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Sources of Geography :→

1) NCERT : XIth & XIIth classes.

2) Atlas + Maps.

3) Indian Geography : Dr. Khullar.

4) Notes.

5) Environmental geography
↓
Arihant Publications.

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Geography

Geo + Graphy.
↓ ↓
The Earth. Study.

∴ The study of earth is called geography.

The study has been divided into the two parts:-

Natural System:

→ Physical Geography.
* Geomorphology.
* Climatology
* Oceanography.
* Biography.
* Environmental Geography.

Cultural System

↓
Created by Human role.

→ Human geography.
* Races / tribes.
* Demography.
* Economic geo
* Settlement Geography
* Socio-cultural geography.

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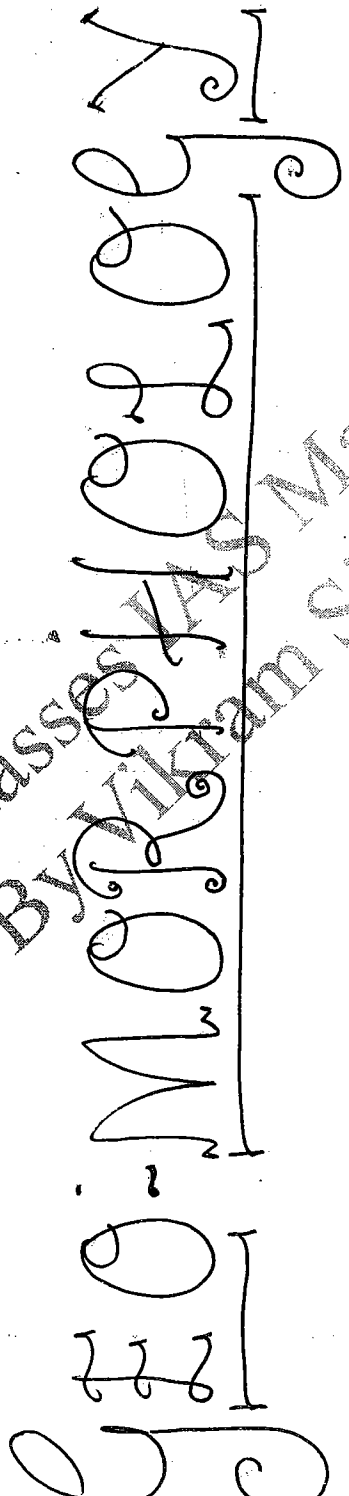


Earth Motion

Earth is a dynamic object possess five kind of motion such as :-

i) Rotation :- Spining on its own axis in a period of 24 hours.

ii) Revolution :- Earth revolve around the sun in one year i.e. 365.25 days.

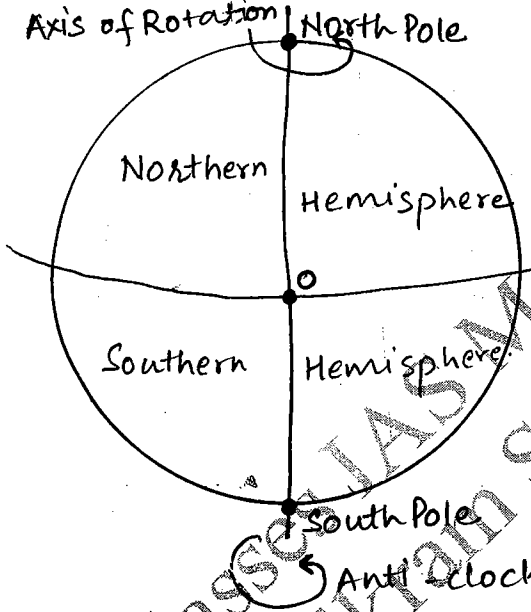
iii) Obliquity :- Tilt the angle of the earth change from 22.1° to 24.5° with respect to vertical axis within the period of 40,000 years.

iv) Ecentricity :- the earth orbit shape changes from circle to ellipse and vice-versa in a period of 1 lakh year.

v) Precession/wobbling :- the position of the earth lattitudly or North Pole changes with respect to fixed star in the sky.

In a period of 26,000 year earth wobble in clockwise direction & crosses 12 constellation.

Rotation the earth spins on its own axis within a day i.e. 24 Hours is known as Rotation.



Equator: Circular, at to the centre of earth and perpendicular to the line.

* It divides the earth into two equal parts known as Northern and Southern Hemisphere.

* Equator Diameter > Polar Diameter
  = 42 km

So, the equator is an imaginary line that is perpendicular to the axis of rotation and its centre is the centre of the earth.

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Poles :→ the axis of rotation make the surface of the earth at two points called poles.

Shape of the Earth The earth geometrical shape is oblate spheroid.

The geographer called the shape of earth as "geoid" which means the earth like shape.

Coriolis's Force $C_F = v\sin\theta$.

* It deflects the moving object.
* A psendo force.

Ferrel's Law :- In Northern Hemisphere due to C_F, it deflects towards right and in Southern Hemisphere it deflects towards left.

→ Bothe latitude and longitude called geographical lines. They wide for geographical grid.

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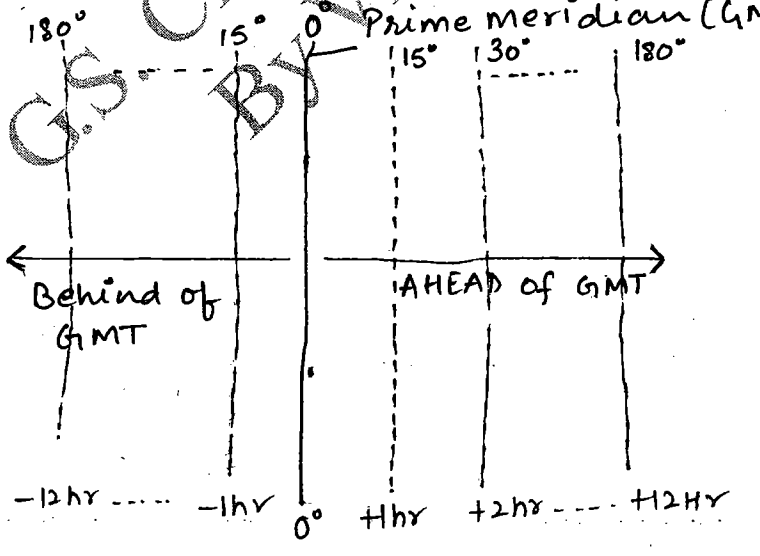
Latitudes:- An imaginary line running East - West direction i.e, Horizontally called latitudes.

Longitudes:- An imaginary line running North-South direction i.e, vertically called longitudes. They all are of equal length. They converge towards the poles and diverge near the equator.

Significance of Latitudes & Longitudes

* Concept of date, time and day:-

→ every longitude has its own time.



* there are two kinds of time. i.e, standard time and local time. Every longitude has its own local time since over the same longitudes sunrays reaches at the same time.
* when the sun is at the highest position and sunrays falls more perpendicular and the shadow form is shortest in the day. The time is fixed at 12:00 Noon and before it become AM and after it become PM.
* For the world, the country to have uniform time some longitude are choosen as standard and their local time become the standard time of the country. For the world, the Prime Meridian i.e, GMT, Greenwitch Mean Time is choosen as standard time.
* time on the eastern side, is ahead of GMT with positive (+ve) notion but on the other side time is behind of GMT with Negative (-ve) notion.

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* 1 Hour = 15° longitude difference

1° = 4 min.

A country has three choices to have on to choose their standard time with respect to GMT, Prime meridian on country standard.

1 Hour = 15°

1/2 Hour = 7.5°

1/4 Hour = 3.75°.

eg. India has choosen 1/2 hour or 7.5° multiple longitude i.e. 82.5° east.

* The world is divided into 24 time zones where 1 time zone differs from 1 hour or 15° longitude.

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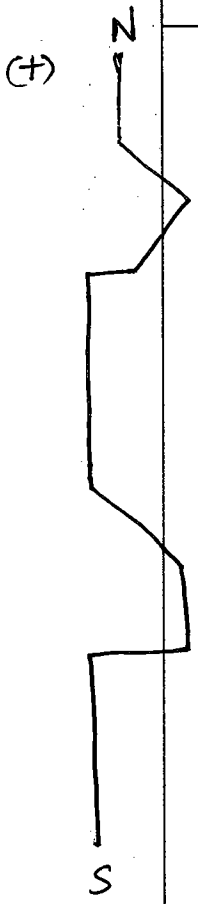

International Date Line:-

* There exists two kinds of paradox:-
  i) the places lies on 180° Longitude has two time, +12hr ahead of GMT and -12 hr behind the GMT. This leads to two different timings which is not possible over the same place.
  ii) 24 Hours is lost in calculation, we have to know the starting of day and date.
* To resolve the above two paradox 180° longitude is roughly choosen as International Date Line (IDL).
* This line is a zig-zag line to avoid bifurcation of any country and clearly demarket either of eastern Hemisphere or western hemisphere.
* It defines the day and date clearly on eastern and western hemisphere by adjusting the calender and watches when we crosses the IDL:-
  → On the eastern hemisphere, one day is added while on the western one day is lost.

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* Because of the zig-zagness of IDL the time zone may be +13 hrs like of Kiribati Island and -13 hrs of Alentian Island.

Geographic Grid :-

* Grid reference is used to specify the places or location.
* Intersection of latitudes & longitudes.
* Distance is calculated b/w the two points.
* Area is calculated by joining the multiple points of the location.
* Navigation :- the place that is farthest from equator is showed as bigger rather than actual.

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GEOGRAPHIC GRID:→

A network of lattitude and longitude is called geographic grid. It is used for:→

i) to specify the place or location on earth surface by grid reference point. It is formed by the intersection of lattitude and longitude.

ii) Two points are used to represent the distance and more than two points are used to represent the area or the shape of the area.

iii) Navigation → for Arial and marine navigation, the map projection system is used. Here lattitude & longitudes are streight lines & perpendicular to each other. The lattitude closer or near the equator and widely seperated in the higher lattitudes.

Here, magnetic compass bearing follow the great circle route that is the shortest distance to be followed on a map b/w any two points. It is an imaginary circle route that is the

shortest distance to be followed on a map between any two points whose centre is the centre of the earth. for eg. equator / longitudes or any other inclined great circle.

iv) World Communication System :- It consist of 24 or more constellation of satellites placed in geo-stationary orbit at the height of 36,000 km.

* It will provide satellite based real time communication between any two points on the earth surface, till now, USA, China, India etc. has their own GPS (Global positioning system). Many countries like India uses GPS of USA which result into the compromising the security and sovereignty of the country. So, now India also develop its communication system IRNSS.

Other countries :-

* India - IRNSS
* Russia - Glonas
* Europe - Gallileo
* China - Compass.

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Earth Revolution and its Significance:-

Earth revolve around the sun in a orbit where Peri helion (shortest distance b/w sun and earth i.e. 147m km) and Aphelion (farthest distance b/w sun & earth i.e. 152 m km) distance differ by 3% in a period of 365.25 days. In this revolution earth spins by 366 times. It also rotate in anti-clock wise direction.

In a long period of time, the shape of earth orbit circle and orbit and vice versa in a period of 1 lakh year is called ecentricity. This explains the ice ages occurences on the earth.

Significances:-

(1) **Seasons:-**

* One calender years is divided into 4 seasons that every part of earth experiences i.e, summer, winter, spring and Autumn.
* It occurs due to revolution of the earth and the tilt angle of earth. This result into the variation in

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Sunlight with respect to time. This difference between the duration of sunlight between day and night is only a season.

* Summer:- when sunrays falls more perpendicular on the earth hemisphere then that hemisphere will experience summers.
* Winter:- when the sun is away from the hemisphere that means tilt away from the sunrays, the hemisphere will experience winter.
* But Spring and Autumn is a transition season between Summer & Winter
* Spring occurs intermediate between winter to Summer.
* Autumn occurs intermediate between Summer to winter.
* In terms of length of day and night the concept of equinoxes and solistices arises.
* Equinoxes:- equal duration of day and Night.
* Solistices:- unequal duration of day and Night.

Dates	N·H	S·H
21st March	Spring Equinoxes	Autumnal Equinoxes.
21st June	Summer Solistices	Winter Solistices
23rd Sept	Autumnal Equinoxes	Spring Equinoxes
22nd Dec.	Winter Solistices	Summer Solistices

* If a tilt angle of earth is "zero", then there will be no season.
* Northern Hemisphere (NH) Season are less than Southern Since on Jan 03 earth is at Perihellion position while on July 04, earth is at the Aphellion position.

(2) Eclipse:-

When Earth, Moon and Sun is in a same line or straight line or in a same plane then shadow of one objects falls on another and the people on the earth are unable to see the sun or moon is called eclipse. There are two kinds of eclipse:-

A) Lunar Eclipse

B) Solar Eclipse.

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* Lunar Eclipse:- occurs when the earth passes in front of the sun and the the shadow of earth falls on the moon. This phenomena takes place on new moon and full moon but not on every full moon we experience the Lunar eclipse.

When the ambra (dark part) of shadow falls on the moon it is called total Lunar eclipse but Penumbra part of shadow raise different phases of moon.

* Solar Eclipse:- Eclipse occur when the moon is closest to sun and its shadow falls on the earth.

when ambra part falls on the earth called total solar eclipse. It occurs not every year Maximum it can stay for 7min 31sec covering 250 km.

When Penumbra part falls on the earth then partial or annular solar eclipse we experience.

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Milkanowitch Cycles:- The Russian climatist Milkanowitch observed the relationship between the earth orbital motion such as obliquity, ecentricity and the precession with the natural climate changes.

* According to him, In a period of 40,000 years the climate of the earth reoccur that means the time gap between in glaciation and deglaciation phases. In 19000 periods or years the gap b/w ice age and warming age of the earth.
* 1 lakh years is a period of two ice ages on a large scale.

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Internal Structure of Earth:-

* Temperature, pressure and density increases as we go deeper into the earth.
* Sesmicity is the best method for revealing the internal structure of earth.
* There are three types of waves:-
  - p waves. } - Body waves.
  - S waves
  - L waves } surface wave.
* There exist direct methods such as volcanism or deepless but these direct methods are insufficient to reveal interior properties of the earth and its structure.
* By Indirect methods such as Sesmicity or earthquake, sesmic waves reveal the entire internal properties of the earth and structure since the sesmic waves passes through earth interior and suffer refraction, reflection etc.

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* Properties of Sesmic waves:-

there are three types of sesmic waves which directly or indirectly originates from the focus of an earthquake are

a) Primary wave - p wave.

b) Secondary wave - S wave

c) Surface wave or Long wave - L wave

* Primary wave (P wave):-

→ It is the fastest wave recorded first in the sesmograph.

→ It is longitudnal wave.

→ It can pass through both from solid and liquid.

* S wave :-

→ It is slower than p wave and recorded after it.

→ It is a transverse wave.

→ It can pass only through solid medium.

* L wave :-

→ It is a surface wave which cause large scale particle movement at the surface so it is most destructive wave.

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→ It is slowest wave and recorded last on the graph.

→ It has both transverse and the longitudnal components and can be passed through solid and liquid medium.

→ L wave decay with depth, so it do not carry any internal information of earth.

⊛ But P & S waves through the earth interior and reveals the internal properties of the earth so P & S wave together known as Body waves.

⊛ Sismic waves are curved line and Concave ~~phase~~ face is towards the surface of earth indicate that density gradually increases with depth.

