonic Plates



## Minor Tectonic Plates



## Three Types of Plate Boundaries

### Divergent

- Occurs When two tectonic plates move away from each other, causes lava to explode, leading to new crust formation.

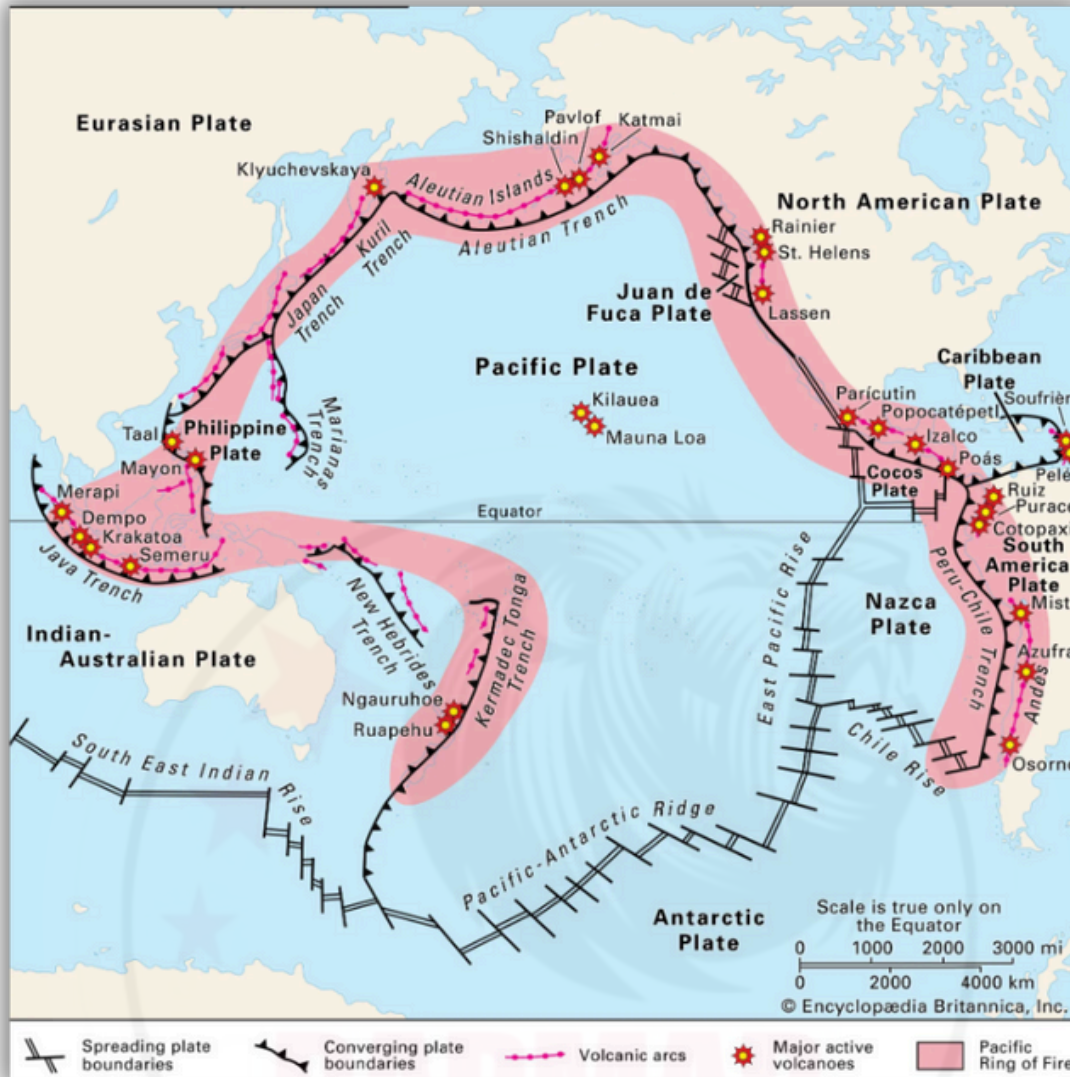
### Convergent

- It happens when plates collide, causing one plate to subduct beneath the other creating a subduction zone, potentially destroying the crust.

### Transform

- It is a plate boundary where plates slide past each other horizontally, neither creating nor destroying crust.

# Ring Of Fire



- It is a result of plate tectonic. It is a horse - shoe-shaped region around the Pacific Ocean. It is a high earthquake and volcano prone region.

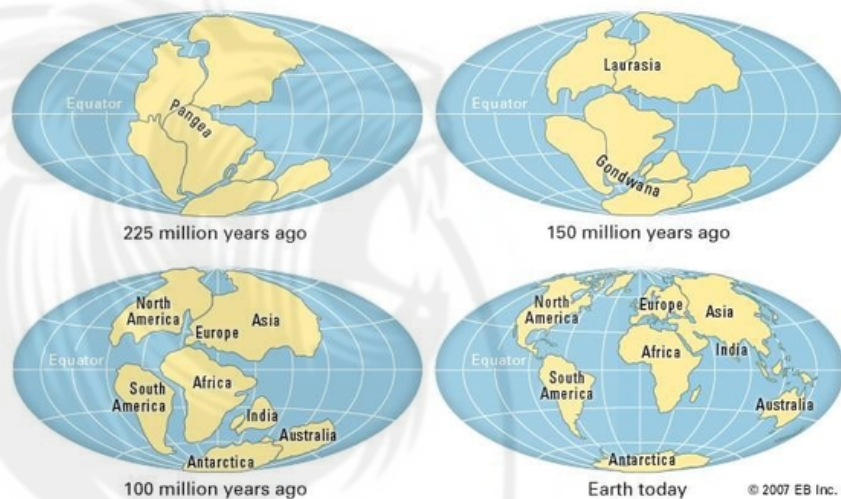
Convection current that occurs in the asthenosphere is the force behind the plate movement. The heat from the Earth's interior causes currents of hot rising magma and cooler sinking magma to flow, moving the lithospheric plates along with them.

# Continents and Ocean

- In 1912, **Alfred Wegener** gave Continental Drift Theory.
- First proposed by **Abraham Ortelius** in 1596
- All of the modern day continents had previously been clunk together in a supercontinent called **Pangea** and the water body is called **Panthalassa**.

## Evidences

1. Jig-Saw Fit
2. Fossil Deposits
3. Placer Deposits (Gold Deposit)
4. Botanical Evidences
5. Rocks of Same age Across the Oceans
6. Tillite Deposits (Evidence from Glaciation)



Tillite Deposits as similar to india found in 6 other continents.

## Reason of Continental Drift

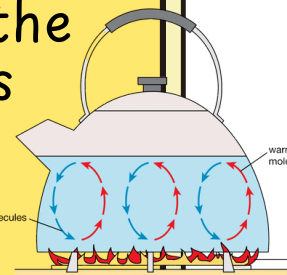
### 1. Tidal Force

As Suggested by Alfred Wegener

### 2. Polar Fleeing Force

- Actual reason was later given by **Arthur Holmes in 1930**
- Continental drift occurs due to the movement of tectonic plates, which is driven by **convection cells** in the earth's mantle.

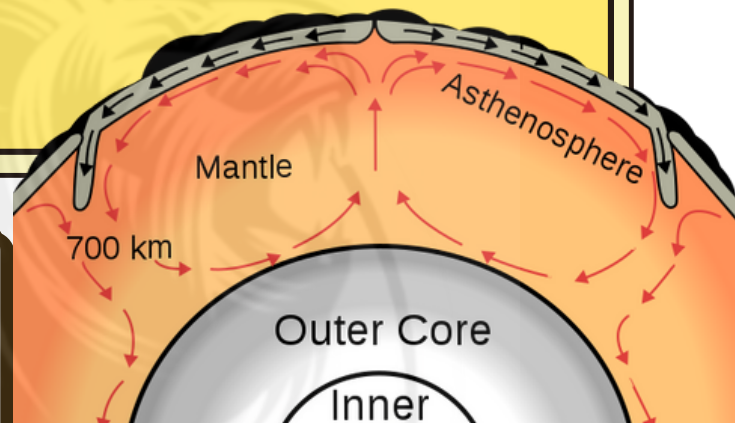
The heat that drives convection cells in the Earth's mantle and plate motion comes mainly from **three** sources:



**1. Radioactive decay** of elements.

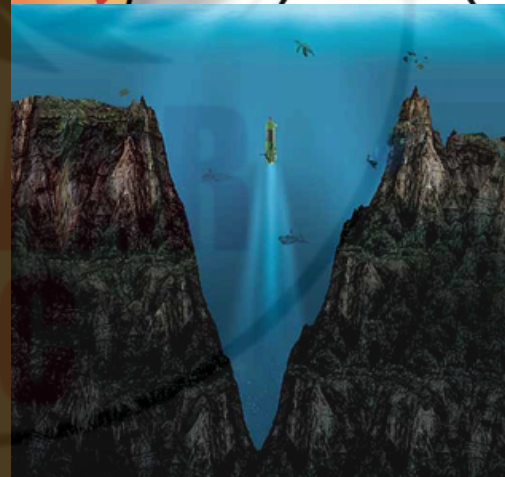
**2. Residual heat** from the earth's formation when gravitational energy was converted into heat.

**3. Latent heat** released by the solidification of the Earth's core as it cools down.

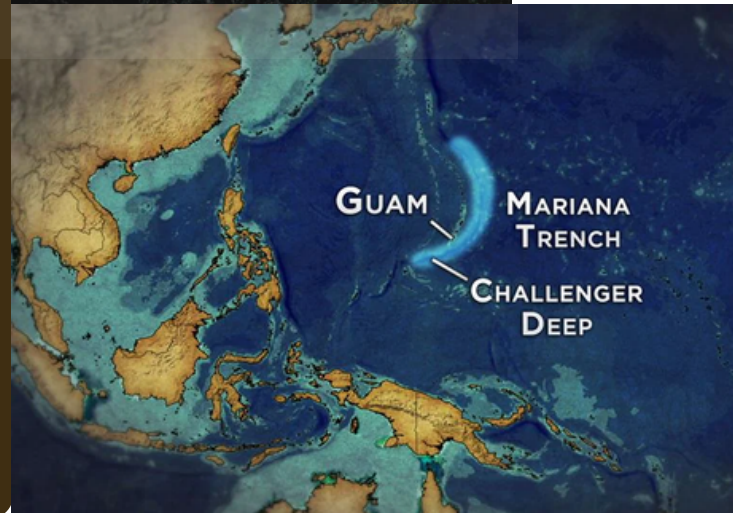


## Facts :

- Mariana Trench is the deepest part of the Pacific Ocean (11 km).
- Challenger Deep is the deepest known point in Mariana Trench.
- Atlantic Ocean is the Busiest ocean. Sargasso Sea is a unique region in the Atlantic Ocean, which is a borderless sea (brown algae Sargassum is seen here).



Mariana Trench

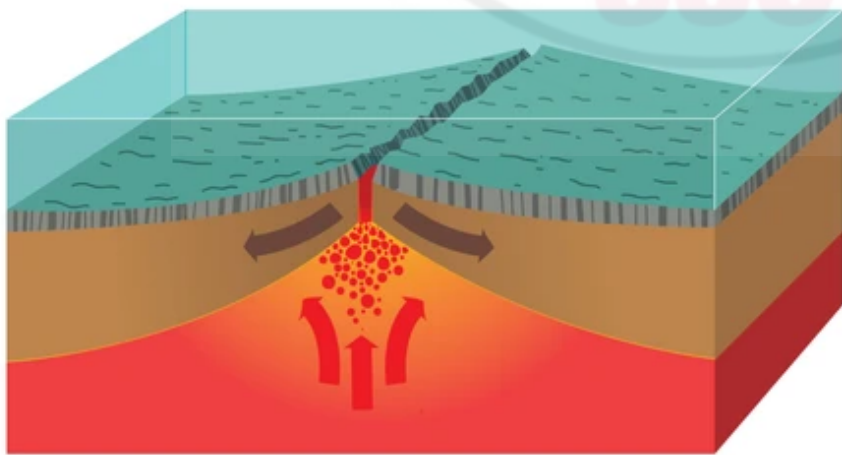


## Milankovitch Theory

- It describes the collective effects of changes in Earth's movement on its climate over thousands of years.
- In 1596, **Abraham Ortelius's** work, "Thesaurus Geographicus", first suggested that Earth's continents were not always in their current locations.

## Seafloor Spreading

- In 1962, **Harry H. Hess** gave Seafloor spreading Theory.
- It is a process by which new oceanic crust is formed at mid-ocean, due to divergent plate boundary. The magma erupts from beneath pushing the older crust away from the ridge in the centre.



- Oceanic Crust is younger than Continental Crust
- The age of oceanic Rocks increases as you move away from mid ocean ridge
- Rocks equidistant from Mid oceanic ridge is of same age.
- Oceanic Crust and Mantle have same composition that is **Si and Ma.**

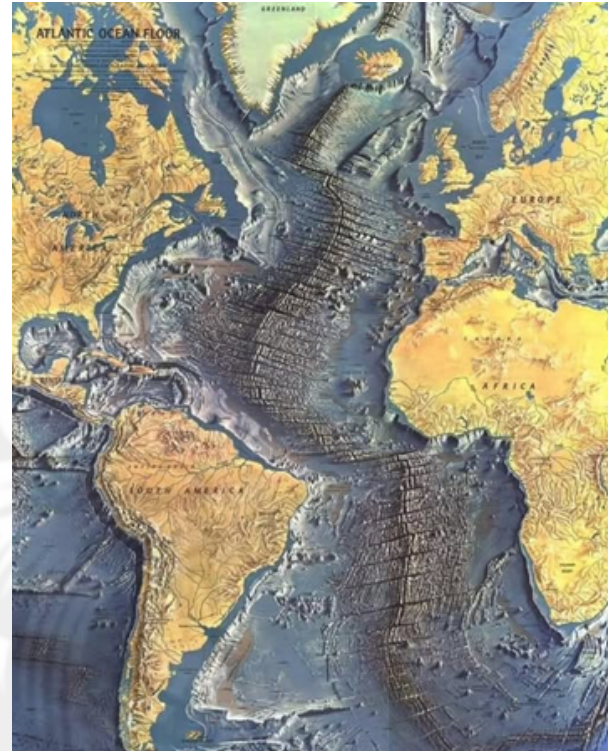
# Relief Features are of two types :

## Major Relief Features:

1. Continental Shelf
2. Continental Slope
3. Continental Rise
4. Abyssal Plain / Deep Sea Plains

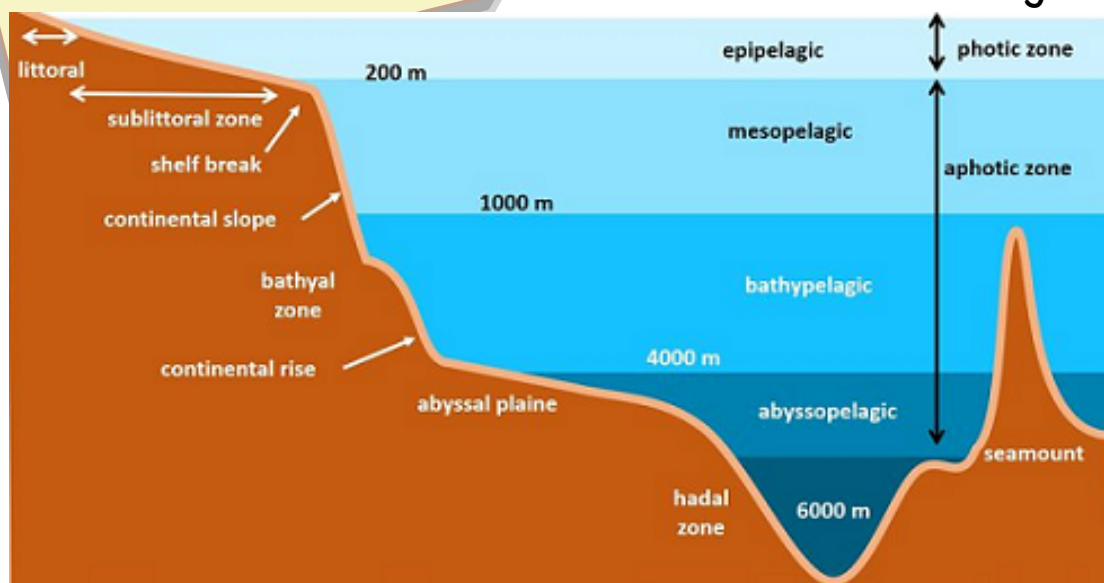
## Minor Relief Features:

1. Seamount
2. Guyot (flat topped seamount)
3. Mid-Ocean Ridge
4. Trench
5. Coral
6. Atoll, etc.



- Continental shelf is the shallowest part of the ocean, having a gradient of  $1^\circ$  or less.
- The gradient of Continental Slope region varies between  $2-5^\circ$ .

- The Mid-Atlantic Ridge is a Mid Ocean Ridge located along the floor of Atlantic Ocean and part of the longest relief feature in the world.
- It got created due to divergent plate boundary.



# Corals

- Corals are marine organisms known as "Rainforest of Sea"
- They exist in symbiotic relationship with *Zooxanthella* algae.
- They secrete  $\text{CaCO}_3$  that provides protection to the algae and in return the algae make food for the corals.
- The corals exist in colonies.



# Coral Bleaching

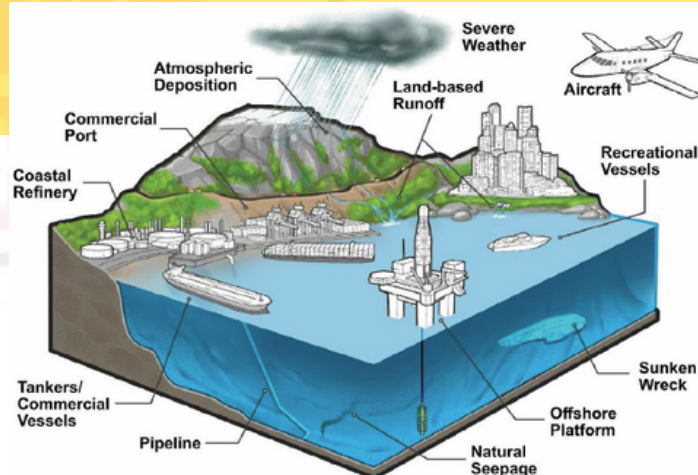
- When water is too warm, corals will expel the algae (*Zooxanthella*) living in their tissues, causing the coral to turn completely white.
- Climate Change is a major key factor in this change.

# Facts

- Petroleum is extracted from Continental Shelf (start of Ocean basin and is very narrow)
- Siberian Shelf in the Arctic Ocean is the widest Continental Shelf (1500 km wide).
- West Coast of South America is the narrowest continental shelf.
- Great Barrier reef in Australia is the largest barrier reef (Colony of Corals) in the world.

## Favourable Conditions Required for corals to survive

- Saline water (They Cannot survive in fresh water)
- Sunlight
- Clear Water
- Temperature (They required Moderate Temperature,  $20^{\circ}$ - $32^{\circ}$  C)



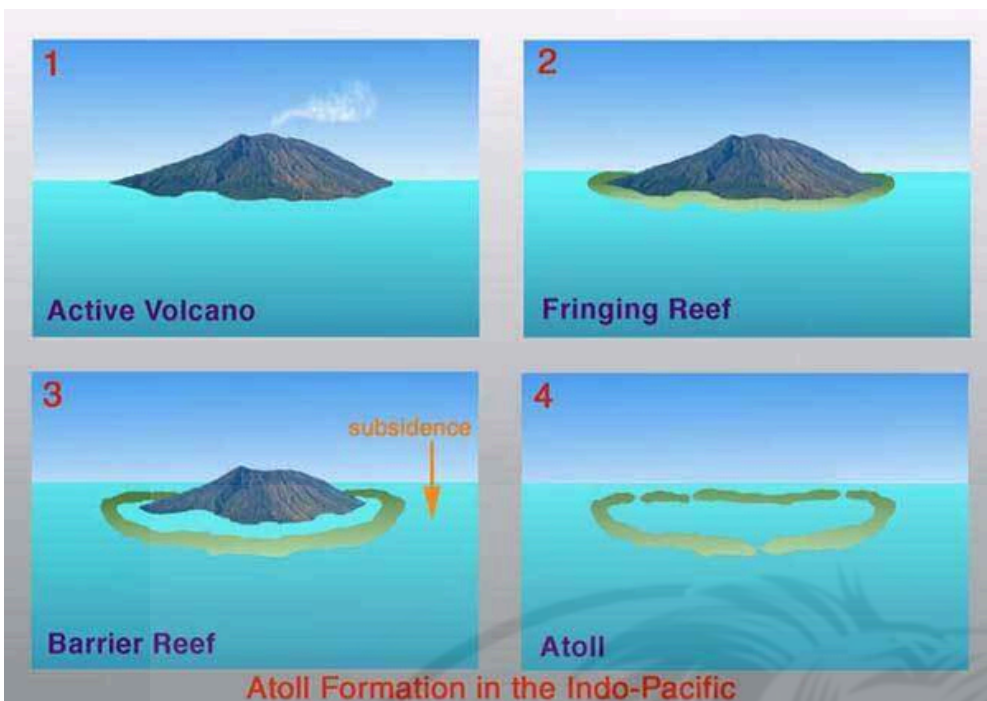
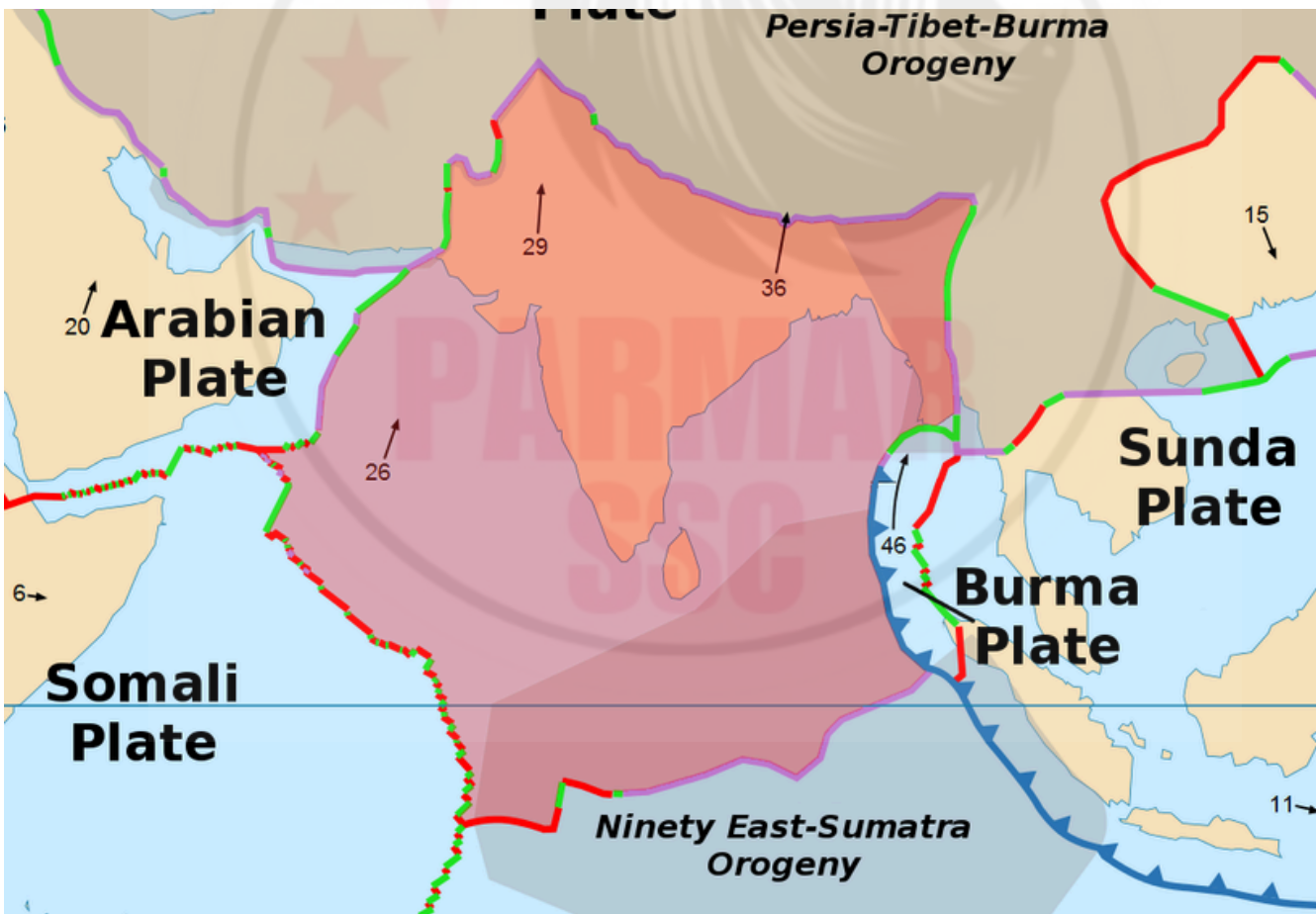


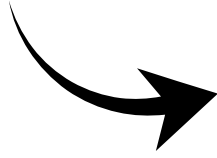
Figure : Atoll Formation



- Andaman & Nicobar island is extension of Arakan Yoma
- Andaman & Nicobar island is created by subduction of Indian Plate under Burma Plate.
- Lakshadweep is mainly formed by Corals but there are more corals in Andaman & Nicobar than Lakshadweep.

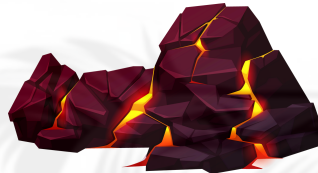
# Formation Of Rock

- Study of rocks is called **Petrology**



Age of Rock is calculated using **Radioactive Dating**

## Igneous Rock



The word Igneous derived from Latin word **IGNIS** which means "**fire**".

Igneous rocks are formed through the cooling and solidification of molten Rock, known as **Magma or Lava**

## Types of Igneous Rocks

### **Intrusive Igneous Rock / Plutonic Rock**

When magma solidifies **within** the earth crust, it forms **intrusive** Igneous rocks  
E.g. Granite, Gabbro

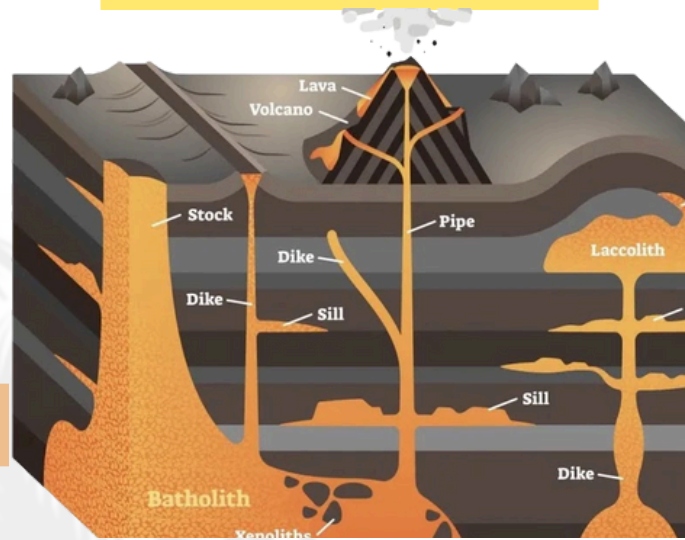
### **Extrusive Igneous Rock / Volcanic Rock**

When magma solidifies on the earth surface as Lava, it cools and Solidifies quickly. This rapid cooling result in the formation of small crystals and glassy texture.  
E.g. Basalt, Pumice (It floats in water)

# Plutonic Bodies

Plutonic Bodies, Also known as Plutons, are large bodies of intrusive igneous rock, that form beneath the earth's surface.

- **Granite** is found in continental Crust.
- **Basalt** is found in Oceanic Crust .



