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# Interior Of The Earth

* The configuration of the surface of the earth is largely a product of the processes operating in the interior of the earth.
* Exogenic as well as endogenic processes are constantly shaping the landscape.

## Why know about earth’s interior

Understanding of the earth's interior is essential to understand the nature of changes that take place over and below the earth's surface.

* To understand geophysical phenomenon like volcanism, earthquakes etc..
* To understand the internal structure of various solar system objects
* To understand the evolution and present composition of atmosphere
* Future deep-sea mineral exploration etc.

## Sources of information about the interior

### Direct Sources

* Deep earth mining and drilling reveals the nature of rocks deep down the surface. [Mponeng gold mine and TauTona gold mine in South Africa are deepest mines reaching to a depth of 3.9 km. And the deepest drilling is about 12 km deep]
* **Volcanic eruption** forms another source of obtaining direct information.

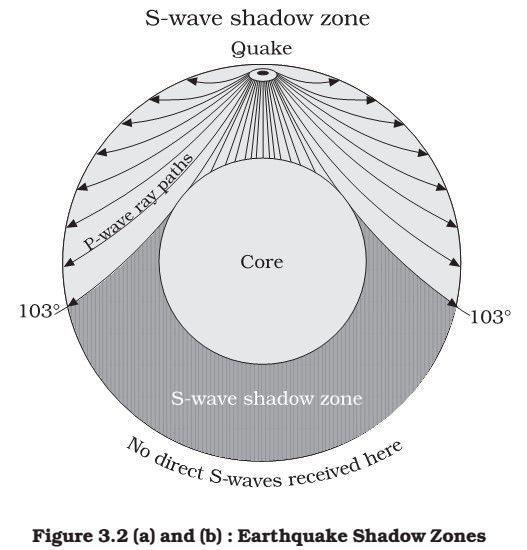
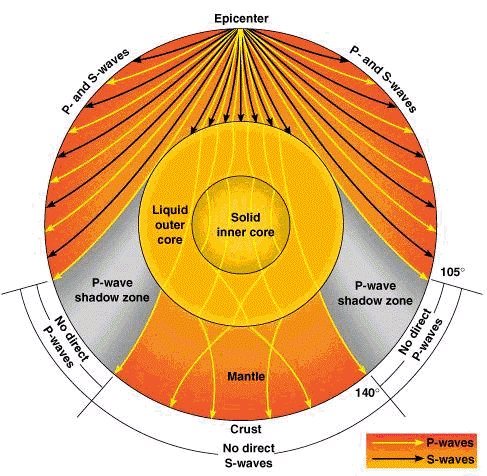
|  |
| --- |
| Mponeng mine  * South Africa * Deepest mine * Gold mine * Deapth: 2.4 miles (3.9 km) |

### Indirect Sources

* **Depth:** With depth, pressure and density increases and hence temperature. This is mainly due to gravitation.
* **Meteors:** Meteors and Earth are solar system objects that are born from the same nebular cloud. Thus they are likely to have a similar internal structure.
* **Gravitation:** The gravitation force (g) is not the same at different latitudes on the surface. It is greater near the poles and less at the equator. This is because of the distance from the center at the equator being greater than that at the poles.
* The gravity values also differ according to the mass of material. The uneven distribution of mass of material within the earth influences this value. Such a difference is called gravity anomaly. Gravity anomalies give us information about the distribution of mass of the material in the crust of the earth.
* Magnetic field: The **geodynamo effect** helps scientists understand what's happening inside the Earth's core. Shifts in the magnetic field also provide clues to the inaccessible iron core. But their source remains a mystery.

|  |
| --- |
| ***Not important for exam****. But if you are a science enthusiast and if you want to know more…* What causes the magnetic field of earth?  * Our planet’s magnetic field is believed to be generated deep down in the Earth’s core. * Nobody has ever taken the mythical journey to the centre of the Earth, but by studying the way shockwaves from earthquakes travel through the planet, physicists have been able to work out its likely structure. * Right at the heart of the Earth is a solid inner core, two thirds of the size of the Moon and composed primarily of iron. At a hellish 5,700°C, this iron is as hot as the Sun’s surface, but the crushing pressure caused by gravity prevents it from becoming liquid. * Surrounding this is the outer core, a 2,000 km thick layer of iron, nickel, and small quantities of other metals. Lower pressure than the inner core means the metal here is fluid. * Differences in temperature, pressure and composition within the outer core cause convection currents in the molten metal as cool, dense matter sinks whilst warm, less dense matter rises. The Coriolis force, resulting from the Earth’s spin, also causes swirling whirlpools. * This flow of liquid iron generates electric currents, which in turn produce magnetic fields. Charged metals passing through these fields go on to create electric currents of their own, and so the cycle continues. This self-sustaining loop is known as the geodynamo. * The spiraling caused by the Coriolis force means that separate magnetic fields created are roughly aligned in the same direction, their combined effect adding up to produce one vast magnetic field engulfing the planet. |

* The shadow zone of 'S' waves extends almost halfway around the globe from the earthquake's focus.
* The shadow zone for ‘S’ waves is an area that corresponds to an angle between 1030 and 1800
* This observation led to the discovery of liquid outer core. Since S waves cannot travel through liquid, they do not pass through the liquid outer core.

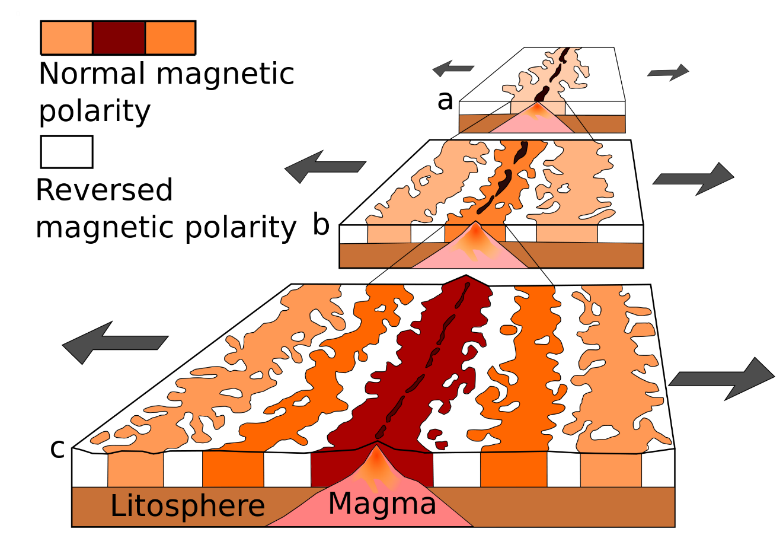
### Surface Waves (L waves)

* Also called as long period waves.
* They are low frequency, long wavelength, and transverse vibration.
* Generally affect the surface of the Earth only and die out at smaller depth.
* Develop in the immediate neighborhood of the epicenter.
* They cause displacement of rocks, and hence, the collapse of structures occurs.
* These waves are responsible for most the destructive force of earthquake.
* Recoded last on the seismograph.

# Propagation of Earthquake Waves

* Different types of earthquake waves travel in different manners. As they move or propagate, they cause vibration in the body of the rocks through which they pass.

## Distribution of Earthquakes and Volcanoes

* + - * This movement of the plates allowed the magma to rise up and harden into new rock.
      * As the new rock was formed near the ridge, older rock, which formed millions of years ago when the magnetic field was reversed, got pushed farther away, resulting in this **magnetic striping.**
      * Rising magma assumes the polarity of Earth’s geomagnetic field before it solidifies into oceanic crust.
      * At spreading centres, this crust is separated into parallel bands of rock by successive waves of emergent magma.
      * When Earth’s geomagnetic field undergoes a reversal, the change in polarity is recorded in the magma, which contributes to the **alternating pattern of magnetic striping on the seafloor.**

# Concept of Sea Floor Spreading

* + - * The idea that the seafloor itself moves (and carries the continents with it) as it expands from a central axis was proposed by **Harry Hess.**
      * According to this theory, the intense heat generated by radioactive substances in the mantle (100-2900 km below the earth surface) seeks a path to escape, and gives rise to the formation of convention currents in the mantle.
      * Wherever rising limbs of these currents meet, oceanic ridges are formed on the sea floor and wherever the failing limbs meet, trenches are formed.
      * Seafloor spreading is a process that occurs at mid-ocean ridges, where new oceanic crust is formed through volcanic activity and then **gradually moves away from the ridge**.
      * Seafloor spreading helps explain continental drift in the theory of plate tectonics. When oceanic plates diverge, tensional stress causes fractures to occur in the lithosphere.
      * Basaltic magma rises up the fractures and cools on the ocean floor to form new sea floor.
      * Older rocks will be found farther away from the spreading zone while younger rocks will be found nearer to the spreading zone.