⊛ P wave is observed everywhere across the earth but S-wave form swave shadow zone 120° opposite the focus indicate that internal part or core of the earth is made up of liquid state material.

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* The sismic curve lines becomes discontinuous due to abrupt changes of density at 5 regions. These discontinuities becomes boundary of the different layer of the earth such as Mohorovic Discontinuity b/w crust and Mantle boundaries.

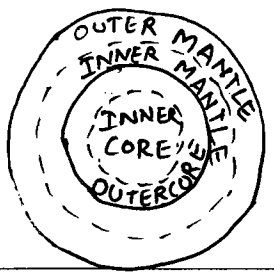
* Mohorovic Discontinuity.
  ↓
  (Crust - Mantle) Boundaries.

* Gruttenberg Discontinuity.
  ↓
  (Mantle - Core) Boundaries.

* Concard Discontinuity.
  ↓
  (Inner v/s Outer Crust)

* Repetti Discontinuity.
  ↓
  (Inner v/s Outer Mantle).

* Lehyvanah's Discontinuity.
  ↓
  (Inner v/s Outer Core)



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* Earth consist of three major concentric layers called crust, mantle and core and each is subdivided into 2 parts as outer and inner so total are the 6 concentric layers or rings.

* Properties of Crust :→

→ The outermost layer of the earth remains in solid and it is formed cooling and solidification of earth. In this process, chemical differentiation takes place. Silicates of Aluminium form the continent & the silicates of magnesium SIMA Layer for the oceanic crust.

→ Average thickness of crust varies from 2.5km to 100km. the continental crust is of 70km.

→ Density of continental crust + 2.7 g/cm³ and oceanic crust is 2.9 g/cm³ so Average density is 2.8 g/cm³.

→ Concard Discontinuity lies b/w the SIAL and SIMA Layers.

↓ Silicates of Aluminium

↳ Silicates of Magnesium.

Properties of Mantle:→

→ the intermediate or the middle layer of the earth lies b/w mohorovic and gutenberg discontinuity in a depth of 70 - 2900 km. Most of the mantle lies in solid form and it contains silicates of Mg in high concentration but the outer mantle contains in a plastic from layer in a depth of 100km - 300 km called Asthenosphere.

→ this layer form due to the pressure of Radio-active material such as uranium, radium it undergoes spontaneous radioactivity and radiation emmission raise the temperature upto 1000°C that partially melt the rock and the molten rock is known as magma. This magma moves & rotates in several convection cells which later on leads to the plate-tectonics movement.

→ Density - 3.5 - 6.5 g/cm³

→ Temperature - 850° - 3700°C.

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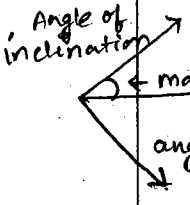
Properties of core :→ The inner part of the earth is called core lies below 2900 km depth. It contains outer & inner core made up of ferro-magnetic material such as Nickel - Iron (Ni-Fe) layer.

→ the outer-core which is in liquid form because its temperature is around 5000°c and density below 10g/cm³ that is sufficient to melt (Ni-Fe) material, the liquid outer core give rise to earth magnetic field around it called magnetosphere.

→ the inner core lies in the solid form because density raise the melting point of Ni-fe. More than 7000°c but the inner core temperature below 7000°c.

Earth's Magnetic Field or Geo-magnetism:-



* Magnetic Pole in Northern Hemisphere → Ellesemer Island (Canada).

* Magnetic Pole in Southern Hemisphere → In Southern Ocean b/w New Zealand & the Antarctica

* Changing from Southern to Northern Pole is Polar Reversibility.

* Magnetic Equator: is where angle becomes zero is called "magnetic equator.

* Magnetic Poles: where angle becomes 90°

* Earth behave like a bar magnet and generate a magnetic field around the earth. The total earth magnetism is explained by 2 ways:-

95% of magnetism arises due to outer core liquid form and rest 5% magnetism arises due to the Crystal magnetism i.e. by Asthenosphere.

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Properties of Earth Magnetic field :-

* Magnetic poles are situated in the northern Hemisphere, Ellesemer Island of Canada and in Southern Hemisphere, b/w newzealand and Antarctica in Southern Ocean.
* Magnetic axes make angle with the geographic axes called angle of declination. Present angle - 17.5°.
* Magnetic compass needle move vertically with respect to the Horizontal axes & form an angle called angle of magnetic depth or angle of inclination.
* Due to solar cycle, magnetic axes rotate in anticlockwise direction in a long period of time. So, magnetic poles appear to be moving in northern Hemisphere from East to west while in Southern Hemisphere West to east called "Polar Wondering".
* While North and South magnetic poles reverses called Polar reversibility. This magnetism of the earth get stored in the rock called "value magnetism". The rock store in alternate

magnetic lines called "magnetic Anamdy". when magnetic lines matches with the present magnetic axes called positive or otherwise become negative.

* when magnetic depth is "0". it is called as Magnetic equator and at 90 called Magnetic Poles and other angle of inclination or depth form magnitude lattitudes. these lattitudes are not parallel like geographic lattitude.
* Magnetic strength is strongest at the poles.

Significance:

* Auroras:- It is an optical phenomena observed near the poles where sky appear with different colours due to interaction of Ionosphere layer of the earth atmosphere with the magnetosphere.

  Northern Hemisphere - Aurora Boralis

  Southern Hemisphere - Aurora Auralis.

* VanAllen Radiation Belt:- The charged particles such as electrons and protons under the earth's magnetic field start rotating giving rise in 2 rings till 2013. The inner rings contains

both, electrons under motion and outer ring contain only rotating electrons. Recently in 2013, Van Allen Space probe of NASA identified and discovered 3rd outermost ring contain realativistic electron. This radiation protects the earth from harmful high energy radiation approaching the earth such as cosmic rays, gamma rays and x-rays.

* Navigation.
* Communication.
* Geological Role.
* Magnetic field and Magnetic Anomaly is used to identified fersomagnetic core source.

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ROCKS

On the basis of origin or formation process the litosphere rocks can be grouped into the three categories:-

i) Igneous Rocks.

ii) Sedimentary Rocks.

iii) Metamorphic Rocks.

Igneous Rocks:-

* The rock originates from fire or the molten hot rock called igneous rocks. when already existing rock undergo subdection proces the subdected rock get melted and turns into a molten rock or magma. This magma is beyond and rises upward by the process of volcanism and then magma cools and solidates & forming a crystalline rock called igneous rocks. There are more than 700types of Igneous Rocks.

On the basis of its chemical composition and its existence they can be further subdivided:→.

Types of subdivided Rocks:-

→ Intrusive Igneous Rocks.

→ Extrusive Igneous Rocks.

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Intrusive Igneous Rocks:- Those rocks that lies below the surface of the earth called intrusive. Here the rate of cooling is slower giving rise to large size crystal grains. The intrusive igneous rocks exist in 5 form such as:-

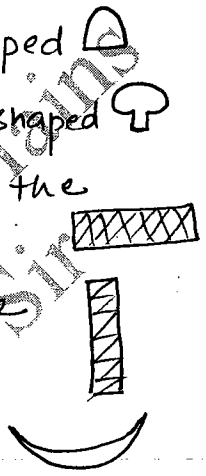
A) Batholiths - Dome shaped

B) Lacoliths - Mushroom shaped

C) Sills - Horizontal to the surface

D) Dykes - Vertical to the surface

E) Lopoliths - Saucer shaped



Extrusive Igneous Rocks:- When magma cools and solidifies the above the surface of earth then those rocks called extrusive igneous rocks. Here, rate of cooling and solidification is fast so the crystal grain size is small or fine. It give rise to the relief features such as volcanic mountains, lava plains, lava plateau etc.

On the basis of chemical composition there are five types:-

A) Felsic Igneous Rocks:- which appear lighter in the color. Silica concentration is more than 65%.

B) Intermediate Igneous Rocks:- There are Silica concentration between 52 to 65%.

C) Mafic Igneous Rocks:- It contains SiO_2 between 45 to 52%. along iron (Fe) and Magnesium (Mg). So, it appears darker in color.

D) Alcatic Igneous Rocks:- It contains sodium Oxides & Potassium oxides (Na_2O & K_2O). Alkalis between 5 to 15% and the ratio of alkali to silica is 1:6.

Examples:-

Minerals:- Mica, Feldspar, Quartz, Olivine, Pyroxene, Bolvine

Rocks:- Basalt, granite, periodicate, Kamatite, Gabbra.

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Sedimentary Rocks:-

When pre-existing rocks come under the exogenetic forces, it undergo weathering and erosion that produces particles called sediments such as Gravels, Sand, Silt, clay and mud (Inorganic sediments). Silicneous and Calcorous (organic).

These sediments get transported and deposited by the agents such as wind, glaciers, sea-waves, gravity etc. there is a layer by layer deposition of sediments called sedimentation then it undergo the prices of compaction, lithification, cementing giving rise to a sedimentary rock.

Mostly they occurs in the coastal areas of lakes and seas.

Types of Sedimentary Rocks:- On the basis of the dominant process the sedimentary rocks grouped into three types:-

A) Mechanical Rocks.

B) Organic Rocks.

C) Chemical Rocks.

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A) Mechanical Rocks:- Here mechanical physical process dominates of the inorganic sediments combined to form sedimentary rocks.

eg. conglomorates:- contains rounded gravels with sand and silt.

Brecias:- contains angular gravels along with sand and silt.

other examples are; sandstone, siltstone clay and mud rocks.

B) Organic Sedimentary Rocks:- the rocks where bio-chemical process dominates and the sediment is obtained from biological organism such as the plants, animals or micro-organism.

eg. coal → carbon of plants.

limestone → Rich in calcium carbonate $CaCO_3$ from skeleton of sea animals.

chert → Rich in SiO_2 obtain from skeleton of sea animals and micro-organisms.

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c) Chemical Sedimentary Rocks:- Here chemical process dominates when a solution become supersaturated then it precipitate out giving rise to chemical sedimentary process.
eg. Gypsum → Hydrates of $CaSO_4$ (Calcium Sulphate).
Halite, Barite, salt rocks are other examples.

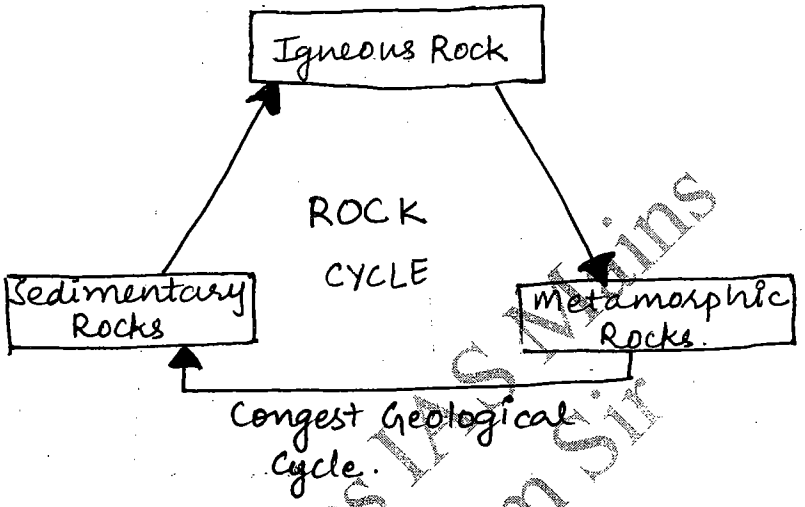
METAMORPHIC ROCKS: When already existing rocks changes its physical or chemical form then the new kind of rock is called Metamorphic rock. It arises due to the heat change or pressure change in pre-existing rocks.

Types of metamorphic Rocks:-

(A) Contact Metamorpism:- Here rising magma cause in physical contact with the rock and transfer heat energy that result into new type of the metamorphism rocks mainly occurs near volcanic regions of world.

(B) Regional Metamorphism:- Here the pre-existing rocks temperature & pressure changes due to plate tectonic

movements of the boundaries such as zone of subduction or vertical uplift-ment of land etc.



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Continental Drift :-

To explain the distribution of continent and ocean. Alfered Wegener proposed continental theory between 1910 to 1928. According to this theory continents are not stationary for drifting one against the another due to gravitational pull exerted by continental masses and the rotation of the earth. These forces split the large continent into small land masses or join them to form large land masses.

Last 300 millions years, there exist large single continent called Pangea surrounded by single large waterbody called as Panthalasa.

Later on 200 millions year ago, In the Pangea split into two continents, Angaralands and Gondwanaland en the South creating Tethys sea between them.

Later b/w Jurassic to Creataceons phase, these continents further splits into the subcontinents in Northern Hemisphere; North America, Europe, Asia while in Southern Hemisphere; South America, India, Australia Antarctica.

These continent drift in two directions
→ towards the equatorial plane.
→ From East to West, this created 7 continents and 5 oceans in present time.

Evidences of Continental Drift:-

Ⓐ **Drifts of Puzzle fit of continents:-**

Here roughly one continent fit into the another like the Jigsaw puzzle fit.
eg. South America Brazilian part fits with Africa "Gulf of Guinea".

Ⓑ **Fossil Evidences:-**

there exist similarity of plants and animals fossils on widely seperated continents such as eg. Mesosaurus, a freshwater reptile found in India, Australia, South America and America.

Ⓒ **Geological Evidences:-**

the continental margins are geologically same in 4 ways:-
i) same type of rocks.
ii) same edges of rocks.
iii) similar Mountain chains.
iv) same type of ore deposits.
eg. geologically the boundaries of East Greenland, Scandinavian countries, Britain, Ireland, Iceland, North East of

North America and North west of Africa are geologically same.

(D) Climatic Evidence:-

Due to drifting of continents climate changes. for eg. glacial deposits at current equatorial countries. for eg. South America, Africa, India and Australia. The continents at tropical location has polar climate & vice-versa.

Criticism of Continental Drift:

Wegner Continental drift theory was highly accepted but fails to explain the causes of continental drifting is the forces of gravitational pull and rotation of earth is not sufficient and splits into large continent to the small pieces and later drift them to form single large continent origin.