## Types of Plutonic Bodies

- **Batholiths** : A batholith is a large mass of igneous rock that forms deep within the Earth's crust and is exposed at the surface through erosion and uplift.
- **Dykes** : Dykes are vertical or steeply inclined sheets of magma that cut across the layers of surrounding rock.
- **Sills** : Sills are horizontal sheets of magma that intrude between layers of pre-existing rock.
- **Phacolith** : A Phacolith is a lens-shaped igneous rock pluton that forms in folded sedimentary rock found at Anticlines and Synclines.
- **Laccoliths** : Dome-shaped intrusions with a flat base that push overlying layers upward. It is connected by pipe like structure
- **Lapoliths**: These are saucer shaped instrusions with concave top and bottom.

# Sedimentary Rock

- Sedimentary rocks are a type of rock that forms from the accumulation and consolidation of sediments over time.
- Lithification is a process by which loose sediments are transformed into solid sedimentary rocks. This occurs through a combination of compaction and cementation over long periods of time.
- They exist in Layers/Strata.
- Fossils are found in sedimentary rocks.

## Types of Sedimentary Rocks

- **Mechanically / Clastically formed** : Sandstone, Limestone, Conglomerate, Shale, Loess, etc.
- **Organically formed** : Chalk, Limestone, Coal, Geyserite, etc.
- **Chemically formed** : Limestone, Halite, Chert, etc.



Breccia



Caliche



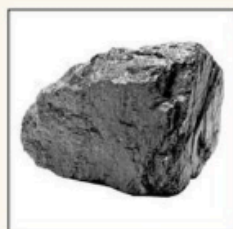
Chalk



Chert



Coquina



Coal



Conglomerate



Diatomite



Limestone



Gypsum



Sandstone



Shale



Dolomite



Siltstone



Ironstone

# Metamorphic Rocks

- Metamorphic rocks are rocks that form when existing rocks (igneous, sedimentary, or even other metamorphic rocks) are subjected to intense heat, pressure, or volume change, causing them to undergo physical and chemical changes. this process is also called metamorphism.
- These rocks are formed by recrystallisation and reorganisation of materials within the original rocks.

## Types of Metamorphic Rocks

**1. Thermal Metamorphism** : Metamorphic rocks formed due to sudden temperature change.

**2. Dynamic Metamorphism** : Metamorphic rocks formed without any chemical change.

- These are generally formed as a result of high pressure.

## Types of Thermal Metamorphism

**1. Contact Metamorphism** : It Occurs when rocks are altered by intense heat due to their proximity to magma or lava

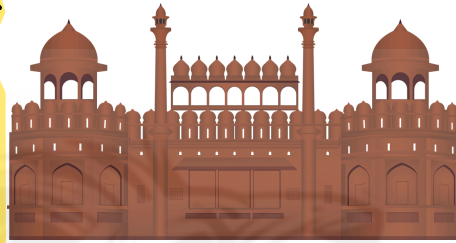
**2. Regional Metamorphism** : It occurs when rocks are subjected to High pressure and temperature



Alternate Light and Dark Bands on rock is called Banding



Lines formed in Rock is called Lineation



- Quartz is not a rock, It is Mineral.
- **Taj mahal** is made of Metamorphic rock
- **Red Fort** is made of Red Sandstone (Sedimentary Rock)
- **India Gate** is made of Red and Yellow sandstone. (Sedimentary Rock)

Granite (Igneous)	Metamorphism	Gneiss
Shale (Sedimentary)	Metamorphism	Slate, Schist
Sandstone (Sedimentary)	Metamorphism	Quartzite
Limestone (Sedimentary)	Metamorphism	Marble
Basalt/Gabbro (Igneous)	Metamorphism	Amphibolite
Clay (Sedimentary)	Metamorphism	Slate

# Minerals

## Feldspar



Silicon and oxygen are common elements in all types of feldspar and sodium, potassium, calcium, aluminium etc. are found in specific feldspar variety. Half of the earth's crust is composed of feldspar. It has light cream to salmon pink colour. It is used in ceramics and glass making

## Quartz



It is one of the most important components of sand and granite. It consists of silica. It is a hard mineral virtually insoluble in water. It is white or colourless and used in radio and radar. It is one of the most important components of granite.

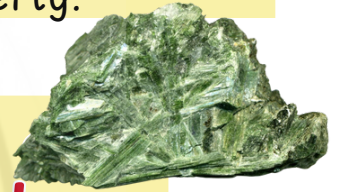
- Quartz is used in making watches due to its Peizelectric Property.

## Pyroxene



Pyroxene consists of calcium, aluminum, magnesium, iron and silica. Pyroxene forms 10 per cent of the earth's crust. It is commonly found in meteorites. It is in green or black colour.

## Amphibole



Aluminium, calcium, silica, iron, magnesium are the major elements of amphiboles. They form 7 per cent of the earth's crust. It is in green or black colour and is used in asbestos industry. Hornblende is another form of amphiboles.

## Mica



It comprises of potassium, aluminium, magnesium, iron, silica etc. It forms 4 per cent of the earth's crust. It is commonly found in igneous and metamorphic rocks. It is used in electrical instruments.

## Olivine



Magnesium, iron and silica are major elements of olivine. It is used in Jewellery. It is usually a greenish crystal, often found in basaltic rocks. Besides these main minerals, other minerals like chlorite, calcite, magnetite, hematite, bauxite and barite are also present in some quantities in the rocks.

## Types Of Rocks :

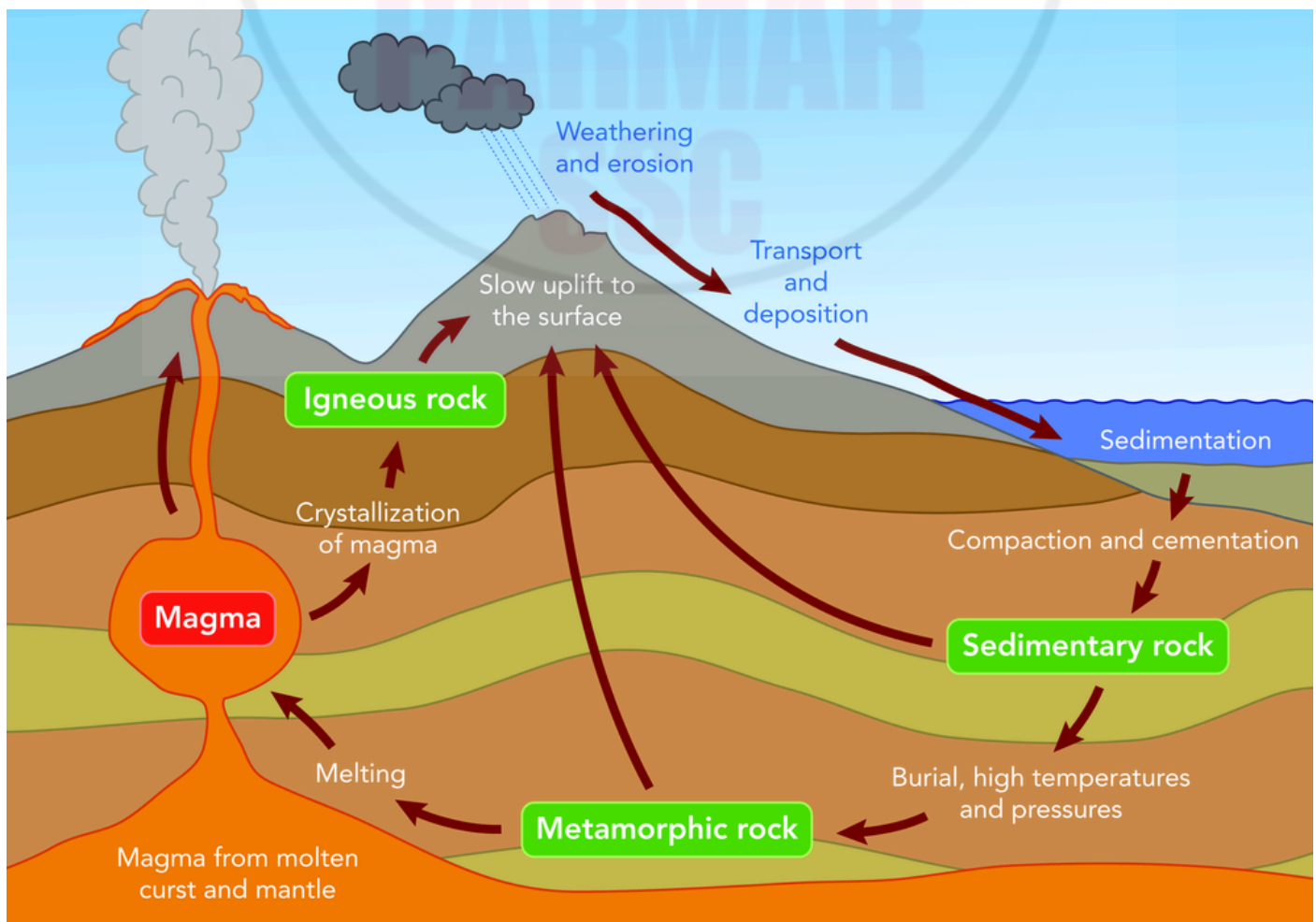
- Soft Rock : Talc
- Hard Rock : Diamond
- Feldspar consist of 50% of the earth's crust and is widely used in glass and ceramic industries.

• Limestone is one of the key minerals used in cement making.

• Mica is used in electrical industry, constitutes 4 % of Earth's Crust.

## Rock Cycle

It is a geological process that describes how the three main types of rocks ; Igneous, Sedimentary and Metamorphic change over time.

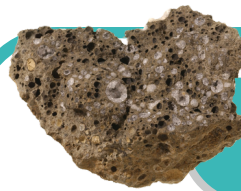


## Acidic Rock



- They are high in Silica (mostly feldspar and quartz minerals) upto 80%.
- They are light in colour.
- Due to high Silica content, acidic magma cools faster.
- **Eg. : Granite, Quartz, Feldspar**

## Basic Rock



- They are Poor in Silica ;mostly feldspar and quartz minerals upto 40%.
- They are Dark in colour.
- Due to low Silica content, Basic magma cools slowly.
- **Eg. : Basalt, Gabbro, Dolerite**

## Volcano



A volcano is a geological feature formed by the eruption of molten rock (magma) from beneath the earth's crust

### Cinder Cone

They are small, steep-sided volcanoes formed by moderately explosive eruptions.

### Flood Basalt Province

These volcanoes outpour, highly fluid lava that flows for long distances.  
E.g. Deccan Traps (in west central region)

### Shield

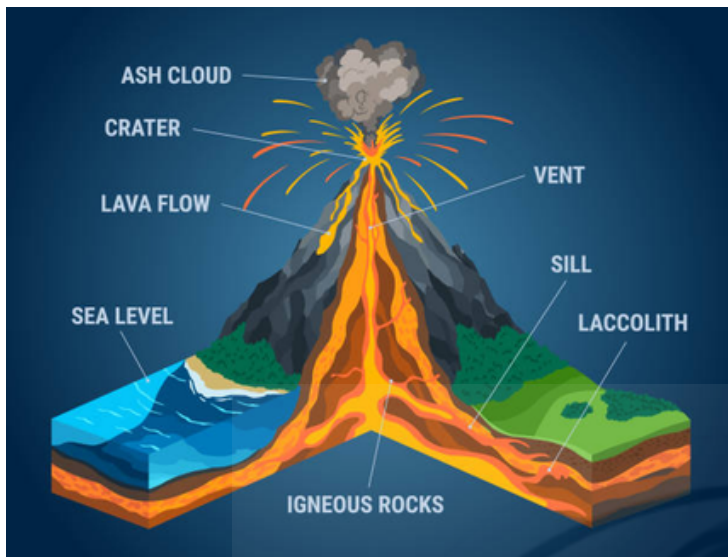
They are primarily formed by eruption of basaltic lava which is non viscous fluid.  
E.g. Kilauea Volcano in Hawaii, USA

### Composite

They are generally cooler and viscous in nature. They are also known as Stratovolcano.  
E.g. Mt. Chimborazo and Mt. Fuzi.

### Caldera

It is the most explosive types of volcano, it collapses on itself.



**Figure : Volcanic Crater**

- Highest Volcano : Ojas del Salado ( It is located between Chile and Argentina in Andes Mountain range)
- Lighthouse of Mediterranean : Mount Stromboli

## Geyser

- A geyser is a hot spring that intermittently erupts steam and hot water due to geothermal activity beneath the Earth's surface.
- Geysers are commonly found in areas of volcanic activity because the heat from magma or hot rocks below the Earth's surface heats the groundwater, leading to the formation of geysers.



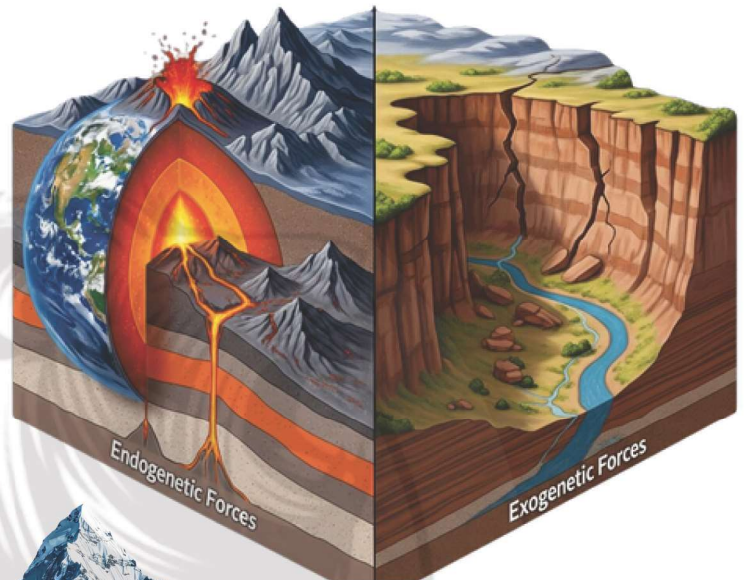
Figure: Hot Spring;  
Puga Valley, Ladakh



# Geomorphological Process

- Geomorphology is description and classification of earth's topographic features.
- Father of geomorphology is **William Morris Davis**.
- All geomorphologic process occur due to **Endogenic (Bole to internal)** & **Exogenic (Bole to External) Forces**.

- Endogenic processes is an internal geomorphic process.
- Endogenic forces get their energy from within the earth (convection current)
- All relief features on earth are due to endogenic and exogenic forces.
- **Himalayas** : They are continuously increasing, because of more endogenic force.
- **Aravali**: They are continuously decreasing, because of more exogenic force.



## Hydrology

The study of distribution and movement of water, both in and below the Earth's surface as well as the impact of human activity on water availability and condition, is known as Hydrology.



## Recall !

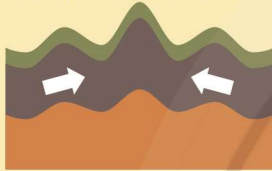
- Convection Currents in Asthenosphere in upper Mantle provides energy to endogenic forces.
- Convection Current develops due to Primordial or Residual Heat and Radioactive Decay.
- Convectional Current Theory was given by Arthur Holmes in 1930.

# Effect of Endogenic Forces

**Diastrophism** Diastrophism is a process of deformation and movement of Earth's crust. These movements are responsible for shaping large-scale landforms over geological time period.

## Orogenic Process

Oro: Mountain, Genic: Formation. It is a process through which mountains are built.



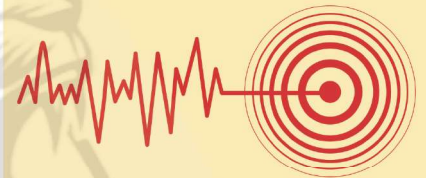
## Epeirogenic Process

Epeiro: Crust ; Genic : Formation. It involves upliftment of large parts of the Earth's



## Earthquake

It involves shaking of Earth.



## Plate Tectonic

It explains how major landforms are created as a result of Earth's subterranean movements.

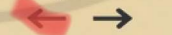
## Orogenic Process

- It is a Horizontal Movement
- It does not occur in large landmass.
- It is faster than Epeirogenic process.

Compression



Compression



Mantle

## Epeirogenic Process

- It is a Vertical Movement
- It occurs in large landmass.
- It is slower than Orogenic Process.

Uplift



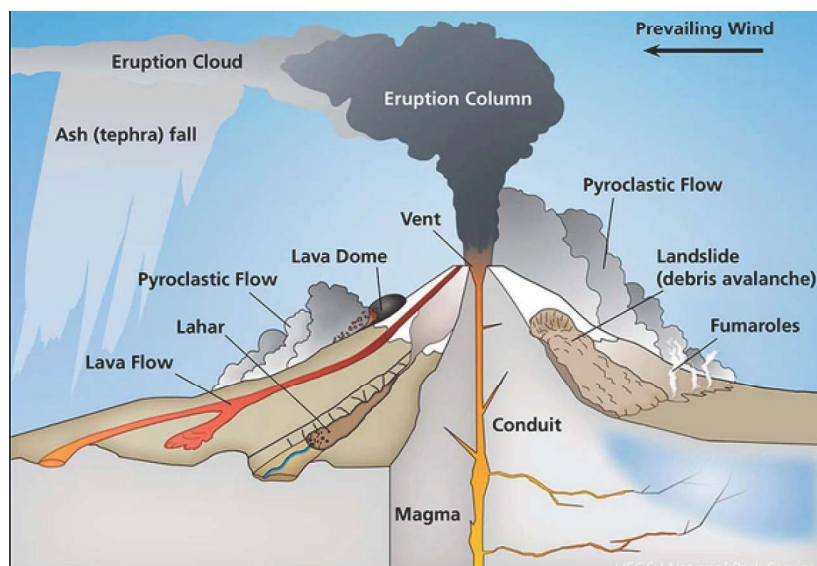
Subsidence



Crust

## Volcano

They are commonly described as openings / vents where lava or Magma erupts.



# Exogenic Processes

- It is a geological processes that occur on earth's surface due to external forces.
- **Denudation** refers to long term processes that cause the wearing away the earth's surface, leading to a reduction in elevation and relief of landforms and landscapes.
- Source of energy for exogenic forces is the **Sun**.
- Exogenic agents are **Wind, Glaciers, Water**

## Process

## Driving Force

- |   |   |
|---|---|
| <ul style="list-style-type: none"><li>• <b>Weathering</b><br/>( Breaking of rocks )</li><li>• <b>Mass Movement</b><br/>( Weathering is not a prerequisite but it aids the mass movement )</li><li>• <b>Erosion / Transportation</b><br/>(Ex-Situ Process<br/>Agents: Wind, Water)</li></ul> | <p>Gravitational / Molecular stresses / Chemical actions</p> <p>Gravitational force</p> <p>Kinetic Energy</p> |
|---|---|

## Weathering

- Weathering is the process of rocks and minerals breaking down or dissolving on the earth's surface.
- It is an In-Situ Process.
- It has three types :

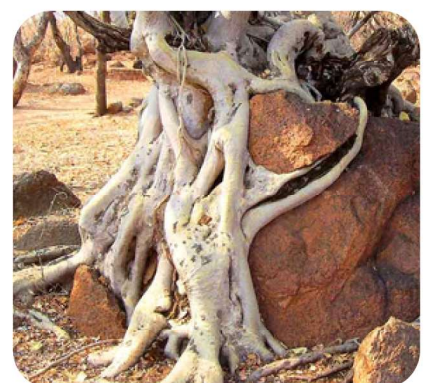
### Physical Weathering



### Chemical Weathering



### Biological Weathering



## Physical Weathering

Physical weathering involves breakdown of rocks through direct contact with atmospheric conditions such as heat, water, ice etc.



### Types of Physical Weathering

01

**Unloading  
and  
Expansion**

02

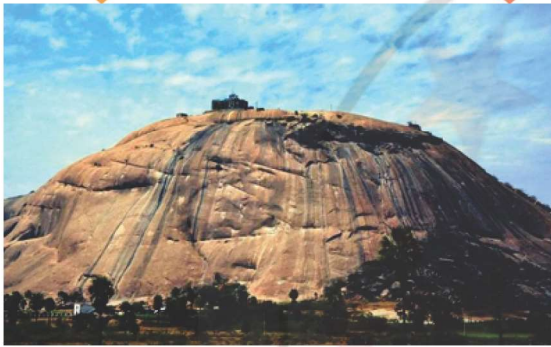
**Temperature  
Changes &  
Expansion**

03

**Freezing,  
Thawing &  
Frost  
Wedging**

04

**Salt  
Weathering**



A large exfoliation dome in granite rock near Bhongir (Bhuvanagiri) town in Andhra Pradesh.

**Exfoliation** is a process when large, curved plates or slabs of rocks are striped away from the outer surface of a rock mass.

**Tor** : It is a rounded hill, generally seen in Granite Rocks

**Salt Crystallisation** is the effective of all the salt weathering processes. It occurs where rate of evaporation is high.

## Chemical Weathering

Chemical weathering involves decomposition of rocks through chemical reactions such as oxidation and reduction, carbonation, solution, and hydration.



### Types of Chemical Weathering

01

**Solution**

02

**Carbonation**

03

**Hydration**

04

**Oxidation &  
Reduction**



**Solution (Dissolution)**



**Hydrolysis**



**Oxidation**



**Carbonation**



**Spheroidal Weathering**



**Hydration**

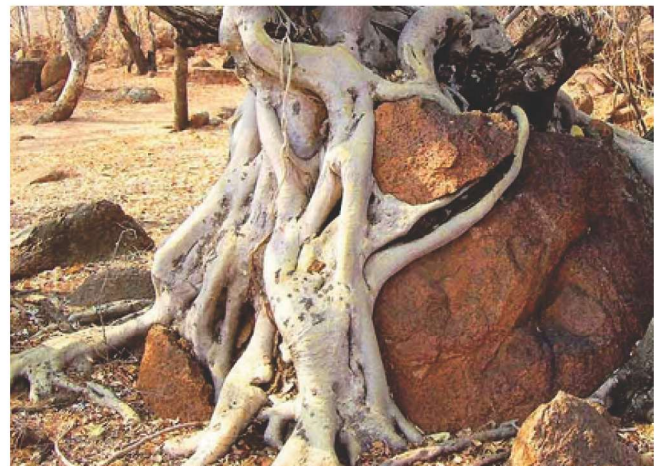
Chemicals like Nitrates, Sulphates, Potassium, Carbonates are prone to leaching, hence they easily washed away and dissolve with water.



Chemicals like  $\text{CaSO}_4$  absorbs water easily to form Gypsum (  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$  )

## Biological Weathering

Biological weathering is the breakdown of rocks through the activities of living organisms such as earthworms, rodents etc.



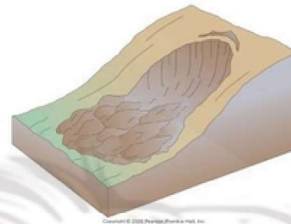
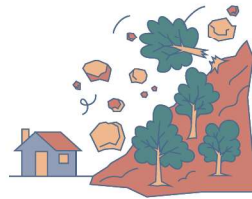
# Mass Movement

It is a downslope movement of soil, rock and other debris under the influence of gravity. Weathering is not a prerequisite but it can aid the mass movement.

## Types

### Rapid

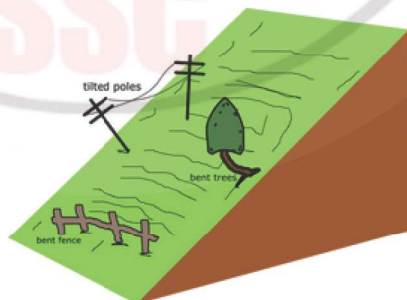
- Landslides
- Avalanche
- Earthflow
- Mudflow



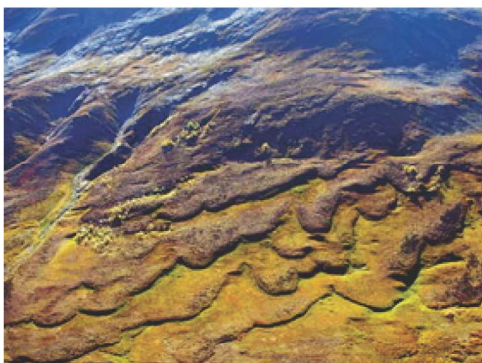
- Earthflow and Mudflow occurs in water saturated regions.
- Earthflow is slow while Mudflow is a fast process.
- Mudflow occurs in absence of Vegetation and is more saturated with water.

### Slow

- Creep
- Solifluction



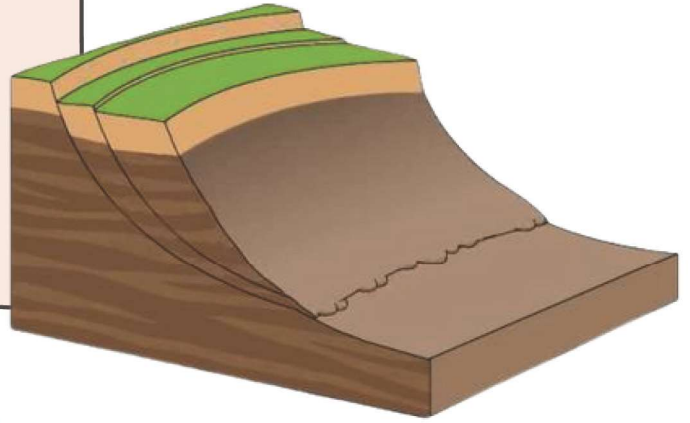
(c)The Geo Room



Solifluction Mainly Occurs in **Permafrost** Regions.

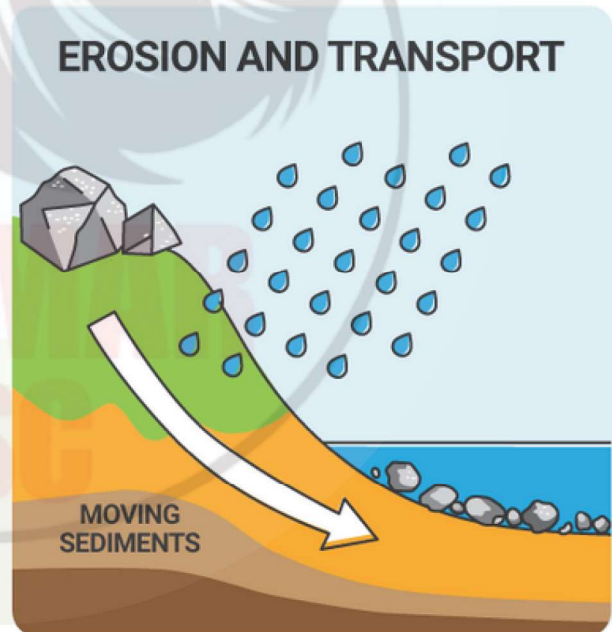
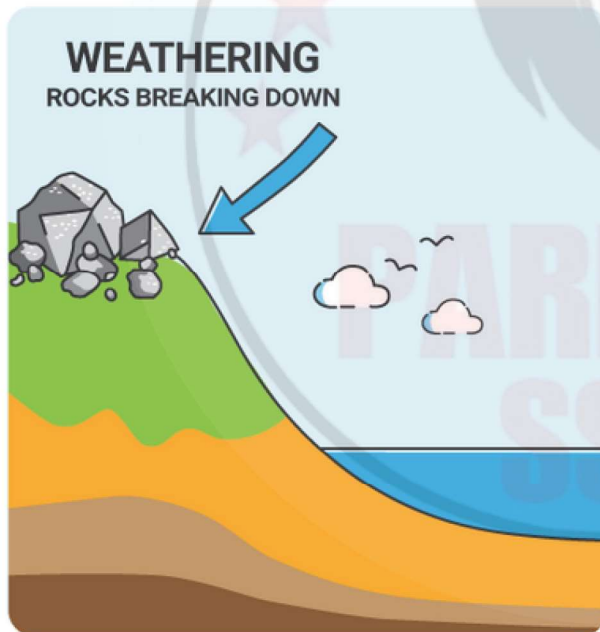
## Slump

A specific type of mass movement where a coherent mass of soil or rock slides down a slope along a curved, spoon-shaped surface.



## Erosion

- It involves transportation of Rock debris through geomorphic agents like running water, ground Water, Glaciers, Winds, and Waves.
- It is an Ex-situ process.