## Evidences

* The **Hawaiian volcanoes** are the most famous examples.
* These volcanoes are mostly made up of basalt, a type of lava that is very fluid when erupted.
* These volcanoes are not steep.
* They become explosive if somehow water gets into the vent; otherwise, they are less explosive.
* Example: Mauna Loa (Hawaii).

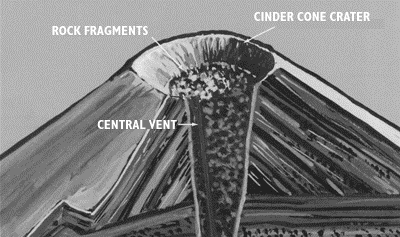
### Fissure Type Flood Basalt Landforms [Lava Plateaus]

* Sometimes, a very thin magma escapes through cracks and fissures in the earth's surface and flows after intervals for a long time, spreading over a vast area, finally producing a layered, undulating (wave like), flat surface.
* Example: **Deccan traps** (peninsular India), **Snake Basin, U.S.A, Icelandic Shield, Canadian Shield etc..**

### C:\Users\AXE\Pictures\9.6.jpgCaldera Lake

* After the eruption of magma has ceased, the crater frequently turns into a lake at a later time. This lake is called a 'caldera'. Examples: **Lonar in Maharashtra** and **Krakatao in Indonesia.**

### Cinder cone

* A cinder cone is a steep conical hill of loose pyroclastic fragments, such as either volcanic clinkers, cinders, volcanic ash, or scoria that has been built around a volcanic vent.

# Tsunami

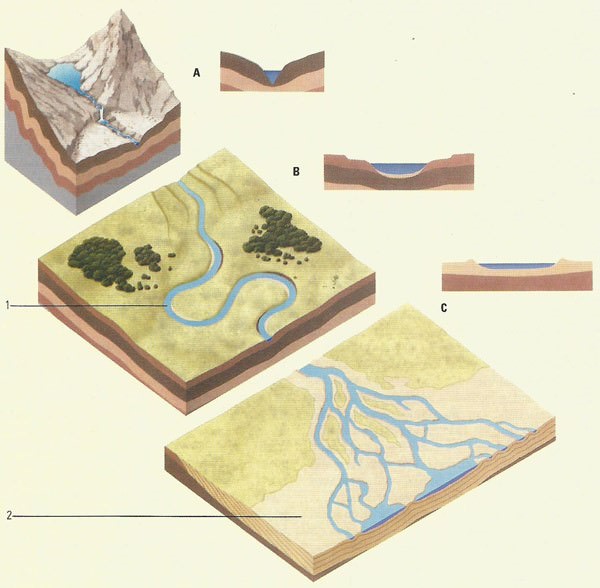
* Tsunami is a Japanese word for “**Harbour wave**”. They are also known as seismic sea waves.
* They are very long-wavelength water waves in oceans or seas. They are commonly referred to as **tidal waves** because of **long wavelengths**, although the attractions of the Moon and Sun play no role in their formation.
* They sometimes come ashore to great heights – tens of metres above mean tide level – and may be extremely destructive.

## What causes Tsunami?

* A tsunami can be caused by any disturbance that displaces a large water mass from its equilibrium position.

## River course

### Youth

* Young rivers (A) close to their source tend to be fast-flowing, high-energy environments with rapid headward erosion, despite the hardness of the rock over which they may flow.
* Steep-sided "V-shaped' valleys, waterfalls, and rapids are characteristic features. 

### Maturity

* Mature rivers (B) are lower-energy systems. Erosion takes place on the outside of bends, creating looping meanders in the soft alluvium of the river plain. Deposition occurs on the inside of bends and on the river bed.

### Old Age

* At a river's mouth (C), sediment is deposited as the velocity of the river slows. As the river becomes shallower more deposition occurs, forming islands and braiding the main channel into multiple, narrower channels.
* As the sediment is laid down, the actual mouth of the river moves away from the source into the sea or lake, forming a delta.
* **Head ward erosion** == Erosion at the origin of a stream channel, which causes the origin to move back away from the direction of the stream flow, and so causes the stream channel to lengthen.

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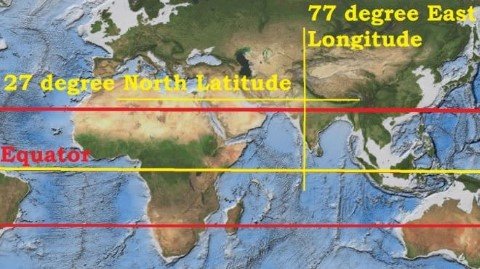
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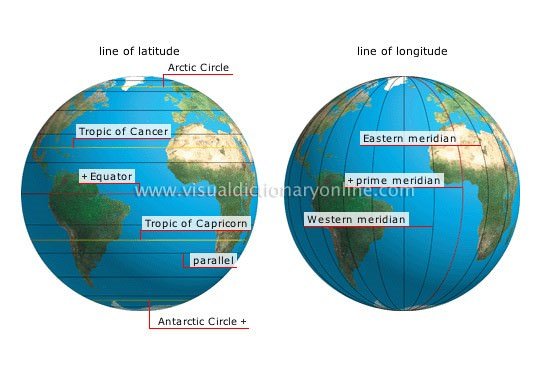
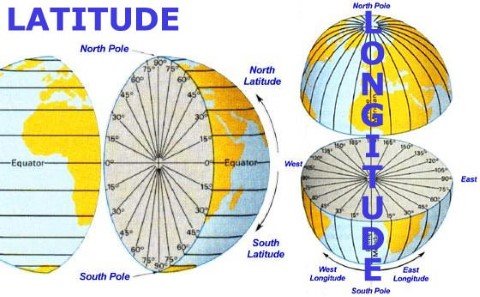
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# Latitudes and Longitudes

* Latitudes and Longitudes are imaginary lines used to determine the location of a place on earth.
* The shape of the earth is **‘Geoid’.** And the location of a place on the earth can be mentioned in terms of latitudes and longitudes.
* Example: The location of New Delhi is 28° N, 77° E.

## Latitude

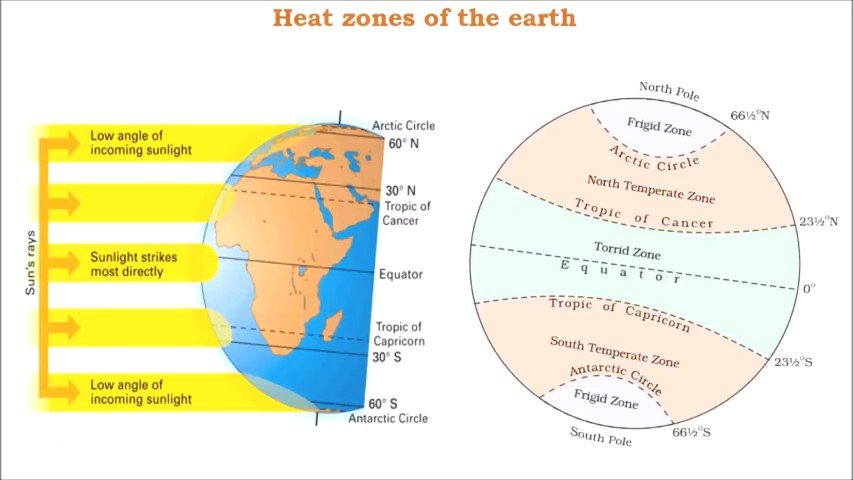
* Latitude is the angular distance of a point on the earth’s surface, measured in degrees from the center of the earth.
* ***As the earth is slightly flattened at the poles, the linear distance of a degree of latitude at the pole is a little longer than that at the equator.***
* For example at the equator (0°) it is 68.704 miles, at 45° it is 69.054 miles and at the poles it is 69.407 miles. The average is taken as **69 miles (111km).**
* **1 mile = 1.607 km.**

### Important parallels of latitudes

* Besides the equator (0°), the north pole (90°N) and the south pole (90° S), there are four important parallels of latitudes–

1. **Tropic of Cancer (23½° N) in the northern hemisphere.**
2. **Tropic of Capricorn (23½° S) in the southern hemisphere.**
3. **Arctic circle at 66½° north of the equator.**
4. **Antarctic circle at 66½° south of the equator.**