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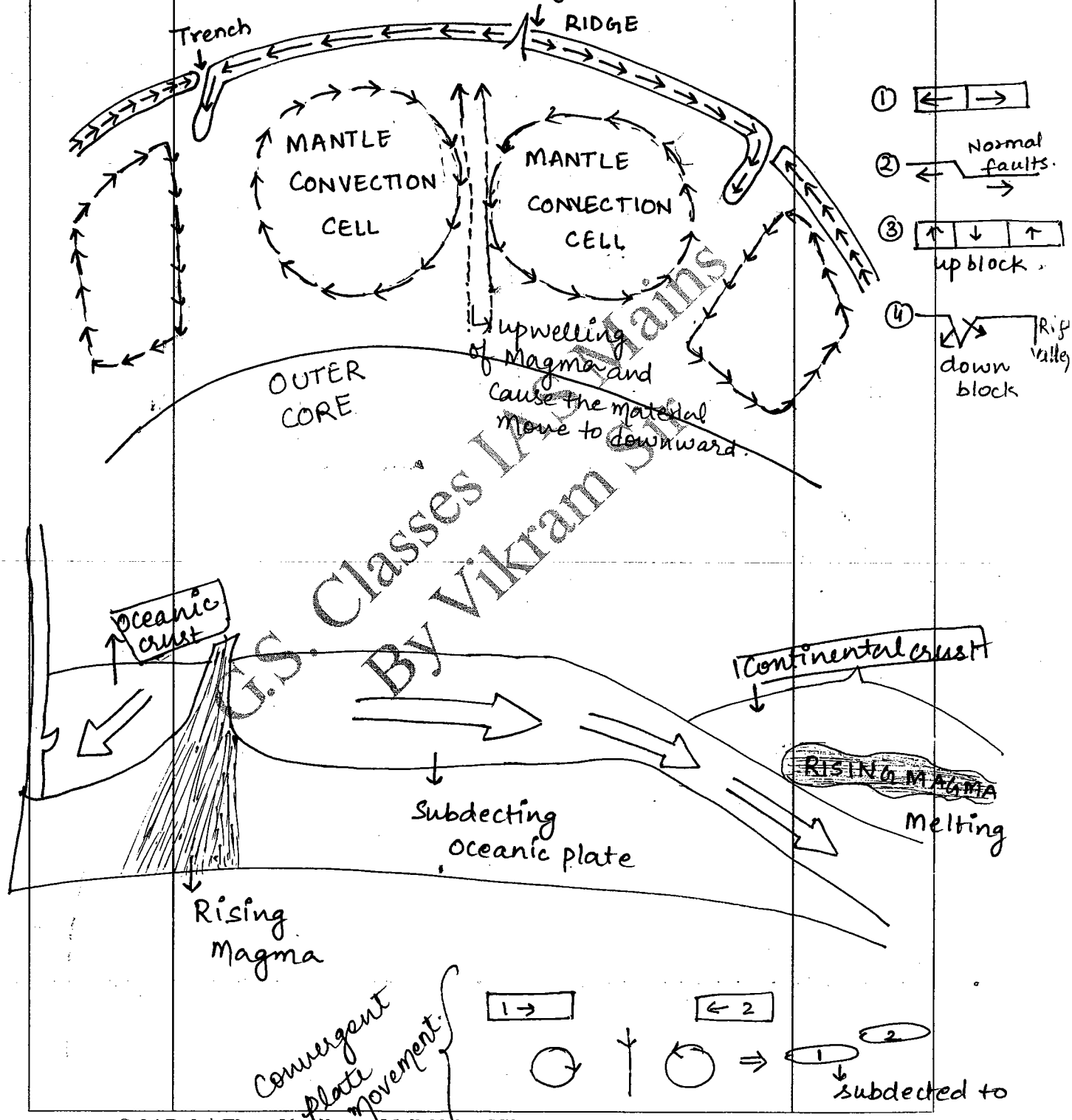
Plate Tectonic Theory :-



various geologist and scientist put forward plate tectonic theory to explain various geological events such as the earthquake, various type of faults, volcanisation, rift valley, blocked mountains, folded mountains, sea-floor spreading, island arcs etc.

According to this theory, lithosphere is divided into various broken solid parts called plates. these plates presides over asthenosphere. the asthenosphere contain molten rocks called the magma which more in several cycle across the earth called as magma which move in the several cycles across the earth called as magnetic or mantle convection cell. these convection cell. acts as a belt and move towards each other or away from each other increasing or decreasing the no. of plates. Presently there exist 20 plates which may be continent or oceanic or both but grouped into major and minor plates. eg. of major plates, there are 7 major plates

Such as :-

* Pacific Plate
* North American Plate
* South America Plate
* Eurasian Plate
* African Plate
* Indo Australian Plate
* Antarctica Plate.

there are 13 minor plates such as Juan De Fuca Plate, Cocos Plate, Nazca Plate, Caribean Plate, Phillipine Plate, Bismark Plate, Carolina Plate, Arabian Plate, Indian Plate, Saumalian Plate, Scotia Plate.

PLATE MOVEMENTS:

there are three types of plate movements;

→ Convergent Plate movement
→ Divergent Plate movement
→ Parallel / Transform / Shear fault Boundary.

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Ⓐ Convergent Plate Movement:-

* when two plates moves towards each other then heavier & denser plate subduct under the lighter plate & subducted rocks melted and turning into magma. This entire region is called subduction zone or Benioff zone. There are 3 types of collisions:-
  ① Continent - Continent
  ② Continent - Ocean
  ③ Ocean - Ocean
  giving rise to different geological events on the subduction zone.
* when either of the plate is continental type then softer material get folded and form mountain chains.
  eg. Himalayas, Alps, Atlas in North America, Andes, Rockies, Drakainsburg, great dividing Ranges/Australia.
* If the rocks are harder of the convergent zone the land move vertically up and down giving rise to plateau, Febitian plateau, Baltian Plateau, and the sea such as the Mediterrian sea.

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* When either of the plate is oceanic then its subdection leads to the volcanism since it contained lot of water vapours, under oceanic -oceanic collision, chain of volcanic island developed called as "Island arc" also called "festoons".
eg. Japan Island, Phillipines Island,
* When deep linear depression formed in water bodies called as deep zone treaches eg. Mariana Trench in the Pacific ocean., the deepest trench of the world (11,022 km), Sundo or Java trench.

(B) Divergent Plate movement:

Here Plates moves away from eachother due to rise of magma. At the divergent boundaries various the geological events occurs.

* Mid Oceanic Ridges:- It is under water long mountain chain formed by cooling and the solidification of Magma at the divergence zones. Indian ocean and Atlantic ocean has well developed Ridge system.

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* Rifting and faulting:- rising in magma splits the plates or rocks into two parts after thinning the crust called rifting and faulting. Here normal faults develop. eg. of normal faults is East African rift valley.
* Rift valley:- eg. East African rift valley, Narmada Rift valley (India), Rhina in the Europe.
* Block Mountains / Horst:- western ghats (India), VOSAGES and Black forest (germany)
* Sea floor Spreading:- Here at the divergent boundaries magma rises and spread outward leading to formation of new oceanic crust (Basaltic crust). Oceanic crust is always newer than the continental crust due to its continual renewal.

(C) Parallel / Transform / Shear fault Boundary:-

Here plate neither move towards each other nor away but slides one against the another in parallel manner. It creates fault on side ways called transform fault. These

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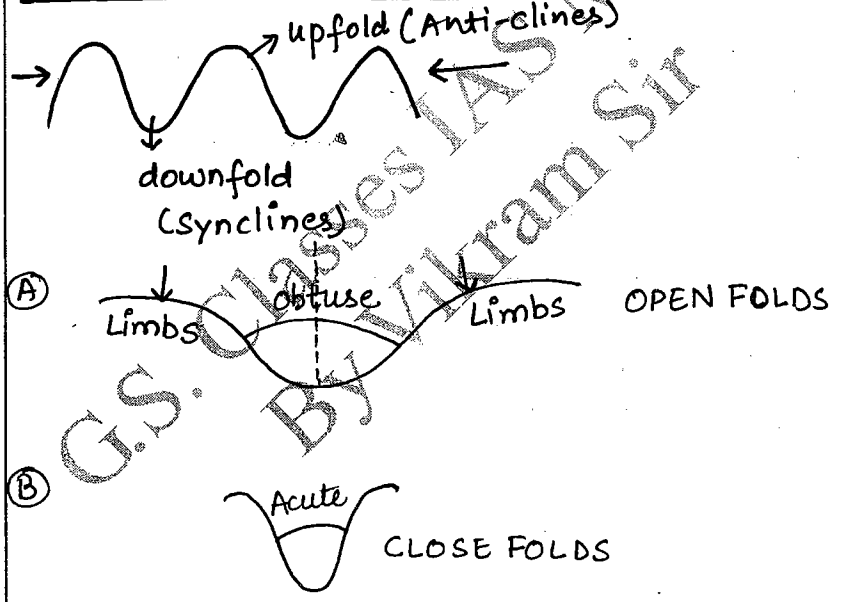
boundaries also called the conservative plate boundaries.

Points to this:-

→ All the three boundaries is a zone of seismicity or earthquake.

→ Convergent plate boundaries materialist remove so called as destructive plates margins.

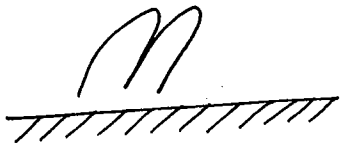
Folds and faults:-



© Both the limbs form equal angle with the central axis is called Symmetrical fold.

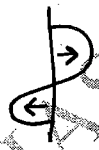
(D) When the limbs form unequal angle with the central axis is called as unsymmetrical fold.

(e)



(f) Recumbent fold :- they are parallel as well as horizontal to each other or surface but not slipping. 3

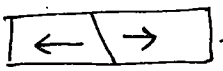
(g) Overturned fold :- also called as Thrust fold.



(h) Nappes fold :- Here above length is overthrown so relief get inversed.

Faults :-

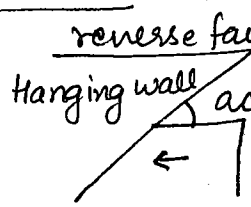
When a gap arise b/w two geological structure called as fault. on the basis of forces, there are three types of faults.

(a) Normal faults :-  → Tensional forces.

At the divergent plate margins the tensional forces acts and the rocks slips against the dip line forming an obtuse angle with horizontal

Surface called Normal fault.

⑥ Reverse Fault :-



In India, In the Himalayas the thrust faults exists and also in Shivalik Himalayas and middle Himalayas. Due to intense convergence fold breakdown and start slipping against the another over and forming an acute dip angle and the hanging wall. for eg. In Himalayas, MBT zone, MCT zone, HFF (Himalayan Frontal Fault).

Shear / transform / parallel / strike fault :-
Here, one rock slips against the another along the strike face creating a fault or a gap on side ways called transform fault Here, the shear forces are very active eg. fracture zones in oceans and San andraus fault in California.

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Forces and Relief features:-

On the basis of Nature of forces earth relief feature are grouped into 3 categories.

i) 1st order relief features
ii) 2nd Order relief features.
iii) 3rd Order relief features

Ist Order relief features:-

Due to chemical differentiation of the crust of the earth. The granite which is lighter form the continent while Basalt which is denser form the ocean bases. It includes sea or ocean and continent.

2nd Order relief features:-

the relief features produce from the forces originates within the earth called endogenetic forces with itself device their energy from earth internal heat energy.

1. Radio-active materials ⟵ Internal Heat energy ⟵ Endogenetic forces.

2. Conversion of gravital energy to heat energy → "center".

Internal heat energy can be generated as :-

1. Radiation from Radio active material
2. Conversion of gravitational energy to heat energy.
3. Premordial solar energy is still entrapped in the earth.

Endogenetic forces :- (constructive landforms).

- Diastrophic forces (slow).
  - Epierographic forces
    - upliftment → emergence
    - Subsidence (lakes, depression). → Submergence
  - Orogenetic forces → mountain building.
    - Compressional forces
      - ↓ Convergent movement
        - → folding (margins)
          - upfold (Anticlines)
          - downfold (Syncline)
        - → Warping (large).
          - → upward (continent)
          - → downward (sea)
    - Tensional forces.
      - ↓ Divergence of Plates.
        - → a) cracking / fracturing
        - → Faults.
        - → Block mountains.
        - → Downblock (Riftvalley)
        - → Seafloor spreading
    - Shear or Parallel Tear forces.
      - ↓ Parallel mvnt
        - → transform faults.
- Sudden forces
  - → volcanism
  - → earthquake

3rd Order Relief features :→

Due to exogenetic forces that arises from atmosphere and drive the energy from gravity and solar energy directly or indirectly called 3rd order relief features.

denudational process → Agents

- → weathering.
- → mass movements
- → erosion.
- → transportation
- → Deposition.

Agents:
- → wind
- → river
- → sea waves
- → glaciers
- → under ground waters.

Here the 2nd order relief feature re-sculptures again i.e. it removes the irregularities produced by endogenetic forces. So, third order relief feature is also called destructive landforms. Here, gradient changes so called as the graduation forces. If gradient decrease by the erosional process then such lands are called erosional or degradational landforms otherwise if gradient increase the landforms is called depositional or agradational landforms.

Deserts

It is a climatic region where rainfall is less than 25cm in year and the natural vegetation is absent or highly scaree. If exist called as xerophytes.

The deserts on temperature bases grouped into three categories:-

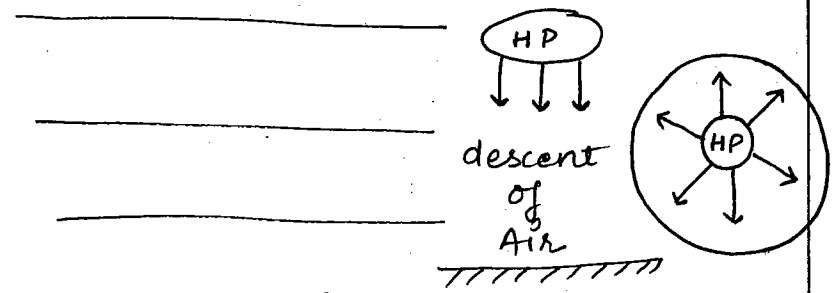
i) Hot desert
ii) Temperate desert – 0–18°c } Cold
iii) Cold desert – <0°c }

General cause for desert formation:

When warm moist air rises vertically upward by either of the process by convection, orographic or cyclonic then it crosses the condensation level thereafter condensation cloud formation takes place. When the cloud is heavy and air is unable to hold it then precipitation occurs. If the assent of warm air or moist air is blocked permanently then rainfall will be less since less condensation, less cloud formation etc.

There are 4 conditions that could explain the formation of deserts:-

(A) High Pressure or Anti-cyclonic Condition



due to atmospheric circulation system and low temperatures permanent high pressure cells exists around 30° & 90° lattitude. these high pressure cells is characterized by descent or subsidence of air that block the convection, cyclonic and orographic process of absent of warm moist air that result into no condensation, no cloud formation and no rainfall.

Distribution

i) 25° to 30° lattitude in Both Nosthern and Southern Hemisphere deserts as follows:-

* Thar desert (India - Pakistan)
* Daste-Lut and Daste-Kavir in Iran.
* Nefud and Rub-al-Khali in Arabian peninsula.
* Negrav (Israel and Jordan)

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* Sahara desert (11 countries of North and central Africa).
* Mozambique, Arizona, South California in USA, Sonarana (USA + Mexico).

ii) Desert on 30°S latitude :-

* Gibson, Simson, Stuart, Great Australian and West Australian desert → Australia (Most arid Continent)
* Kalhari Desert (Botswana + S.A).
* Nambian Desert.

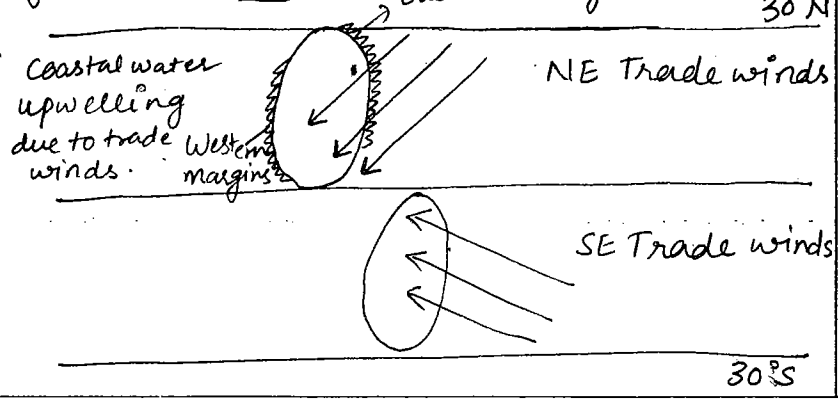
iii) Desert around 90° North & South :-

Polar High pressure produces cold deserts and the region is permanently under snow called permafrost areas.
eg Antarctica, Greenland and Iceland.