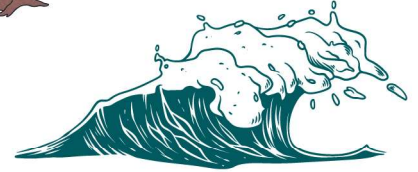
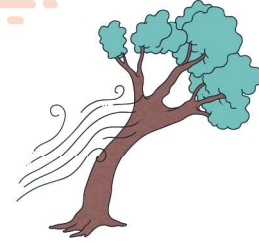
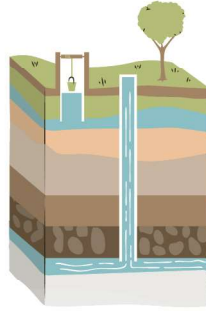
# Landforms

- Landforms are natural or human-made features on the Earth's surface.
- It include hills, mountains, plains, and more.



## Landforms Due To Various Agents

- → River
- → Glacier
- → Wind
- → Sea waves
- → Ground Water



## Types of Landforms

### Erosional landforms

They are created by process of Erosion



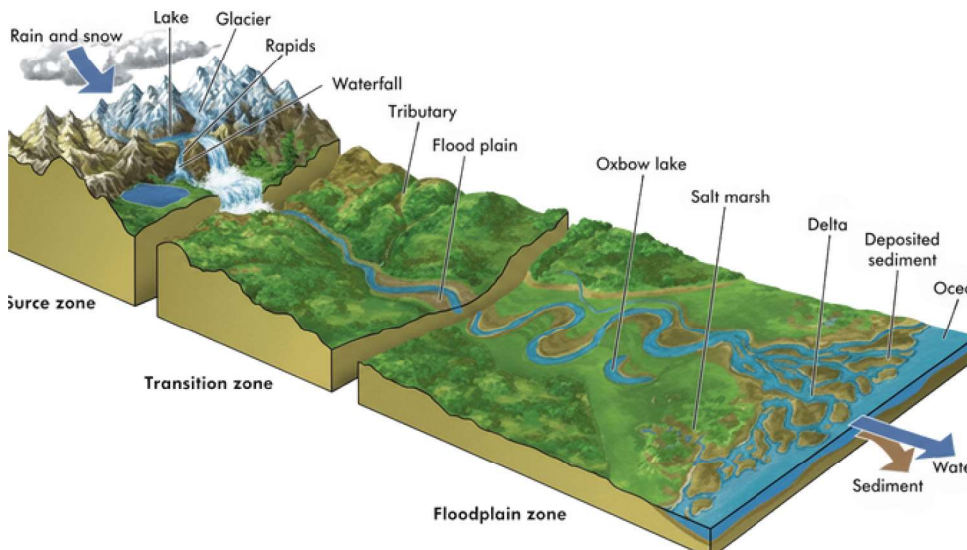
### Depositional landforms

They are created when sediments are deposited in areas of reduced flow energy.



## Landforms Created by River

A river goes through three stages: **Youthful**, **Mature** and **Old**. The course of river includes the **upper stage**, the **middle stage**, and the **lower stage**.



## Stages of River

### Youthful Stage

River flows in speed and creates V-shaped Valley, Gorges, Canyons, Waterfalls, Entrenched Meander.

### Mature Stage

The river flows through gradient to flat plain and starts to Meander.

### Old Stage

The Final stage of river's journey to make Ox-Bow lakes, Delta, Flood Plains.

# Riverine Landforms

## Erosional

Potholes, Waterfalls, Plunge Pools, V-Shaped Valley, Gorges, Canyons, River Terraces, Entrenched Meanders, Cataract Waterfall

## Depositional

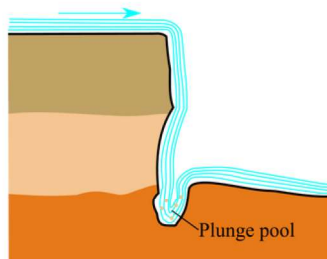
Flood Plains, Ox-bow lakes, Point Bar, Alluvial Fans, Levees, Braided Channel.



**Pothole**



**V-Shaped Valley**



**Plunge Pool**



**Waterfalls**



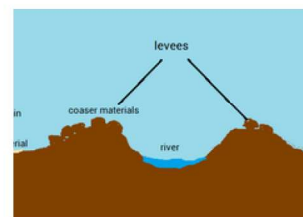
**River Terraces**



**Flood Plains**



**Entrenched Meanders**



**Levees**



**Alluvial Fans**



**Meanders**



**Braided Channel.**



**Ox-Bow lake**

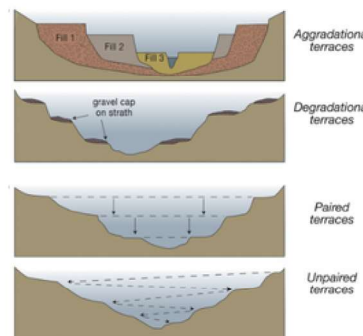
## Rapid

Sections of a river with turbulent, fast-flowing water caused by a steep gradient or obstacles like rocks and boulders



## River Terraces

A flat, elevated landform on the side of a valley that represents a former floodplain or river floor, formed by the river's erosion and deposition processes



# Landforms Created by Glaciers

## Glacial Landforms

### Erosional

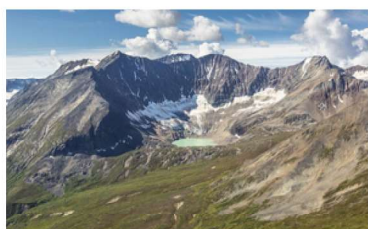
Cirque, Ridge/Arete, Horn, Hanging Valley, Glacial Valleys.

### Depositional

Moraines, Eskers, Drumlins, Outwash Plains.



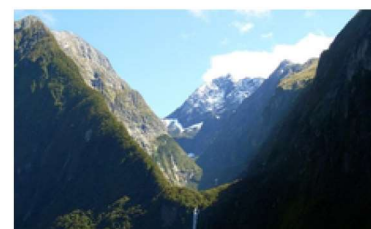
**Arete**



**Cirque**



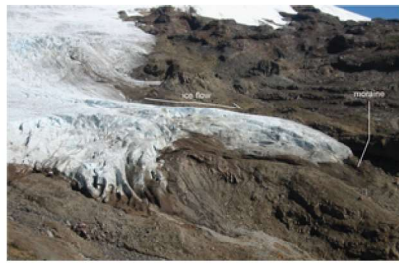
**Horn**



**U-shaped Valley**



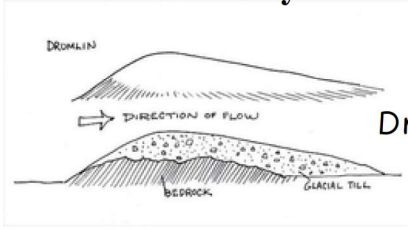
**Glacial Valley**



**Moraines**



**Eskers**



Drumlins are called Basket of Egg Topography

**Drumlins**



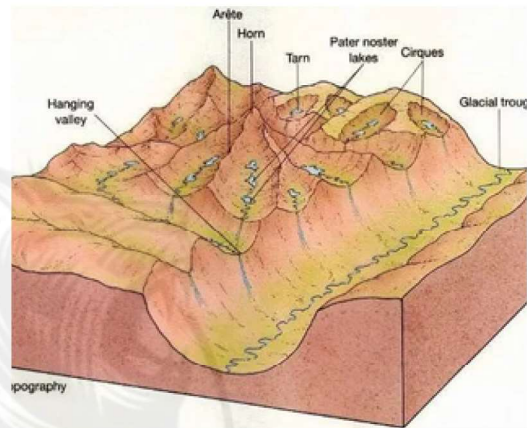
**Outwash Plains.**

**Fjord**

Sea water entering into Glacial Valley

**Tarn Lake**

It is created when water fill up in cirque.



**Landforms Created by Groundwater**

- It is also known as Karst Topography.
- They are found in rocks that are permeable, thinly bedded and highly jointed and cracked like limestone and dolomite, which are rich in calcium carbonate.

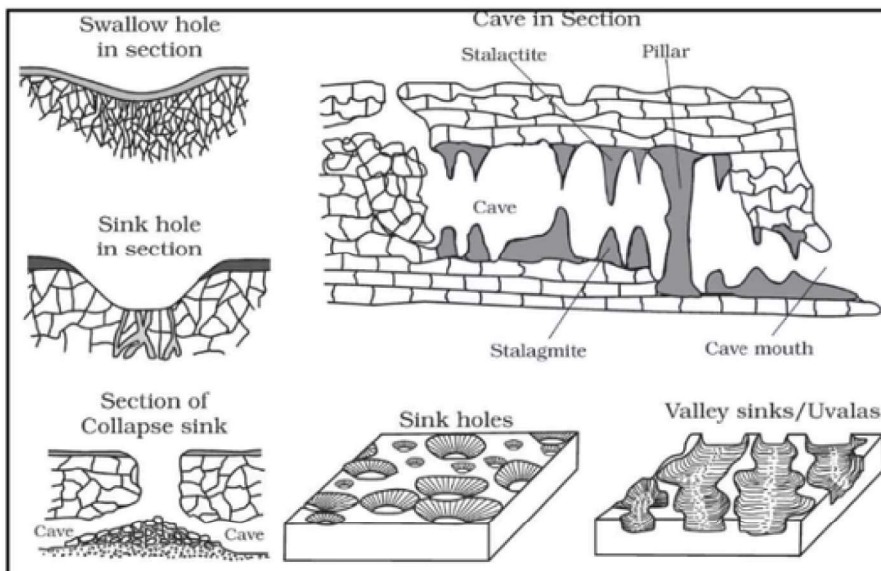
**Karst Topography**

**Erosional**

Sink Hole, Dolines, Lapies, Uvalas, Limestone pavements, Swallow Hole

**Depositional**

Stalactite, Pillars, Stalagmite, Aquifer.



# Landforms Created by Seawaves

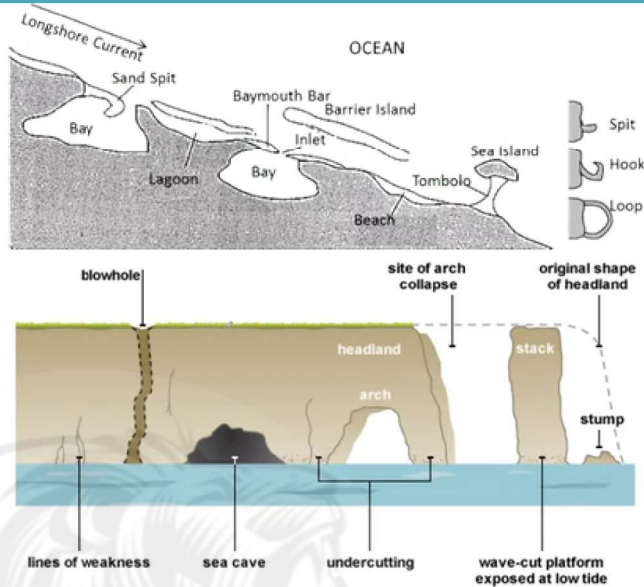
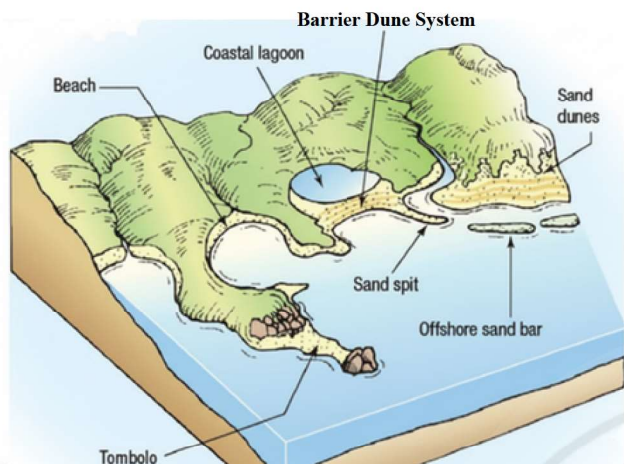
## Landforms Created by Seawaves

### Erosional

Cliff, Sea Caves, Stack, Arch, Headland..

### Depositional

Beaches, Bars, Barriers, Spits, Tombolo



# Landforms Created by Winds

## Landforms Created by Winds

### Erosional

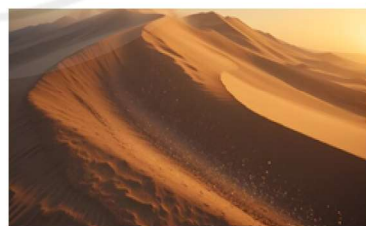
Pediplain, Playas, Mushroom Rock, Pedestal Rocks, Yardang, Zeugen

### Depositional

Sand Dunes ( Barchan and Seif )

✔ **Barchans** : They are crescent shaped dunes whose point or wings are directed away from wind direction. They are found in Jaisalmer, Rajasthan.

✔ **Seif** : It is similar to a Barchan with only one wing



Sand Dunes



Mushroom rock



Playas



Pediplain



Pedestal Rock



Zeugen



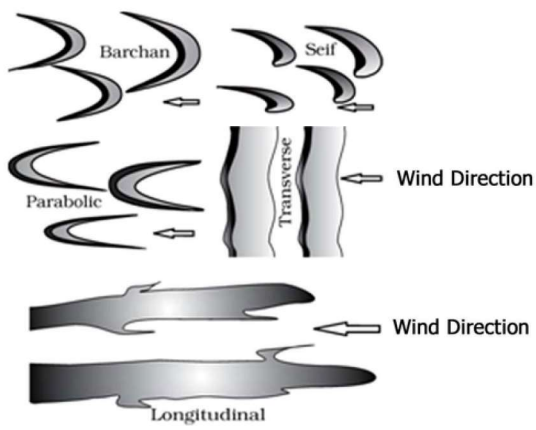
Yardang



Barchan



Inselberg / Monadnock

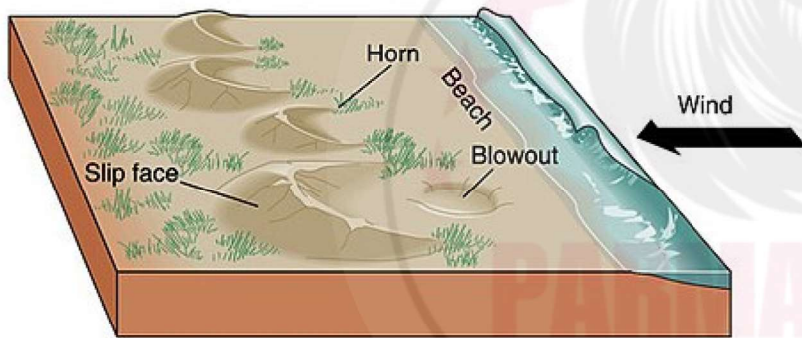


**Oasis**



**Loess**

- ✓ **Oasis :** A fertile area in an arid region, like a desert, where a freshwater source makes plant life possible
- ✓ **Loess :** When the grains of sand are very fine and light, the wind can carry it over a very long distance, such sand gets deposited in large areas and is called as Loess.
- ✓ **Parabolic Dunes :** It is created by vegetation that anchors the sides of the dune while wind erosion forms a depression in the center and deposits sand at the downwind tip



**C Parabolic dunes**

# ATMOSPHERE

The atmosphere is a mixture of gases surrounding Earth, held in place by Earth's gravity.

## Evolution of Atmosphere

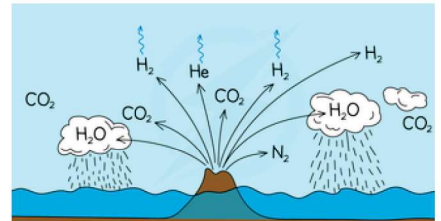
1

**Loss of Primordial Atmosphere:** Initially composed of hydrogen and helium, however this atmosphere was lost due to excessive solar flares.



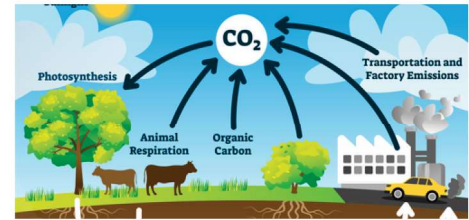
2

**Volcanism:** The hot interior of Earth release gases through volcanic eruptions to form a new atmosphere (Degassing).



3

**Biological Modification:** Plants and living organisms played a key role in further transforming the atmosphere through Photosynthesis.

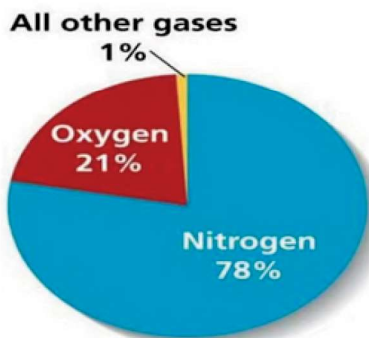


## Different Layers of Atmosphere

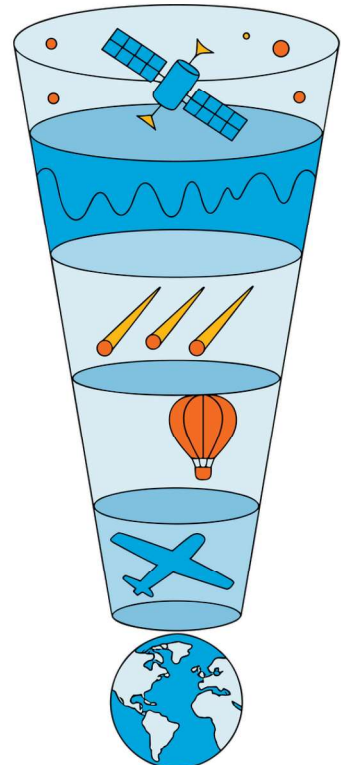
### 1 Troposphere (Tropos : Region of Mixing)

- Troposphere is the lowest layer of Earth's atmosphere.
- All weather phenomena (rain, storms, clouds, etc.) occur in this layer.

### Composition of Gases



Gas	Percentage by Volume
Nitrogen (N <sub>2</sub> )	78.084
Oxygen (O <sub>2</sub> )	20.946
Argon (Ar)	0.934
Carbon dioxide (CO <sub>2</sub> )	0.037
Neon (Ne)	0.00182
Helium (He)	0.00052
Methane (CH <sub>4</sub> )	0.00015
Krypton (Kr)	0.00011



### Height Variation

- At poles : 8 km
- At Equator : 18 km
- Average Height : 13 km

**Reason :** Because Equator receives more heat than the poles and convectional heat is transported to a greater height in equator

- Tropopause is a line that separates Troposphere from Stratosphere.
- As we move upwards in the atmosphere, the density of the air decreases, and that is why the densest air is found in Troposphere.

# Temperature Behavior

- **Lapse Rate** : It is the rate at which temperature changes with altitude in the atmosphere, usually expressed as temperature decreasing with height.
- **Negative Lapse Rate means** Temperature is Increasing with altitude.
- **Positive lapse rate means** Temperature is Decreasing with Altitude.

**Standard Lapse Rate**

165 meters → 1°C decrease

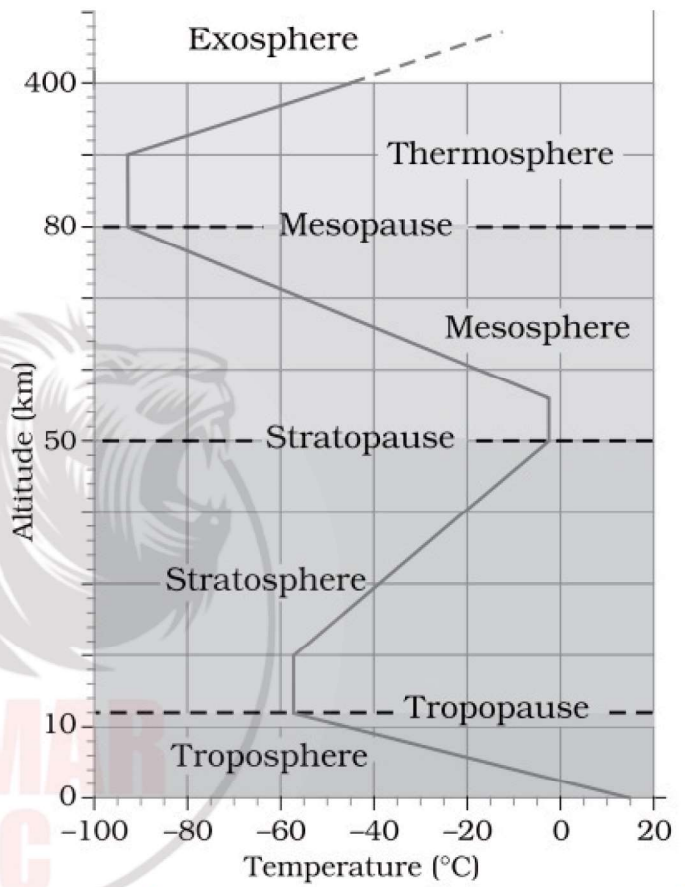
1 km → 6.5°C decrease

## Reason of Temperature Drop

The atmosphere does not heat up directly from solar radiation (insolation). Instead the Earth's surface absorbs solar energy and then emits it as long-wave infrared radiation (Terrestrial Radiation), which warms the lower atmosphere. As the altitude increases, less terrestrial radiation is available, leading to drop in temperature

## remember

- Earth's Surface heats up due to Insolation but Earth's Atmosphere heats up due to Terrestrial Radiation.
- Atmospheric Gases is transparent for short wavelength but not for Long wavelength.

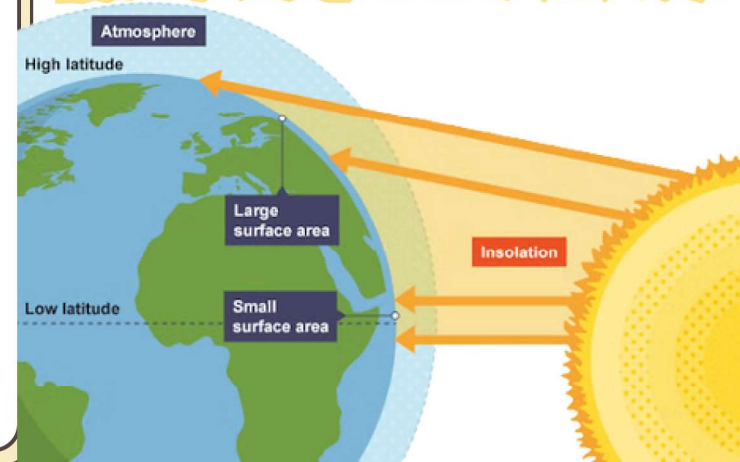


## Effect of Insolation

- **At Equator** : Insolation is less here, due to presence of clouds.
- **At Tropics**: Insolation is maximum here due to minimal cloud covering. E.g. Desert.

## Factors influencing Insolation Includes

- Transparency of the atmosphere
- Length of the day
- Earth's tilt and Rotation
- Surface reflection (Albedo)
- Latitude
- Position of Earth
- Altitude



# Green House Gases

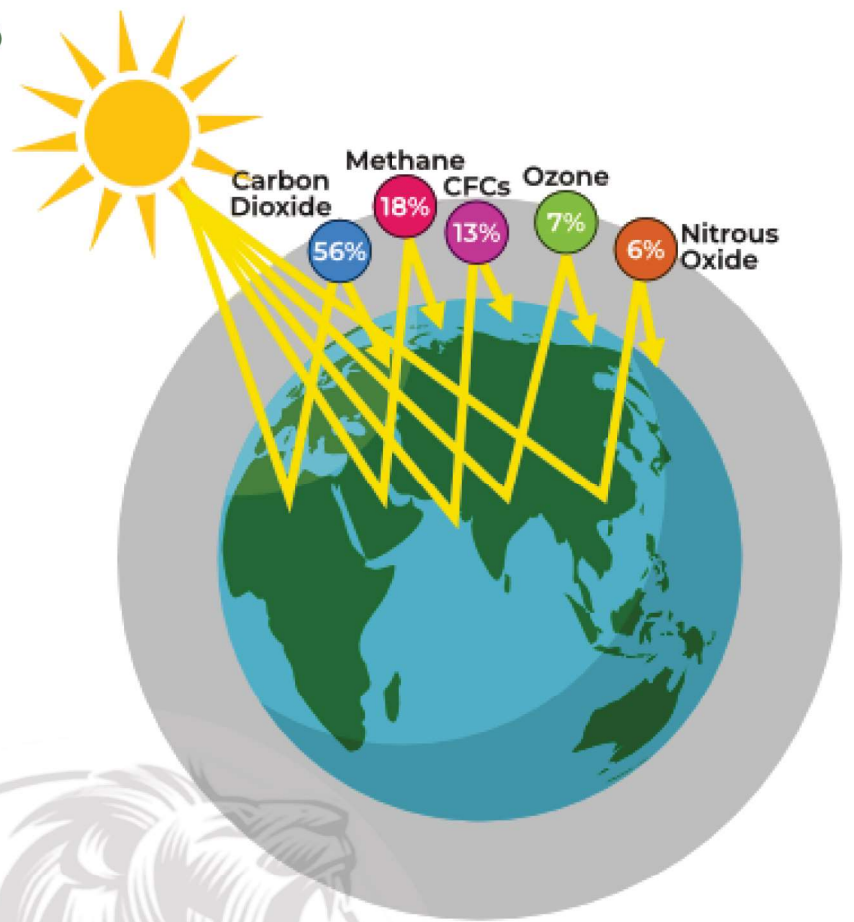
Greenhouse gases keeps earth warm by trapping heat in the atmosphere.

## Key Green House Gases

Water Vapor, Carbon Dioxide, Methane, Nitrous Oxide (Laughing Gas), Ozone.

### Note :

Nitrogen Dioxide is a not Green House gas.

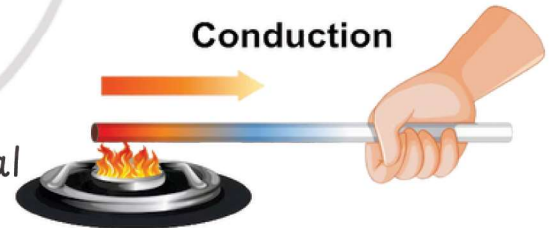


## Heat Transfer Mechanism

The Transfer of Heat in the atmosphere occurs through three primary mechanism.

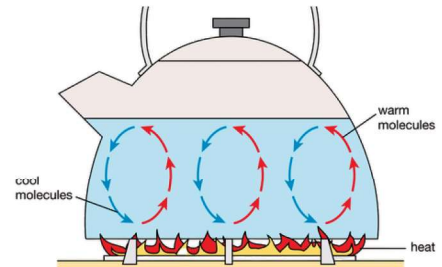
### Conduction

The Process by which heat is transferred directly from one molecule to another without actual movement of air.



### Convection

The vertical transfer of Heat through the movement of air mass.