### Latitudinal Heat zones of the earth



## Equatorial Low Pressure Belt or ‘Doldrums’

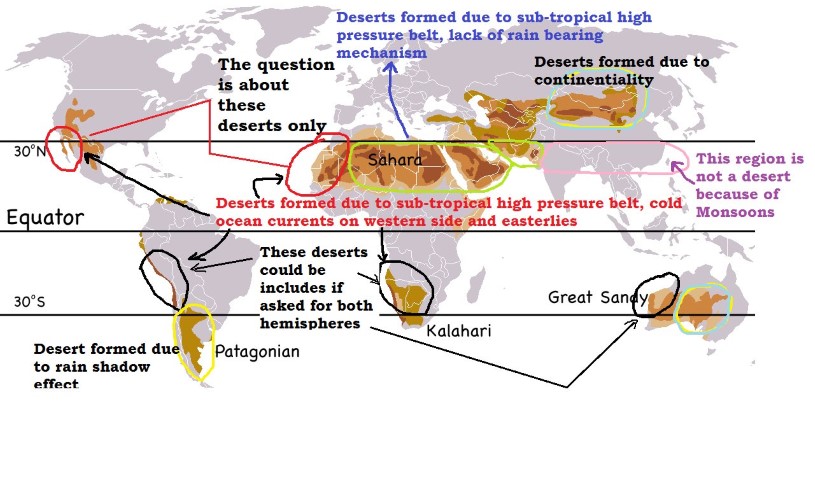
* Lies between **10°N and 10°S latitudes.**
* Width may vary between 5°N and 5°S and 20°N and 20°S.
* This belt happens to be the **zone of convergence of trade winds** from two hemispheres from sub-tropical high pressure belts.
* This belt is also called the **Doldrums**, because of the **extremely calm air movements.**
* The position of the belt varies with the apparent movement of the Sun.

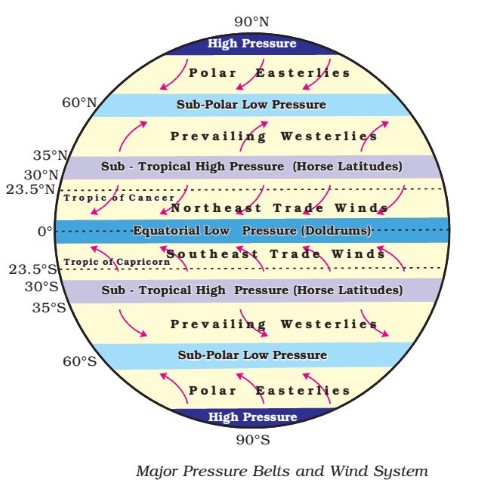


### Formation

* As this region lies along the equator, it receives highest amount of insolation.
* Due to intense heating, air gets warmed up and rises over the equatorial region (convection).
* Whenever there is vertically upward movement of air, the region at the surface will be at low pressure. Thus the belt along the equator is called equatorial low pressure belt.

### Question mains 2013: Major hot deserts in northern hemisphere are located between 20-30 degree north and on the western side of the continents. Why?





## Sub-Polar Low Pressure Belt

* Located between **45°N and S latitudes** and the **Arctic and the Antarctic circles (66.5° N and S latitudes).**
* Owning to low temperatures in these latitudes the sub polar low pressure belts are not very well pronounced year long.
* On long-term mean climatic maps, the sub polar low-pressure belts of the northern hemisphere are grouped into two centers of atmospheric activity: the **Iceland low** and the **Aleutian depression (Aleutian low).**
* Such belts in the southern hemisphere surround the periphery of Antarctica and are not as well differentiated.

## Forms of Condensation

* The forms of condensation can be classified on the basis of temperature at which the dew point is reached.
* Condensation can take place when the dew point is

1. **lower than the freezing point,**
2. **higher than the freezing point.**

* **White frost, snow and some clouds (cirrus clouds)** are produced when the temperature is lower than the freezing point.
* **Dew, fog and clouds** result even when the temperature is higher than the freezing point.
* Forms of condensation may also be classified on the basis of their location, i.e. at or near the earth’s surface and in free air.
* **Dew, white frost, fog and mist** come in the first category, whereas **clouds** are in the second category.

### Dew

* When the moisture is deposited in the form of water droplets on cooler surfaces of solid objects (rather than nuclei in air above the surface) such as stones, grass blades and plant leaves, it is known as dew.
* The ideal conditions for its formation are **clear sky, calm air, high relative humidity**, and **cold and long nights**.
* For the formation of dew, it is necessary that the **dew point is above the freezing point.**

### White Frost

* Frost forms on cold surfaces when condensation takes place **below freezing point (0° C)**, i.e. the **dew point** is at or below the freezing point.
* The excess moisture is deposited in the form of **minute ice crystals** instead of water droplets.
* The ideal conditions for the formation of white frost are the same as those for the formation of dew, except that the **air temperature must be at or below the freezing point.**

### Fog

* When the temperature of an air mass containing a large quantity of water vapour falls all of a sudden, condensation takes place within itself on fine dust particles.
* So, the fog is a **cloud with its base at or very near to the ground**. Because of the **fog and mist**, the visibility becomes poor to zero.
* In urban and industrial centers smoke provides plenty of nuclei which help the formation of fog and mist. Such a condition when fog is mixed with smoke, is described as **smog (will be discussed in detail in next post).** [Related Question Asked in Mains 2015: ***Mumbai, Delhi and Kolkata are the three mega cities of the country but the air pollution is much more serious problem in Delhi as compared to the other two. Why is this so?]***

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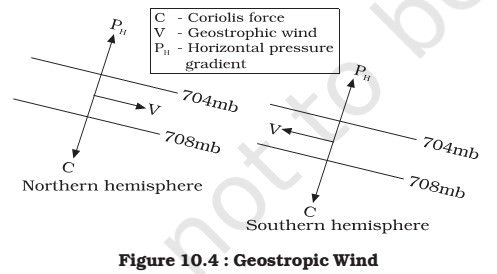
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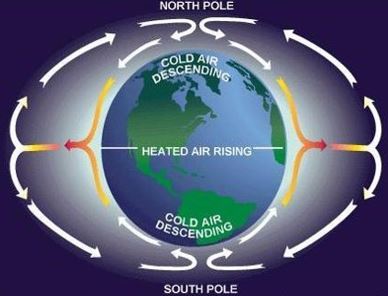
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# Jet streams

## Geostrophic Wind

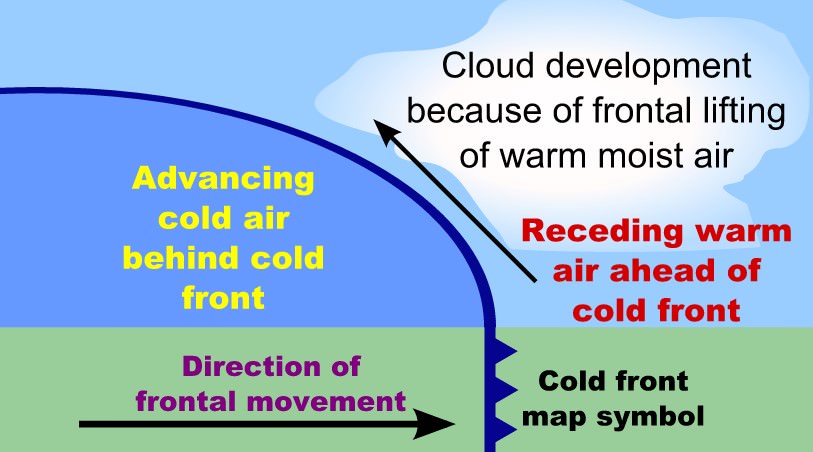
* The velocity and direction of the wind are the net result of the wind generating forces.
* The winds in the upper atmosphere, 2 - 3 km above the surface, are free from frictional effect of the surface and are controlled by the **pressure gradient** and the **Coriolis force.**
* An air parcel initially at rest will move from high pressure to low pressure because of the Pressure Gradient Force (PGF).
* However, as that air parcel begins to move, it is deflected by the Coriolis force to the **right in the northern hemisphere (to the left in the southern hemisphere).**
* As the wind gains speed, the deflection increases until the Coriolis force equals the pressure gradient force (2 – 3 km above the ground, friction is low and winds travel at greater speeds).
* At this point, the wind will be blowing parallel to the isobars (perpendicular to Pressure Gradient Force). When this happens, the wind is referred to as **geostrophic wind.**

##### Why winds don’t flow from tropical high pressure (in upper troposphere) to polar low (in upper troposphere) directly as shown in figure below?

* Because these winds are geostrophic, i.e., they flow at great speeds due to low friction and are subjected to greater Coriolis force.
* So they deflect greatly giving rise to three distinct cells called Hadley cell, Ferrel Cell and Polar cell.
* Instead of one big cell (as shown in fig) we have three small cells that combinedly produces the same effect.