(B) Cold Oceanic Current on Western margins of continent

Cold current → Cold air → denser, heavy → Subsidence of air → High Pressure at Coastal Areas.

Cold currents



on the western margins of continents desert lie in the tropical and subtropical zone only. Since tradewinds move from East to west. On the western margins of continents water is pushed away from coast that give rise to upwelling of cold current.

the cold current produces cold air that is denser and heavy so its subsidies downward producing high pressure cell permanently in the coastal areas. Here winds moves away from land to sea and downward which block condensation of air and cloud formation that result into the deserts

Distribution:

* Cold California current produces California deserts in USA like Santa-ana.

* Cold Peru or Humbhold currents produces in Atacama in chile & Peru

* when Bengula cold current produces Namib desert in Namibia.

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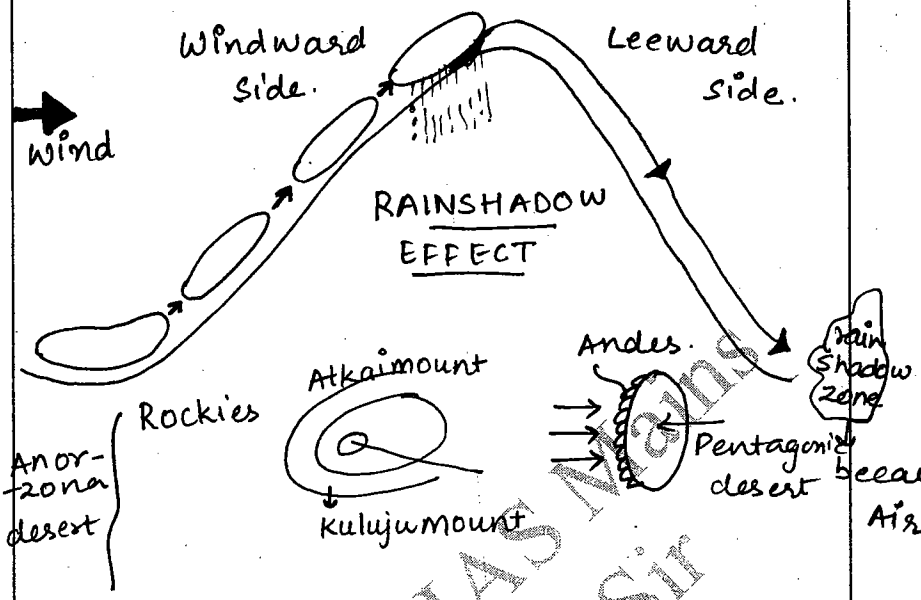
© Rainshadow Effect



On the leeward side of mountain barrier there is a decent of air and moisture is reduced creating a rain shadow zone if mountains are taller than rain shadow zone turned into desert.

eg. * Areas b/w Great Himalays & Tibetan Plateau.
→ Ladakh region in J&K.
→ Lahul Spiti in Himachal Pradesh.
* Takalmakan Desert b/w Alkai and Kuljun mount.
* Arizona b/w rockies.
* Sonaran desert b/w Seirra-de-Madve ranges.

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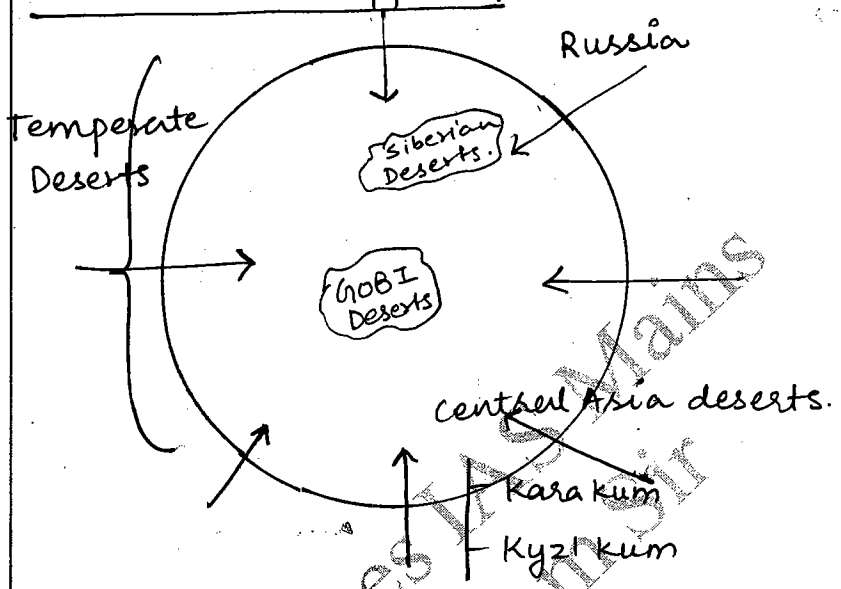
*Panta gonea desert in the leeward side of Andes.

(D) Continental Effect:



On a large continent like Asia, rain bearing winds unable to reach the interiors of the continents so produces deserts such effect is called continental effect.

eg. * In central Asia → Kara kum and Kyzl kum

* In Gobi Desert → Mangolia.

* Siberian Desert → Russia.

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Mountains

On the basis of origin and formations, mountains are grouped into four categories :-

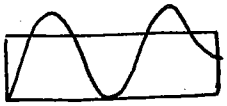
1) Folded Mountains.
2) Block / Horst Mountains.
3) Volcanic Mountains
4) Relict / Residual mountains.

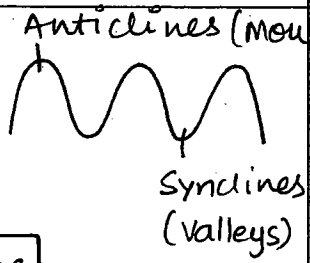
(1) Folded Mountains

the mountains range formed by the collision or convergence of 2 plates. Here, the compressional forces fold the softer material at the plate margins. and giving rise to folded structures where anticline (upfolds) turn into mountain peaks while synclines (downfolds) into valley.

So, folded mountains exist in the present or past plate boundaries. On the basis of age and location they are grouped into two subtypes :-

A) Young folded Mountains.
B) Old folded Mountains.





(A) **Young Folded Mountains**

the mountain range formed by the collision or convergence of 2 plates. Here, the compressional forces fold the softer material at the plate margins and giving rise to folded

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(A) Young Folded Mountains:-

Here mountain originates since territary phase that means 100 millions years ago. Here, mountain ranges matches with present plate boundaries.

→ Circum belt boundaries such as the rockies, Andes, Great dividing range etc.

→ Mid continental belt include Himalaya Indu-Kush, Zagros, Alps mountains, Caucasian mountains, Atlas in South Africa, Drakensberg in South Africa, Cooks Mountains (Newzealand) also called as Southern Alps.

(B) Old folded mountains:-

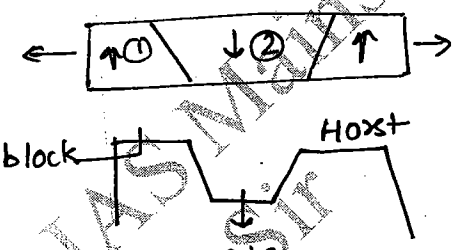
Those mountain ranges older than territary phase i.e. they belongs to Caledonian, Hercanian or Archeans phase (all older than 100 million years ago). Mostly they are located within the plate due to old convergence process for eg.

* Ural (Russian + Ukraine).
* Scandinavian mountains (Norway, Sweden).
* Pinnies (Britain).
* Pyrene (Spain & France Borders).

* Applachain (NE of USA).
* Aravallis, Eastern ghats, Vindhyachal, Satpura [India].

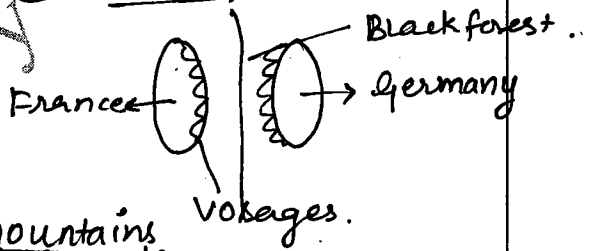
② Block / Horst Mountains:-

These mountains are formed at the divergence zone or the edges of the valleys.



(a) Western ghats:-

(B) Rhine Rift Valley.



© East Africo mountains:- Ethopia to Mozambique.

* Due to divergence process a tensional forces act that produces normal faults and plates or rocks splits into blocks, then upblocks at the edges of the Rift valley act as a mountain or appeared as mountain known as a block mountain.

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3) Volcanic Mountains

Those mountains arises by accumulation of Lava or Tephra (Pyroclat) or both then conical structure called volcanoes emerged called as volcanic mountains. they occured at three volcanic regions:-

A) Convergent Plate boundaries:- they are founded with the folded mountain range in Rockies all written in the examples.

B) Divergent zone:- at the divergent zone they exist along with the rift valley and faulted structure for eg.
→ mountains in East-African Rift valley.
↳ tallest peak in Africa ↓ Mountain Kilimanjaro
↳ Mountain Kenya.
→ Mid-Atlantic Ridges.
→ Iceland
→ Greenland
→ St. Helen Island.
→ South Georgian / sandwich Island.

C) Volcanic Hotspot:- is a natural vent where the magma plume rise upward giving rise to Intra plate volcanoes. eg. Hawai Islands.

Examples of Convergent

*Rockies
→ Mountain Rainier
→ Mountain Shasta
→ Mountain St. Helen

* Andes.
→ Cotopaxi
→ Acancagua.

* Mediterrian Sea:-
→ Mountain Stramboli
→ Mountain Etna.
→ Mountain Visuvius.

* Carribean Sea
↳ Mountain Pelee.

(4) **Relict / Residual Line**

When already existing mountains such as folded, block or volcanic undergo excessive weathering and erosion by exogenetic forces then roots of the mountains gets exposed to the surface such denudational mountains called Relict or residual mountains. eg. Arravalis of India, Monadnocks in Alluvial, Drumlins in glacier regions, Inselberg in desertic or wind plates.

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Volcanism

A natural vent or opening in the earth's crust called 'vent', from this, magma rise upward to form volcanoes and the phenomena associated with it called volcanism.

Causes:-

* under the crust when rock melted, it turned into 'magma' due to the temperature increase or pressure decrease or chemical reaction or change of the composition. The high temperature produces magma that emerged from weak lithospheric crust. There are 3 locations or origins from where volcanism occurs since here crust is weak;

  1st location- Convergent plate boundary
  2nd location - Divergent Plate boundaries
  3rd location - volcanic Hotspot

Plate tectonic theory explain the inter-plate volcanism and volcanic hotspot theory explain the intra-plate volcanoes.

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Convergent Boundaries location:-

* Ring of fire - circum pacific belt
* Mid-Atlantic Belt - from Indonesia to mediterrian sea
* Carribean Sea

Divergent Boundaries location:-

* Mid Atlantic Ridge.
* Indian Ocean Ridge System
* East African Rift Valley

Volcanic Boundaries location:-

* Hawaii Islands

CLASSIFICATIONS

- Intrusive Volcanism
- Extrusive Volcanism

→ The volcanism occurs below the surface of earth called Intrusive volcanism.

→ The volcanism occurs above the surface of the earth called extrusive volcanism.

The 'extrusive volcanism itself grouped into 3 categories:-

i) On the basis of periodicity:-

* Active
* Dormant
* Extinct.

* **Active Volcanoes:-**
those volcanoes still erupting since they exist at volcanic Hotspot on plate margins. eg. Barren Island.

* eg. volcanoes of Newzealand, Greenland, Alaska, Indonesia, Phillipines, Carribean sea and mediterrian sea.

* **Dormant Volcanoes:-**
Not erupting now but may erupt in future since they still exist in the volcanic sources but their vent is plugged due to solidification of magma. eg. Narcondam Island (India) Mount Fujiyama (Japan). Volcanos mountains in Rockies of USA.

* **Extinct Volcanoes:-**
those volcanoes erupted in the past but may not erupt in the future since they moved away from volcanic sources like old lava plateaus, deccan plateaus (India), Colardo plateau of USA, Polardo, St. Helen Islands in Antarctica.

ii) On the basis of Silica Concentration, volcanoes are grouped in 2 types.

* Acidic
* Basic

* **Acidic:-**

Here magma cools down in the vent leads to plugging of volcanoes. later on it develop high hydrostatic pressure and leading to explosive type of volcanoes later on.

It contains silica more than 55%. High viscosity and low fluidity are properties of it. It contain Andesite to Rhyolite type of.

eg. Convergent Boundaries locations.

* **Basic:-**

Here lava slowly emerged without cooling in the vent & produces non-explosive type of volcanoes. It happens due to low viscosity and High fluidity and silica %age is less than 55%. It contain Basaltic Rocks.

eg. Hawaii Island, divergent plate boundaries location.

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(iii) On the basis of Material Composition volcanoes group into three types:-

a) Shield volcanoes:- The volcanoes made up of lava only. Hawai Island is example.

b) Cinder volcanoes:- the volcanoes contain tephra or pyroclast ~~etc~~ of different size. eg. visuvivs.

c) Composite volcanoes:- It contain both tephra & Lava.

Impacts of Volcanism:

* It cause destruction to settlement areas leading to loss of life, property and economic destruction. eg: In 1990, the city of Pampii in Italy was completely destructed.
* Volcanoes form both extrusive and intrusive landforms. Extrusive landforms follow lava plateau, volcanic mountains, lava plains (circular depression diameter less than 1 km) and more than 1 km diameter calderas, later in it forms lakes. all are these volcanic.
* It produces igneous and metamorphic rocks.

* It induces slope failure or instability which result into landslides and earthquake.
* Lahar:- It is a lava mud avalanche formed after a rainfall which moved down floor and cover the settlement below.
* It produce black fertile soil after weathering and erosion of basaltic lava rocks.
  eg. Deccan Plateau of India
  Java Islands of Indonesia.
* Tourism:- It produces distinctive landforms and use for re-creational activities. eg. Hawaii Islands. Hot springs act as medical resort or spa. eg. In Himalayas and Kerala.
* Geothermal Power:- under the underground water, heated up by volcanism produces hot spring, geyser that is used to generate electricity called geothermal power. eg. 100% electricity in Island is a source of the geothermal power.

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* It effects the visibility which obstruct here navigation. the volcanic dust provides surface for condensation to take place so leading to cloud formation and rainfall. Excessive volcanic dust and air here bounce back incident rays leading to cooling of earth as global cooling or global dimming.
* Nitrogen oxides fall back on the earth as acid rain dry or wet.

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Earth Quake:

Making or the vibration or oscillation of the earth called earthquake.

Cause

i) Earthquake is explained by plate tectonic theory which occurs at the plate margins divergent, convergent and conservate plate margins which defines interplate earthquake.

ii) The dam induce sismicity explain the intra-plate earthquake.

There are other minor factors that induces earthquake such as landslides, volcanism, slop failure, meteore falling on the earth, sand blasting, mining, nuclear testing etc.

Above factors produces stress and strain in the brittle rocks and these rocks get deformed and releases stress strain energy by breaking or faulting of rocks. so within the plate margins. rock slips one against the another creating either of the fault, reverse, normal, transform fault.

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From the point, within the fault energy release outward in all the direction called sismic waves or called focus. This sismic rays reaches to the different parts of the surface by passing through earth interior in the form of body waves [Primary & secondary] At the surface where sismic rays reaching first and far to focus called epiccenter from here surface or L-wave originates outward with decreasing intensity and meghitude.