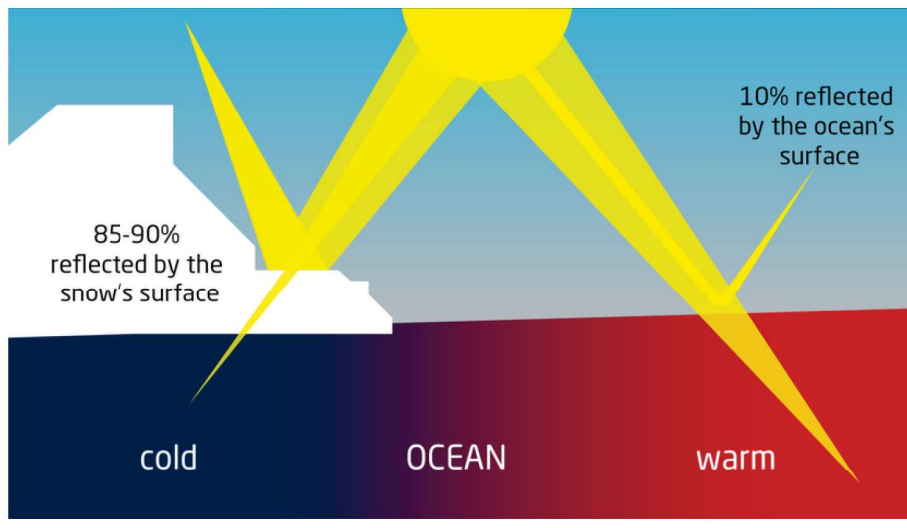
### Advection

The Horizontal Transfer of Heat due to the movement of air .  
Eg. Loo is a result of Advection



# Albedo

- Albedo Refers to the proportion of incident light or Radiation that is reflected by a surface.
- High Albedo is seen in Snow, Ice Caps or Glaciers

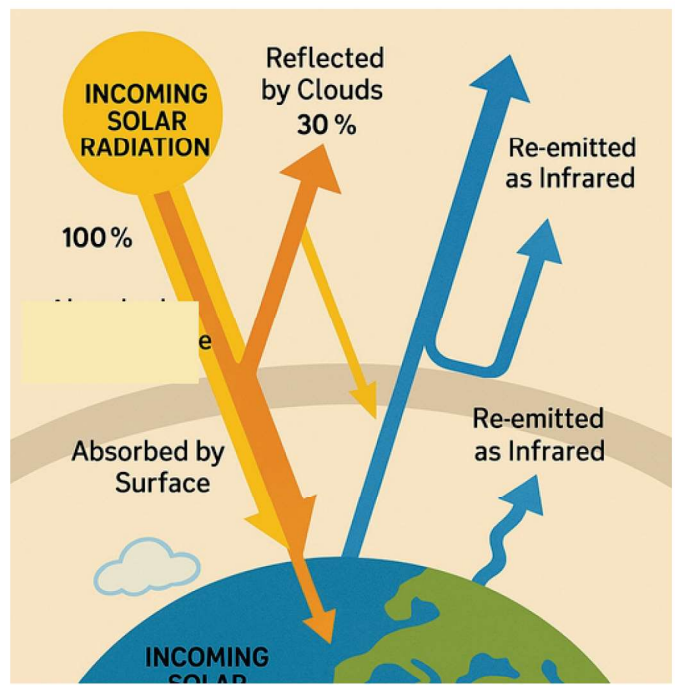
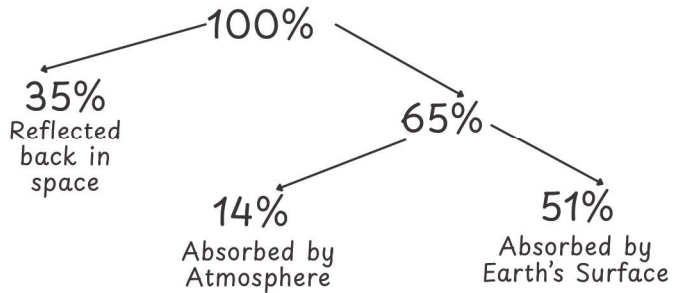


## Albedo Values of Different Surfaces and Clouds

Earth Surface	(%)	Clouds	(%)
Ocean Lakes	8	Shallow broken clouds Cu, Ci, Cs, Cc	30
Land Surface	14-18	St	35
Sand, Desert	27	Thick Clouds (Cs)	40
Ice and Snow		Ac, As, Sc	74
Sea Ice	35	Cu	68
Old Snow	59	Ns	75
Fresh Snow	80	Cb	85
			90

# Heat Budget

- A heat budget is the balance between the heat that the earth absorbs from the sun and the heat that radiates back into space.



# Temperature Inversion

- A phenomenon where temperature increases with Height instead of decreasing.

## Favourable Condition for Temperature Inversion

### Long Winter Nights

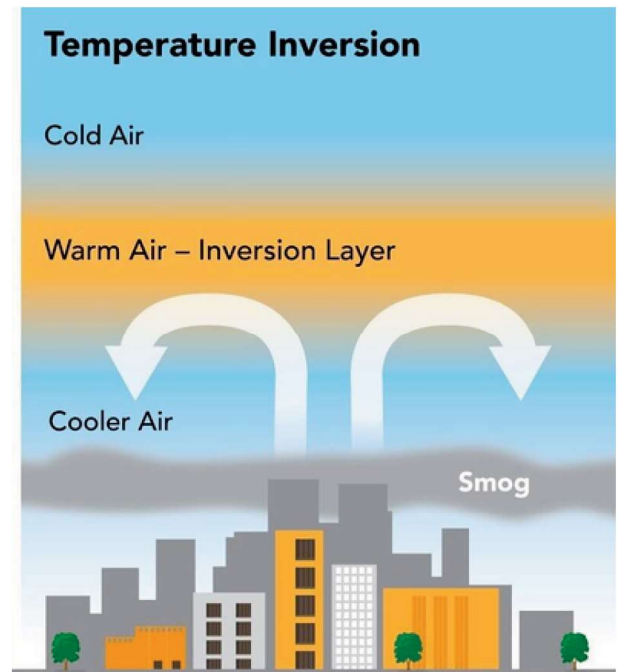
During long nights, the earth's surface loses heat rapidly through radiation, Cooling the air near the surface.

### Still Air

Calm and Stable air prevents the mixing of cold surface air with warmer air above, maintaining the inversion layer.

### Clear Cloudless Sky

Clear skies enhance heat loss from the surface through terrestrial radiation, promoting rapid cooling and inversion formation

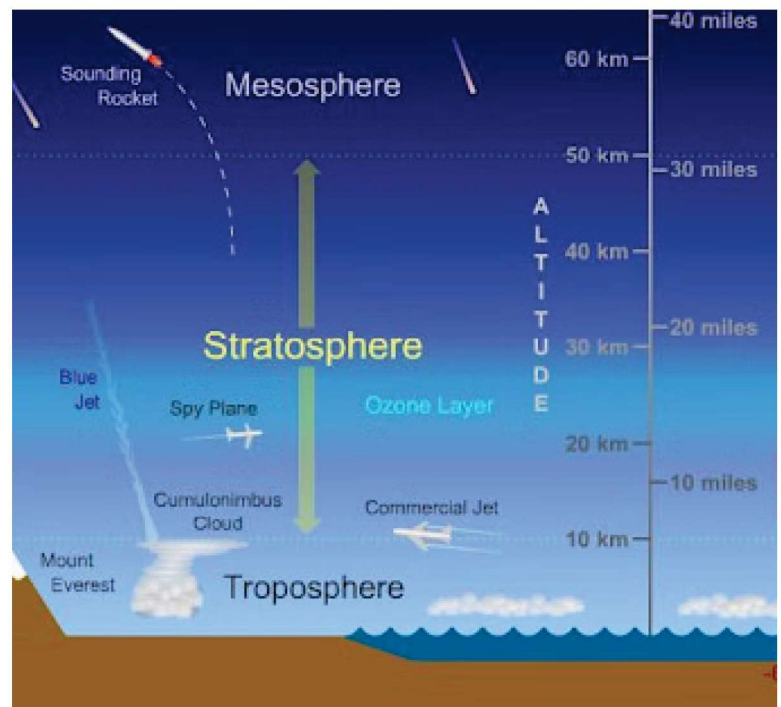


### Note :

- Temperature inversion leads to stability, means No Rain.
- Temperature at tropopause near equator is lower ( $-60^{\circ}\text{C}$  to  $-80^{\circ}\text{C}$ ) as compared to poles ( $-40^{\circ}\text{C}$  to  $-50^{\circ}\text{C}$ ).

## 2 Stratosphere

- It is stretched upto 50 km above earth's crust of the Earth's Atmosphere.
- Temperature increases with altitude in this layer.
- Jet planes fly in this layer.
- Stratopause divided stratosphere and Mesosphere



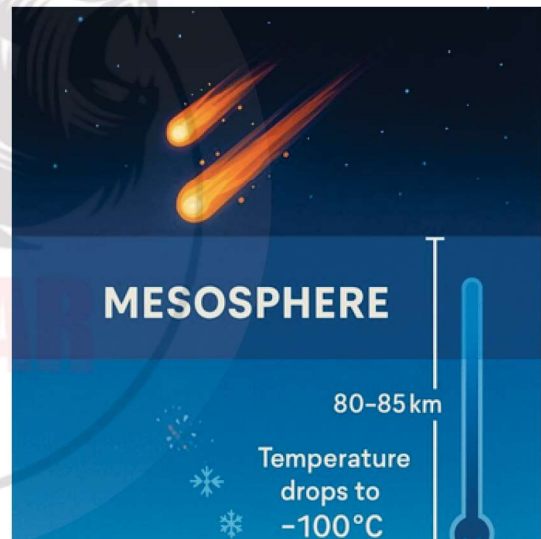
# Ozone Layer



- Ozone layer is located in this layer ( 30-35 km above Earth's Surface), which protects us from Harmful UV-Rays of the Sun.
- Ozone layer thickness is measured in Dobson unit.
- Ozone Day is celebrated on 16 September to commemorate the adoption of the Montreal Protocol in 1987 in Montreal, Canada.
- This international agreement aimed to phase out Chlorofluorocarbons (CFCs), which deplete the ozone layer and contribute to the formation of the ozone hole.
- Kigali Amendment was made to phase out HFCs (Hydrofluorocarbons).

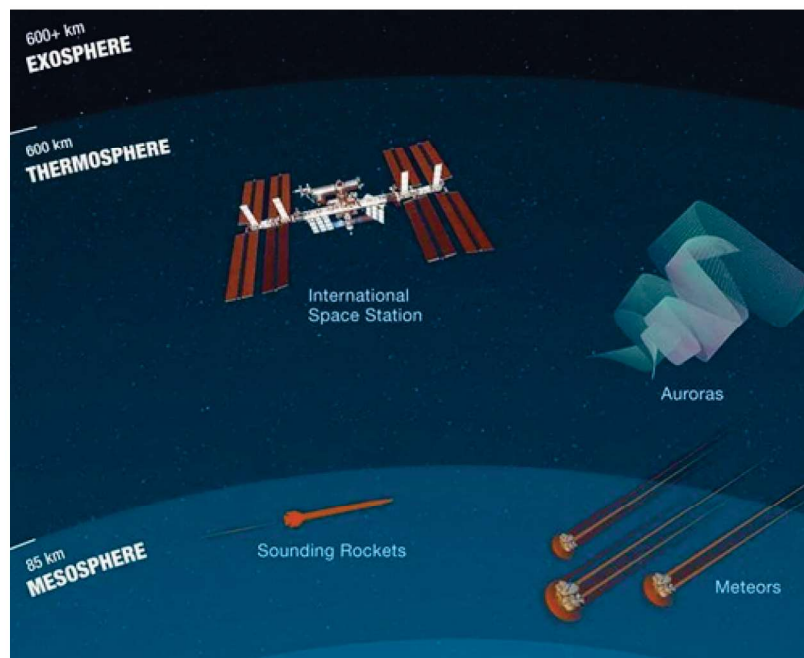
## 3 Mesosphere

- It is located upto 85 km above earth's surface in Earth's Atmosphere.
- It is the coldest layer of atmosphere.
- Meteoroids burn up and end in the mesosphere layer.
- While moving upwards, temperature decreases with altitude.



## 4 Thermosphere

- It is also known as Ionosphere.
- It is located upto 80-400 Km above earth's surface.
- It is the Hottest layer of atmosphere.
- While moving upwards, temperature increases with altitude
- It contains electrically charged particles known as ions, and hence, it is also known as the ionosphere.
- Radio waves transmitted from the earth are reflected back to the earth by this layer



## 5 Exosphere

- It is the 5th and the last layer of atmosphere.
- Mostly composed of Hydrogen and Helium



### Karman line

- It is an imaginary boundary located 100 kilometers (about 62 miles) above sea level that separates Earth's atmosphere from outer space.

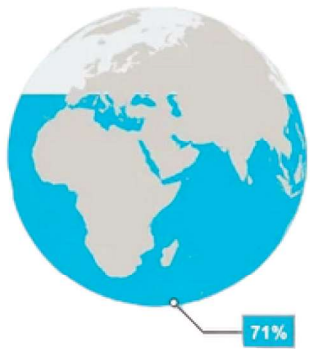
### Isotherm Line

- These are lines or points on map/chart of the Earth's surface connecting points having same temperature at a given time.

PARMAR  
SSC

# Water on earth

- 97.2 % of Earth's water is saline; only 2.8% is fresh water.
- Out of 2.8% freshwater : Ice caps / glacier (2%), Groundwater (0.68%), Lakes (0.4%), Atmosphere, River.
- As a whole (Freshwater): Ice caps / glacier (68.7%), groundwater (30.1%)



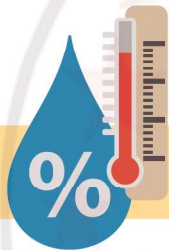
Percentage of the Earth's surface covered in water



Readily available freshwater

71% of Earth's surface covered with water.  
29% of Earth's surface is covered with land

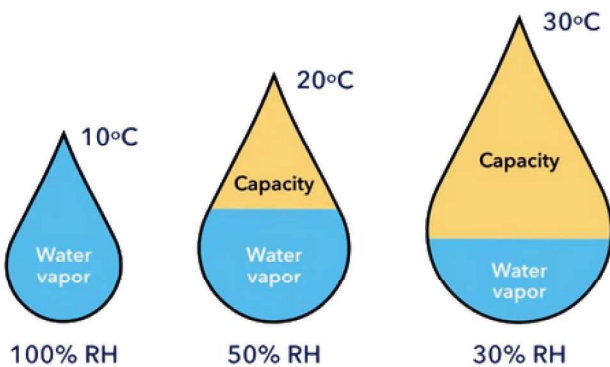
## Humidity



Humidity is the concentration of water vapour present in the air.

### Types of Humidity

- 1 **Absolute Humidity:** It is the total mass of water vapour present in a unit volume of air at a given temperature.
- 2 **Relative Humidity:** Actual moisture percentage compared to maximum capacity.



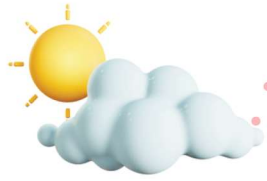
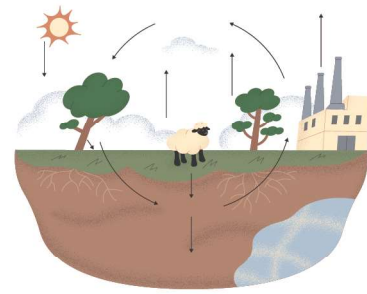
$$RH = \frac{\text{Absolute Humidity}}{\text{Capacity}} \times 100$$

## DON'T FORGET

- Absolute humidity is higher in warm air compared to cold air Because warm air can hold more water vapour due to its higher energy level.
- Humidity is measured by Hygrometer

# Water Cycle

Water cycle is the continuous movement of water between the Earth's atmosphere and surface.



## Evaporation

Evaporation is a process in the water cycle that changes liquid water into water vapour.



## Latent Heat of Vaporization

The amount of heat energy required to change a unit mass of a liquid into a gas at a constant temperature is called **Latent Heat of Vaporization**

## Precipitation

Precipitation is any liquid or frozen water that forms in the atmosphere and falls back to the earth in the form of rain, snow or hail.

### Types of Precipitation

**01 Rain** Liquid water droplet that fall when the air temperature is above freezing point.



**02 Snow** Frozen water crystals that are formed when temperature is below freezing point.



**03 Sleet** Small pellets of ice that forms when a layer of warm air lies above a subfreezing layer resulting raindrops freeze before reaching the surface.



**04 Hail** It is a type of precipitation that falls to the ground in the form of ice balls or lumps.

- Concentric Rings are seen in Hailstone



# Condensation

It is the process where water vapour (gas) becomes water (liquid).



## Forms of Condensation

**01 Dew** It is the moisture that form as a result of condensation.



**02 Fog** It is the thick clouds that forms close to the ground and reduce visibility. In fog the size of water droplets tend to be larger compared to those in mist. Fog contain less moisture than mist and has visibility less than 1 km.



**03 Mist** Mist is a phenomenon caused by small droplets of water suspended in the cold air, usually by condensation. Mist contains more moisture than fog and has visibility of more than 1 km.



**04 Frost** It forms when water vapor (gas) directly turns into solid ice crystals without becoming liquid first.



**05 Clouds** A mass of very small drops of water that floats in the sky and is usually white or grey



**Note:** Dew, Fog and Mist are formed when Dew point is greater than Freezing point, while Frost is formed when Freezing point is greater than Dew point.

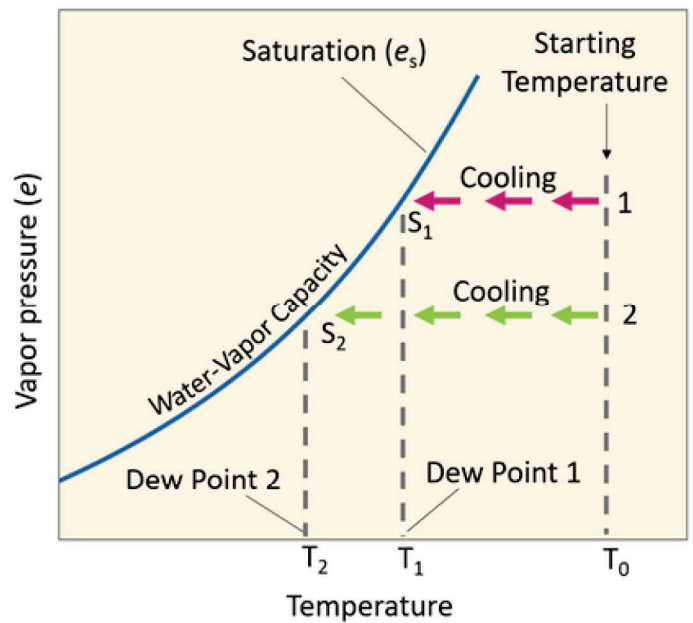
## Smog

Smog is a type of air pollution that results from the combination of smoke and fog



# Dew Point

- The dew point is the temperature at which air becomes fully saturated with moisture, causing water vapour to condense into liquid droplets.
- In winter air cools down due to which dew point reduces, water vapour condenses into water.

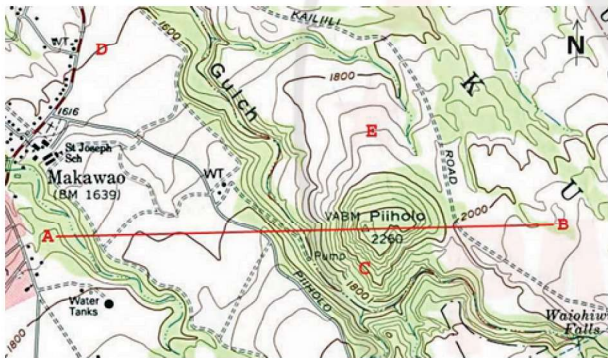


# Clouds

Clouds are visible masses of tiny water droplets or ice crystals suspended in the Earth's atmosphere

## Isoneph

- Line drawn on map, connecting the points containing same amount of clouds.



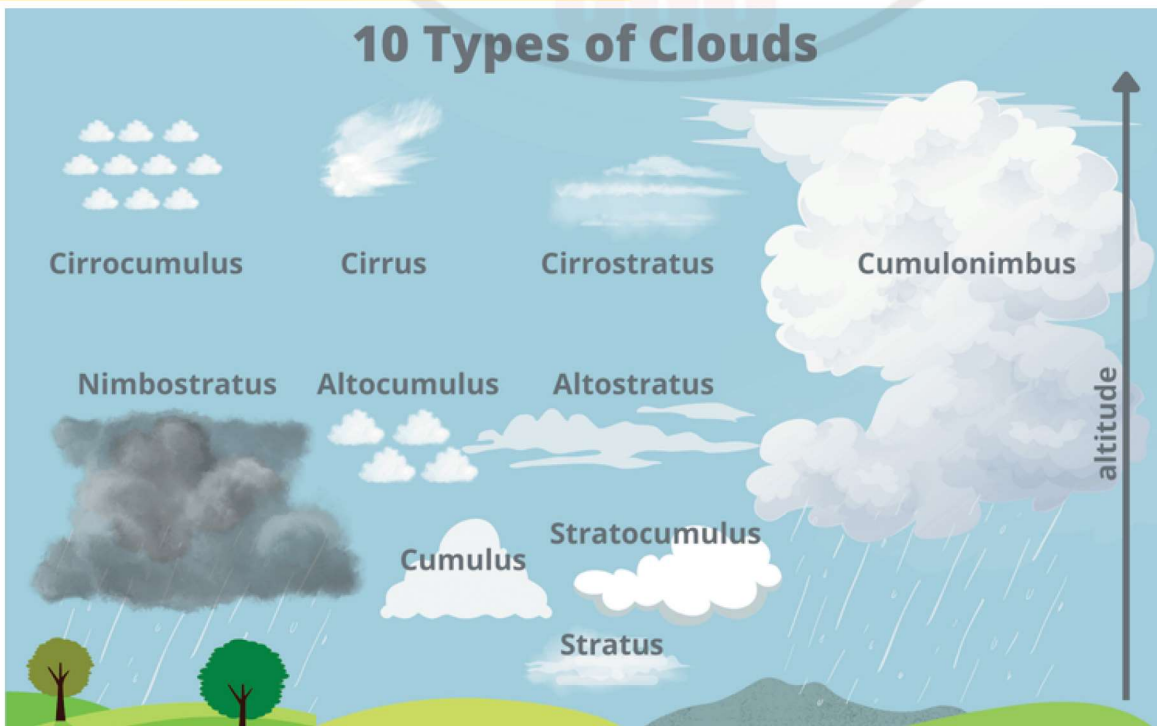
## Hygroscopic Nuclei

- Microscopic particles in the atmosphere, like dust, salt, and smoke, that attract and absorb water vapor, acting as surfaces for clouds to form

## Collision-coalescence process

- It is a weather mechanism where cloud droplets grow by colliding and merging into larger droplets that eventually fall as precipitation

# Different Types of Clouds

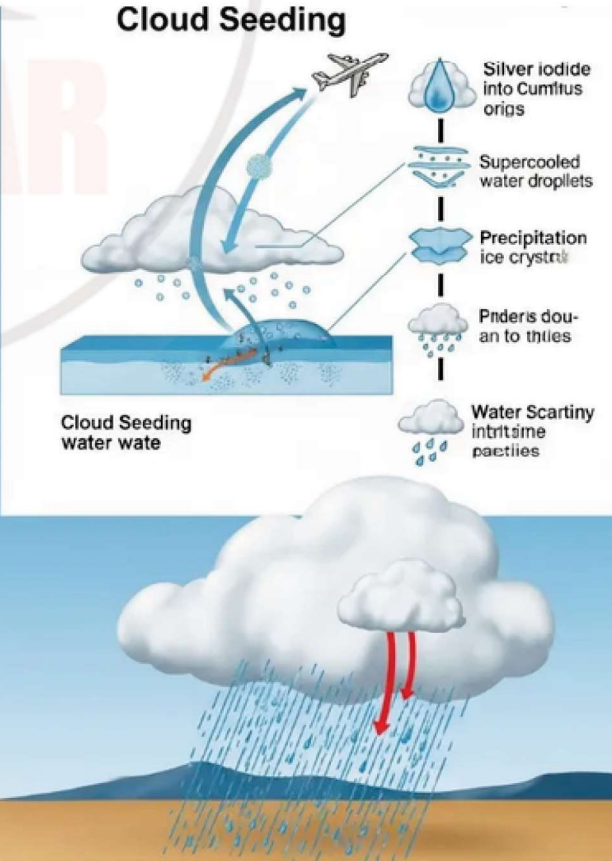
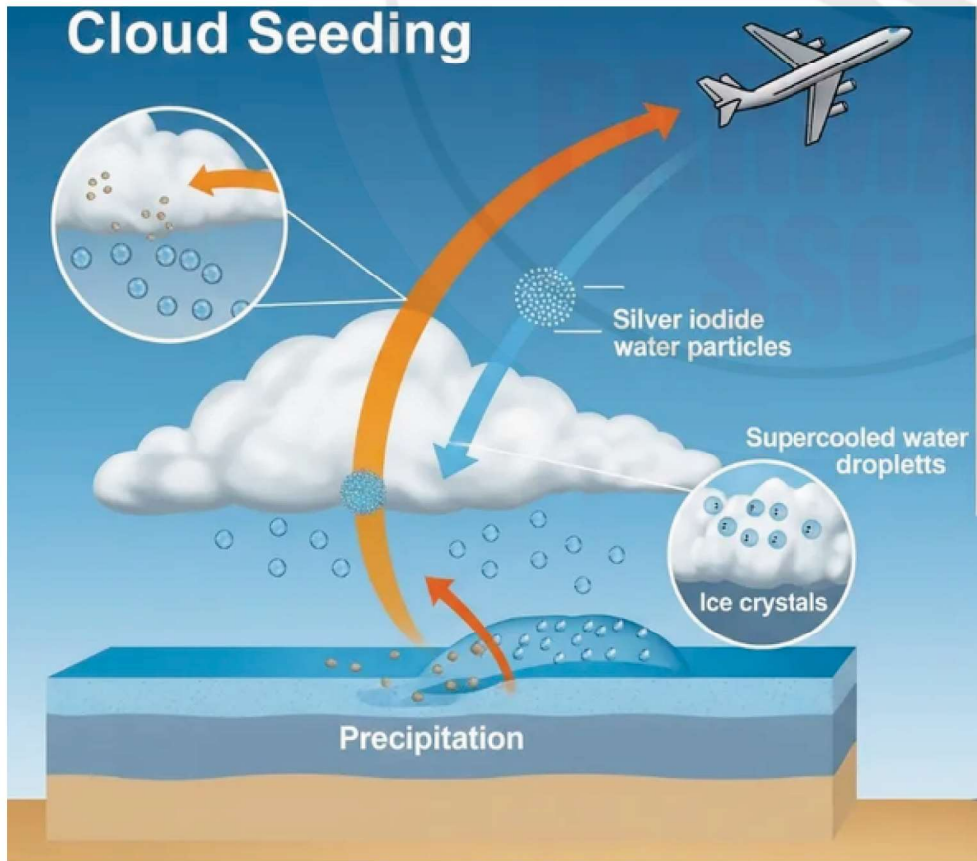


# Different Types of Clouds

Clouds	Height	Features
Nimbus	Low Level (<4km)	Rain Bearing, Opaque, Grey
Stratus	Low Level (<4 Km)	Layered Clouds
Cumulus	Middle level 4-7 Km	Wool / Cauliflower shaped, flat base
Cirrus	High Altitude 8-12 Km	Feather shaped clouds, Do not cause Rain
Cumulonimbus	Extensive Vertical Development	Produce severe weather that contributes to cyclone & has Anvil top.

## Cloud Seeding

Cloud seeding is a weather modification technique that involves dispersing substances like silver iodide, dry ice, or salts into clouds to increase the amount of precipitation that falls, such as rain or snow



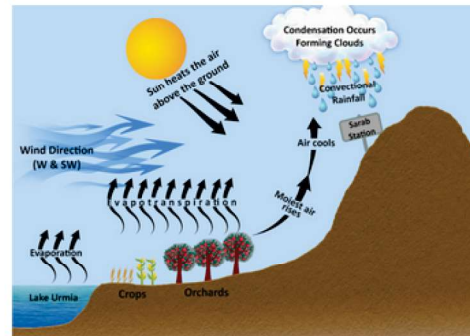
# Rainfall

Rainfall is the amount of water that falls from the atmosphere as precipitation over a specific period and area.

## Types of Rainfall

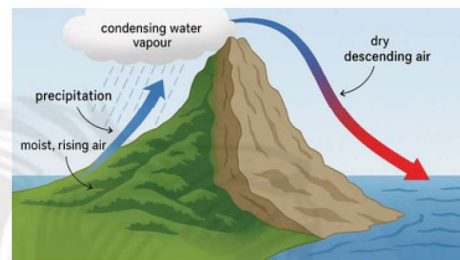
### 1 Convectional Rainfall

It occurs when the surface of earth is heated up by the sun.



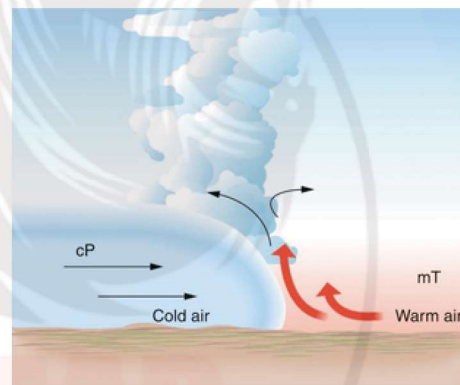
### 2 Orographic Rainfall

Precipitation that occurs when moist air is forced to rise over a mountain.