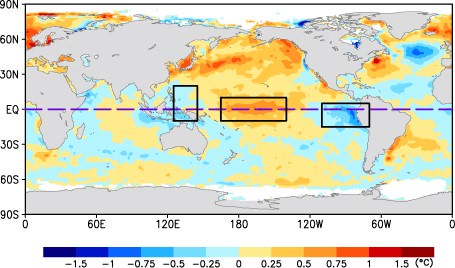
## **Cold Front**

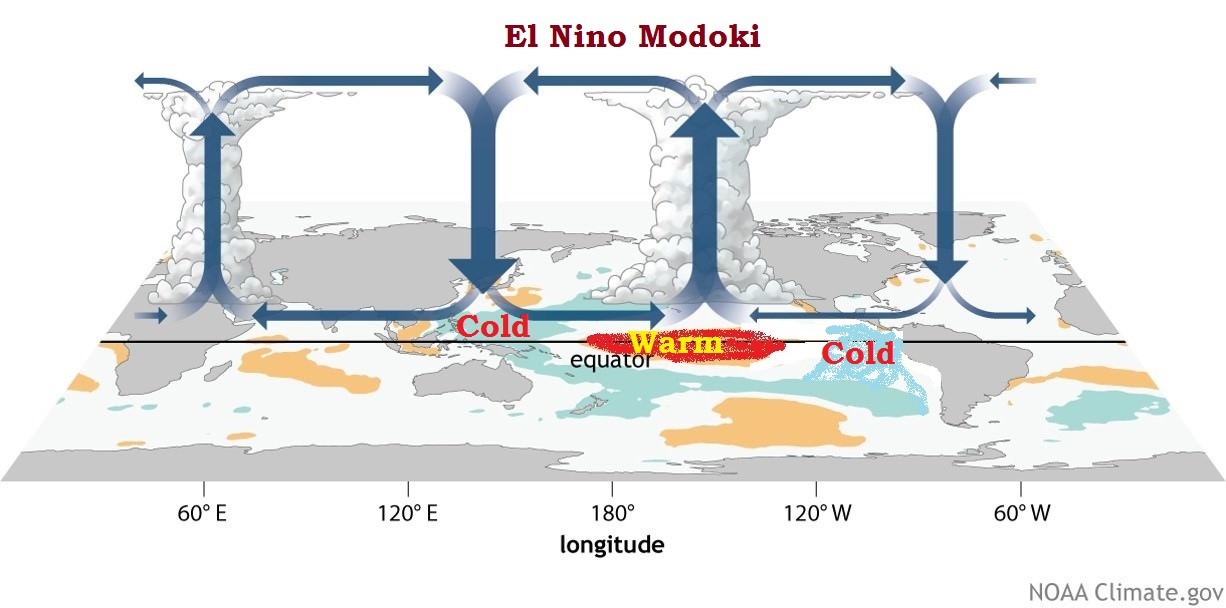
* Such a front is formed when a cold air mass replaces a warm air mass by advancing into it or that the warm air mass retreats and cold air mass advances (cold air mass is the clear winner).
* In such a situation, the transition zone between the two is a cold front.
* **Cold front moves up to twice as quickly as warm fronts**.
* Frontolysis begin when the warm air mass is completely uplifted by the cold air mass.



### Weather along a cold front

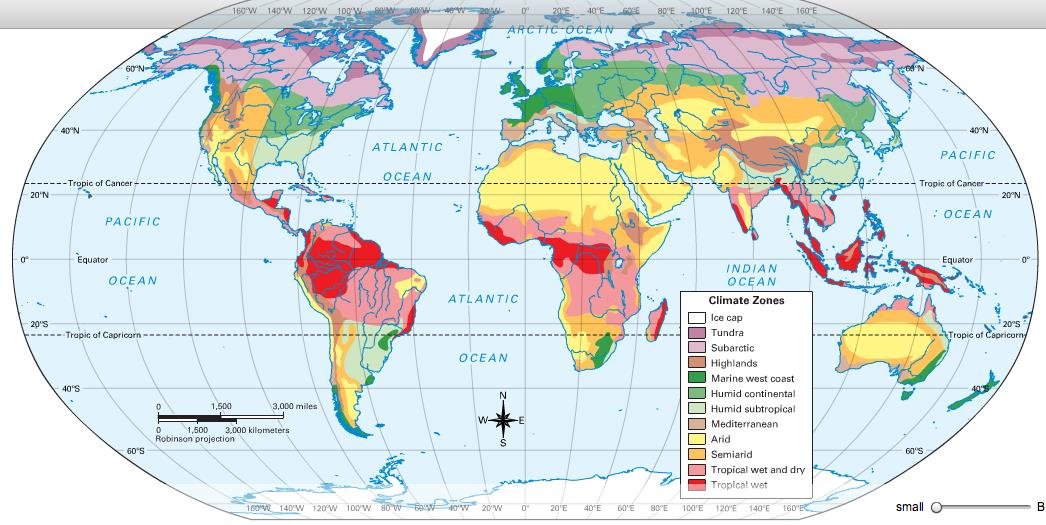
* The weather along such a front depends on a narrow band of cloudiness and precipitation.
* Severe storms can occur. During the summer months **thunderstorms** are common in **warm sector.**
* In some regions like USA **tornadoes** occur in warm sector. El Niño Modoki
* El Niño Modoki is a coupled ocean-atmosphere phenomenon in the tropical Pacific.
* It is different from another coupled phenomenon in the tropical Pacific namely, El Niño.
* Conventional El Niño is characterized by strong anomalous warming in the eastern equatorial Pacific.
* Whereas, El Niño Modoki is associated with **strong anomalous warming in the central tropical Pacific and cooling in the eastern and western tropical Pacific** (see figure below).



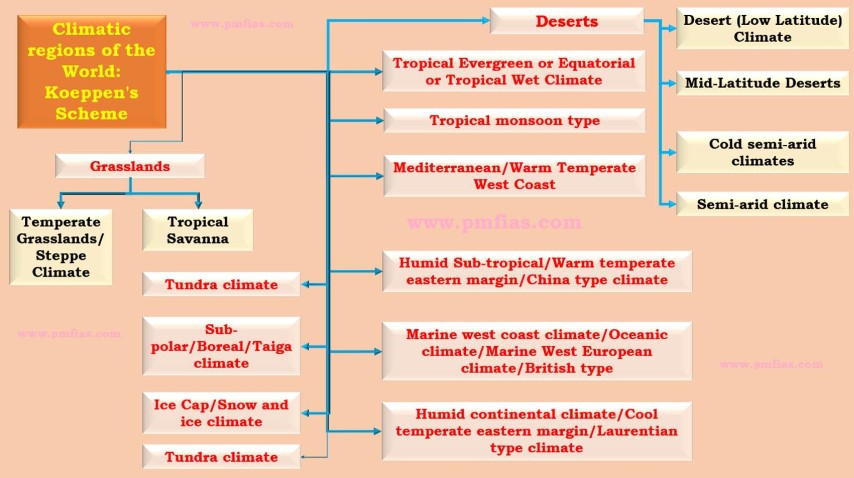


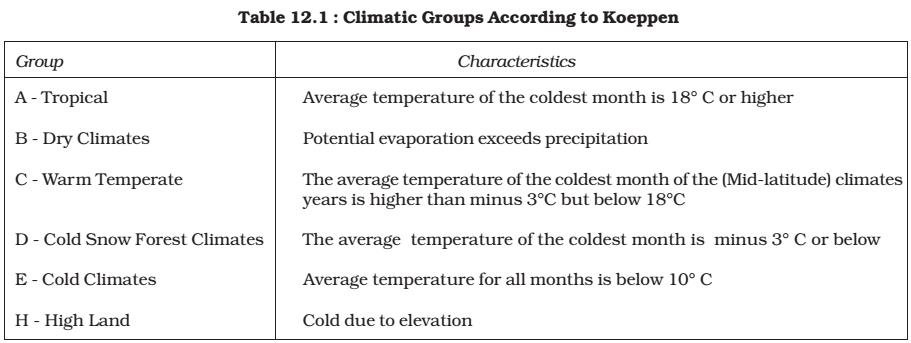
# Koeppen’s scheme Of Classification Of Climate

* The most widely used classification of climate is the empirical climate classification scheme developed by V. Koeppen. [**empirical**: verifiable by observation or experience rather than theory or pure logic][when dropped, stone falls to the ground – logic. Drop a stone to confirm that it falls to the ground – empirical]
* Koeppen identified a close relationship between the **distribution of vegetation** and **climate.** He selected certain values of **temperature** and **precipitation** and related them to the **distribution of vegetation** and used these values for classifying the climates.