Measurement of Earthquake:-

Earthquake is measured in two ways:-

1) Magnitude of an earthquake :- Here sismic wave is recorded on sismograph and the sismic energy is represented by sismic waves amplitude.

$E \propto A^2$ where E - energy
A - Amplitude.

There are various scales that calibrated sismic energy called magnitude such as JSK, MSK scale and Rithtches scale.

→ It is a logarithm scale where magnitude (m) lies b/w 0 to 9. Here increase in energy when $m=0, m=1$ $E=10^0$, $E=10$

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① This scale record upto 9 magnitude value because energy increase by billion times this energy makes the rocks liquified and ductile and such rocks do not produce faulting means no earthquake.

② Intensity of an earthquake :- It measure and the effect of earthquake on the earth surface it measures differently by different countries like India used both modified mercelli scale which has values from I to XII in a increasing order of impact.

Impacts :

* It leads to loose of life, property, tsunami,
* High intensity earthquake liquifies the rock surface, soil become infertile and unfit for agriculture.
* Bursting of gas Pipeline results to fire
* Bursting of Dams and opening of lakes leading to flash flooding.
* It form temporary lakes and landslides and slope failure in hill regions.

Denudation:-

It involve five process:-

1) Mass Movements.
2) Weathering.
3) Erosion → landforms.
4) Transportation.
5) Deposition.

① Mass Movements

under gravity material such as rock, land, soil and debris moves down-slope in the form of fall, creep, flow and slump.

Factors that promotes mass movements.

* Heavy rainfall.
* Steeper slopes.
* Higher Altitudes.
* Instable slopes.
* Volcanism & Earthquake also includes slope failures.
* Human activities like deforestation, mining, construction, sand mining, duping of waste materials.

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Weathering

↓

Weathering of Big rocks into smaller rocks.

Types of Weathering

Physical / Mechanical Weathering

↓

Sediments.

↓

sand, silts

gravel ← boulder, cobbles, Pebbles, granules.

Properties & Cause :-

* Corrosion.
* Abrasion.
* Attrition.
* Hydraulic Action.
* Pressure Change.
* Temperature change.
* Plucking (Glacier).
* Deflation → done by wind A/c.
* Exfoliation.
  ↓
  layer by layer the rock is broken to small rocks.

Chemical Weathering

(process where chemical reactions takes place).

↓

fine sediments.

↓

clay, mud.

Products of chemical weathering

* Solution
* oxidation.
* carbonation.
* Hydration (H_2O).
* Chelation (cold climates)
  ↓
  In Humid climate $CaCO_3$ is rich and it mainly occurs under the chemical weathering.

Biological Weathering.

↓

Plants and animals. micro-organisms.

↓

Anthropogenetic weathering by Human Action.

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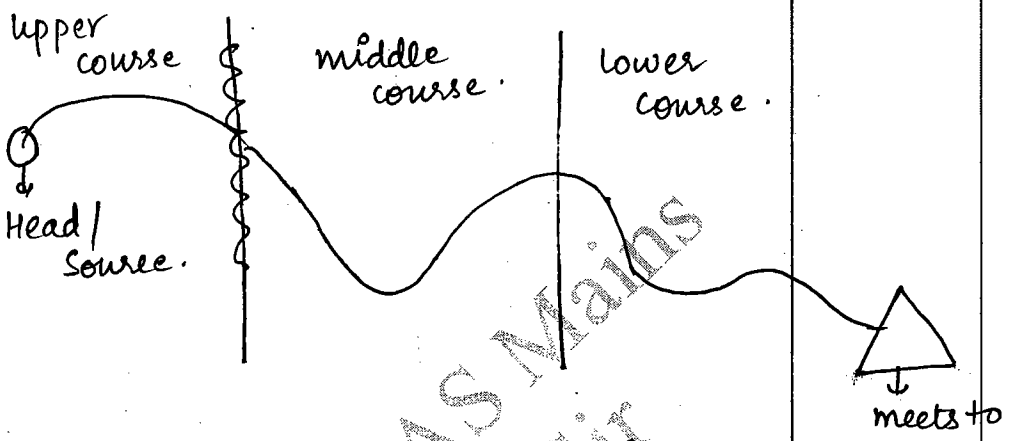
LAND FORMS

① Fluvial Landforms :-



The landforms formed by running water or rivers called fluvial landforms. In the upper course of the river any mountain regions mainly erosional landforms develops due to steeper slope and more velocity of water such as V-shaped valley, I shaped valley, Gorges, Canyons, Rapids & Cataracts, waterfalls, potholes and plunge pool.

At the foothills of mountains depositional process dominate due to sudden break of slope such as alluvial cone, alluvial fans etc. Then river flows in plains with very gentle slope creating both erosional &

depositional features such as valley widening, U-shaped valley, structural benches / terraces.

* Meanders go both erosional & depositional
* Natural leeves, flood plains, Bluffs Ox-bow lakes are depositional features
→ In the lower course near the mouth of the river depositional features dominate due to very gentle slope such as distributries & delta.

Q:- Why East Coast of India has more deltas than the west coast of India?

A:- Conditions for deltas:-

* Slope at the mouth and slope of the region should be very gentle (less than 1 gradient).
* Rivers must carry lots of sediments.
* Tidal currents must not be too strong
* Depth of the coastal water should not be too greater or sediments may be deposit in the sea.

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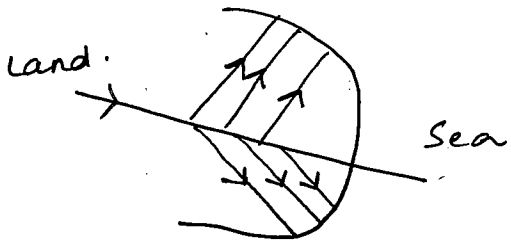
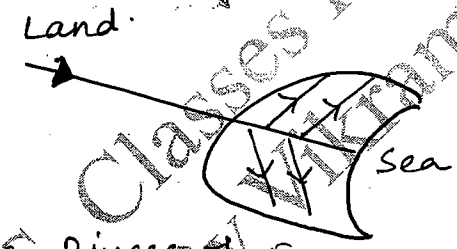
On the basis of shape of delta there are three types of deltas:-

1) Accurate Deltas



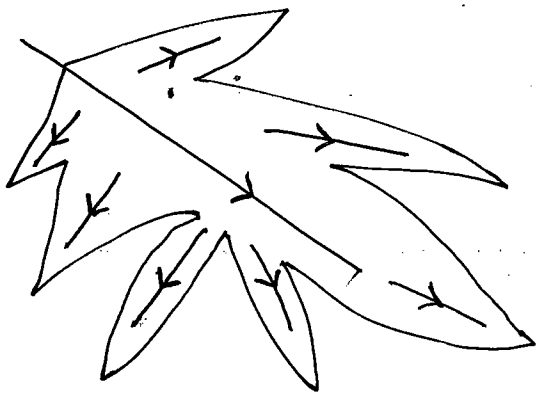
eg. Ganga, Amazon.

2) Cuspate Deltas:-



eg. Rivers of Europe, Mediterrian, Baltic Sea.

3) Bird-Foot Delta:-



eg. → Mishppi Delta.
→ Krishna Delta.

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Desertic landforms

Wind (eolian landforms)

Erosional

- Mushroom Rocks
- Pedesteral Rocks.
- ventifacts.
- Deflation bagins blow out.
- Oasis
- Yard langs.
- and Zeugens.

Depositional

- Loess (very fine sediments).
- Sand Dunes.
  - ↓
  - it depends on following factors:-
    a) strength of wind
    b) Direction of wind Prevailing & seasonal
    c) Presence of the Vegetation.
    d) Continuous supply of sediments.
  - ↓
  - Diff^{t} types of Sand dunes:-
    - Barchans.
    - Parabolics.
    - Transverse.
    - Longitudnal.
    - Star shaped.
    - Dome shaped.

Fluvial land forms (occasional)

Seasonal River, Flooding, Rainfall

→ In the intermountain deserts occassional / rainfall flooding and seasonal rivers created fluvial landforms.

→ Here, landforms develop a Alluvial fans & cons called "BAJADA".

→ the raised platform at the foothills of mountain called Piedimount Plateau.

→ Central salty lake in depression called "Playa Lake".

→ Area b/w two mountain ranges called Bolsons.

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Coastal landforms

→ Outgoing from sea to land is known as backwash.

→ Incoming from land to sea is known as swash.

→ Depositional creates constructive and erosional creates destructive.

→ Swash wave are stronger than the backwash wave in constructive waves.

→ Swash wave are weaker than backwash in the destructive waves creates erosional landforms such as :-

a) Head lands.
b) Bays / gulfs / creek.
c) Cliffs
d) Notch
e) wave cut plateform.
f) cones / caves.
g) arch.
h) Stack / stump / Chimneys.

→ Such creates depositional landforms :-

a) spits.
b) Lagoon lakes.
c) Hooks.
d) Longitudnal Islands
e) Beaches.

Karst landforms

* In a humid climate condition Carbonate rocks reacts with water from acids. This acid act as a leaching or erosional agents and form erosional landforms such as:-

→ solution holes. } Circular erosional.
→ sink holes.
→ Dolines.
→ Uvalas.

→ Poljes (large) } Linear erosional.
→ Karren (small)
→ Blind valley (vegetation)
→ Dry valley (No vegetation)

When ideological or geological cond" changes then the underground water become super saturated with lime and it starts depositing within the caves in the following depositional forms:-

→ stalgmites.
→ stalctites.
→ Cave Pillars.
→ Curtains.
→ Flowstone.
→ Dripstone.

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Glacial Landforms:-

A landform produced by moving ice downslope under gravity called glacial landforms. when glaciers start melting and such glaciers cause land called glacio-fluvial landform (both glacial & running water).

Erosional type:-

* Circuler glacier are also called Nuntaks.
* glacial lakes called Tarn glacial lakes.
* U-shaped valleys.
* Hanging valley.

Depositional

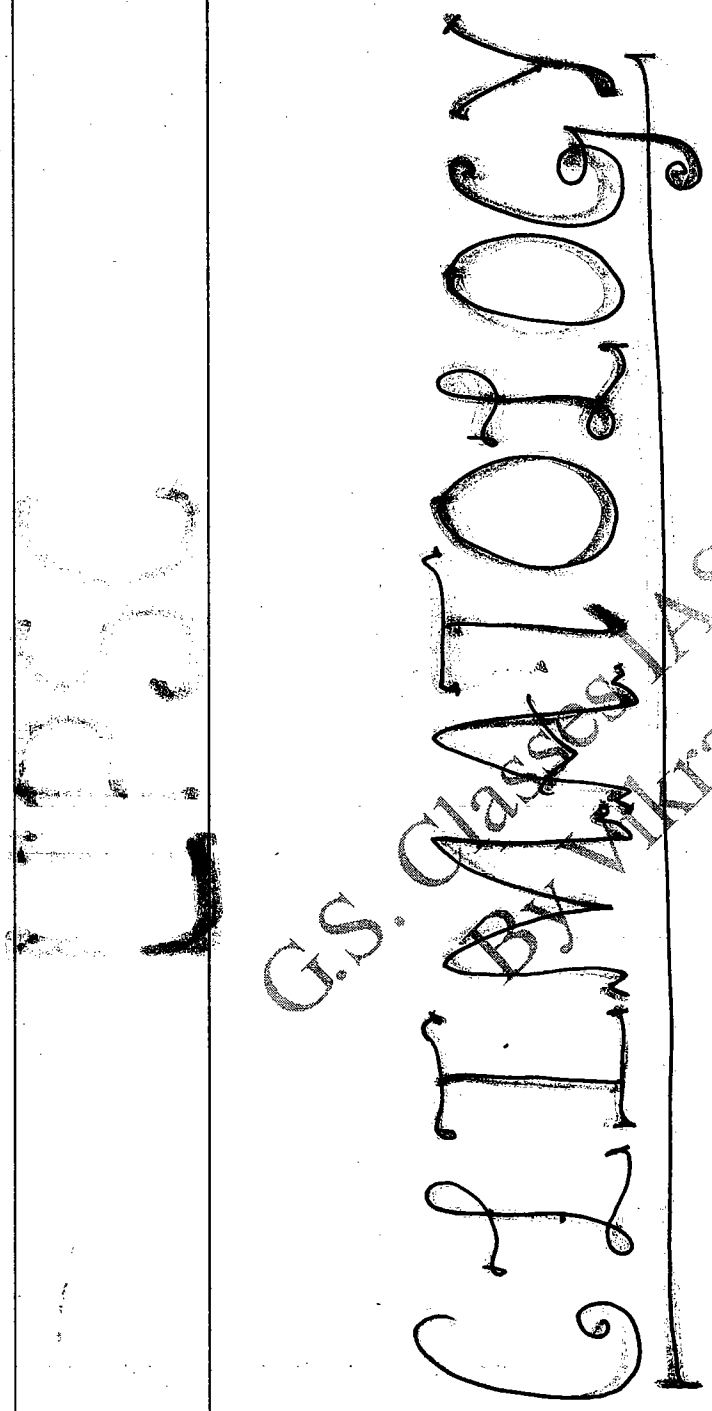
After the melting of glaciers the glacial depositional landforms creates called by the term moraine. Tills → It may be end, lateral and media.

Glacio-Fluvial landforms:

* the landforms created by melting the snow.

Depositional features:-

→ Esker. → Drumlin.
→ Kame → Flood Plains,
→ Kettles


GEOLOGY
G.S. Classes IAS Mains
By Vikram Sir

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Atmosphere :-

The outermost layer of the earth is called atmosphere. It is a blanket of air held by gravity. It consist of material in all the four state:- solid, liquid, gas and plasma.

Composition of Atmosphere

i) Solid materials :- solid components such as dust, volcanic ash or dust, pollengrains, seasalts, Radioactive decay elements etc. it is also called particulate matter or erosions suspended in air. This act as a condensation nuclear or hygroscopic nuclear.

ii) Liquid materials exists in water vapour form. Have both & solid composition is vary with respect to space and time so we called it is variable component.

iii) Gases exists in fixed proportion by volume in the lower atmosphere.

Nitrogen - 78.08 %.
Oxygen - 20.946 %.
Argon - 0.9340 %.
CO_2 - 0.033 (earlier during 17th & 18th).
- 0.038 %.

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Role of Composition

The solid - liquid - gases material on the basis of its heating and cooling properties it grouped into two types of components.

i) Warming / greenhouse element :-
It allow the shortwaves but obstruct the outgoing long waves.
eg. Watervapours, CO_2, CH_4, O_3, NO_2, (SF_6) → Not natural but high intensity.

ii) Cooling element :- the cooling elements mainly the particulates matters or volcanic dust that leads to more outgoing radiation and less incoming.

Plasma :- The charge particles or ions that exists above 80 km height.
Its role is in Auroraform^n, van-allen radiation belt, radiocomm^n on the basis of layer.

Structure :- on the basis of homogeneous mixture or not, it is grouped into 2 parts :-

① Homosphere :- upto 90 km of height all the materials solid, liquid, gas & Plasma is homogeneously mixture &

cannot be identified seperately.

② Hetrosphere :- Above 90 - 10,000km height, atmosphere consist of distinct layer according to their weight.

It contain 4 layers :-

→ 90km - 200km - molecular Nitrogen layer
→ 200km - 1100 km - Atomic oxygen layer
→ 1100km - 3500km - Helium layer.
→ above 3500km - Hydrogen layer.