### 3 Frontal / Cyclonic Rainfall

It is type of precipitation that occurs when warm, moist air meets cold, dry air mass.



### Leeward Side (Dryside)

This side of mountain faces away from the wind (mostly affected by Katabatic wind) receives the Less rainfall as the air loses it's moisture on the windward side before descending dry. It is also a rain shadow region.  
Eg. : Leeward side of Western Ghats

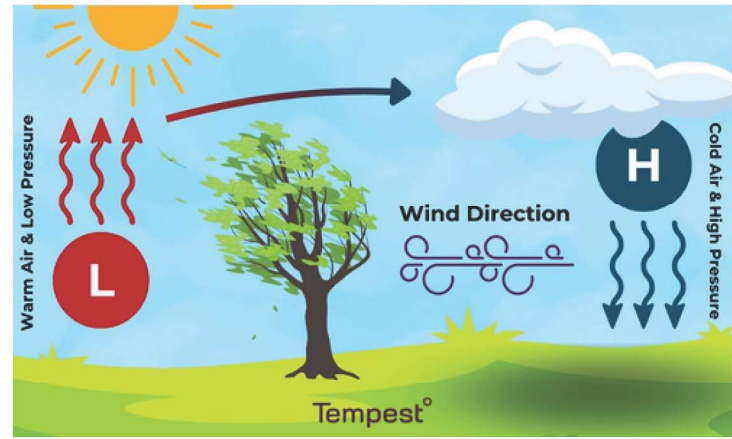
### Windward Side (Wet side)

This side of mountain facing the wind (mostly affected by Anabatic wind) receives the heavy rainfall as the air rises and cools there.  
Eg. : Windward side of Western ghats

Mumbai (Maharashtra) and Manglore (Karnataka) are in windward side of Western Ghats unlike Vidarbh (Maharashtra) and Banglore (Karnataka), hence experience more Rainfall.

# Wind & Pressure Difference

- Wind blows due to differences in air pressure in the Earth's atmosphere often called as Pressure Gradient.
- Air moves from high pressure to low pressure.
- The sun heats the Earth unevenly, so some places get warmer than others.
- At the Equator, there is generally low air pressure due to the rising of warm and light air; while at the Poles, there is high air pressure because of the sinking of cold and dense air.



## Types of Wind

### 1 Permanent Winds

Permanent winds, also known as planetary winds, are winds that blow consistently from the same direction throughout the year, moving air across large area of earth.

Three Division of Permanent Winds are : Trade Winds, Westerlies and Polar Easterlies.

- Trade winds are divided into Northern Easterlies and southern Easterlies

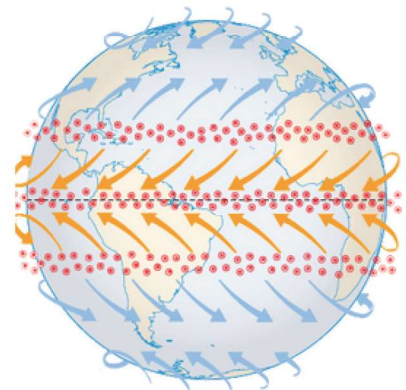
### 2 Local Winds

Local winds are winds that blow over short distances and are typically caused by local geographic features and temperature differences in specific areas.



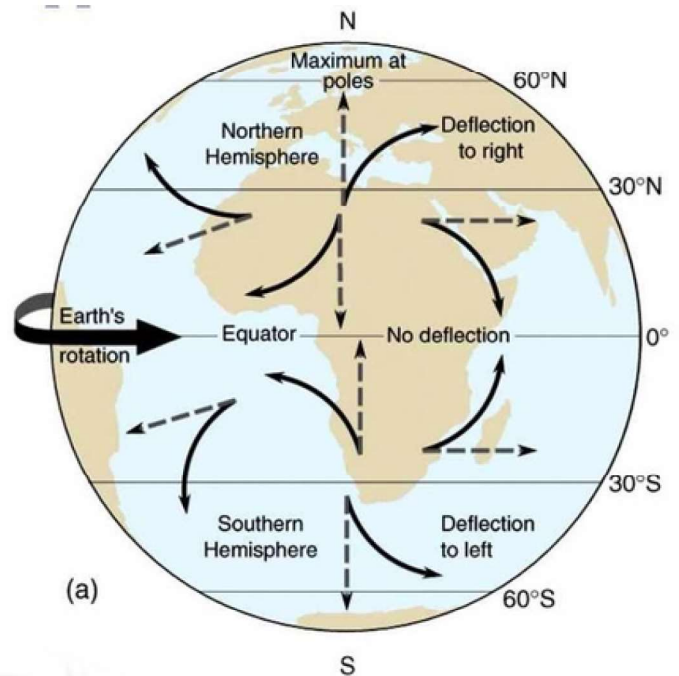
## Easterlies & Westerlies

- A wind is named based on the direction from which it originates.
- If it originates from East and flows towards West, called Easterlies.
- If it originates from West and flows towards East, called Westerlies.



## Coriolis Force

- Coriolis force is an apparent force that is caused due to rotation of Earth.
- The Coriolis force is responsible for deflecting winds towards the right in the Northern Hemisphere and towards the left in the Southern Hemisphere.
- Coriolis force is maximum at the Poles and zero at the Equator.
- The Coriolis force is directly dependent on the wind speed. The faster the wind moves, the stronger the Coriolis force becomes and greater is the wind deflection.



## Trade Winds

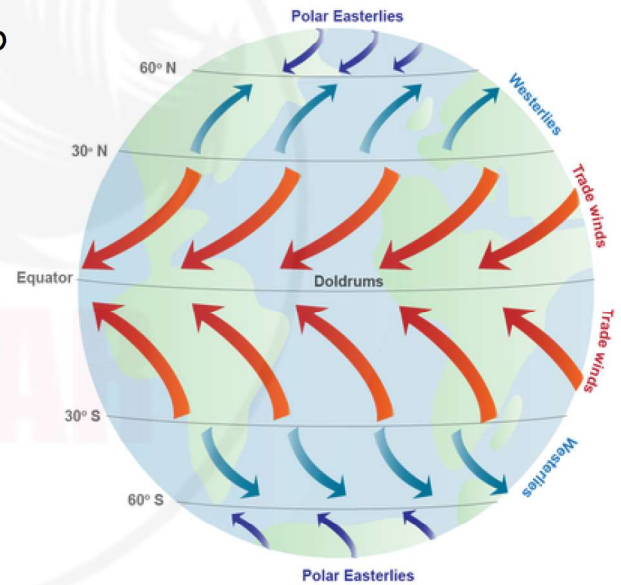
They are steady winds that blow from east to west near the Earth's equator.

### Location

- They are found between approximately 30° latitude (north and south) and the equator.
- They blow from northeast in the Northern Hemisphere and southeast in the Southern Hemisphere towards the equator.

### Cause

- They are created due to Coriolis effect (rotation of the Earth) and the unequal heating of the Earth's surface.



## Westerlies

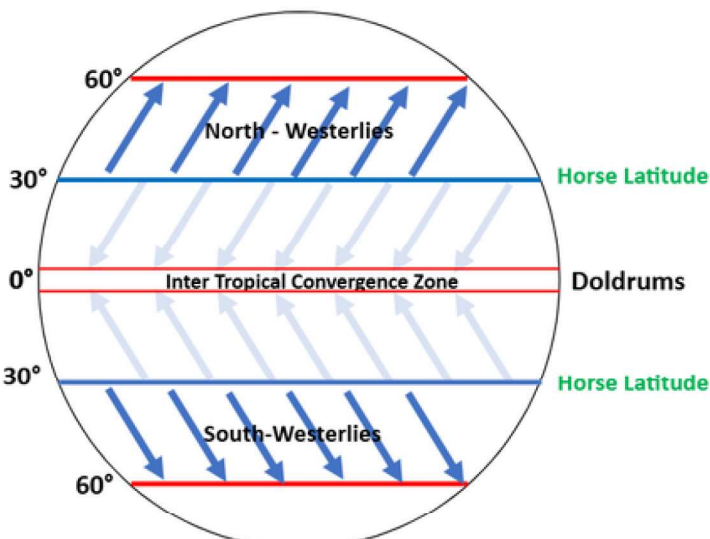
Westerlies are winds that blow from west to east in the mid-latitudes.

### Location

- They blow between 30° and 60° latitude (in both hemispheres).
- They come from the southwest in the Northern Hemisphere and the northwest in the Southern Hemisphere.

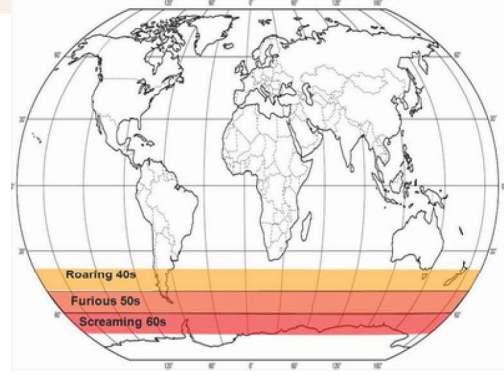
### Cause

- The Coriolis effect causes these winds to deflect toward the east.



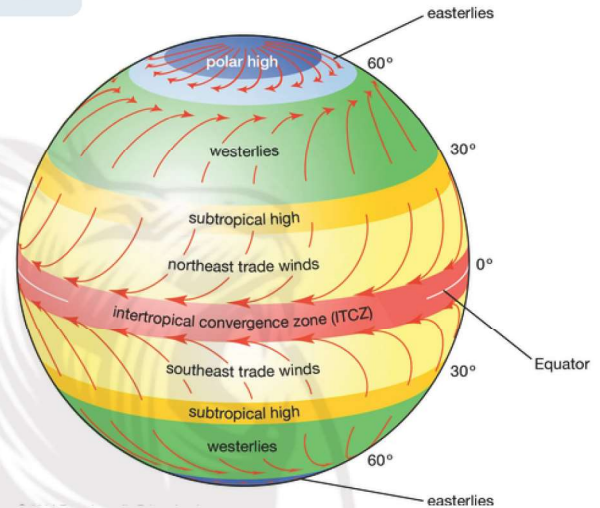
## Roaring Forties, Furious Fifties, Shrieking Sixties

These are names given to strong Westerly winds in Southern Hemisphere that blow over the 40°S, 50°S, and 60°S latitudes. Reason for their high speed is less landmass in Southern Hemisphere.



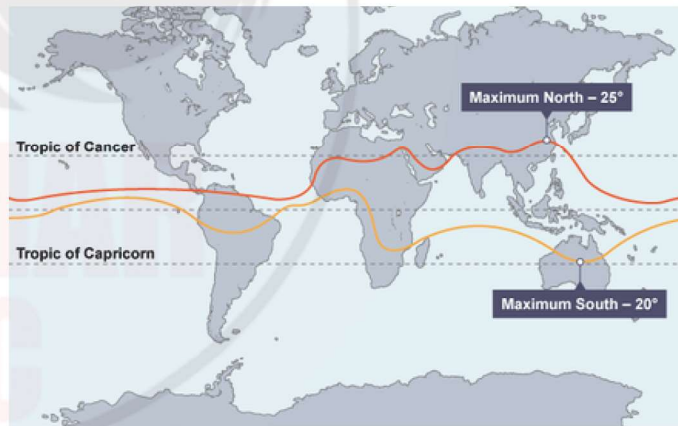
## ITCZ (Intertropical Convergence Zone)

- The ITCZ forms where the northeast trade winds from the Northern Hemisphere meet the southeast trade winds from the Southern Hemisphere.
- It is typically found between the Tropic of Cancer and Tropic of Capricorn. In the month of July it is located at 20°N-25°N.



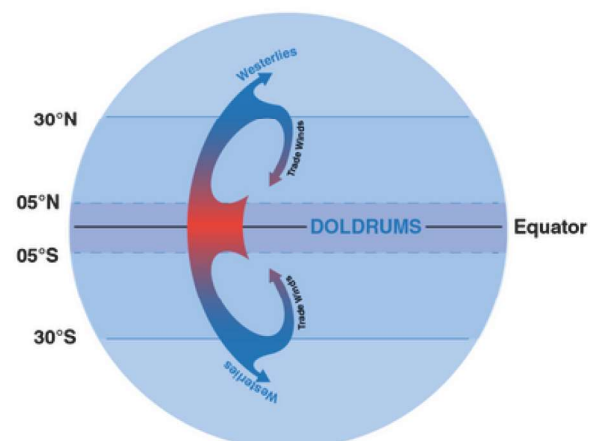
## Movement of ITCZ

- The ITCZ moves seasonally, following the sun's position.
- In the Northern Hemisphere, it moves north in the summer and south in the winter.
- The ITCZ moves more north and south over land than over water because the ocean heats up more slowly as compared to land.



## Doldrum

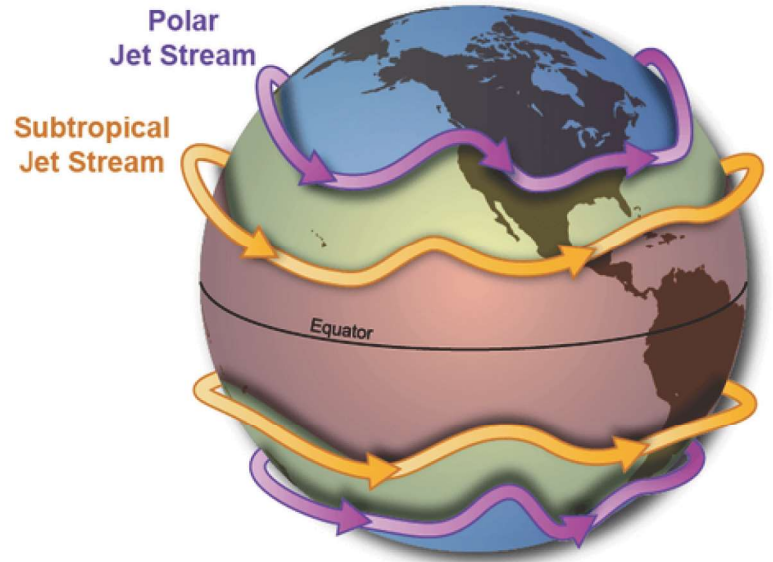
- The Doldrums is a low pressure area around the Equator where the prevailing winds are calm.
- They are found between 10°N and 10°S.
- The Doldrums overlap with the ITCZ region.





## Jet Stream

- A jet Stream is a narrow band of wind in the upper atmosphere, 30,000 feet (9,100 meters)
- Jet Stream shift north and South as they follow boundaries of hot and cold air.
- In Both Hemispheres, Jet streams blow west to east.



## Land Breeze and Sea Breeze

Land Breeze and Sea Breeze are types of local winds that occur due to temperature difference between land and water.

### Land Breeze

It occurs at night when land cools faster than sea, creating high-pressure over land and low pressure over the sea, causing air to move from land to sea; more common in autumn and winter.

- Specific Heat Capacity of Land is Less as compared to Sea.



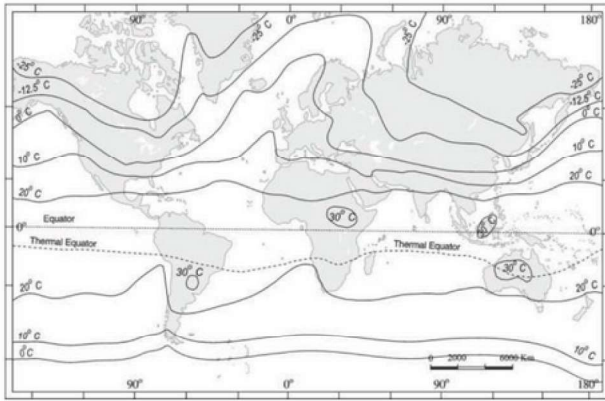
### Sea Breeze

It occurs during the day when land heats up faster than the sea, creating low pressure over land and high-pressure over the sea, causing air to move from sea to land; more common in spring and summer.

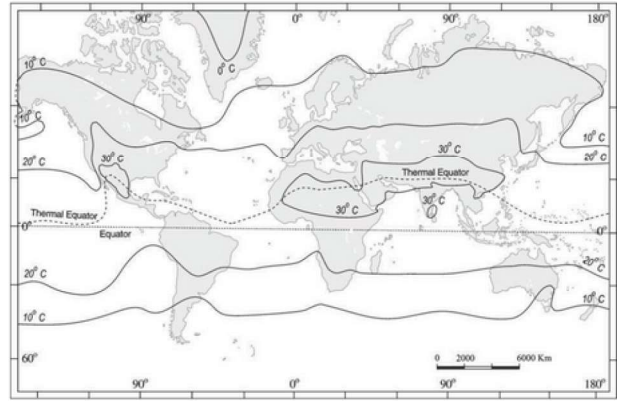
- Specific Heat Capacity of Sea is More as compared to Land.



# Distribution of Surface air Temperature



January



July

## Local Winds



## Local Winds (Hot)

### Chinook

- Type: Hot, dry wind
- Blows in : The Rockies mountains
- Also Known as Snow Eater.

### Sirocco

- Type: Hot, moist wind
- Blows in : Sahara to the Mediterranean Sea

### Harmattan

- Type: Hot, dry wind
- Blows in : West Africa
- Also known as "Guinea Doctor"

### Khamsin

- Type: Hot, dry wind
- Blows in : Egypt

### Brickfielder

- Type: Hot, dry and Dusty wind
- Blows in : Australia

### Foehn

- Type: Hot, dry wind
- Blows in : The Alps

## Local Winds (Cold)

### Blizzard

- Type: Cold wind
- Blows in : Tundra region

### Mistral

- Type: Cold Wind
- Blows in : The Alps and France

### Bora

- Type: Cold, dry wind
- Blows in : Blows from Hungary to North Italy

## Levanter

- Type: Cold Wind
- Blows in : Spain

## Purga

- Type: Cold wind
- Blows in : Russia

## Punas

- Type: Cold dry wind
- Blows in : The western side of Andes Mountain



# Cyclone

- Cyclone are rotating mass of air.
- They are large powerful storm that forms over warm ocean waters, with strong winds and Heavy rains.



## Formation of Cyclone

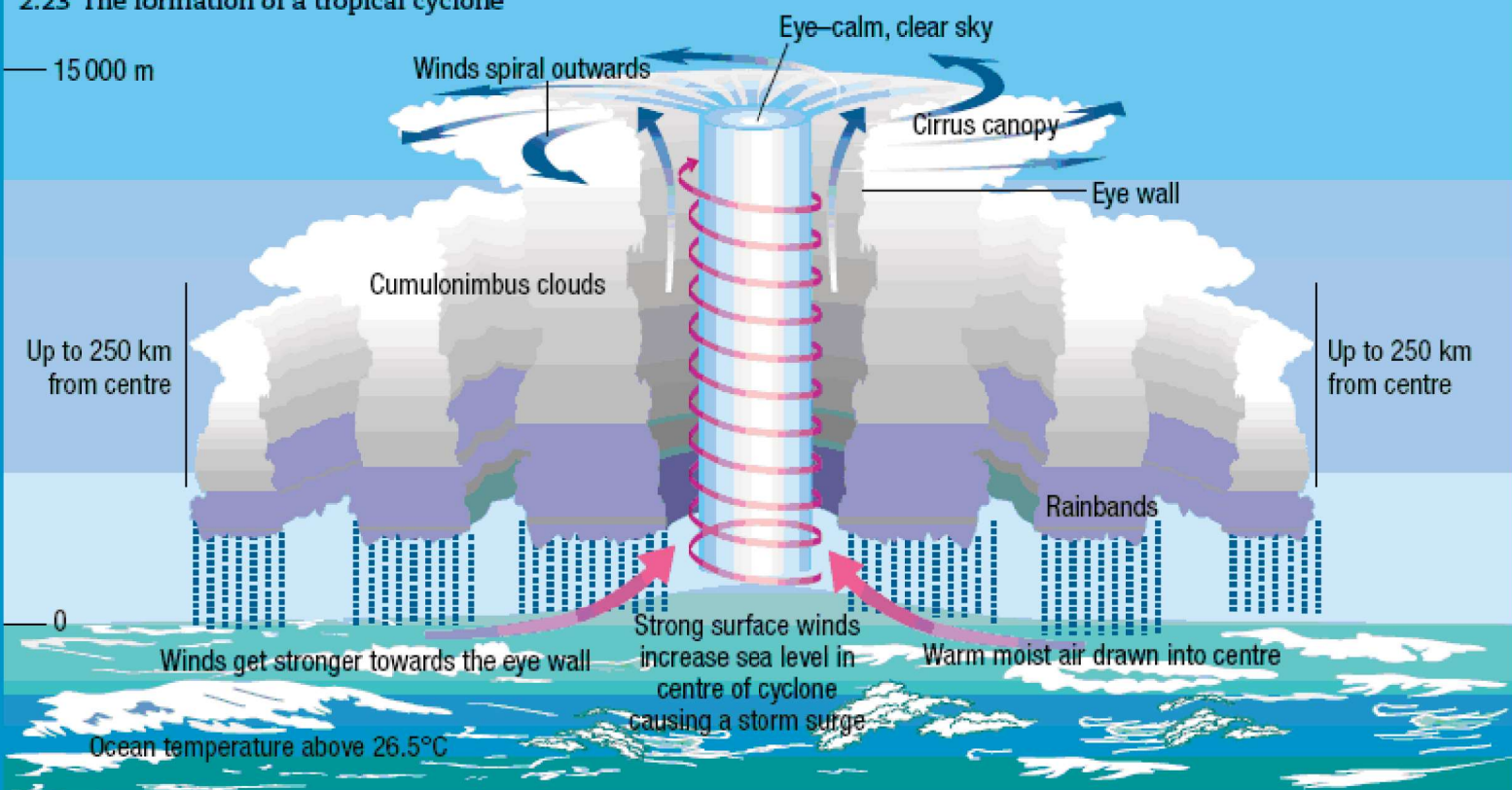
- Cyclones form when warm, moist air rises over the ocean.
- As the air rises, it creates weak low pressure, and cooler air rushes in to replace it.
- The Earth's rotation causes the air to Spin, and the storm grows stronger.
- When the storm gets big enough, it becomes a cyclone with strong winds and heavy rain.

## Favorable Conditions For Formation of Cyclone

1. Large Sea Surface Temperature
2. Atmospheric Instability
3. Coriolis Force
4. Pre-Existing weak low pressure Area
5. Sea Temperature must be at least 27° C or higher.

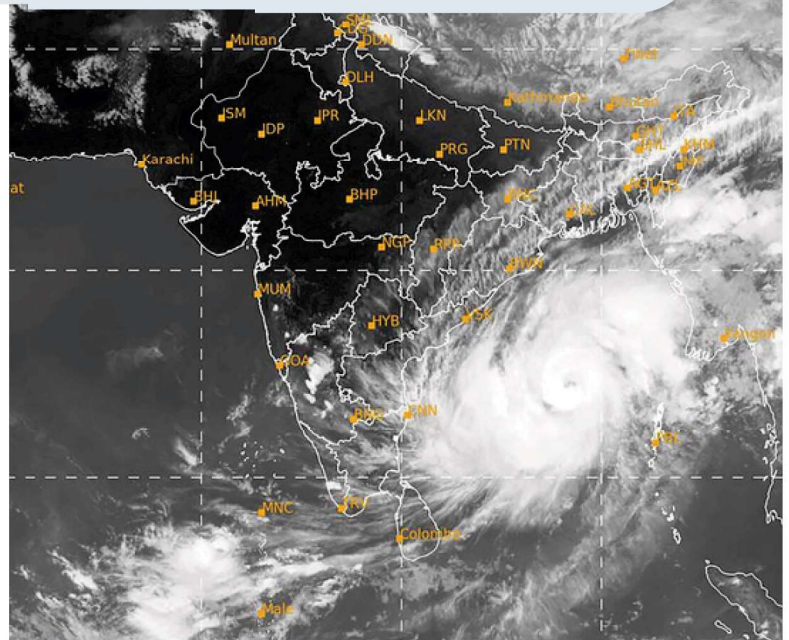
A Cyclone Rotates anti-clockwise in Northern Hemisphere and Clockwise in southern Hemisphere

2.23 The formation of a tropical cyclone



# Different Names of Cyclone Around the World

- 
- **Hurricane** : Atlantic Ocean
  - **Typhoon** : South China Sea & Western Pacific Ocean
  - **Willy-Willy** : Australia
  - **Cyclone** : India



## Why Bay of Bengal (BOB) Experience More Cyclones than Arabian Sea ?

- BOB is surrounded by landmass which leads to more heat transfer in BOB.
- It is Funnel shaped, hence wind rushes in BOB from all direction.
- More Fresh water Influx.
- Monsoonal trough



## How naming of a Cyclone is decided ?

- Cyclone names are decided by regional committees, like the WMO/ESCAP Panel on Tropical Cyclones for the Bay of Bengal and Arabian Sea, that use pre-approved, sequentially assigned lists of names.
- There are total of 13 countries in this list including India, Iran, Maldives, Myanmar, Oman, Pakistan, Bangladesh, Qatar, Saudi Arabia, Sri Lanka, Thailand, United Arab Emirates, and Yemen

# Formation of Temperate Cyclone

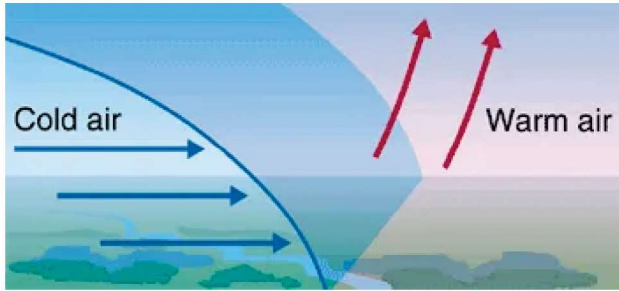
Mid-latitude cyclones or temperate cyclones or extra-tropical cyclones occur due to frontogenesis.

## Frontogenesis

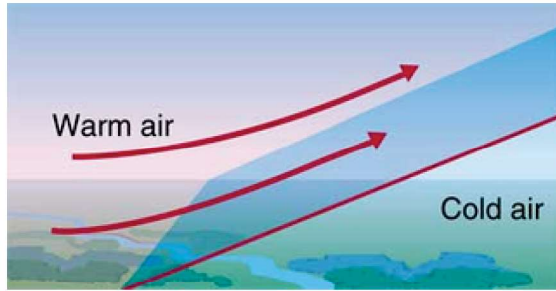
- Frontogenesis involves convergence of two distinct air masses.