* Koeppen recognized five major climatic groups, four of them are based on temperature and one on precipitation.
* The capital letters : **A, C, D and E delineate humid climates** and **B dry climates**.
* The climatic groups are subdivided into types, designated by small letters, based on seasonality of precipitation and temperature characteristics.
* The seasons of dryness are indicated by the small letters : f, m, w and s, where **f corresponds to no dry season, m - monsoon climate, w - winter dry season and s - summer dry season.**
* The small letters a, b, c and d refer to the degree of severity of temperature.
* The B - Dry Climates are subdivided using the capital letters **S for steppe or semi-arid** and **W for deserts**.





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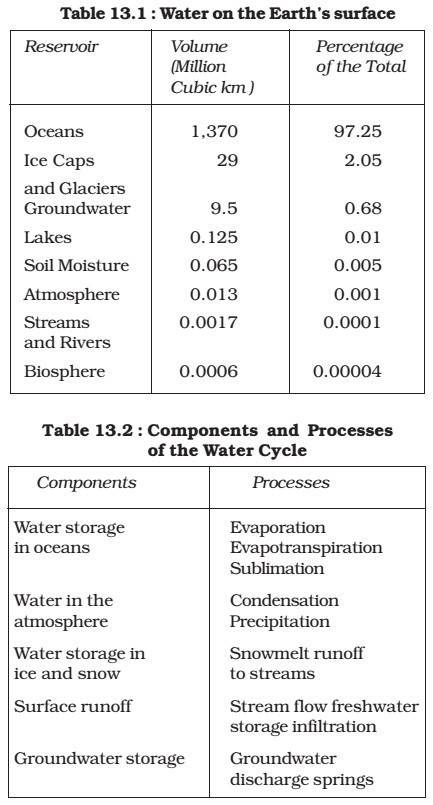
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# Ocean Relief

* Ocean relief is largely due to **tectonic, volcanic, erosional and depositional processes and their interactions.**
* Ocean relief features are divided into major and minor relief features.

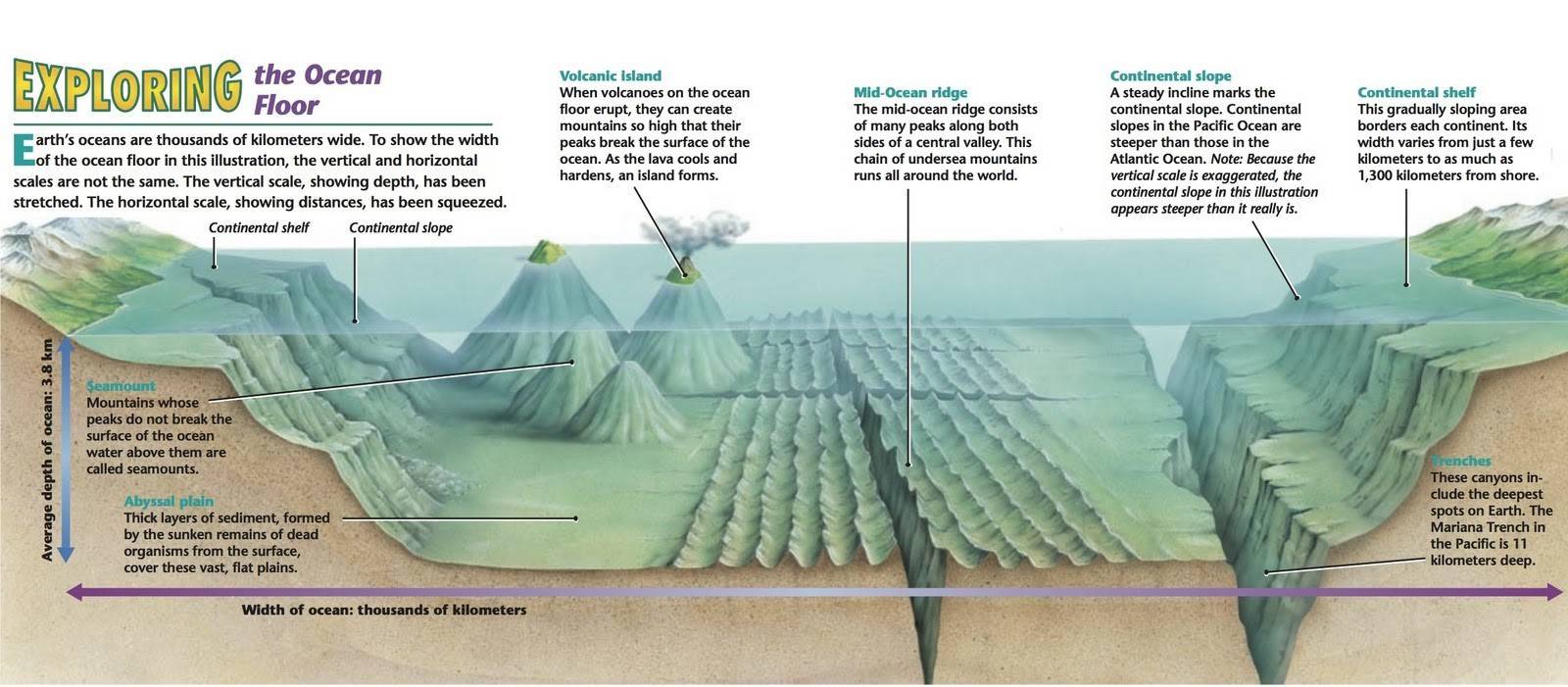
## Major Ocean Relief Features

Four major divisions in the ocean relief are:

1. **the continental shelf,**
2. **the continental slope,**
3. **the continental rise,**
4. **the Deep Sea Plain or the abyssal plain.**

## Minor Ocean Relief Features

* **Ridges,**
* **Hills,**
* **Seamounts,**
* **Guyots,**
* **Trenches,**
* **Canyons,**
* **Sleeps,**
* **Fracture zones,**
* **Island arcs,**
* **Atolls,**
* **Coral reefs,**
* **Submerged volcanoes and**
* **Sea-scarps.**



### Continental Shelf

* Continental Shelf is the **gently sloping** seaward extension of continental plate.
* These extended margins of each continent are occupied by relatively **shallow seas and gulfs.**
* Continental Shelf of all oceans together cover **7.5%** of the total area of the oceans.
* Gradient of continental is of **1° or even less.**
* The shelf typically ends at a very steep slope, called the **shelf break.**
* The continental shelves are covered with variable thicknesses of sediments brought down by **rivers, glaciers** etc..
* Massive sedimentary deposits received over a long time by the continental shelves, become the source of fossil fuels [Petroleum].
* Examples: Continental Shelf of South-East Asia, Great Banks around Newfoundland, Submerged region between Australia and New Guinea.
* The shelf is formed mainly due to

1. **submergence of a part of a continent**
2. **relative rise in sea level**
3. **Sedimentary deposits brought down by rivers**

* There are various types of shelves based on different sediments of terrestrial origin —

1. **glaciated shelf (Surrounding Greenland),**
2. **coral reef shelf (Queensland, Australia),**
3. **shelf of a large river (Around Nile Delta),**
4. **shelf with dendritic valleys (At the Mouth of Hudson River)**
5. **shelf along young mountain ranges (Shelves between Hawaiian Islands).**



###### Width

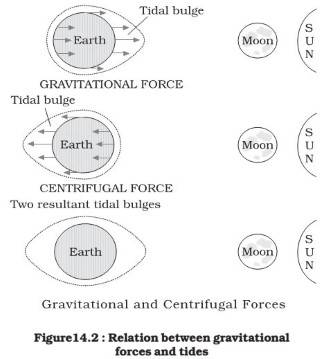
* The average width of continental shelves is between **70 – 80 km.**
* The shelves are almost absent or very narrow along some of the margins like the coasts of Chile, the west coast of Sumatra, etc. [Ocean – Continent Convergence and Ocean – Ocean Convergence].
* It is up to 120 km wide along the eastern coast of USA. On the contrary, the **Siberian shelf** in the Arctic Ocean, the largest in the world, stretches to 1,500 km in width.