On the basis of temperature, atmosphere is divided into 5 layers :-

* Troposphere
* Stratosphere
* Mesosphere
* Thermosphere / Ionosphere.
* Exosphere

Troposphere

* lower layer of atmosphere.
* It lies b/w 6-16 km, 6 at the poles & 16 at equator, so average height is 12 km.
* Here, temperature (↓ses) with increase in altitude by constant rate called normal lapse rate or environment lapse rate. Its value is 6.5°c/km.

* It contain 75% of atmospheric material by weight.
* It is responsible for all weather phenomena of the earth.

Stratosphere:

The layer b/w stratopause and tropopause that lies at a height of 12-50 km. Here, temperature increases with an increase in altitude from -100°C to +80°C due to the presence of ozone layer. Ozone is a trimatomic oxygen that absorb ultraviolet radiation. This ozone layer act as protective shield against the incoming of harmful UV rays to the earth.

→ It is an ideal zone for flying.

Mesosphere:

The middle layer b/w stratopause & tropopause at a height of 50 to 80 km layer called mesosphere.

→ Here, temperature ↓ses from 50 to 100°C.

→ Here most of the meteors burns & evaporates.

Ionosphere or Thermosphere

→ The layer b/w 80 to 640 km height called ionosphere or thermosphere.

→ Here, High energy radiation such as cosmic rays, gamma rays and x-rays reaches and raise the temperature around 1000°c. At this height material get ionized and turned into charged particle form proton and electron.

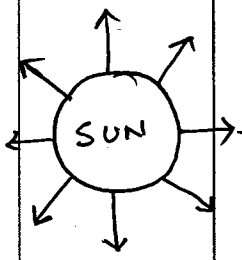
Its role is, its produces the fourth state of matter called plasma & this plasma layer may interact with ~~each other~~ earth magnetosphere and produces polar lights called Auroras

The charged particle electrons proton and rotating in earth magnetic field and form a van-allen radiation belt. At this belt consist of rings of electron, protons but that supports to expell the incoming cosmic gamma rays and x-rays.

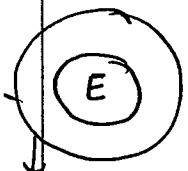
The radiowaves exist in the ionosphere D, E, F, G layer with increase in altitude which is used for radio communication.

Exosphere :- above 640 km the outer most layer is known as exosphere.

INSOLATION



→ gamma rays
→ X rays.
→ UV rays.
→ visible rays / shortwaves.
→ IR rays
→ microwave rays
→ radiowaves.



earth recieves 1/2 billionth.

Solar Constant = 1.96 cal / cm / min.

Incoming solar radiation called insolation, the sun is releasing the energy in all direction uniformly in the form of electromagnetic spectrum or radiation. It includes gamma rays, X rays, UV rays, visible rays, Infrared rays, microwave rays, radio rays. (increasing order arrangement) The earth recieve 1/2 billionth of total Sun's output energy around 0.00005 % of it.

* every part of the earth in a year term receives same amount of insolation.
* This means total energy received by the earth per unit area per unit time is constant called the solar constant.
* There exist a variation and insolation w.r.t space and time that produces energy differences temperature differences, density differences, atmospheric pressure differences.
* In a year shortwaves to the earth is equal to earth outgoing long waves from the earth called as heat budget of earth atmosphere.

Conditions controlling the Insolation

* Angle of sun-rays (0 to 90°).
* Length of day-time (0hr to 6 months)
* Height of a relief
* Atmospheric composition.
* Albedo.
* Sun-spot cycles.

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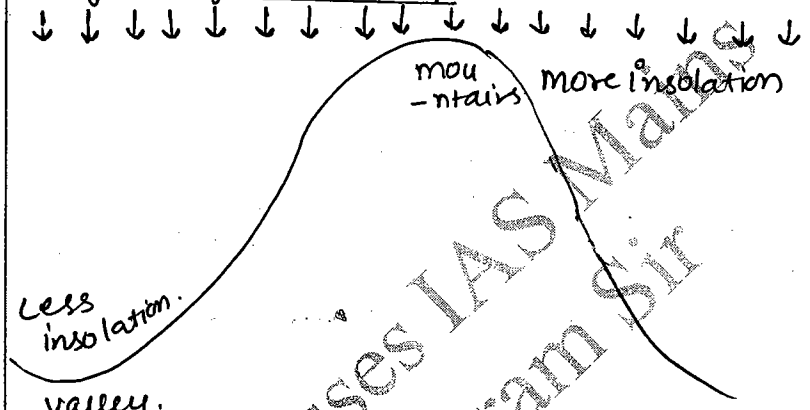
1. The angle of sunrays falling on the part of the earth anytime determine the insolation. The angle of sunrays to the surface lies b/w 0° to 90°, when sunrays are far then more insolation is received since spread is small but when sunrays are more inclined then insolation receive is less due to more spread.
* In a year maximum insolation receive during summer but in winter minimum insolation received.
* In a daytime maximum insolation is 12 noon and decreases to 6AM & 6PM become minimum.
* lattitudnal applications :- within the tropic, insolation received maximum and minimum at the poles.

2. Length of the Day or duration of Sunlight
It varies from 0 hr to 6 months, we know at any place or lattitude, length of the day varies with the season. During summer, length of the day is longer and night is shorter leading to the max^m insolation during summer days.

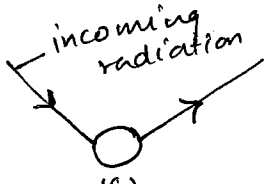
while winters day are shorter and produces minimum insolation. So, maximum and minimum insolation in this concept is at poles during the summer & winters respectively.

3. Height of the relief:-

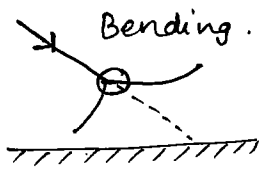


the higher relief receive higher insolation than the lower relief irrespective of other factor.

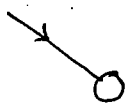
4. Atmospheric Composition:-



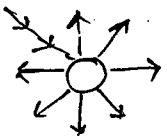
(a)
Reflection



(b)
Refraction.



(c)
Absorption.



(d) Scattering

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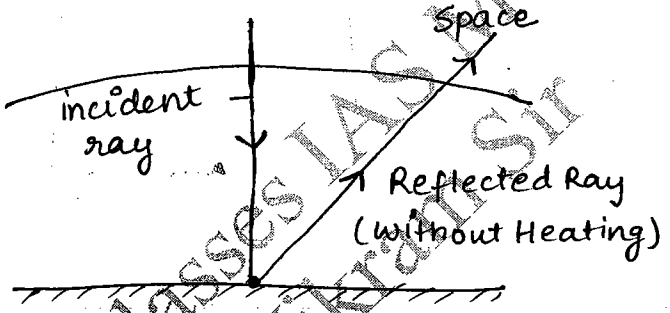
The atmospheric material interact with the incoming solar radiation undergo four processes, reflection, refraction, absorption and scattering and these process change the amount or the direction of insolation reaching the ground.

5. Albedo :-



Nature of the ground / Surface

$$= \frac{\text{Reflected rays}}{\text{incident rays}} \times 100 \text{ (in \%age)}.$$

Albedo $\propto \frac{1}{\text{insolation}}$

The proportion of reflected rays to the incident rays is called Albedo. It is expressed in %age and depends on the nature of the surfaces or ground such as dark surfaces have low albedo, light surfaces have high Albedo. Smooth surfaces have high albedo, Rough surface low Albedo, porous have less Albedo.

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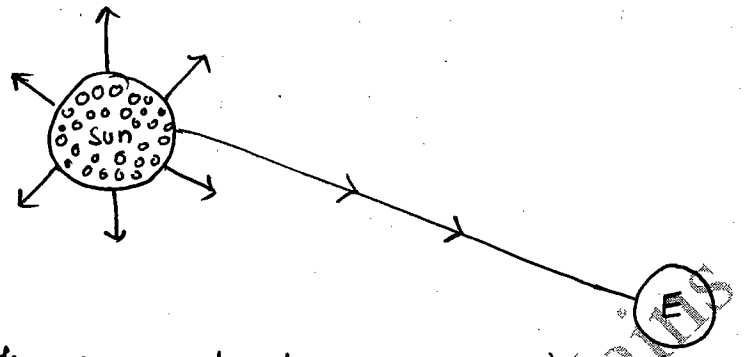
6. Sun-Spot Cycle:-



the sun output energy varies with the shifting of solar magnetic field. This period is called solar cycle. It varies from 11 years to 22,000 years. Here, during high thermonuclear reactions more darker regions is observed over the sun called sun-spot. This indicate more radiation emitted and more insolation received by the earth.

Temperature

Temperature is a measure of heat energy It measures hotness and coldness of the region. It depends on two factors:-

(a) Intensity of Insolation.

(b) Transfer of heat energy mechanism by conduction, convection and radiation process.

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* In daytime, earth receive insolation & its intensity determine heatness and coldness and by conduction and convection there is transfer of heat energy from one place to another but during night energy converted into longwaves or IR waves and leave the earth atmosphere system called terrestial radiation or radiative losses. So, in night cooling takes place.
* In a year, incoming shortwaves is equal to outgoing longwaves. This concept is called Heat Budget.
* There is a time lack between insolation received and temperature raised. Max^{m} temperature recorded in a day between 2 to 4PM and min^{m} temperature recorded between 4 to 6AM.

Highest temperature recorded in Al-Azizya in SAHARA DESERT (+58°C).

Variation in Temperature:

There exist both Horizontal & Vertical.

Vertical: In general temperature decreases with increase in altitude at a constant rate called environmental or normal lapse rate that is 6.5°C/km that

means above air is cold and lower is warm.

Temperature Inversion

In normal situation temperature decrease with the height so above air is colder than the below air. If the situation reverses then temperature increases with the increase in height that means above air is warmer than the below air. This is called temp-erature inversion.

Causes:

there are three mechanism by which temperature inversion increases:-

① During long winter nights, the radiative losses by the ground is higher so ground comes colder and the air in contact also become colder and denser and this process continues till first sunrays reaches the ground. this ~~ground~~ produces warm air above and cold air below i.e, temperature inversion. It occurs in subtropical region, temperate region, polar regions, specially in winter season.

2. Advection :- mid-latitude zones + Advection of polar + tropical winds. Here, the alternate air moves over the ground :-
Here, when cold air move over the warm surface or vice-versa then cold air sink downward and the warm air, rises upward and after sometime warm air is above and cold air is below that create a temperature inversion. It occurs mainly in mid-latitude zone due to advection of polar winds & the tropical winds.

3. At the ~~diverge~~ convergence of cold & warm oceanic currents, here, cold and warm currents carries the air accordingly and these air also meets resulting into sinking of cold air and rising of warm air and temperature inversion develops. eg. At Newfoundland labrador cold current meets with Gulf-stream, at Mokkaido, (Japan), Oyashio meets with Kurashio warm current.

Impacts of temperature Inversion :-

→ It produces anti-cyclonic circulation system, here the cold surface air sink, downward and resulting into higher pressure on outward circulatory winds called anti-cyclones.

→ It produces dryness in weather cond^n's :-

* At the ground condensation of warm air takes place during early winter mornings or evenings so the surface cloud is called FOG that reduces the visibility.

→ It is a photochemical reaction produced pollution between fog and smoke. It generally occurs over urban Industrial area in winter season. eg. Before 2nd world war smog leads to death in Mosco, London, Paris etc. But today this problem is mainly in the developing countries like India, China etc.

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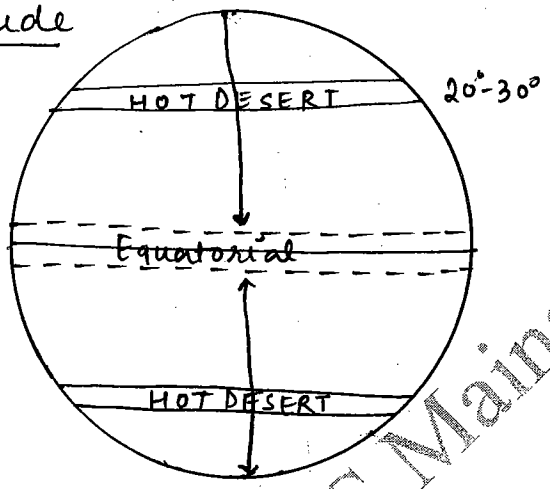
Horizontal Distribution of Temperature

i) Lattitude



In general, temperature decreases from equator to poles but higher temperature is recorded in the hot desert not in the equatorial region despite high insolation because equatorial region relatively more close to water bodies, has higher rate of evaporation, more albedo by clouds, higher precipitation region.

ii) Altitude:- Temperature decreases with height of relief. eg. Darjeling, Shimla

iii) Nearness to Sea/coast:- It influences the climate or temperature of the place. This effect is called maritime effect, here diurnal range and annual range

is low (moderate conditions), Kolkata, Mumbai. The regions away from coast has continental effect and attain extreme temperature that means diurnal and annual ranges of temperature is high. eg. Delhi and deserts in interior parts.

iii) Prevailing winds nature:- It may be cold winds or warm winds

iv) Nature of Oceanic current:-

eg. North Atlantic current.

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DRAINAGE SYSTEM

The surface flow of water from higher region to lower region. It includes main river its tributries & the distributries. It is called drainage system.

Drainage system depends of 2 factors:-

1.) Geological conditions.

2.) Hydrological conditions.

1.) Geological Conditions:- It includes types of rocks, the folded structure, faulted structure, inclined structures, hard or soft rocks etc.

2.) Hydrological conditions:- It includes amount of water sources of water, river regime (fluctuation in water), melting of snow, rainfall, catchment area, its tributries and distributries, dimensions, geometry of river.

There are two types of drainage system:-

1. Sequent Drainage System: Here rivers follows the regional slope. That means rivers has originated after the regional slope and follows. It consist of 4 kinds of streams.

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* Consequent stream- (main river)
* Subsequent stream- (A tributry joins the main river at an acute angle <90°
* Obsequent stream- A stream joining the main river at an Obtuse angle.
* Resequent stream- The stream produce after re-adjustment to the new slope. Here also rivers follows regional slope.
eg. Ganga River System.
The rivers flowing in the peninsular India leaving Deccan Plateau.

2. Insequent Drainage System :- Here river flows against the regional slope. It is only possible river is existing prior to a regional slope and slope modified later on by tectonic activity or other factors and still rivers maintaing original path.

Types of Insequent Drainage System:-

1. Antecedant :- Here the rivers flow against the regional slope generally by tectonic activities like rise of mountains etc.
eg. Rivers originates from Tibetan Plateau, Trans-Himalayas move against the

Himalayan region by creating Deep U shaped valleys called Gorges.
eg. Indus, Satluj, Kali, Brahamputra

2. Superimposed:- Here, due to accumulation process especially lava by volcanic activity modify the regional slope but rivers maintain the original path by eroding the basaltic lava.
eg. Deccan Trap Rivers

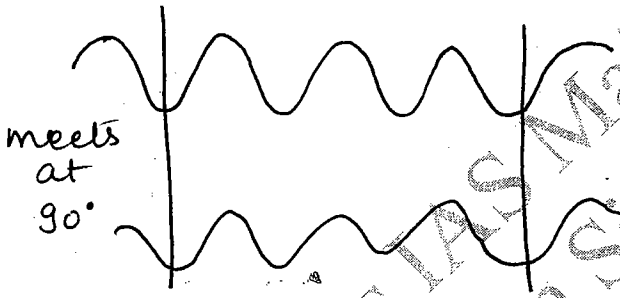
DRAINAGE PATTERN

Internal Drainage System:- Here rivers meet or ends in the lower region of depressions in the interior part of the land. This situation generally arise in deserts or in lakes. Such river is called as the ephemal river.
eg. Ladakh region in India, Thar desert in India, Around black sea in Europe. Aral sea in central Asia.