## Frontolysis

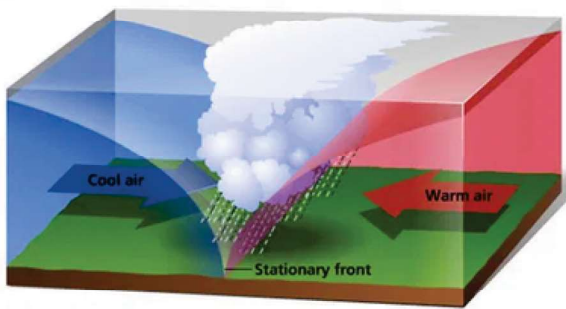
- Frontolysis involves overriding of one of the air mass by another



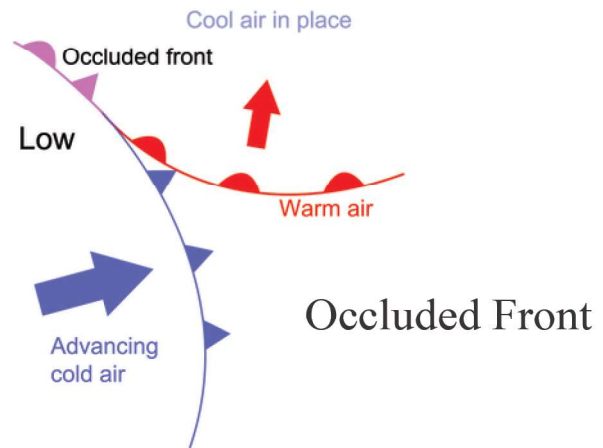
Cold Front



Warm Front

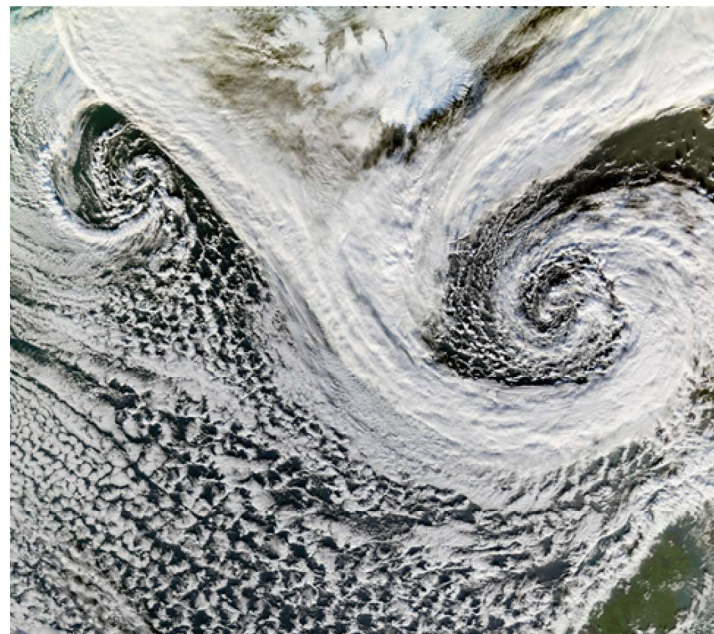


Stationary Front



Occluded Front

- Temperate cyclone originates due to convergence of polar easterly cold air mass and sub-tropical westerly warm air mass in sub polar low pressure belt around  $60^{\circ}$  to  $65^{\circ}$  latitudes.
- Since the air masses are of two different properties, so they can't intermingle readily. They mix with each other very slowly. As a result, front develops between them.
- Temperate Cyclones move from West to East under the influence of Westerlies.



# Difference Between Tropical & Temperate Cyclone

## Tropical Cyclone

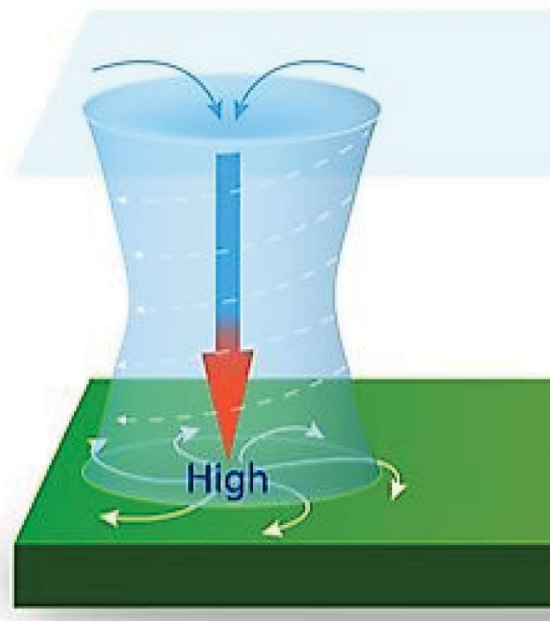
- They originate over sea.
- They are formed due to certain favourable condition over the sea.
- They cover less area but cause more destruction
- They occur rarely
- They move from east to west

## Temperate Cyclone

- They originate over sea and land.
- They are formed due to Frontogenesis.
- They cover large area but cause less destruction.
- They occur frequently.
- They move from west to east

## Anticyclone

- An anticyclone is formed around an area of high pressure where the air sinks, causing clear skies and calm weather.
- It usually brings dry and sunny condition.
- An anticyclone rotates clockwise in Northern Hemisphere and anti-clockwise in Southern Hemisphere.



### Note:

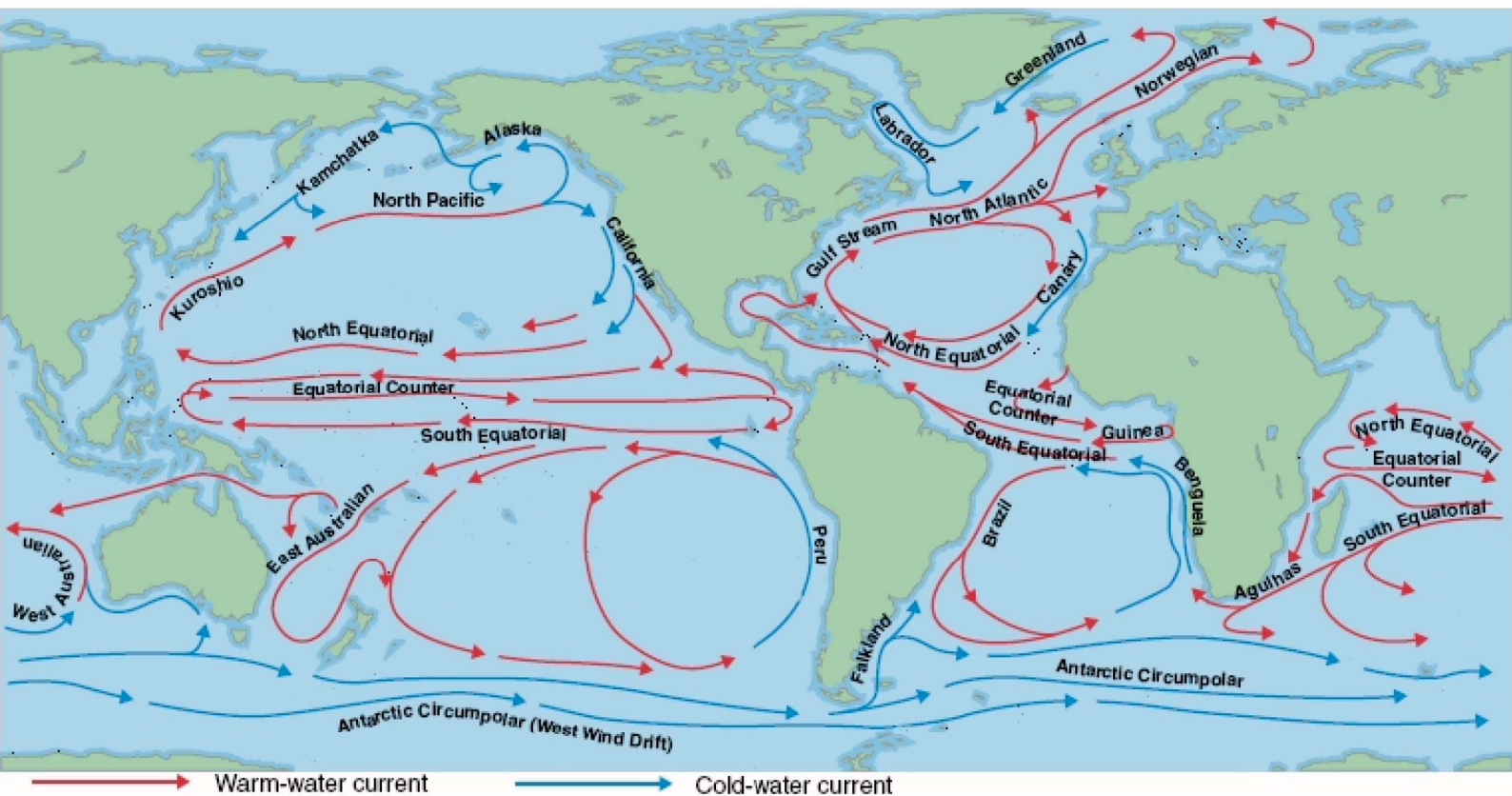
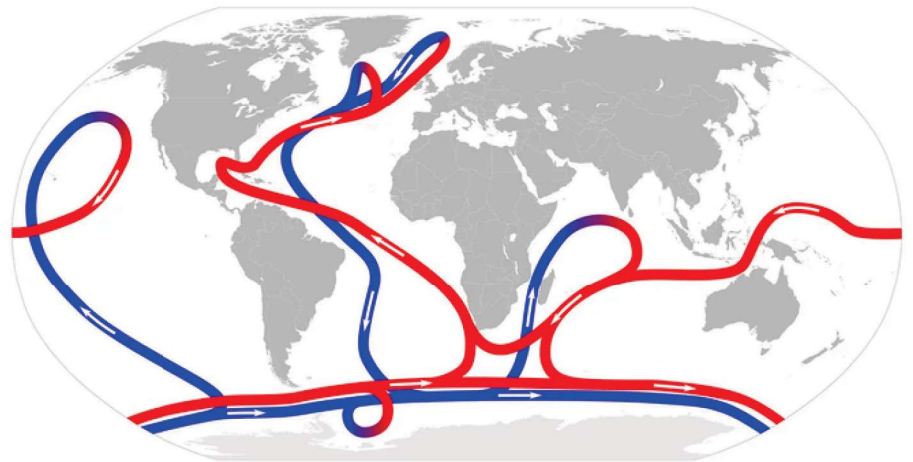
**Cyclones do not form in Equator as there is lack of Coriolis Force at Equator.**

# Ocean Currents

- Ocean currents are large movements of water in the ocean that flow in a specific direction.
- Ocean water moves in two directions: horizontally and vertically.
- Horizontal movements are referred to as currents, while vertical changes are called upwellings or downwellings.

## Thermohaline Circulation

It is a global ocean current system driven by differences in seawater temperature and salinity, which affect its density. This process, often called the "global conveyor belt".



# Reason of Movement of Ocean Currents

01

Wind

- Cold water moves from Poles to Equator.
- Warm Water moves from Equator to Poles.

02

Density difference

**Thermocline** is the point below which temperature declines suddenly.

03

Gravity

04

Coriolis Force

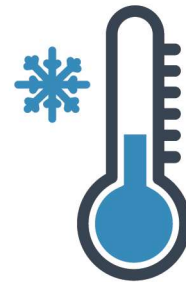
**Halocline** is the point below which Salinity increases rapidly in sea

05

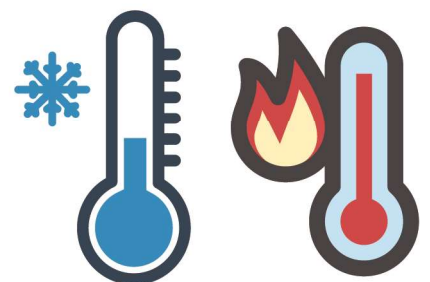
Coast Line

## Effect of Ocean Currents

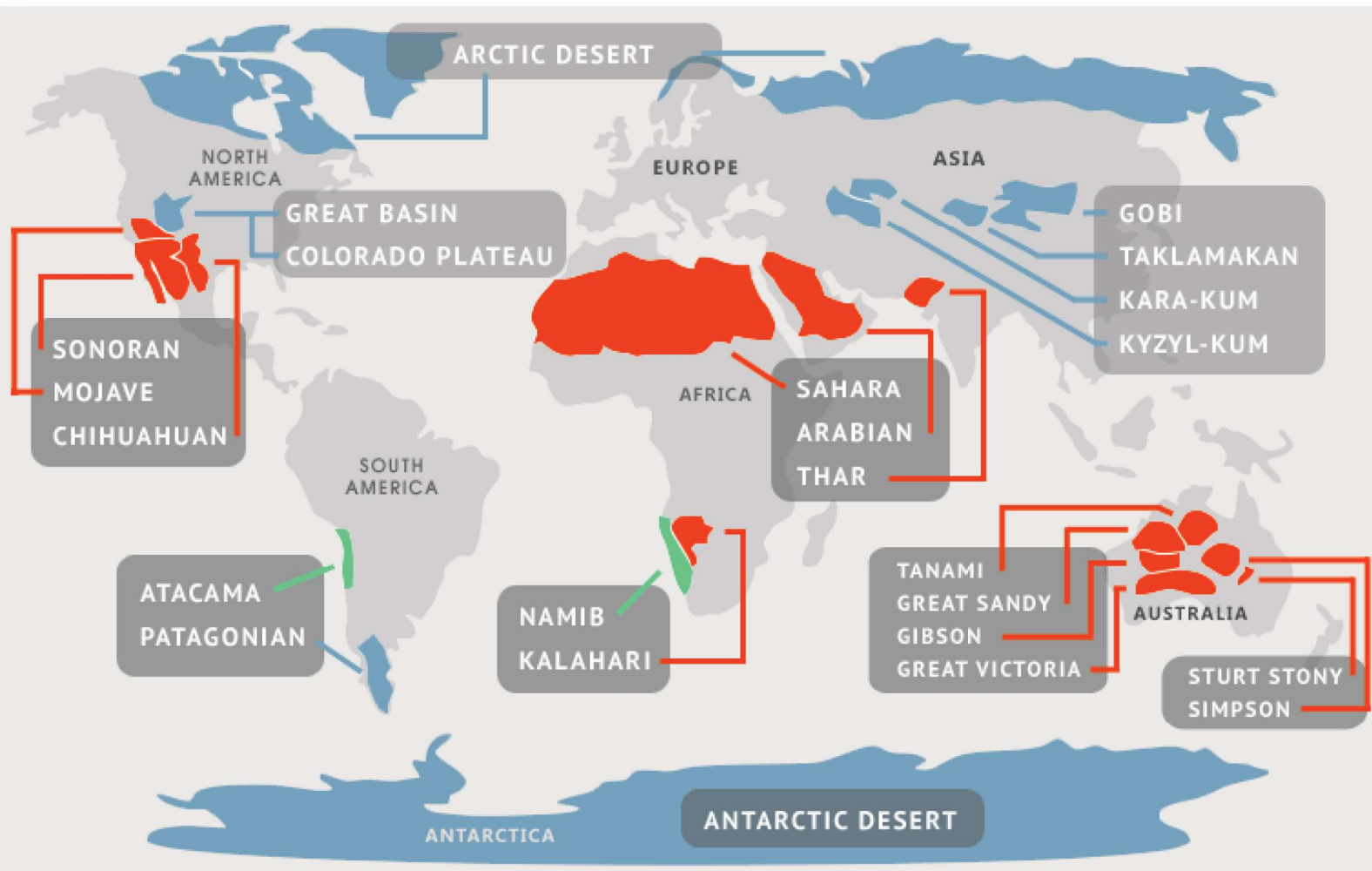
**Cold ocean currents:** They largely contribute to the formation of coastal deserts in west coast regions of tropical and sub-tropical continents. This is because the cold water makes the air above it cooler and less able to hold moisture.



**Warm ocean currents + Cold ocean currents:** Together they create best fishing zones due to deposition of planktons. The meeting of warm and cold ocean currents also creates fog that is dangerous for harbouring.



# Desertification due to Cold Ocean Currents



## Warm Ocean Currents

- Brazil
- Mozambique
- East. Australian
- Agulhas
- Gulf Stream
- Alaska
- Norwegian
- Kuroshio

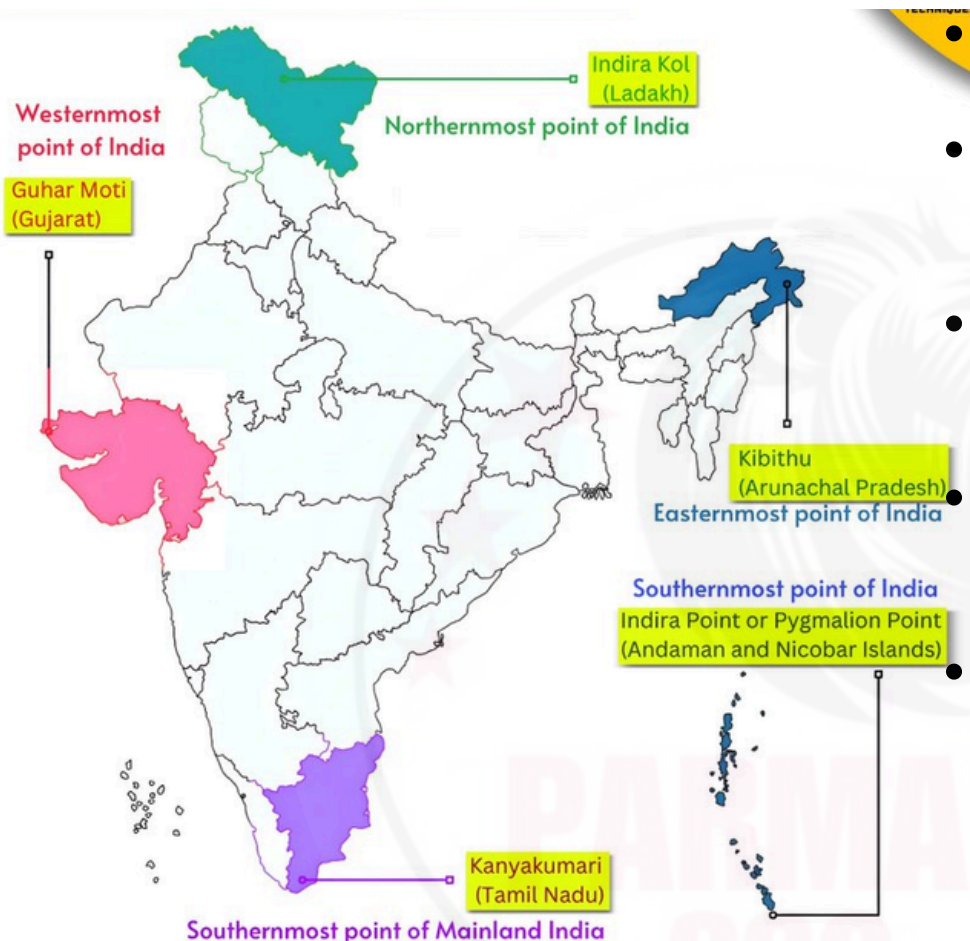
## Cold Ocean Currents

- Bengula
- Peru / Humbolt
- Greenland
- Oyashio
- Labrador
- Falkland
- West Australian Drift
- Canary
- California

**Trick (Cold Current) : BP GOLF World Cup in California.**

# Some facts about India

- India was a part of Gondwana land and is situated in continent of Asia.
- **In terms of Area** : 7th largest country; Russia > Canada > China > USA > Brazil > Australia > **India** > Argentina
- India occupies 2.4% of the world's area
- **In terms of population** : 1<sup>st</sup> (17.7% of world's population lives in India)



- India has 28 States and 8 Union Territories.
- Northernmost point of India is Indira Col (Ladakh)
- Southernmost Point of India is Indira Point (A&N islands)
- Easternmost Point of India is Kibithu (Arunachal Pradesh)
- Westernmost Point of India is Guhar Moti (Gujarat)

The Smallest Country in the world : Vatican City

## According to Area :

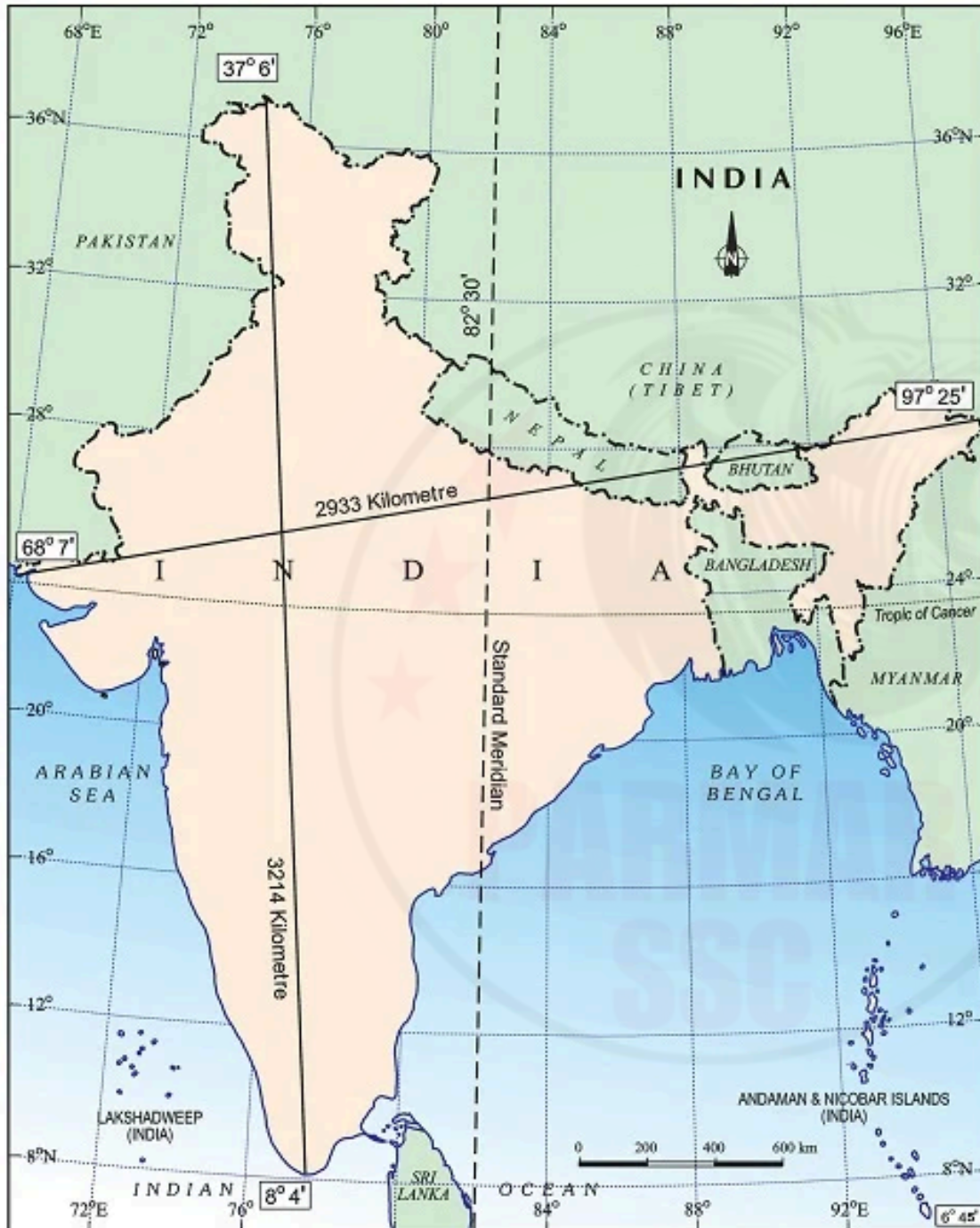
- Rajasthan is the largest State while Goa is the Smallest.
- Ladakh is the Largest UT while Lakshadweep is the smallest.

## According to Population:

- Uttar Pradesh is the most Populous state, while Sikkim is the least Populous.
- Delhi is the most Populous UT while Lakshadweep is the least populous.

# Longitudinal & Latitudinal Extent of India

- It lies completely in the North-Eastern hemisphere between latitude  $8^{\circ}4'N$  and  $37^{\circ}6'N$  and Longitudes  $68^{\circ}7'E$  and  $97^{\circ}25'E$
- North-South Extent is 3214 Km and East-West Extent is 2933 km.



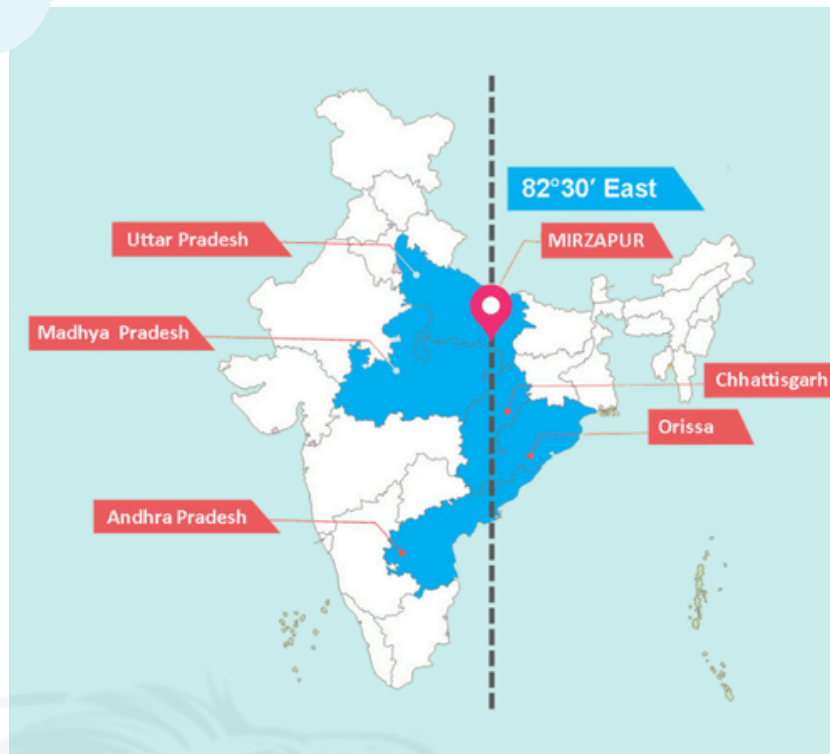
- Tropic of Cancer ( $23^{\circ} 30'N$  latitude) Passes through 8 states (Gujarat, Rajasthan, Madhya Pradesh, Chhatisgarh, Jharkhand, West Bengal, Tripura and Mizoram ) of India and divide the country in almost equal halves.

Latitudes are equidistant but not longitudes, that's why India's N-S extension is more than E-W Extension.

- Trick to Remember the States through which Tropic Of Cancer Passes : **G**ujarati **R**aja **M**ade **C**hief **J**ustice **W**in **T**he **M**eeting
- Jaipur (Rajasthan), Agartala (Tripura) Aizwal (Mizoram) are only Capitals that are above tropic of Cancer.

# Indian Standard Time

- India Follows only one time Zone Known as Indian Standard Time (IST; 5:30 hours ahead of GMT) across whole nation Unlike Countries like Russia (11), USA (6), France (13).
- IST is along  $82.30^{\circ}$  E longitude.
- It passes through Uttar Pradesh (Mirzapur), Madhya Pradesh, Chhatisgarh, Orissa, Andhra Pradesh.



**Trick : M O U C A**

## DID YOU KNOW?

Tropic Of Cancer Meets Indian Standard Time (IST) at : Korea District of Chhatisgarh; (Baikunthpur)



**Trick : B Ch P N M B A**

## Land Borders Of India

### Bordering Nations Of India is:

- Bangladesh (4096.7 km)
- China (3488 Km)
- Pakistan (3323 Km)
- Nepal (1751 Km)
- Myanmar (1643 Km)
- Bhutan (699 Km)
- Afghanistan (106 Km)

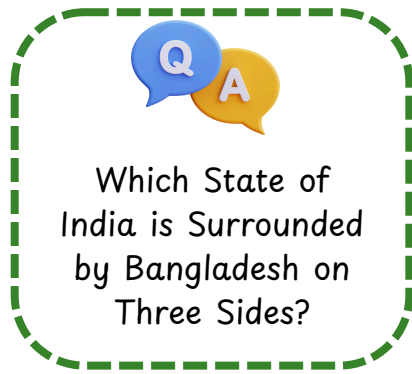
- Total land border Area of India is : 15,106.7 Km
- Total Sea Border area of India is : 11,098.81 Km



**DID YOU KNOW?**

# India-Bangladesh Border

1. Meghalaya
2. Assam
3. Mizoram
4. Tripura
5. West Bengal



## Train Between India-Bangladesh:

Mitali Express, Maitree Express, Bandhan Express

The **Radcliffe Line** is the boundary that separates India and Bangladesh

Trick To Remember : **MAM** Take **W**ater

# India-Nepal Border



1. Sikkim
2. Uttrakhand
3. Bihar
4. West Bengal
5. Uttar Pradesh

Trick To Remember : **SUBBU**

**REMEMBER!**

**Treaty of Sugauli** was signed in 1816, that established the boundary line between India and Nepal.

1. West Bengal
2. Assam
3. Sikkim
4. Arunachal Pradesh

Trick To Remember : **BASA**

# India-Bhutan Border



# India-Pakistan Border



- **The Radcliffe Line** ( Sir Cyril Radcliffe drew the line) is the boundary that separates India and Pakistan.
- **Line of Control (LOC)** is a military control line that separates India and Pakistan in the disputed Indian region of J&K.
- **Train Between India-Pakistan :** Samjhauta Express (Started by Indira Gandhi following the Shimla Agreement in 1976), Thar Express

1. Gujarat
2. Rajasthan
3. Punjab
4. Jammu & Kashmir
5. Ladakh

Trick To Remember : **GRP J&K**  
**Ladakh**

# India-China Border

Indo China Border is divided into three Sectors:

1. **Western Sector (Johnson Line)** : It defines the boundary in the western sector Indo China Border.
2. **Middle Sector**
3. **Eastern Sector (McMohan Line)**: It defines the Boundary in the eastern sector of India and China.