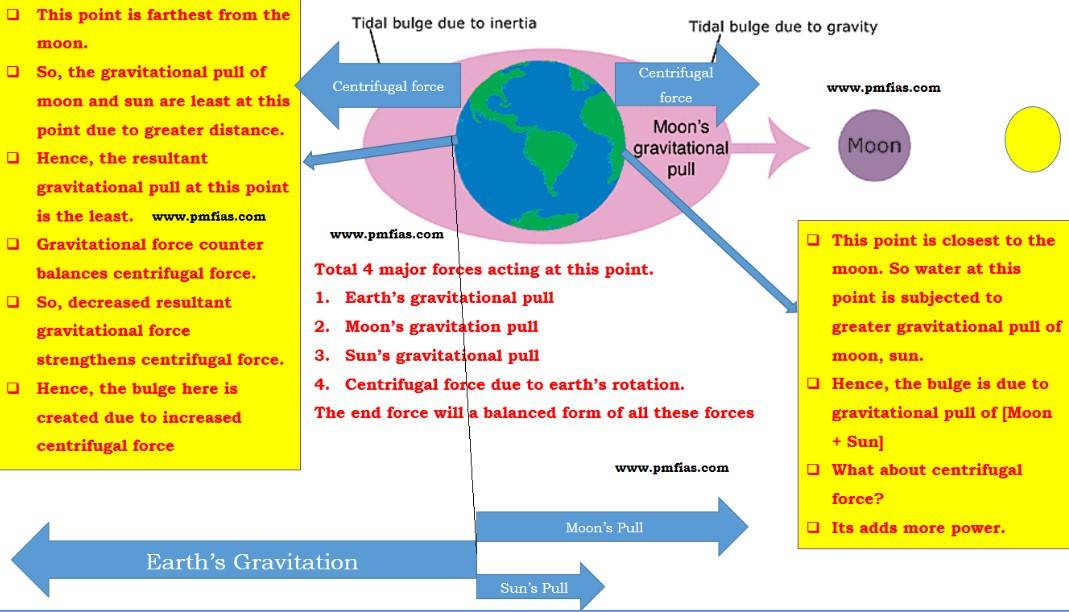


# Tides

* The periodical rise and fall of the sea level, once or twice a day, mainly due to the attraction of the sun and the moon, is called a tide.
* Movement of water caused by meteorological effects (winds and atmospheric pressure changes) are called **surges (storm surge during cyclones).**
* The study of tides is very complex, spatially and temporally, as it has great variations in frequency, magnitude and height.
* The **moon’s gravitational pull** to a great extent and to a lesser extent the **sun’s gravitational pull**, are the major causes for the occurrence of tides.
* Another factor is **centrifugal force** which acts opposite to **gravitational pull** of earth.
* Tides occur due to a balance between all these forces.

## Tidal Bulge - Why there are two tidal bulges? - Why is there a tidal bulge on the other side?





* Together, the gravitational pull and the centrifugal force are responsible for creating the two major **tidal bulges** on the earth.
* On the side of the earth facing the moon, a tidal bulge occurs while on the opposite side though the gravitational attraction of the moon is less as it is farther away, the centrifugal force causes tidal bulge on the other side.
* The ‘tide-generating’ force is the difference between these two forces; i.e. **the gravitational attraction of the moon and the centrifugal force.**
* On the surface of the earth, nearest the moon, pull or the attractive force of the moon is greater than the centrifugal force, and so there is a net force causing a bulge towards the moon.

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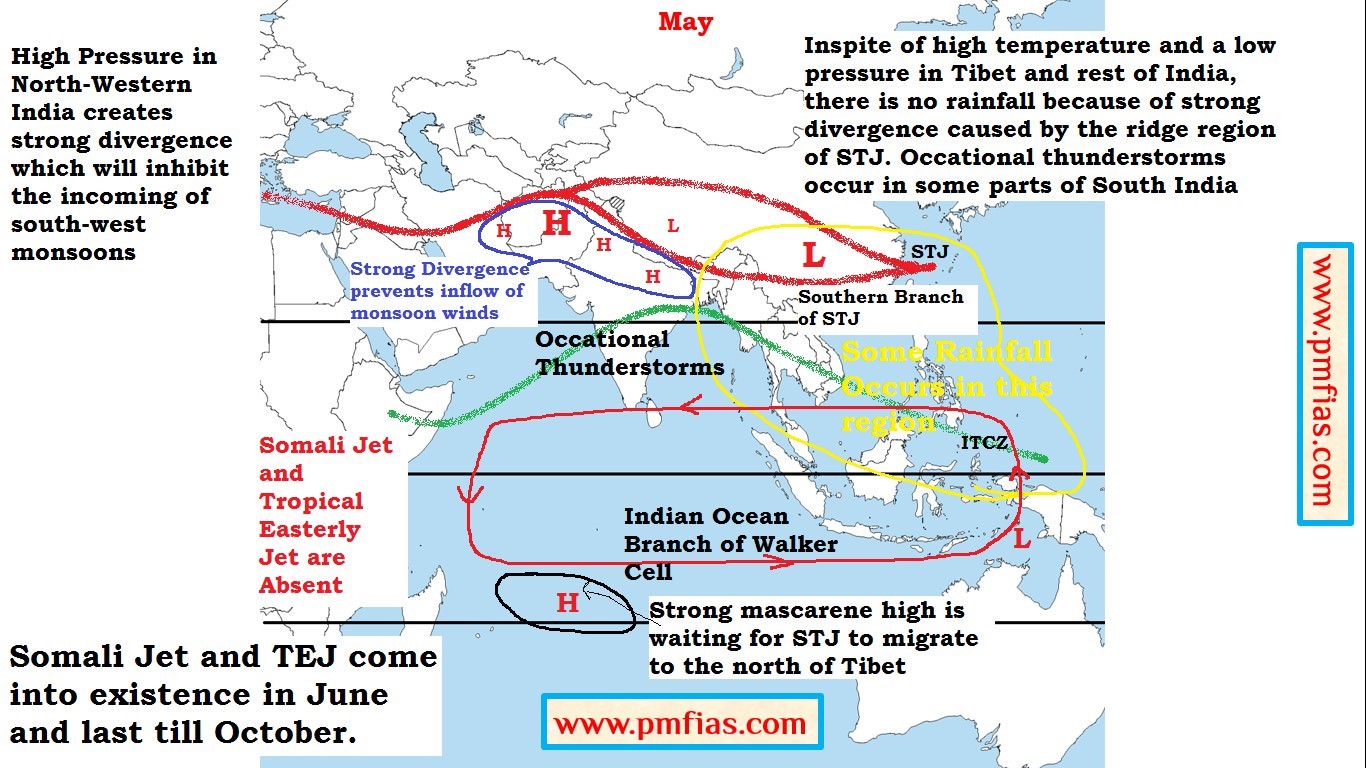
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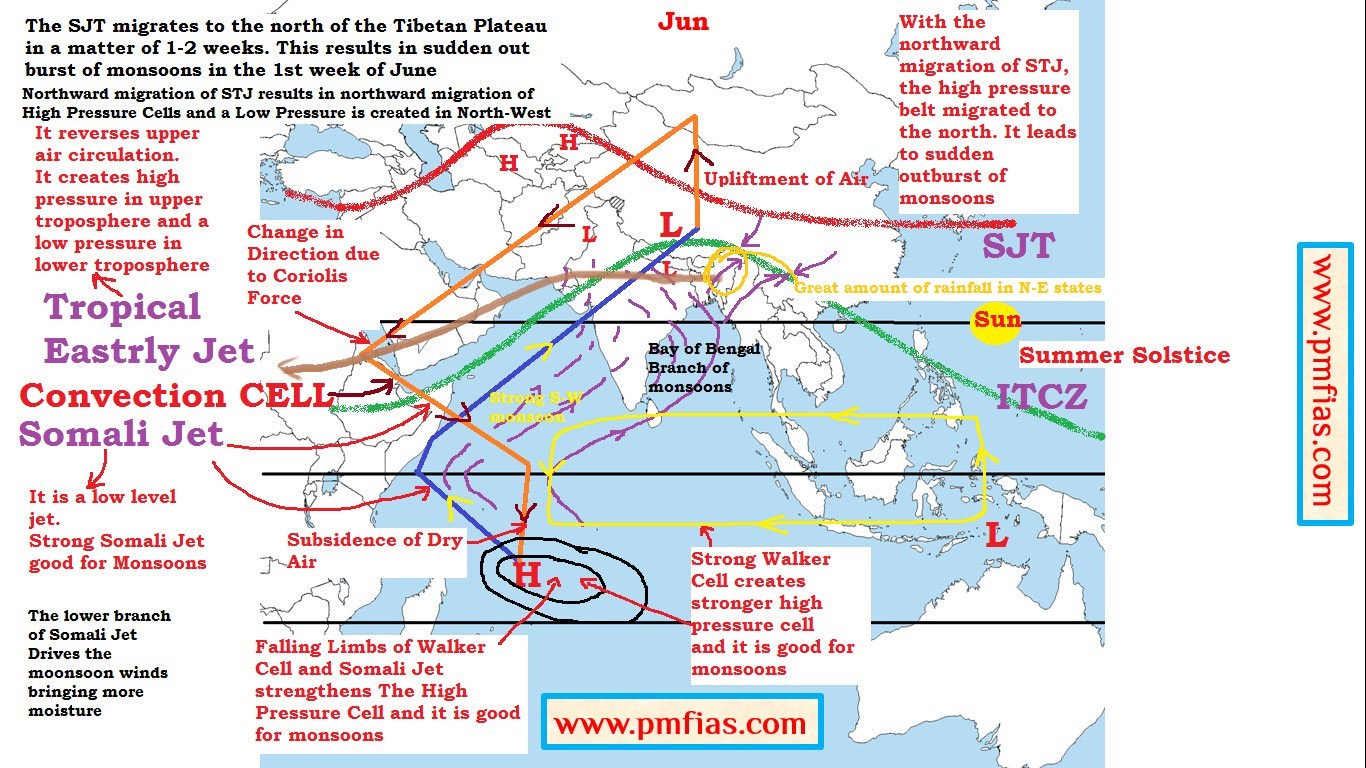
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## Indian Monsoons – Modern theory: Air Mass Theory

* According to this theory, the monsoon is simply a **modification of the planetary winds of the tropics.**
* The theory is based on the migration of ITCZ based on seasons.