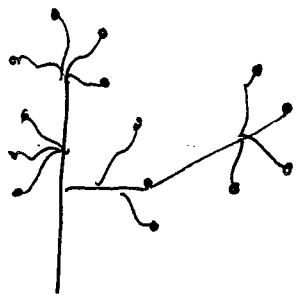
* Types of Drainage pattern:-
the geometrical arrangement how different rivers appear called drainage pattern.

there exists different types of drainage pattern as follows:-

A) Trellis Pattern:- Here main rivers appears parallel to each other & its tributries joins as right angles.
eg. Rivers & Himalayan region.



B) Dendrite Pattern:- occurs in the Alluvial plains or soft soils. Here the rivers move irregular and cannot controlled by any geological structure. It is found in alluvial soils or any other soft soils. It look like tree & branches. eg. Indo-Gangetic Plain, Northern plains of India, Eastal Coastal Plains.



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ATMOSPHERIC PRESSURE

Pressure exerted by the air mass under gravity highs per unit area is called the atmospheric pressure. At the sea level, atmospheric pressure is high around 1013.15×10^{-5} mb (milibar) also known as 1atm. pressure. This is also expressed in terms of rise of mercury upto 76cm at sea level in Barrometer.

Atmospheric pressure is an expression of air density. High density corresponds high pressure and low density corresponds low atmospheric pressure. Air density depends on temperature or movement of air at any place.

Vertical Distribution

Vertically pressure decreases with the increase in altitude around 34mb/km.

Horizontal Distribution

Horizontally there exist different atmospheric variations at different scales i.e, global, regional and local.

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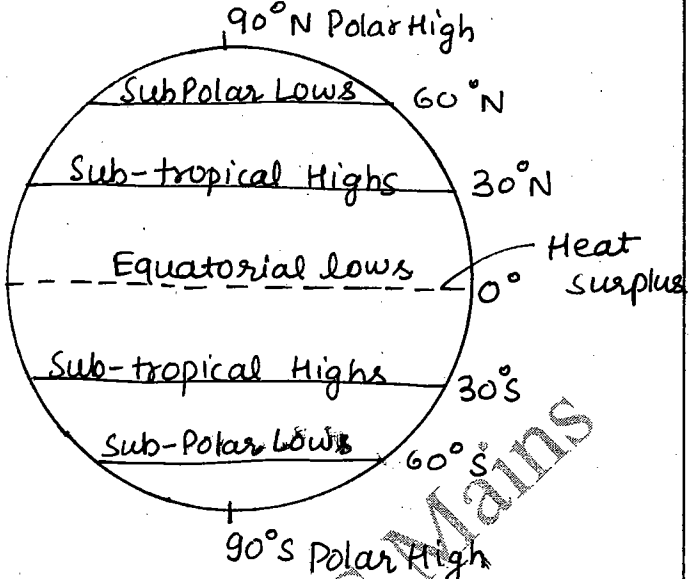

1.) Global pressure Belts:- due to uniform temperature belts and uniform atmospheric circulation system '7'. Pressure belts horizontally produce from North Pole to South Pole called Global Pressure Belts.

(i) Temperature Induced belts:-

a) Equatorial lows:- It lies 5°N to 5°S continuously. It is caused by surplus of heat energy due to high insolation and high temperature. The Heated molecule of air by convection lifted and creating low pressure and the rotation of the earth having a maximum rotational speed producing highest centrifugal forces. This

further pushed the air upward upto 16 km height.

* It is also called DOLDRUM due to calm winds condⁿ.
* It is characterized by everyday rainfall for convection rainfall (more than 200cm/yr)

(b) Polar Highs:-

Around the Poles 90°, energy is deficit due to low temperature and low insolation. So, air molecule contracts density increases and give rise to high pressure at poles. Here centripetal force dominants over centrifugal forces that further increase the polar high pressure due to the descent of air.

ii) Dynamic factors induced pressure belts:-

dynamic factors means the atmospheric circulation & rotation of earth moving the air upward & downward in some regions resulting into high pressure & low pressure:-

2 conditions:-

1. Ascent of air - leads to low pressure
2. Descent of air - leads to high pressure.

(a) Sub-~~Polar~~ tropical Highs:- Around 20° to 30° Sub-tropical high pressure is produced due to the descent of air. Here, Centripetal forces dominant over the centrifugal forces. It is a discontinuous belt forming high pressure belts. It is also called horse latitude since it is characterized by desertic climate region, anti-cyclone conditions, clear slices, circulation systems.

(b) Sub Polar Lows:- Around 60° latitude zone, both easterly and westeraly converge and move vertically upward creating a subpolar low pressure at the surface. It is characterized by polar front and the weather associated with like temperature cyclone.

* the pressure belt shifts with thermal equator or season. In summer, towards the poles and in the winters, towards the equator.

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2. **Regional / Seasonal Pressure Belts**

those pressure belts or cells arises due to shifting of equatorial lows & sub-tropical high with season between land and sea. There are two types:-

(a) **Monsoonal Region**:- Here Inter-tropical convergent zone shift between land and sea with the season.

	Land	Sea
(a) Summer	Low →	High
(b) Winter	High →	Low

Regions:-

It lies in the monsoonal climatic regions such as South East Asia, South Asia, North Australia, East Africa, Coastal areas of USA in Gulf of Mexico, North East of Brazil.

(b) **Mediterrian Pressure belts**:-

* 30 to 45° at the coastal area.
* Shifting Sub-Tropical High Pressure belt between land and sea with season

	Land	Sea
Summer	High →	Low
Winter	Low →	High.

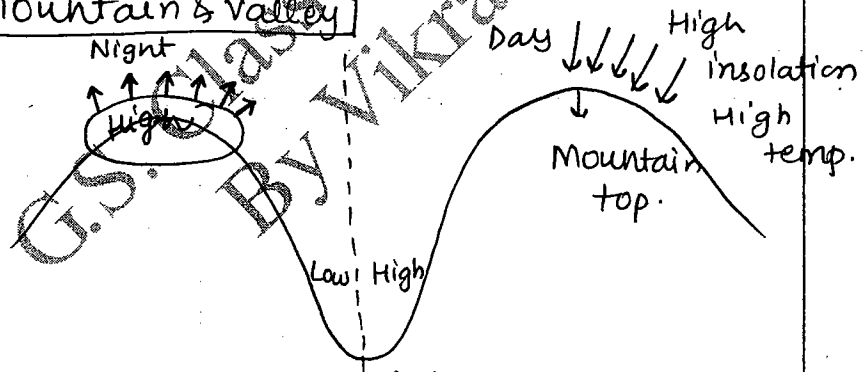
Regions:-

* mediterrian sea coast.
* California coast
* Chilean coast
* Capetown (South Africa).
* South East & South West Coast of Australia.

In mediterrian

Note:- within the regional & global pressure belts, there lies local pressure belts due to local heating and cooling mechanism.

Mountain & Valley



	Day	Night
mountain top	Low Pressure	High Pressure
valley Bottom	High Pressure	Low Pressure

Here, irrespective of latitude and the seasonal shifting pressure varies with day and night. In the daytime creating low pressure and during night high pressure.

WIND SYSTEM

The movement of air is called wind. It arises due to three forces:-

① Pressure Gradient Force (PGF):- It is defined as difference of pressure between two points and divided by the distance between them. It leads to origin of wind from high pressure regions to low pressure regions & the strength of the wind directly proportional to PGF.

② Coriolis Force:- It is defined as pseudo force that acts on a moving object on a rotating frame of reference. Here, wind get deflected from its original direction and the amount of deflection is given by $V \sin\theta$ and the direction of deflection is given by Ferrel's law. In NH deflections towards right while in SH deflections is towards the left.

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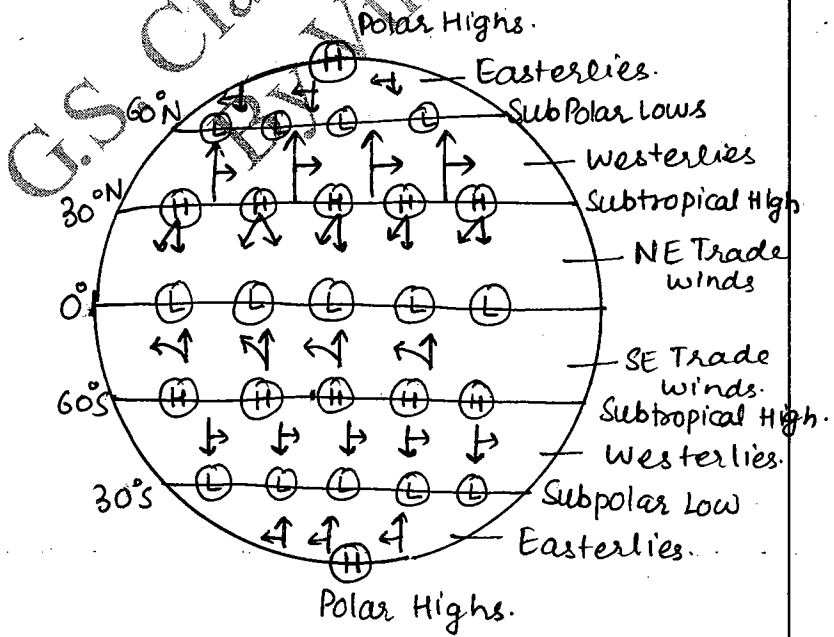
(3) Frictional Force:- It is a retarding force that acts on a moving object and it is determined by the roughness of the surfaces such as topography, vegetation, building etc. this produce variation in wind at local level.

WINDS CLASSIFICATION

* Permanent winds or Planetry winds

those winds that consistently flows over a region throughout the year called permanent or planetry winds. It arises due to global pressure belts from North to South.



* **Regional / Seasonal Wind System:-**
those wind that reverse the direction within 6 months or between summer and winters.

(i) **Monsoonal winds:-**

	Land	Sea	Rainfall
Summer	Low ←	High	✓
winter	High →	Low	✗

eg. South Asia, Australia.
the temporary winds that reverse their direction in 6 months occurs in monsoonal and mediterrian climatic region. In this during summer when move from sea to land while in winters move from land to sea. so summer winds are wet while winters winds are dry.

(ii) **Mediterrian winds:-**

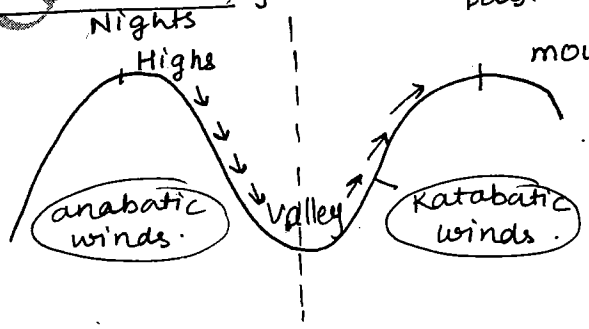
	Land	Sea	Rainfall
Summer	High →	Low	✗
Winter	Low ←	High	✓

Due to the subtropical High pressure, there is a reversal of wind between land and sea during summer when move from land to sea which is dry but in winters wind reverses and move from sea to land which is wet. eg.

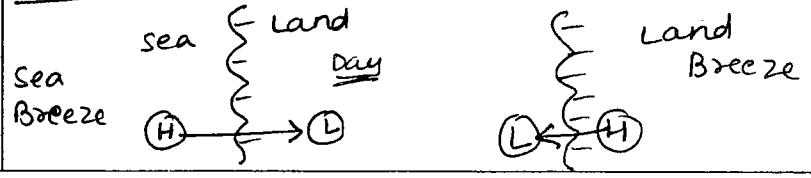
* **Diurnal wind system**

those winds that reverse the air between day and night are called diurnal winds. It arises due to different heating and cooling phenomena b/w day and night respectively. These are generally called breeze & occur in day and night.

→ **Mountain valley**



→ **Land and sea**



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LOCAL WINDS

the winds which depend on the local heating mechanism and topography, it can stay for week for few days or again reappear. On the basis of temperature they are grouped into warm & cold local winds.

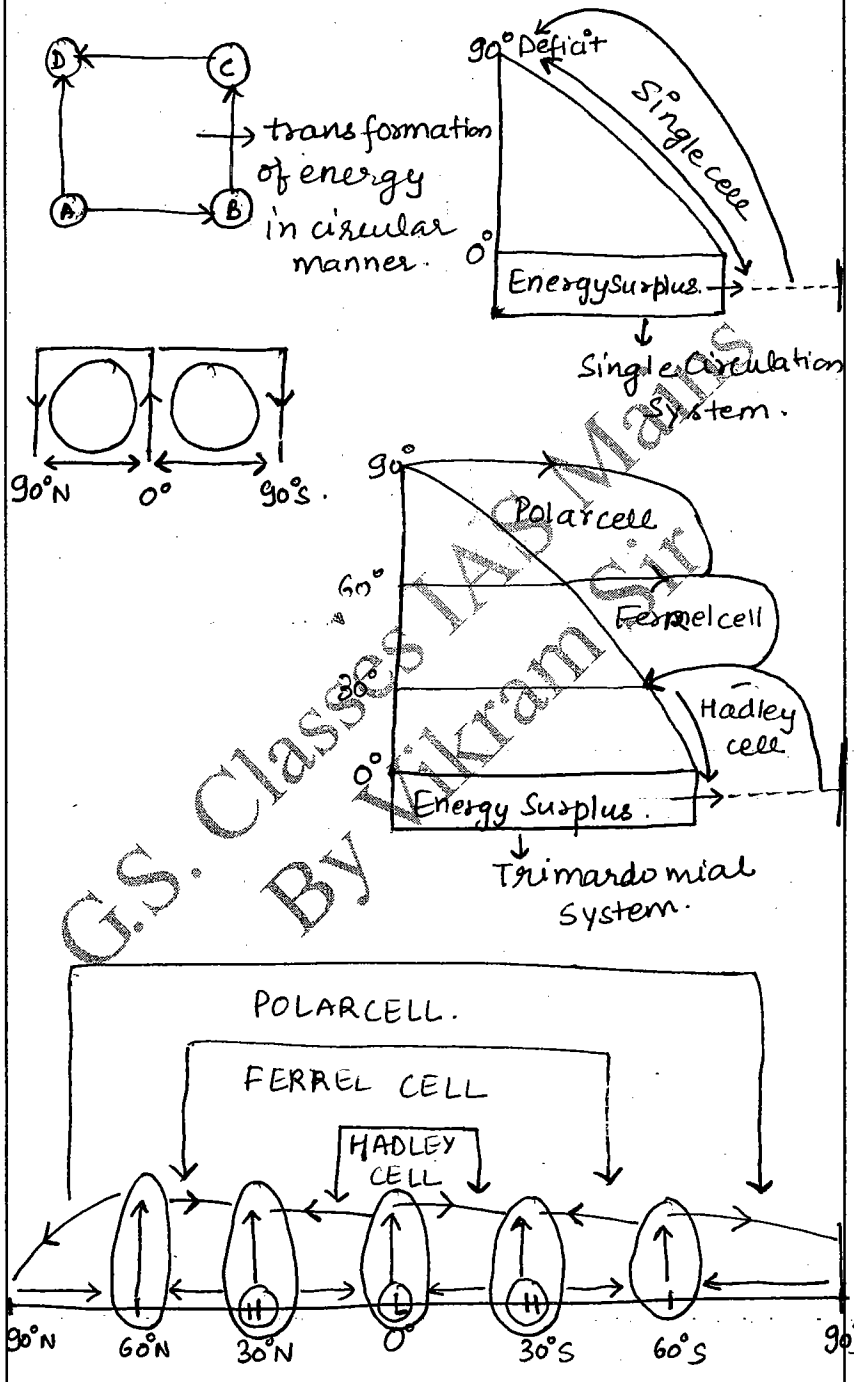
When warm wind? when cold winds?