1. J& K ( Now Ladakh)
2. Himachal Pradesh
3. Uttrakhand
4. Sikkim
5. Arunachal Pradesh

## Vibrant-Village Programme

It is centrally Sponsored Scheme announced in Union budget 2022-23 (to 2025-26) for development of village on India-China Border.



# India-Myanmar Border

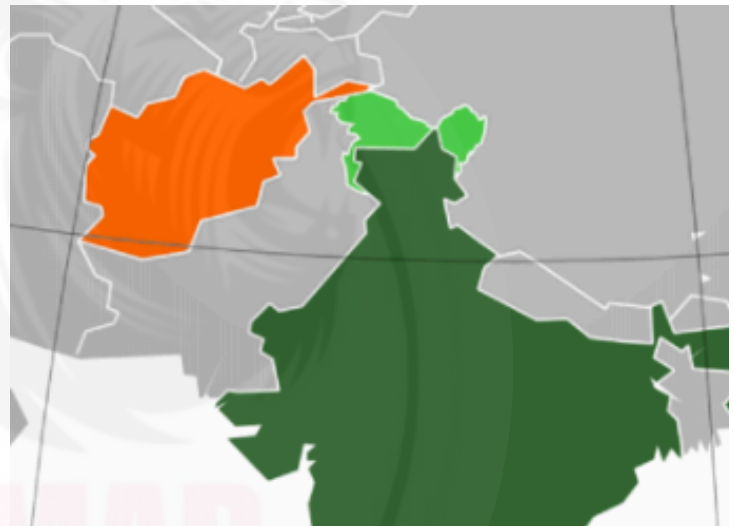


1. Arunachal Pradesh
2. Nagaland
3. Manipur
4. Mizoram

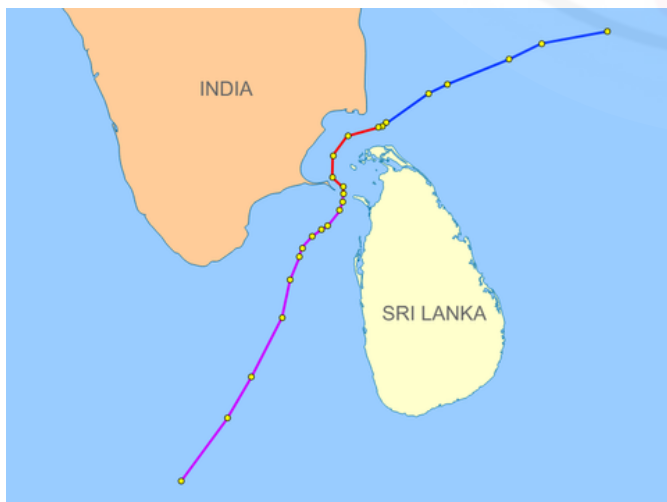
Trick To Remember : **AruNa MaMi**

# India-Afghanistan Border

- India and Afghanistan are separated by Union Territory Ladakh.
- The Border between India and Afghanistan is called Durand Line.



# India and Sri Lanka



- India shares Maritime Boundary with Sri Lanka, which is separated by Palk Strait.
- Palk Bay is above the Gulf of Mannar.

**Strait** : A Narrow water body that separates two landmasses and connects two water bodies.

# Gulf

A gulf is a portion of the ocean that penetrates land. They are generally larger and more deeply indented than bays, Gulfs are sometimes connected to the ocean by narrow passages of water called straits.



# Bay

- A bay is a body of water that is partly surrounded by land. Bays empty out into larger bodies of water like oceans and lakes.
- Bay of Bengal is the largest Bay in the World.

## Some Important Facts

- Largest Gulf in the world: Gulf of Mexico.
- Largest Bay in the world: Bay of Bengal.
- State sharing boundary with maximum number of states: Uttar Pradesh (with 8 States + 1 UT (Delhi)).
- State sharing border with only one state: Sikkim (with West Bengal) and Meghalaya (with Assam).

### State Sharing Border with Three Nations:

1. Sikkim (with Nepal, Bhutan, China).
2. Arunachal Pradesh (with Bhutan, China, Myanmar).
3. West Bengal (with Nepal, Bhutan, Bangladesh).

**Note** : One UT that shares boundary with three countries: is **Ladakh** (with Pakistan, Afghanistan, and China).

## Few Organisations

- **Border Road Organisation (1960):** BRO (under Ministry of Defence) develops and maintains road networks in India's border areas and friendly neighboring countries.
- **The Border Area Development Programme (BADP)** was introduced during the 7th Five-Year Plan (1985-1990) in India.
- The programme aims to meet the special development needs of the people living in remote and inaccessible areas situated near the international borders (Pakistan, China, Nepal, Bhutan, Bangladesh, and Myanmar).

## Organisations under Central Armed Police Force (CAPF)

- **Indo-Tibetan Border Police (1962) ITBP** (under Ministry of Home Affairs) guards the country's border with China along the Indo-Tibetan region.
- **Sashastra Seema Bal (1963) SSB** (under Ministry of Home Affairs) guards the country's borders with Nepal and Bhutan.
- **Assam Rifles:** It is under Ministry of Home Affairs but the operation control is under Ministry of Defence.
- **Border Security Force (1965)** BSF is known as "India's first line of Defence" and was established after Indo-Pak War. It guards country's border with Pakistan and Bangladesh.
- **Central Reserve Police Force (CRPF):** It is India's largest paramilitary force and is under Ministry of Home Affairs.



# Coastal Boundary Of India

- India's coastline is now measured at 11,098.81 km, an increase from the previously cited figure of 7,516.6 km
- It is jointly recalculated by Survey of India ( Sol) and National Hydrographic Office (NHO).
- The mainland coastline of India is 7870.51 kilometers long.
- The Island Territories coastline of India is 3,228.30 km

## Length of Coastline of India

The State-wise/UT-wise 'Length of Coastline of India' are hereby mentioned below.

Sl.No.	State/Union Territory	Coastline length (in Km)
1.	Gujarat	2,340.62
2.	Maharashtra	877.97
3.	Goa	193.95
4.	Karnataka	343.30
5.	Kerala	600.15
6.	Tamil Nadu	1,068.69
7.	Andhra Pradesh	1,053.07
8.	Odisha	574.71
9.	West Bengal	721.02
10.	Daman & Diu	54.38
11.	Pondicherry	42.65
12.	Lakshadweep Islands	144.80
13.	Andaman & Nicobar Islands	3,083.50
<b>Total Length of Coastline of India</b>		<b>11,098.81</b>



largest Coastline in the world is of **Canada**.

## **Union Territories of India that shares Coastal Boundaries are :**

- Andaman & Nicobar Islands (Bay of Bengal) : Located on Eastern Coast of India.
- Lakshadweep (Arabian Sea)
- Puducherry (Bay of Bengal)
- Daman & Diu ( Arabian Sea)

# United Nations Convention on the Law of the Sea (UNCLOS)

- It was adopted on 1982 but came into force on 1994.
- It is an international treaty that establishes rules and guidelines for the use and protection of the world's oceans
- It covers 5 zones: Internal Waters, Territorial Sea, Contiguous Zone, Exclusive Economic Zone (EEZ) and High Seas.

## Territorial Limit Of India

- The length of coastline is measured in Nautical Miles (nm). 1 nautical miles = 1.852 km.
- India's territorial limit extend upto 12 nm (12 nm = 22 km) from the coast.

## Contiguous Zone

- A contiguous zone is a maritime area that lies beyond a country's territorial sea. It extends upto 24 nm.

## Exclusive Economic Zone:

- It is a maritime area that extends upto 200 nm from a coastal nation's territorial sea.

## Sea Borders of India

- India shares its sea borders with two countries: Sri Lanka and Maldives.
- India's sea borders include the Bay of Bengal to the east, the Arabian Sea to the west, and the Indian Ocean to the south.
- Gulf of Mannar is a shallow sea between India and Sri Lanka, located near the southern tip of India.

- Kanyakumari is a place in India where the Bay of Bengal, the Indian Ocean, and the Arabian Sea meet.
- New Pamban Bridge, the first Vertical lift sea Bridge of India which has been inaugurated recently connects Pamban (Rameswaram island) to Mandapam (Mainland India).

# Physiographic Divisions Of India

- India is Divided into six physiographic divisions based on the varied physical features.

1. Himalayas / Northern Mountains
2. Northern Plains
3. Indian Desert
4. Coastal Plains
5. Peninsular Plateau
6. Islands

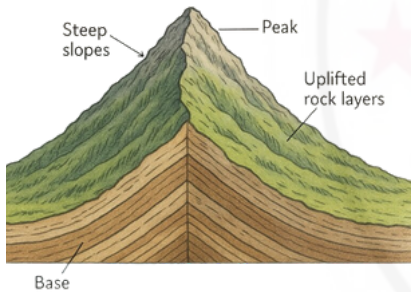


## Mountains

Mountains are landforms that are much higher than the surrounding land. They usually steeper than the hills and often have a sharp peak, or summit.

## Types of Mountains

1. Fold Mountains
2. Block Mountains
3. Volcanic Mountains



### 1. Fold Mountains

They are formed when tectonic plates collide, causing the Earth's crust to buckle and fold. These mountains are often characterized by parallel ridges and valleys.

**There are two types of Fold Mountains**

#### Young Fold Mountain

- Mountains that were formed by tectonic activity a few million years ago.
- E.g. Himalayas, Andes (located in South America and is world's longest mountain range), Alps (Europe), Rockies (North America), Atlas (Africa), Caucasus mountains.

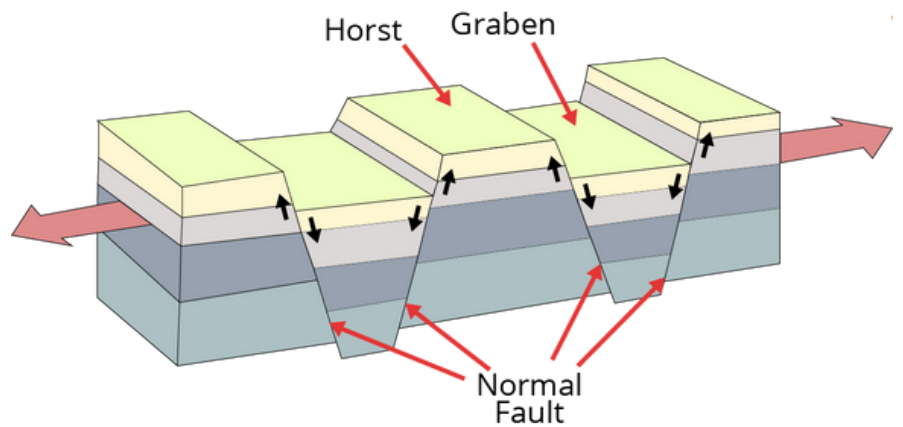
#### Old Fold Mountain

- Mountains that were formed by the folding of the Earth's crust in the distant past.
- E.g. Aravalli (residual mountains), Ural (separates Asia and Europe), Appalachians (North America).

## 2. Block Mountains

Block mountains are formed when large areas of the Earth's crust are broken and displaced due to vertical slippage.

- **Horst:** Raised block of land bounded by faults, often appearing as a ridge or plateau.
- **Graben** (also known as Rift Valley) → Lowered block of land between two faults, often forming a valley are formed in block mountains
- E.g: Vindhya and Satpura, Vosges Mt. (France), Harz Mt. (Germany), Great African Rift Valley

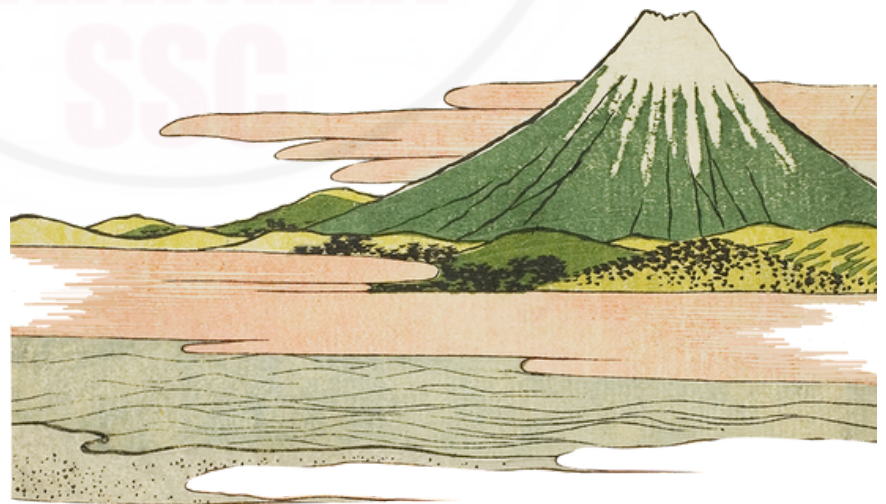


## 3. Volcanic Mountains

They are formed when magma from the Earth's mantle rises to the surface and erupts, Creating lava flows that builds up over time.

Examples:

- Mt. Stromboli (known as "Lighthouse of Mediterranean",
- Mt. Cotopaxi (Ecuador),
- Fujiyama (Japan),
- Barren and Narcondam (Andaman & Nicobar Islands),
- Ojas del Salado (world's highest active volcano in Chile-Argentina border),
- Mt. Kilimanjaro (Africa).



# Himalayas

The Himalayas are one of the youngest fold mountains ranges in the world of tectonic origin and comprise mainly Sedimentary Rocks.



## Formation of Himalayas

They were formed when the Indo-Australian tectonic plate and Eurasian (Asian) tectonic plate collided, this caused the closure of the ancient Tethys Sea, leading to the folding and uplifting of sediments deposited on its seabed. This resulted in creation of multiple massive mountain ranges which are collectively known as the Himalayas.

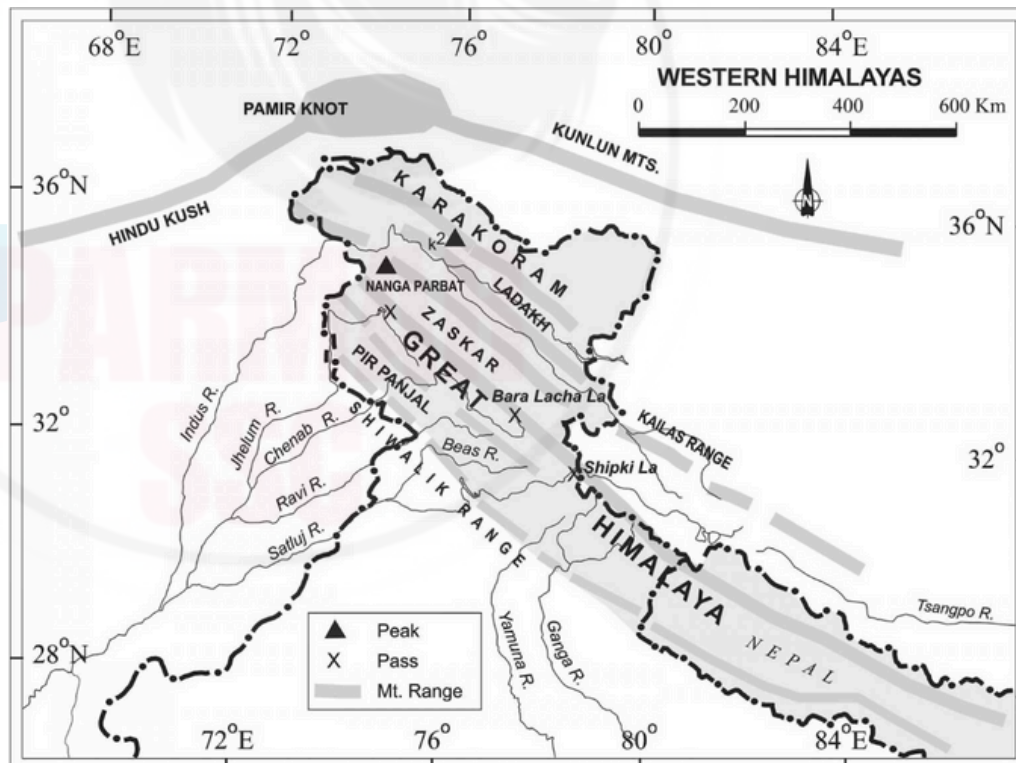
**Geosyncline:** It is an obsolete geological concept that described a long, linear trough in the Earth's crust where vast amounts of sediment accumulate, which was believed to later be deformed into mountain ranges.

## Mountain Ranges in Himalaya

1. Trans Himalayas
2. Greater Himalayas
3. Lesser Himalayas
4. Outer Himalayas

## Trans Himalayas

- It is located north of Great Himalayas, the region is characterized by high plateaus and arid landscape.
- Average Elevation is 3000 m.
- Three divisions of Trans Himalayas are : Karakoram Range, Ladakh Range & Zaskar Range



## Karakoram Range :

- It forms India's boundary with Afghanistan and China.
- Highest peak of this range is K2, also known as Mt. Godwin-Austen (8611 m), which is also world's second highest peak.
- Mt. Rakaposhi, Mt. Gasher Brum is also a part of Karakoram Range

## Ladakh Range :

- It has the highest slope.
- Shyok (tributary of Indus) river flows between Karakoram and Ladakh range.

## Zaskar Range :

- Kamet peak is the highest peak of this range.
- Indus river flows between Ladakh and Zaskar range

## Glaciers of Karakoram Range

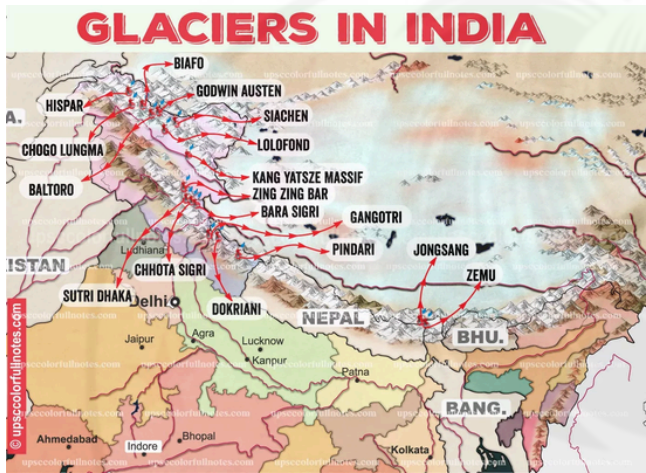
### 1. Siachen

- 2nd longest non-polar glacier.
- Highest battlefield (5700 m above)
- Operation Meghdoot (1984).

### 2. Baltoro (Gilgit-Baltistan of Pakistan)

### 3. Hisper

### 4. Biafo

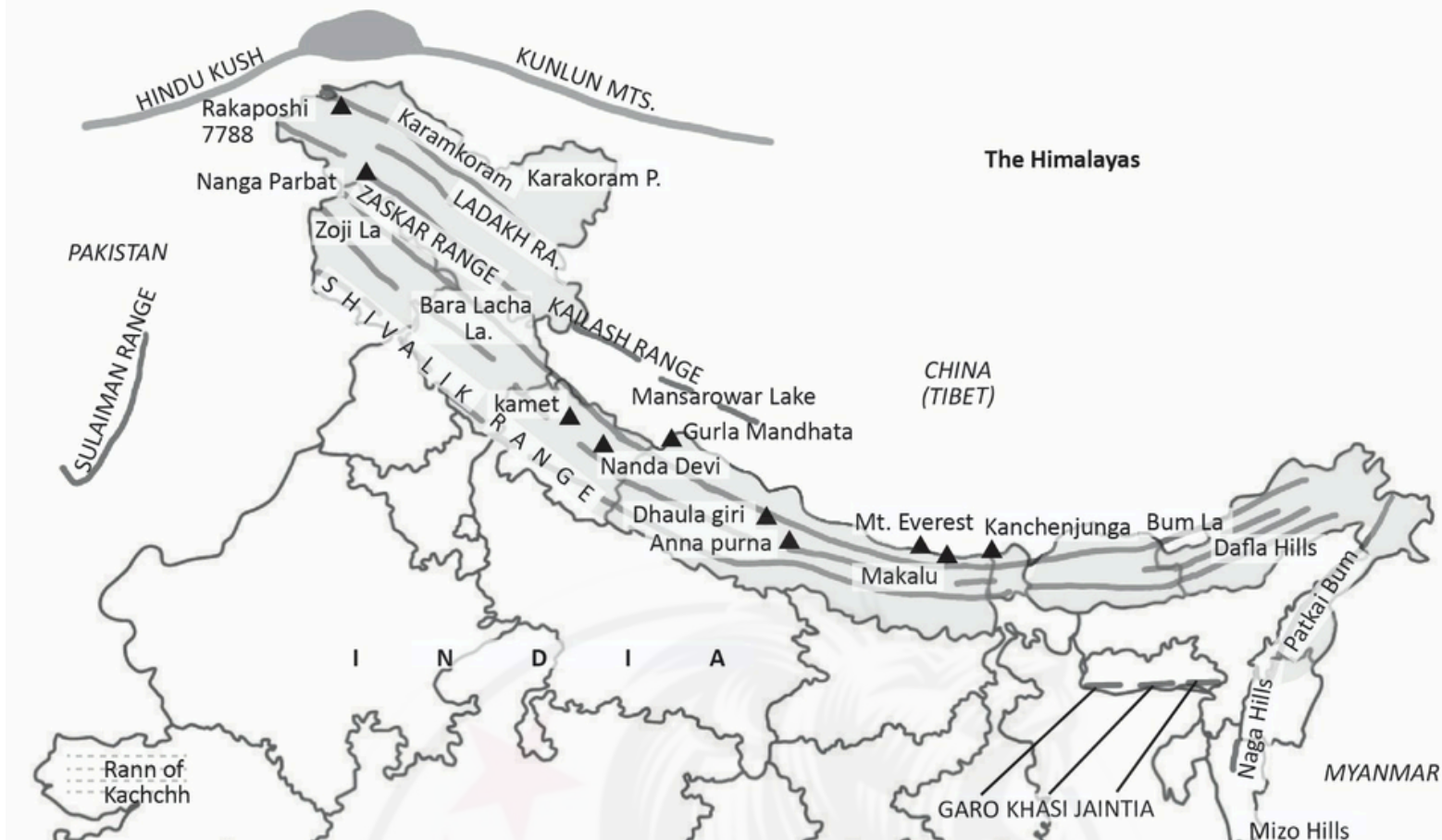


- Longest non-polar glacier in the world: Fedchenko Glacier in Tajikistan
- Longest glacier in the world: The Lambert Glacier in Antarctica

## Greater Himalayas

- They are also known as Himadri /Inner Himalayas.
- They are formed due to asymmetrical folding.
- The core of Greater Himalayas is composed of granitic rock.
- Average height: 6000 m.
- Axial range: 2500 km.
- Width: 120-190 km.
- It's westernmost point is: **Nanga Parbat (8126 m).**
- It's easternmost point is: **Namcha. Barwa (shows syntaxial bending).**





## Peaks of Greater Himalayas

1. **Mt. Everest** (Highest mountain in the world with 8848 m height) Local names: Sagarmatha (in Nepal) and Chomolungma (in Tibet).
2. **Mt. Kanchenjunga** (highest in India (Sikkim) with 8598 m height).
3. **Mt. Lhotse** (in Tibet and Khambu region of Nepal with 8516 m height).
4. **Mt. Makalu** (8485 m).
5. **Dhaulagiri** (8167 m) → Also known as White Mountain. Nepal
6. **Annapurna** (8091 m).
7. **Nanda Devi** (highest peak in Uttarakhand with 7816 m height).
8. **Mt. Kamet** (7756 m in Uttarakhand)

**Note :** Kedarnath, Badrinath, Banderpoonch are part of Great Himalayas.

- All important Peaks are mentioned in the given figure above.

## Lesser Himalayas

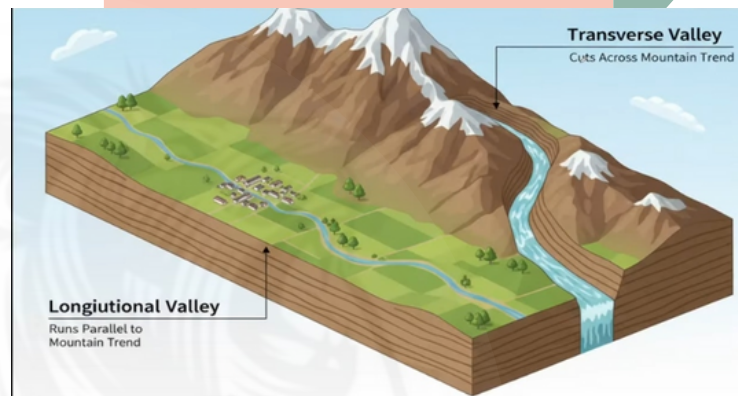
- They are also known as Middle Himalayas / Himachal.
- Average height : 4000 m
- Width: 60-80 Km.

### Valley

- A valley is a low area of land between hills or mountains, typically with a river or stream flowing through it.
- Kashmir Valley is between Great Himalayas and Lesser Himalayas.
- Kangra Valley is type of Longitudinal valley that runs parallel to Mountain Trend, whereas Kullu Valley is type of Transverse Valley that cuts across Mountain Trend

### Different Names of Lesser Himalayas

- In J&K : Pir Panjal Range
- In Himachal Pradesh : Dhauladhar
- Uttarakhand : Nagtibba
- Nepal : Mahabharat Range



## Outer Himalayas

- They are also known as Shivalik
- Average height : 1000 m
- In the eastern part they disappear and Duars take its place.
- Longitudinal Valleys called Duns are formed between Lesser Himalayas and Shiwaliks.
- Largest Dun in India is Dehradun.
- The portion of Shiwalik lying in the region of Nepal is called the Churia Range

Note : Duars are soft unconsolidated deposits that are good for tea cultivation)

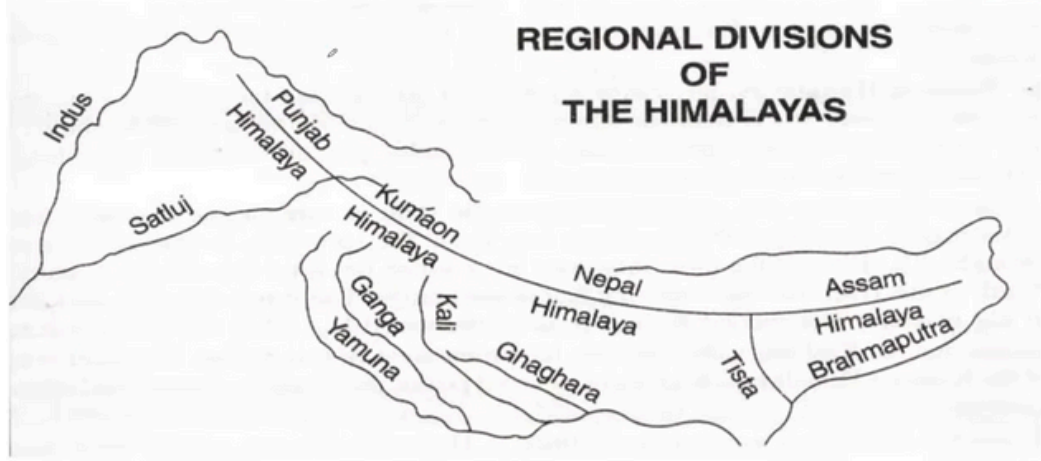
## Regional Division Of Himalayas

**Punjab Himalayas** : Between Indus and Sutlej River.

**Kumaon Himalayas** : Between Sutlej and Kali River.

**Nepal Himalayas** : Between Kali and Teesta River.

**Assam Himalayas**: Between Teesta and Dihang River.



## Kashmir Valley

- The Kashmir Valley is also known for the Karewa formations (composed of glacial and lacustrine deposits), which are used to grow Zafran, a local variety of Saffron.
- Zoji La on the Greater Himalayas, Banihal on the Pir Panjal, Photu La (Ladakh) on the Zaskar, and Khardung La on the Zaskar are some of the region's most important passes.
- This region also has some of the most important freshwater lakes, such as Dal and Wular, as well as saltwater lakes, such as Pangong Tso and Tso Moriri (Both are Salt Water Lakes)
- The Indus River and its tributaries, such as the Jhelum and Chenab, drain in this region.