* South West Monsoon Season – **June to mid-September.**
* South West Monsoon Season is also known as **hot-wet season.**
* Sudden onset is the important feature of South West Monsoons.
* With the onset of monsoons, temperature falls drastically and humidity levels rise.

### Temperature during South West Monsoon Season

* Sudden onset of South West Monsoons leads to significant fall in temperature [3° to 6°C].
* The temperature remains less uniform throughout the rainy season.
* The temperature rises in September with the cease of south-west monsoons.
* There is rise in temperature whenever there is **break in the monsoons**.
* The diurnal range of temperature is small due to clouds and rains.
* The highest temperatures are experienced at places west of the Aravali [38° to 40°C]. This is due to lack of clouds and hot continental air masses.
* Other parts of Northwest India also have temperatures above 30°C.
* The temperatures are quite low over the Western Ghats due to heavy rainfall.
* The coastal areas of Tamil Nadu and adjoining parts of Andhra Pradesh have temperatures above 30°C as they receive little rainfall during this season.

### Pressure and Winds During South West Monsoon Season

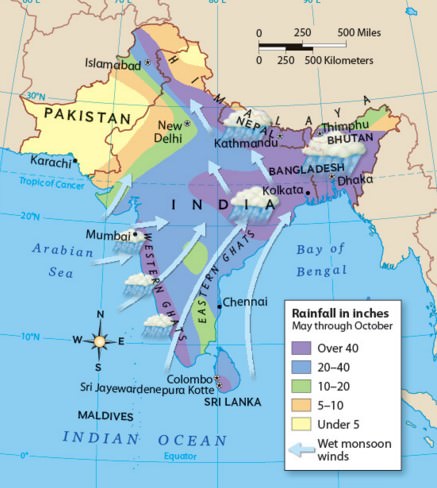
* Low pressure conditions prevail over northwest India due to high temperature.
* ITCZ (monsoon trough) lies along the Ganga plain. There are frequent changes in its location depending upon the weather conditions.
* The atmospheric pressure increases steadily southwards.
* Over the peninsular region, due to pressure gradient between north and south, winds blow in a southwest to northeast direction from Arabian sea and Bay of Bengal.
* Their direction undergoes a change in Indo-Gangetic plain where they move from east to west.

### Rainfall During South West Monsoon Season

* Three fourths of the total annual rainfall is received during this season.
* The average rainfall over the plains of India in this season is about 87 per cent.
* Normal date of the arrival of the monsoon is 20th May in Andaman and Nicobar Islands.
* The advance of the monsoon is **much faster in the Bay of Bengal than in the Arabian Sea.**
* The normal date of onset of the southwest monsoon over **Kerala i.e. the first place** of entry in the mainland of India is 1st June.
* The monsoons advance quickly accompanied with a lot of thunder, lightning and heavy downpour. This sudden onset of rain is termed as **monsoon burst.**
* Sometimes monsoons are delayed or they come much earlier than normal.
* Normally the onset occurs between 29th May and 7th June.
* The earliest onset was on 11th May in 1918 and 1955, while the most delayed onset was on 18th June in 1972.

### South West Monsoon – Arabian Sea branch and Bay of Bengal branch

* Monsoon winds beyond south Kerala progress in the form of two branches viz. the **Arabian Sea branch** and the **Bay of Bengal branch.**

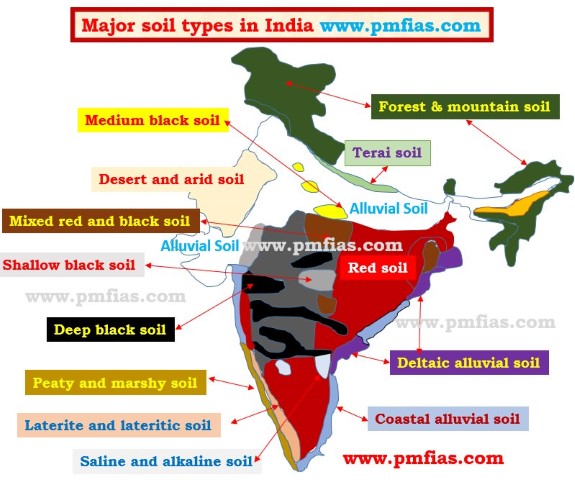


* The Arabian Sea branch gradually advances northwards. It reaches Mumbai by 10th June.
* The Bay of Bengal branch spreads rather rapidly over most of Assam. The normal date of its arrival at Kolkata is 7th June.
* On reaching the foothills of the Himalayas the Bay branch is **deflected westward by the Himalayan barrier** and it advances up the Gangetic plain.
* The two branches merge with each other mostly **around Delhi** to form a single current.
* Both the branches reach Delhi more or less at the **same time**.
* The combined current gradually extends to west Uttar Pradesh, Haryana, Punjab, Rajasthan and finally to Himachal Pradesh and Kashmir.
* By the end of June the monsoon is usually established over most parts of the country.

# Major Soil Groups of India

* Geologically, Indian soils can broadly be divided into soils of peninsular India and soils of extra-peninsular India.
* The soils of Peninsular India are formed by the decomposition of rocks in situ, i.e. directly from the underlying rocks.
* Soils of Peninsular India are transported and re-deposited to a limited extent and are known as **sedentary soils.**
* The soils of the Extra-Peninsula are formed due to the depositional work of rivers and wind. They are very deep. They are often referred to as **transported or azonal soils.**
* Major groups:

1. **Alluvial soils,**
2. **Black soils,**
3. **Red soils,**
4. **Laterite and Lateritic soils,**
5. **Forest and Mountain soils,**
6. **Arid and Desert soils,**
7. **Saline and Alkaline soils and**
8. **Peaty and Marshy soils.**

****

## Alluvial Soils

Economic Geography by Pmfias.com

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# Iron Ore

The below data is important for Prelims [Will be helpful to answer some logic based questions in mains]

* To understand about the factors that influence the location of Iron and Steel Industry, we have to understand about iron ore smelting.
* **Smelting** is a process of converting ore to metal by removing impurities.

## Commonly found impurities in Iron Ore

### Silicon

* Found in small quantities.
* Slightly raises the Strength and Hardness of Steel.
* Acts as a **de-oxidizing Agent** ==> small quantities is good. [Oxides decrease the strength of Iron]

### Sulphur

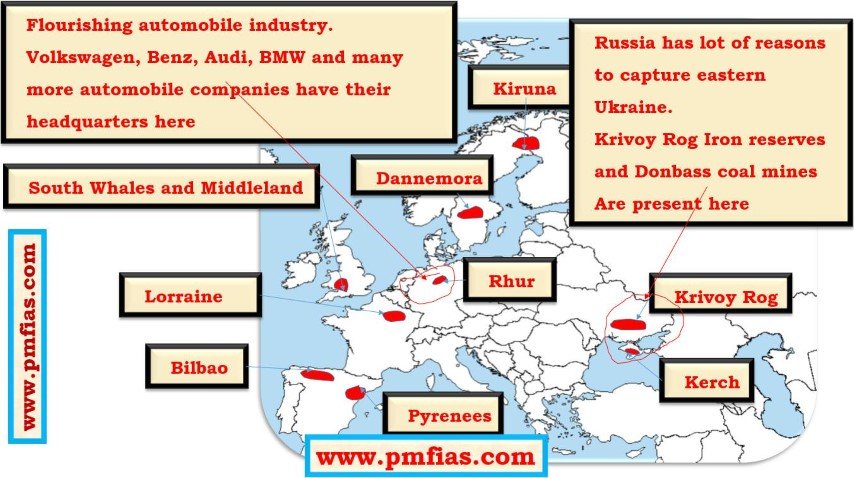
* A **VERY harmful element**.
* Forms Iron Sulphide which is a very **brittle** substance.

# Iron Ore Distribution Across the World

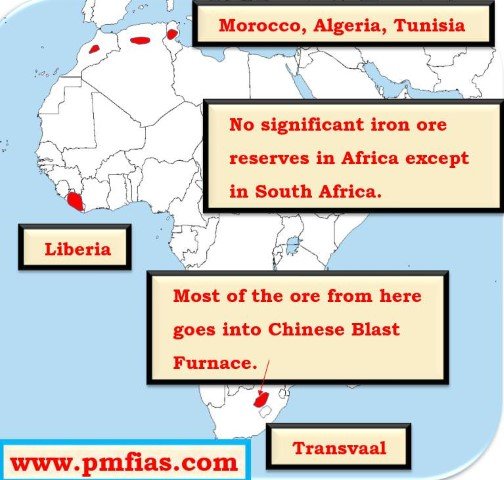
## Iron Ore in China – Manchuria, Sinkiang, Si-kiang, Shandog Peninsula

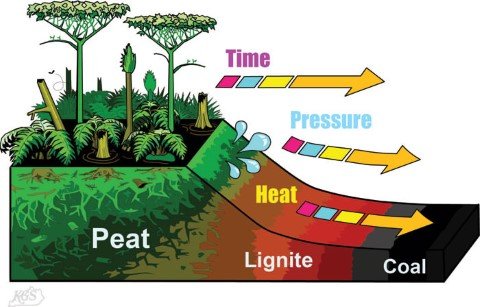


## Iron Ore in Europe – Ruhr, South Whales, Krivoy Rog, Bilbao, Lorraine



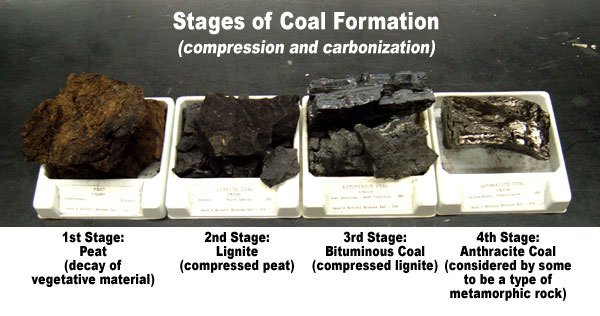
## Iron ore in Africa – Transvaal, Liberia





* Coal formed millions of years ago when the earth was covered with huge swampy [marshy] forests where plants - giant ferns and mosses - grew.
* As the plants grew, some died and fell into the swamp waters. New plants grew up to take their places and when these died still more grew.
* In time, there was thick layer of dead plants rotting in the swamp. The surface of the earth changed and water and dirt washed in, **stopping the decaying process**.
* More plants grew up, but they too died and fell, forming separate layers. After millions of years many layers had formed, one on top of the other.
* The weight of the top layers and the water and dirt packed down the lower layers of plant matter.
* Heat and pressure produced chemical and physical changes in the plant layers which **forced out oxygen and left rich carbon deposits**. In time, material that had been plants became coal.
* Coals are classified into three main ranks, or types: **lignite, bituminous coal, and anthracite.**
* These classifications are based on the **amount of carbon, oxygen, and hydrogen present in the coal.**
* Coals other constituents include **hydrogen, oxygen, nitrogen, ash, and sulfur.**
* Some of the undesirable chemical constituents include **chlorine and sodium**.
* In the process of transformation (coalification), ***peat is altered to lignite, lignite is altered to sub-bituminous, sub-bituminous coal is altered to bituminous coal, and bituminous coal is altered to anthracite.***

## Types of Coal – Peat, Lignite, Bituminous & Anthracite Coal



### Peat

* First stage of transformation.
* Contains **less than 40 to 55 per cent carbon == more impurities.**
* Contains sufficient volatile matter and **lot of moisture** [more smoke and more pollution].
* Left to itself, it burns like **wood**, gives less heat, emits more smoke and leaves a **lot of ash.**

### Lignite

* **Brown coal.**
* Lower grade coal.
* **40 to 55 per cent carbon.**
* Intermediate stage.
* Dark to black brown.
* Moisture content is high (over 35 per cent).
* It undergoes **SPONTANEOUS COMBUSTION** [Bad. Creates fire accidents in mines]

### Bituminous Coal

* Soft coal; most widely available and used coal.
* Derives its name after a liquid called **bitumen.**
* **40 to 80 per cent carbon.**
* Moisture and volatile content (15 to 40 per cent)
* Dense, compact, and is usually of black colour.
* **Does not have traces of original vegetable material.**
* Calorific value is **very high** due to high proportion of carbon and low moisture.
* Used in production of **coke and gas**.

### Anthracite Coal

* **Best quality**; hard coal.
* **80 to 95 per cent carbon**.
* Very little volatile matter.
* Negligibly small proportion of moisture.
* Semi-metallic lustre.
* **Ignites slowly** == less loss of heat == highly efficient.

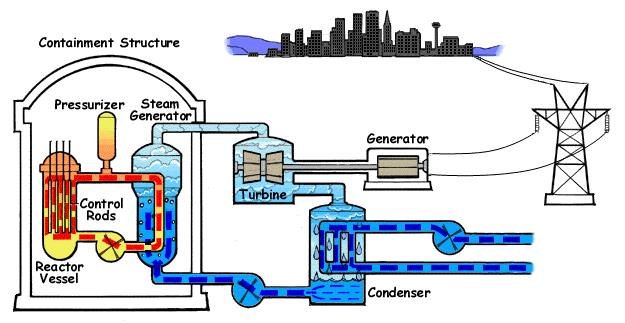
# Unconventional Gas Reservoirs

## Uranium Enrichment

* Natural uranium is only 0.7% U-235, the fissionable isotope.
* The other 99.3% is U-238 which is not fissionable.
* The uranium is usually enriched to 2.5-3.5% U-235 for use in light water reactors.
* Centrifugal separators and laser enrichment procedures are used in uranium enrichment.
* The enriched uranium fuel used in fission reactors cannot be used to make a bomb.
* It takes enrichment to over 90% to obtain the fast chain reaction necessary for weapons applications.
* Enrichment to 15-30% is typical for breeder reactors.

## Nuclear Reactor

* A nuclear reactor is a system that contains and controls sustained nuclear chain reactions.



Pic from: <https://whatisnuclear.com/articles/nucreactor.html>

* Fuel [Enriched uranium-235 or Plutonium-239] is placed into the reactor vessel along with a small neutron source.
* The neutrons start a chain reaction where each atom that splits releases more neutrons that cause other atoms to split.
* Each time an atom splits, it releases large amounts of energy in the form of heat.
* The heat is carried out of the reactor by coolant, which is most commonly just plain water.
* The coolant heats up and goes off to a turbine to spin a generator or drive shaft.
* The coolant is the material that passes through the core, transferring the heat from the fuel to a turbine. It could be water, heavy-water, liquid sodium, helium, or something else.
* The turbine transfers the heat from the coolant to electricity, just like in a fossil-fuel plant.
* The containment is the structure made of steel-reinforced concrete that separates the reactor from the environment. Chernobyl did not have a strong containment structure.

### Nuclear Reactor Coolant

* A nuclear reactor coolant — usually water or molten salt — is circulated past the reactor core to absorb the heat that it generates.
* The heat is carried away from the reactor and is then used to generate steam.

### Neutron Moderator

* A neutron moderator is a medium that **reduces the speed of fast neutrons**, thereby turning them into **thermal neutrons** capable of sustaining a nuclear chain reaction.
* When a large fissile atomic nucleus such as uranium-235 or plutonium-239 absorbs a neutron, it may undergo nuclear fission.
* The heavy nucleus splits into two or more lighter nuclei, (the fission products), releasing kinetic energy, gamma radiation, and free neutrons.
* A portion of these neutrons may later be absorbed by other fissile atoms and trigger further fission events, which release more neutrons, and so on. This is known as a **nuclear chain reaction.**
* To control such a nuclear chain reaction, neutron poisons and neutron moderators can change the portion of neutrons that will go on to cause more fission
* Commonly-used moderators include **regular (light) water** (in 74.8% of the world's reactors), **solid graphite** (20% of reactors), **heavy water** (5% of reactors) and **beryllium.**

### Control Rods or Reactivity control

* The power output of the reactor is adjusted by controlling how many neutrons are able to create more fissions.
* Control rods that are made of a neutron poison are used to **absorb neutrons**.

**Moderators slow down neutrons**

**Control Rods absorb neutrons**

**Moderators are like accelerators**

**Control Rods are like brakes**

* Absorbing more neutrons in a control rod means that there are fewer neutrons available to cause fission.