## Himachal & Uttarakhand Himalayas

- They are spread across three states: J&K, Himachal Pradesh, and Uttarakhand.
- It is drained by two of India's largest river systems, the Indus and the Ganga.
- The Bhotia tribe live largely in the valleys of the Greater Himalayan range. These are nomadic people who travel to the 'Bugyals' (summer grasslands in the mountains) in the summer.

### Important Hill Station

- Dharamshala
- Mussoorie
- Shimla

## Darjeeling and Sikkim Himalayas

- It is home to India's highest peak Mt. Kanchenjunga.
- The Lepcha/Bhutia tribe live in the higher elevations of this region.
- Duar formation can also be seen here.

# Arunachal Himalayas

- The eastern border of Eastern Himalayas is formed by Arunachal Himalayas.
- Orientation of Himalayas in Arunachal is South-west to North-West.
- Important peaks include: Kangtu and Namcha Barwa.
- Important river include: Kameng, Subansiri, Dibang.
- The Monpa, Dafla, Abor, Mishmi, Nyishi, and Nagas are some of the most well-known tribes from west to east.
- **Jhumming** is practiced by the majority of these groups. It's also known as **slash and burn** cultivation or shifting cultivation.



## Eastern/Purvanchal Hills

### Important Ranges

- Patkai Hills.
- Naga Hills.
- Manipur Hills.
- Mizo/Lushai Hills.
- In Manipur and Mizoram (also known as Molasses Basin), the Barak is a significant river.
- The state of Manipur is known for world's only floating lake → Loktak Lake.
- Keibul Lamjao National Park is located here (World's only floating National Park)

**Note** : Garo, Khasi, Jaintia hills are not part of Himalayas but are part of Peninsular Plateau.

- Eastern Hills/Purvanchal Hills are part of the Himalayan mountain chain, with a basic alignment from north to south.
- They extend from Arunachal Pradesh in the north to Mizoram in the south.

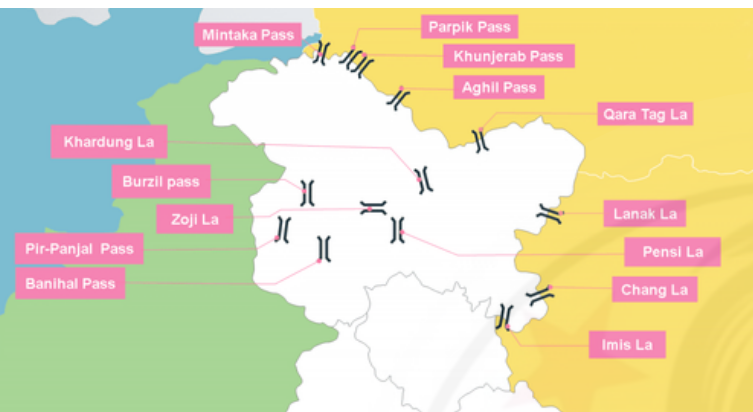
### Orientation of Himalayas

- In J&K: North-West to South-East
- Sikkim: East-West
- Arunachal : South-West to North-East.
- Eastern Himalayas : North-South

# Mountain Passes

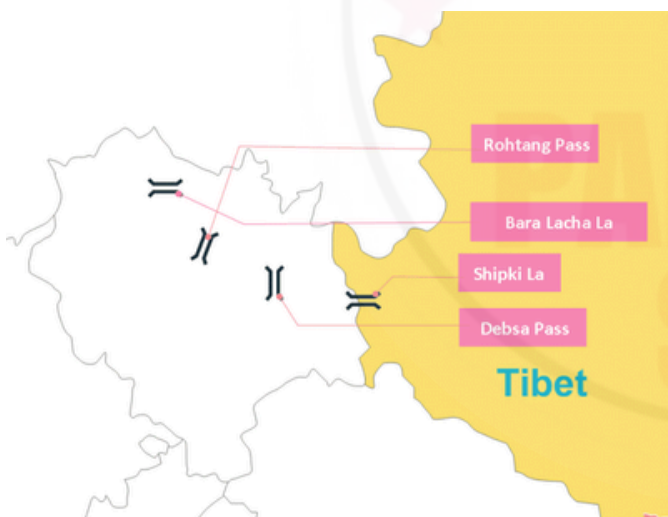
- A mountain pass is a route that runs through or over a mountain range.
- Mountain passes between mountain peaks may form during the formation of the mountain range, or they may form as a result of the action of glaciers, running water, or precipitation in the form of rain or snow.

## J&K and Leh-Ladakh



- Karakoram Pass: It is the highest pass that connects India and China.
- Pir Panjal Pass and Banihal Pass: They connect Jammu to Srinagar.
- Burzil Pass: It is between Srinagar and Gilgit.
- Zoji La: It connects Srinagar in Kashmir to Leh-Ladakh.
- Umling La: World's highest motorable road (constructed through Project Himank) in Ladakh.

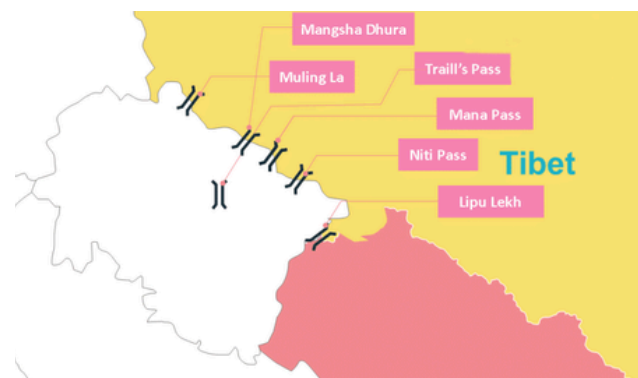
## Himachal Pradesh



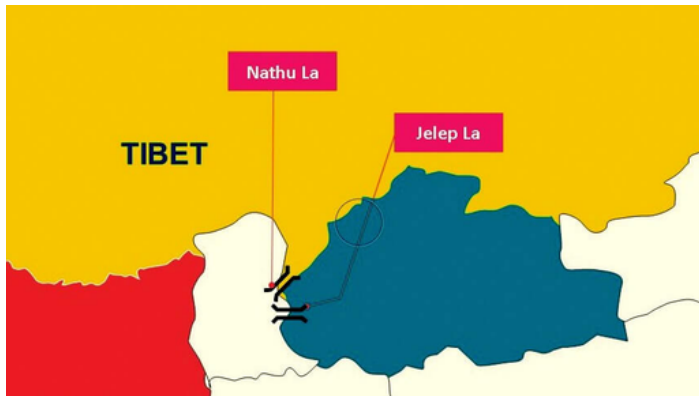
- Shipki La Pass: It connects Kinnaur district of Himachal Pradesh to Tibet, China. Sutlej enters in India through this pass.
- Rohtang Pass: It connects the Kullu Valley to the Lahaul and Spiti valleys in Himachal Pradesh (Atal Tunnel, the longest highway tunnel (9.02 km) is built under the Rohtang Pass).
- Bara-Lacha La Pass: It connects Lahaul and Leh by crossing the Zaskar range.

## Uttarakhand

- Mana Pass: It connects the Mana with Tibet.
- Niti Pass: It also connects Uttarakhand and Tibet.
- Lipu Lekh Pass: It is between Uttarakhand, Tibet and Nepal, it acts as a tri-junction.
- Mauling La Pass: During the winter, this seasonal pass connecting Uttarakhand and Tibet.



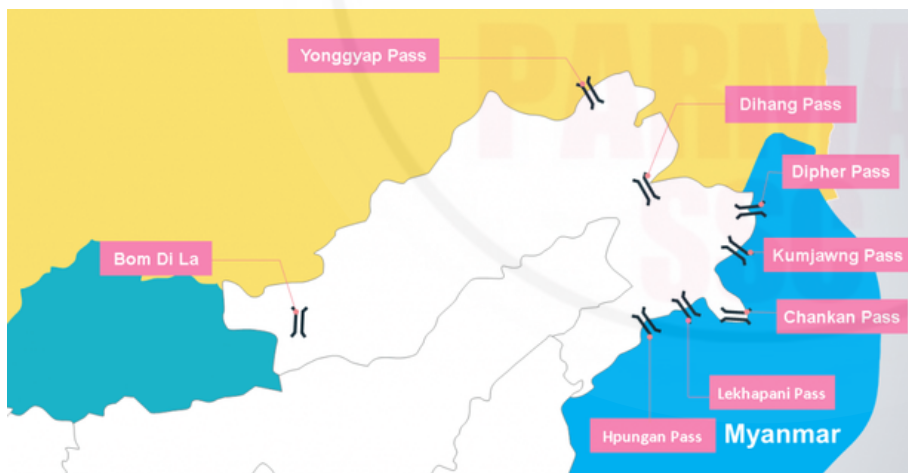
# Sikkim



- Nathu La Pass: It links Sikkim and Tibet.
- Jelep La Pass: It is located on the border of Sikkim and Tibet.

# Arunachal Pradesh

- Bom Di La Pass: It connects Arunachal Pradesh with Lhasa (Tibet)
- Sela Pass
- Dihang La Pass: This pass connects the states of Arunachal Pradesh and Myanmar.
- Pangsu Pass: It connects Arunachal and Myanmar.
- Bum La Pass: It is a border pass between China and Tawang district of Arunachal Pradesh.
- Diphu Pass: It is in Arunachal Pradesh that borders Myanmar and is close to the trijunction of India, Myanmar, and China.
- Yanggyap Pass: It is a pass from where Brahmaputra river enters India.



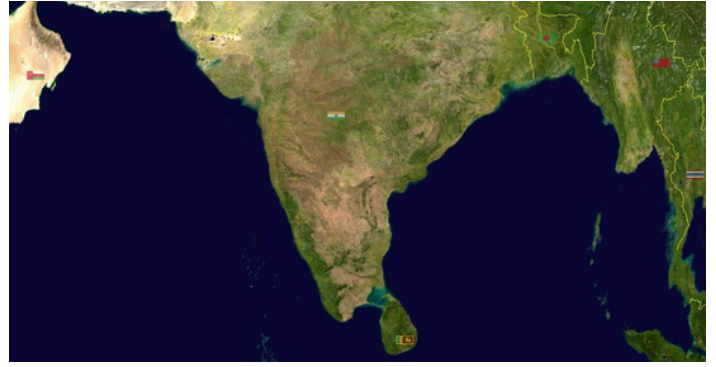
# Some Important Mountain/Peaks

- Mt. Jhopuno: Sikkim.
- Gorichen Peak: Arunachal Pradesh.
- Saramati: Highest peak of Nagaland.
- Kangto: Highest peak of Arunachal.
- Thaidawr Tlang: Tripura.
- Phawngpui (also known as Blue Mountain): Highest peak of Mizoram.
- Mt Iso : Highest Peak of Manipur

# Peninsula & Plateau

## Peninsula

A peninsula is a landform that is surrounded by water on three sides, but connected to a large landmass on one side.



## Plateau

A plateau is a flat or gently sloping elevated landform that rises above the surrounding area. It is often referred to as tableland due to its flat top. Plateaus can be formed due to volcanic activity, tectonic movements, or erosion.



- Peninsular Plateau is the largest physiographic division of India, covering a vast area in the southern part of the country.
- General elevation: West to East.
- The Peninsular Plateau is one of the world's oldest landforms.
- General elevation of Peninsular Plateau: 600-900 m above sea level
- The Peninsular plateau is a tableland made up of old crystalline, igneous and metamorphic rocks.
- It was developed as a result of the breakup and drifting of the Gondwana Land (it was earlier a part of African plate).
- The plateau has large and shallow valleys as well as rounded hills.
- This plateau is divided into two sections: the Central Highlands and the Deccan Plateau.

Highest plateau in the world:  
**Tibetan Plateau** (4500 m),  
also known as "**Roof of the World**".



# Central Highlands

- The Central Highlands are located to the north of the Narmada, covering major area of Malwa Plateau.
- It is bordered by Aravalli Range in the northwest and the Vindhya Range in the south,
- General elevation: 700-1000 m
- Malwa Plateau (largest) → on western side and Chotanagpur Plateau on the eastern side.
- Central Highlands are wider in west but narrower in the east.
- The Chotanagpur plateau marks the further eastward extension, drained by the Damodar river.

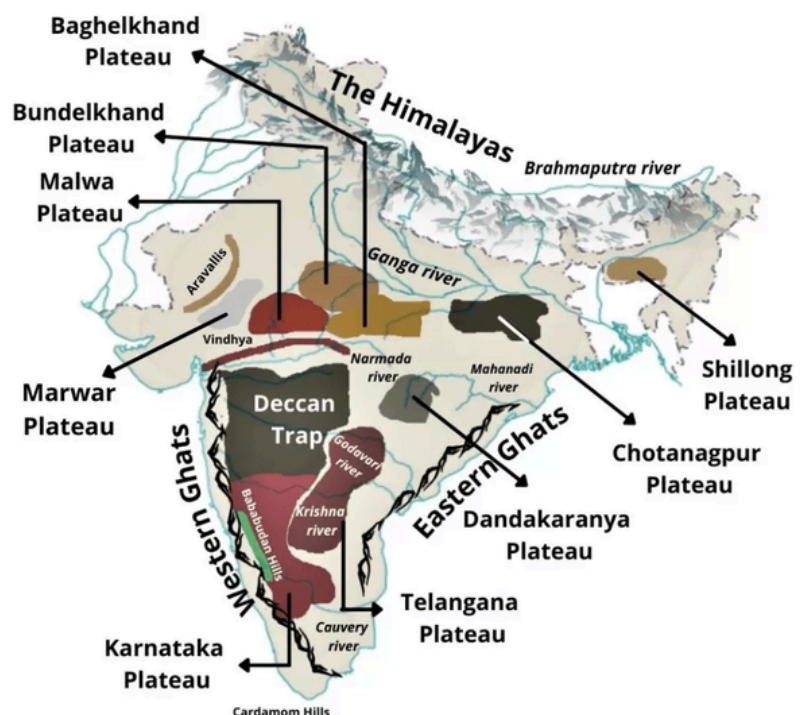


## Marwar / Mewar Plateau

- It is located in eastern Rajasthan.

## Malwa Plateau

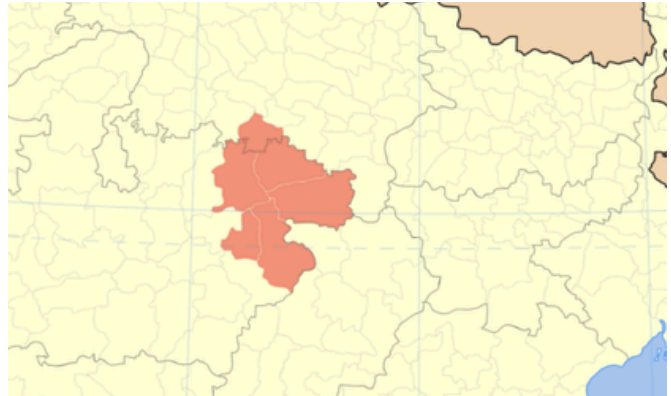
- The plateau is an extension of the Deccan Traps and is spread across Rajasthan and Madhya Pradesh.
- It is composed of extensive lava flow and is covered with black soil.
- Rivers like Mahi, Chambal, Betwa, Sindh, Ken flow southwest to northeast of this region.





## Bundelkhand

- It is spread across the states of Uttar Pradesh (Districts: Chitrakoot, Jhansi, Jalaun, Hamirpur) and Madhya Pradesh.
- General elevation: 300-600 m



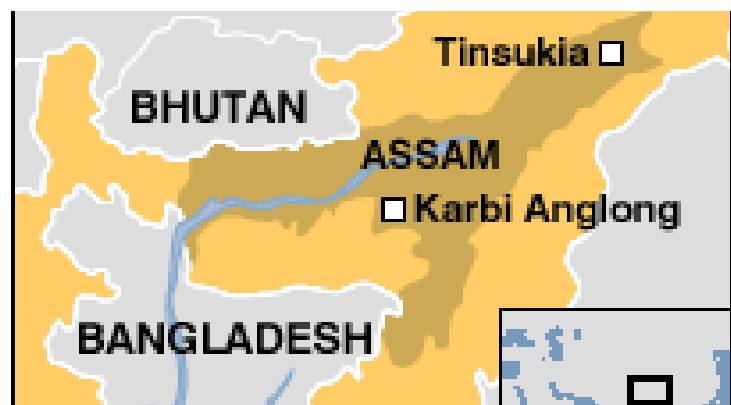
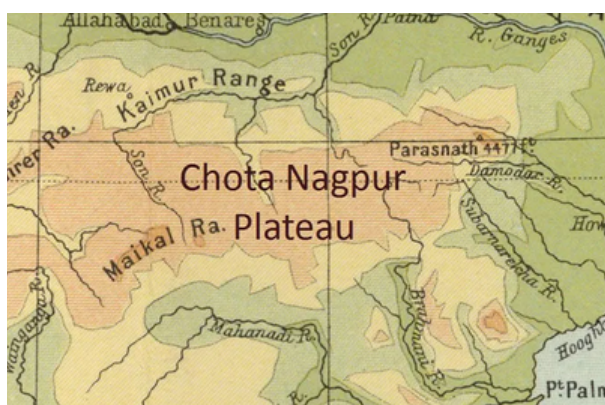
## Baghelkhand

- It is spread across the states of Uttar Pradesh, Madhya Pradesh (Districts: Rewa, Satna, Shahdol, and Sidhi).

## Chotanagpur Plateau

- It is spread across Jharkhand, Chhattisgarh, Odisha, West Bengal.
- It is often referred to as the "Ruhr of India" due to its rich mineral deposits, similar to Ruhr region in Germany.
- Netarhat in Jharkhand is known as "Queen of Chotanagpur" because of its scenic beauty, pleasant climate, and dense forests.
- It comprises of three major plateaus: Ranchi Plateau, Hazaribagh Plateau, and Koderma Plateau
- The highest peak of the Chotanagpur Plateau is Parasnath Hill, located in Jharkhand (on the name of 23rd Tirthankar), which rises to an elevation of 1,365 m.
- The Damodar River flows through the center of the plateau, creating a rift valley that runs from west to east.

- Jaduguda mines of Jharkhand is famous for Uranium mines
- Karbi Anglong Plateau is Extension of Chotanagpur Plateau but are separated by Malda Gap/Fault of Bangladesh.



# Aravallis

- The Aravallis Range is a group of old fold mountains that run from southwest to northeast.
- General elevation: 800 m.
- The Aravalli Range stretches from Delhi to Gujarat, passing through Haryana and Rajasthan.
- Guru Shikhar (1722 m) situated in Mt. Abu Hills is the highest peak of Aravalli.

- Rashtrapati Bhavan is located on **Raisina Hill** (400-600 m) in New Delhi, India.
- **Dilwara Jain Temple** is located on Mt. Abu Hills in Rajasthan.



\*Map not to be scale

# Vindhya Range

- The Vindhya range (also a block mountain) mostly extends through the Indian states of Gujarat, Rajasthan, and Madhya Pradesh.
- The highest point of the Vindhya Range is known as Sadbhawna Shikhar/Kalumar Peak/Goodwill Peak (2467 ft. or 752 m).
- Panna in Madhya Pradesh is located in Vindhya Range and is famous for its diamond mines.
- Kaimur Hills is located in Vindhya Range



\*Map not to be scale

# Satpura Range



- It lies north of Deccan Plateau and runs parallel to Vindhya Range.
- It is a block mountain that extends through the states of Madhya Pradesh, Maharashtra, Chhattisgarh, and Gujarat.

## It comprises of three hills

**1. Mahadeo Hills** to the north → highest point of Satpura range "Dhupgarh" (1350 m) in Madhya Pradesh is located here.

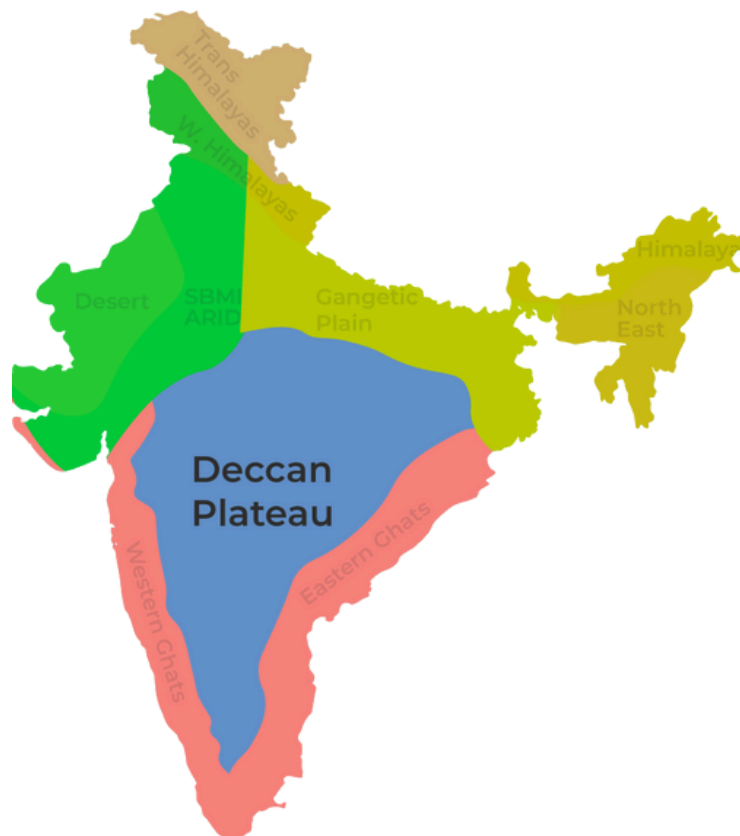
**2. Maikal Range** to the east :- Highest peak of Maikal range is Amarkantak Plateau (in Madhya Pradesh) from where river Narmada and Son originates. Amarkantak (has abundant deposits of Bauxite) is the meeting point of Satpura and Vindhya range.

**3. Rajpipla Hills** to the west.

**Hill Station:** Pachmarhi  
(also known as "Queen of Satpura")

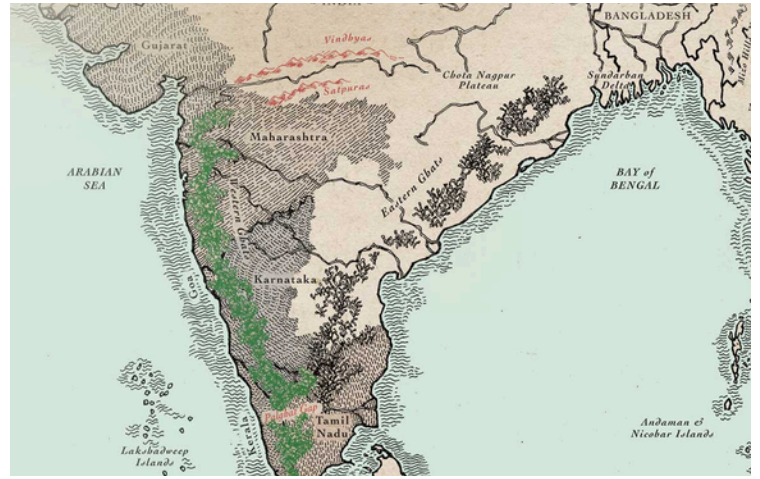
## Deccan Plateau

- The Deccan Plateau is a trigonal landmass to the south of the Narmada river and covers the southern states of Kerala, Tamil Nadu, Andhra Pradesh, Telangana, Karnataka, and Maharashtra.
- The Deccan Plateau is bordered by the Western Ghats to the west and the Eastern Ghats to the east. The Satpura Range forms its northern boundary.
- The Mahadev, Kaimur, and Maikal ranges form its eastern extensions.
- It is higher in the west and slopes gently eastward (the rivers in this region flow towards east).
- An extension of the Plateau is also visible in the northeast, locally known as the Meghalaya Plateau, Karbi-Anglong Plateau and North Cachar Hills.



# Western & Eastern Ghats

- The Western Ghats and the Eastern Ghats mark the western and the eastern edges of the Deccan Plateau respectively.
- These are block mountains.
- The Western and Eastern Ghats meet at Nilgiri Hills in Tamil Nadu



## Western Ghats

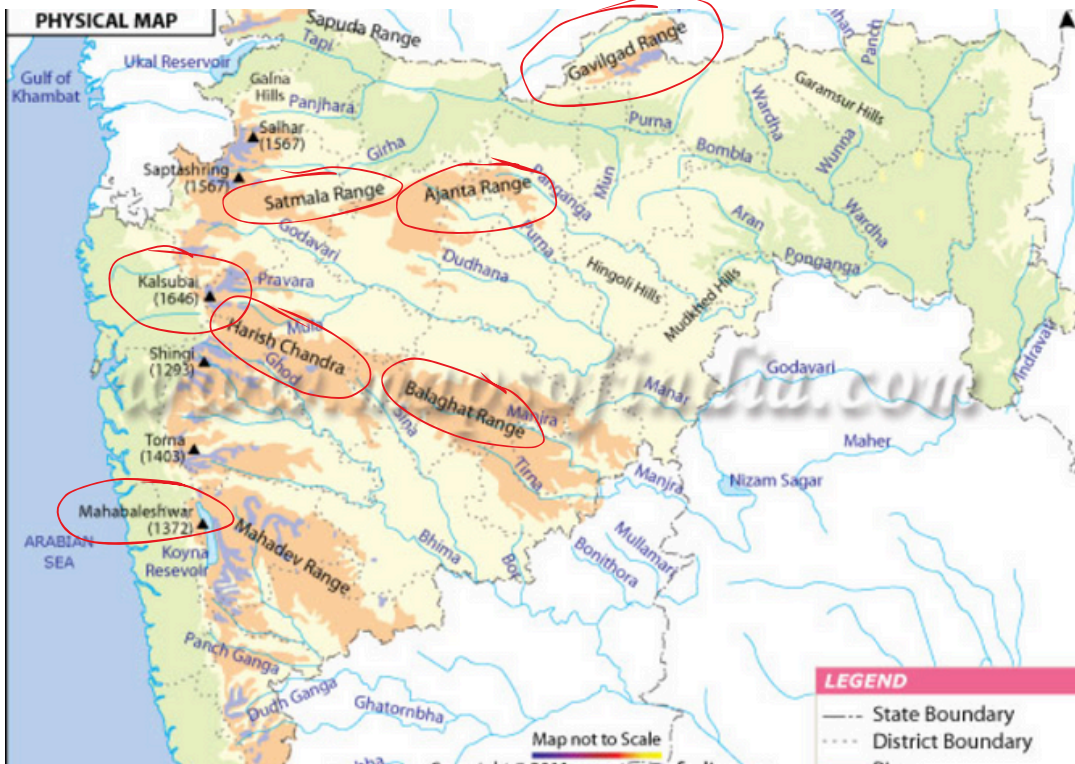
- They are continuous and can be crossed through passes only.
- Average height : 1200 m (higher than Eastern Ghats)
- They stretch from Tapi to south of Nilgiri Hills
- They Spread across Gujarat, Maharashtra, Karnataka, Kerala, Tamil Nadu, Goa.
- Highest Peak : Anamudi (2695 m : On Annamalai Hills) in Kerala and Doddabetta (2637 m : On Nilgiri Hills) in Tamil Nadu
- In Maharashtra, They are known as Sahyadri Hills. Their height increases from North to South

## Eastern Ghats

- They are discontinuous, irregular and dissected by rivers.
- Average height : 600 m (lower and narrower than western ghats)
- They stretch from Mahanadi Valley to the Nilgiri Hills in the south
- They Spread across Odisha, Telangana, Andhra Pradesh, Karnataka, Tamil Nadu.
- Highest Peak : Jindhagada ( 1690 m) and Mahendragiri ( 1501 m : In Odisha)



**Hills of Western Ghat located in Gujarat.**



**Hills of Western Ghat located in Maharashtra**



**Hills of Western Ghat located in Karnataka.**



**Hills of Western Ghat located in Kerala.**