* It depends upon the source of region. The hot desert produced warm winds and cold desert produce cold winds. eg. wind generated from Thar desert called "Loo" in northern India. Wind generated from SAHARA DESERT called Khamsin, Sirocco, Gibbli, Harmattan.

Coldwinds :→ Blizzards in Antaretica, North Canada, Northerly (USA) & Puga.

* Adiabatic process leads to expansion produces cold winds upslopes cold winds eg. BURA winds in upmountains, when wind or air contact adiabatically downslopes of mountain it become warm local winds. eg. chinook winds from Rockies to Parries

Atmospheric Circulation System



Due to energy difference the equatorial region attain energy surplus while polar energy deficit.

* If we considered non-rotating earth then there exist a single cell moves b/w equator & pole. Such circulation called Single Circulation System.
* In a rotating earth and the energy differences produces three cell circulation system in every hemisphere called Trimeridonial circulation system. It consist of three cells b/w 0° to 30°, called HADLEY CELL, b/w 30° to 60° called FERREL CELLS and b/w 60° to 90° Polar cell.
* these cycles determine the weather conditions and weather pattern of the region. At the transition of two cycles weather is more dynamic.
* the cycle or cell shift in the direction of normal equator.

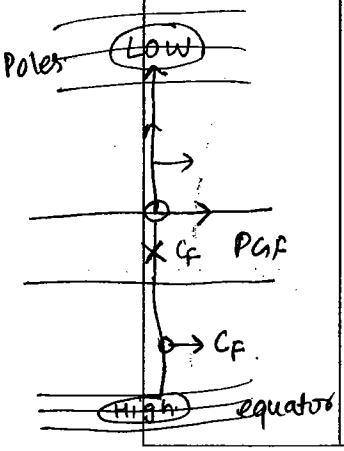
Jet Streams

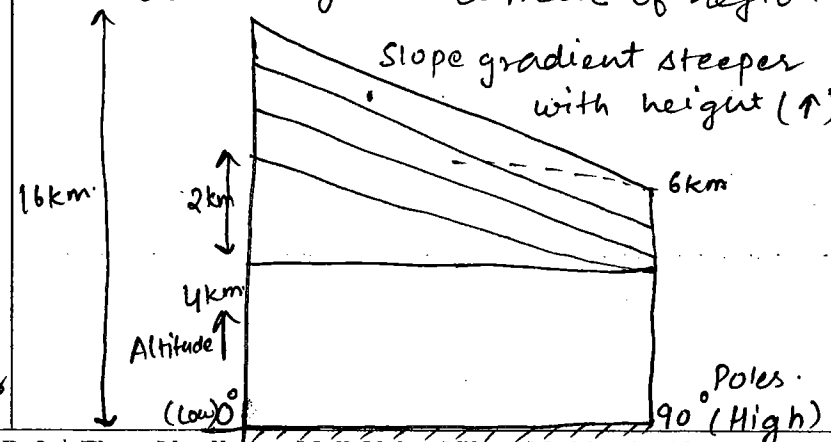
The fast flowing winds in the upper atmosphere is called Jetstreams. It is characterized by:-

* Speed is 300km/hr to 800km/hr.
* the permanent Jetstreams moves eastward.
* Mostly they are circum circular.
* It follows meandering or zigzag path i.e. it shifts both horizontally & Vertically.
* Jetstreams with the nature of ground In summer it shifts towards the poles while in winter towards equator.

Types of Jetstreams:

(i) Subtropically Westerly Jetstreams:- found around 30° to 35° latitude in both the hemisphere and move west to east describing the climate of region.





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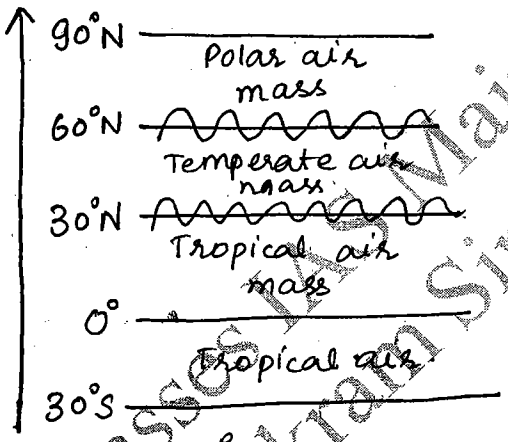
(ii) Polar Front Jetstreams:

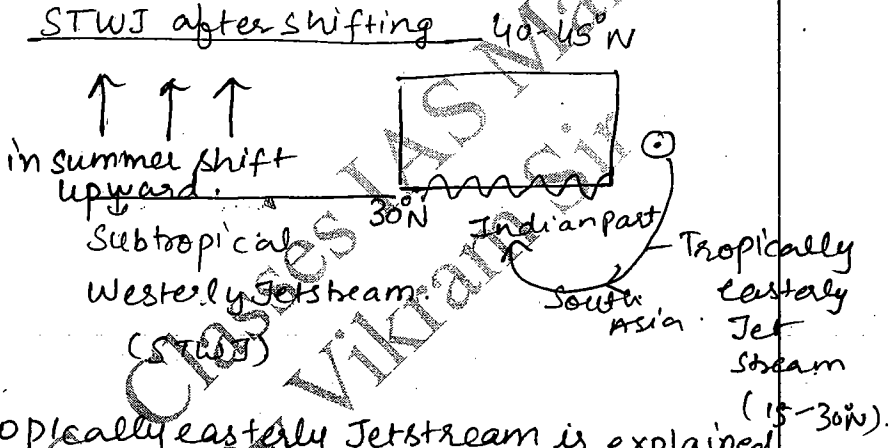
found around 60° lattitude in both the hemisphere and move eastward across the globe. It determine the weather of mid-lattitude and high lattitudes both.



the permanent jetstreams around 30° and 60° occurs where two alternate masses meet. Above 11km altitude from equator to poles the PGF (pressure Gradient force) is towards the poles and it increases with the increase in altitude So in the upper atmosphere wind move from equator towards poles then two forces interupts the PGF & Corolis force. At particular height PGF become equal and opposite to Coroli's force. then the resulted wind become parallel to isobars and lattitude. Such wind called

Geostrophic winds.

(iii) Tropically easterly Jetstreams:- It is a seasonal & regional jetstreams that occur over the china sea and flow westward crossing south Asia and southeast Asia between 15-20° latitude and ends in the east Africa only in summer season.



tropically easterly Jetstream is explained by Tibetan Himalayan zone. During summer South Tropical Westerly Jetstream shift from 30-35°N to 40-45°N. This result into high pressure development at tropoles below 30° North.

During summer, Tibetan Himalayan zone acting as heating engine since temperature is 2 to 3° more than the surrounding region. Due to rotation of earth the tropoles air start moving

westward (East to West) along the tropopause called tropical easterly Jet stream. This stream found 15-30°N latitude only and passes through South East Asia and South Asia.

(iv) Polar night Jetstreams:-

Polar night Jet stream is explained by Polar vertex concept. Here it means, total angle of momentum of atmosphere system remain constant. At the equator atmosphere has minimum angular momentum but at the poles max^m angular momentum this leads to rotation of wind in the polar areas that push the air towards the ground or stratosphere [This leads to rotation of wind in the polar areas that push the air towards the stratosphere] create anticyclonic condition on the ground and polar night Jetstreams in the stratosphere at a height of 30 km. This entire concept is called as Polar vertex.

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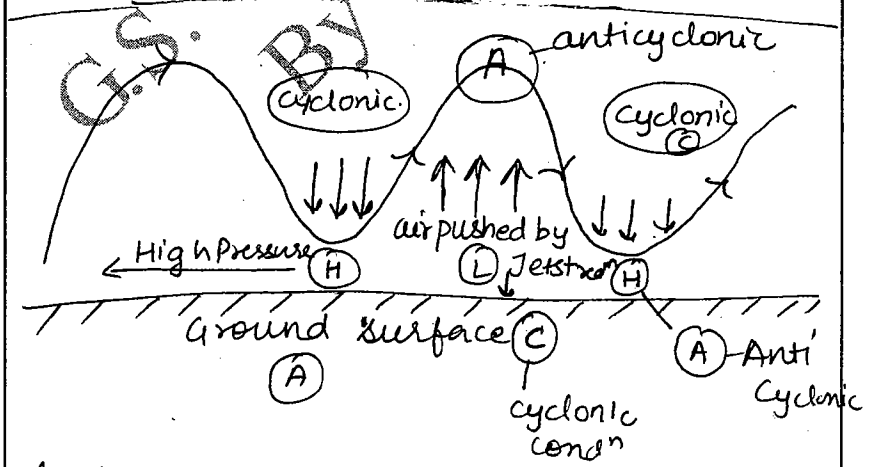
Significance of Jet Streams

* the jetstreams meanders both horizontally and vertically that leads to two situations on the ground.
  - Jet streams pushing the air and creating anti-cyclonic condition or high pressure on the ground
  - Jet streams pull the surface air upward creating low pressure or cyclonic conditions on the ground. Both cyclones and anti-cyclones are connected to each other that means cyclones attracts the wind from the anti-cyclones.



* Cyclones and anticyclones produced rainfall & dryness respectively on the ground.

It affects or influence the monsoonal climate. eg. India.

@ In winter → Subtropicaly Westerly Jets producing anti-cyclonic condition in NW of India that push the air from land to sea called as NE Monsoon winds. and In winter, they create western disturbance rainfall in west Himalayan region.

(b) In summer - tropically easterly Jets intensify low pressure or cyclonic cond^n on the ground that attracts wind from sea to land called as SW monsoonal wind.

* Ozone layer depletion :- Ozone depleting substance which contains fluorides and chlorides that is very reactive and it reacts with ozone in the polar night Jetstream areas by polar vertex. This leads to decrease in ozone layer.

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WATER CYCLE

the circulation of water in all the forms means solid, liquid, gas in the four phases ionosphere, hydrosphere, cryosphere by the 3 process evapo-transpiration, condensation and precipitation is called Water or Hydrological cycle.

1. **Evapo-transpiration** - It includes the purpose of conversion of water into vapours by evaporation and transpiration process from water sources such as lakes, seas, life-forms.

2. **Condensation** :- Here water vapours converted into liquid droplets or ice crystals, when relative humidity at the condensation surface become 100% or it reaches to due point.

Condensation takes place at ground in the form of various forms:-

at surface ←
- i) dew (Gas) → Dew temp > 0°C (water droplets as dew).
- ii) Frost (crystal) → (ice) (Temp < 0°C)

Atmospheric
- iii) Fog → visibility is <1km
- iv) Mist → visibility is within (1-2 km)
- v) Haze → visibility is more than >2km
- vi) Smog → visibility is 0.

above surface → clouds.

CLOUDS :→ An aggregate of millions of droplets and ice crystals is called clouds. For the cloud form" surface is provided by solid suspended partides "called particulate matters. This act as a condensation nuclei or hydroscopic nuclei.

3. **Precipitation** :- An aggregate of millions of droplets and ice crystals is called clouds. For the cloud formation surface is provided by solid suspended particles called the particulate matters. This a

3. **Precipitation** :→ when cloud water falls back into the earth's surface is called precipitation. The precipitation occurs only in few clouds called "Nimbus clouds" and other clouds are

classified in the following forms:-

A) Alto → 2 to 6.5 km (medium clouds).

B) Cirrous clouds → Above 6.5 km (High clouds).

C) Cumbulus clouds → wool form.

D) Stratus clouds → layer form.

Only Cumblo-Nimbus is a vertical thunder storm clouds that occur on surface upto 20km height. When a cloud become denser than air holding it then it falls on to the earth surface in different forms such as rainfall.

* rainfall (>1mm of drop size).
* drizzle (minute droplets).
* Snow (soft ice).
* Hailstone (Hard ice)
* Sleet (rainfall + snofall

Mechanism of cloud becoming denser

In the high clouds, containing a mixture of ice-crystals & super saturated or super cooled water at a temperature of -15°C to -20°C & the vapour pressure around the liquid droplets is high with respect to the ice

crystals.

So due to vapour pressure difference, liquid droplets moves towards the ice crystals & converted itself into large ice crystal piece.

* In low clouds there exist different sizes of liquid droplets they collide among themselves by cohesive forces to form a big droplets.

In this way cloud become denser than the surrounding atmosphere. These two processes leads to condensation which further releases latent heat of condensation so cloud move upward to the new condensation level and due to weight it fall back to the lower condensation level. this process of vertical movement continues till the cloud become denser and leads to precipitation.

Mechanism of Rainfall or Types of Rainfall

* there are three mechanism or types:-

(i) Convection Rainfall

(ii) Orographic Rainfall

(iii) Cyclonic / frontal Rainfall.

(i) **Convectional Rainfall**

Due to local heating mechanism or in summer season the water vapours move vertically upward by convection process. Here, evaporation, condensation, convection, presipitation takes place vertically over the same region. It occurs in equatorial region in everyday or in summer season, then tropical, subtropical and temperate region.

(ii) **Orographic**

the rainfall caused by the mountain barrier on its windward side. Here, warm moist air rises vertically along the slopes of mountains by wind that leads to condensation & precipitation on the windward side. But the leeward side remain the rainshadow region. eg. western slopes of western ghats, Southern slopes of Himalayas. Or In India majority rainfall or high rainfall areas are orographic type.

(iii) **Cyclonic** :- Here due to a cyclonic circular system which is characterized by low pressure inside and high pressure outside and the inward movement of air to fill the low pressure resulted into spiral upward movement of warm moist air that leads to condensation & precipitation It occurs due to tropical cyclones in the coastal areas of monsoonal climate in the pre and post monsoonal climate. The temperate cyclonic caused by a front so in mid-latitude and high latitude areas rainfall is called Frontal Rainfall.

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CYCLONES

the circulatory wind system produced by circular isobars. It is characterized by inside low pressure and outside high pressure. In the North hemisphere it rotate anti-clockwise direction while in the Southern Hemisphere it rotates ~~anti~~-clockwise direction. ~~white~~

Types of Cyclones

* On the basis of location/origin:-
  - → tropical
  - → temperate.

tropical cyclones:- the cyclones occur b/w the 5° to 30° lattitude. It occurs over the warm water bodies when the following conditions exist for 1oto 15 days continuosly:-
- sea surface temperature more than 26.5°c.
- continuous supply of moisture
- Presence of ITCZ
- Monsoonal climatic region

- Surface wind should be light, calm i.e, it occurs in pre and post monsoonal time. In India, pre is before June and Post is after September.
- It is maintained by high pressure in the upper atmosphere. the series of thunderstorm cloud merge.

Mechanism of Tropical Cyclones

* under the above conditions warm bodies acting as a heat engine so this heat engine operates with the continuous supply of moisture in the form of water vapours.
* During evaporation process, vapours takes away latent heat of evaporation and during the condensation, it releases the latent heat of ~~condensation~~ condensation and this created column of low pressure, extending downward till the ground surface in this way low pressure is develop inside and outside there exist high pressure.
* In order to fill the low pressure wind

move inward due to coriolis force, it get deflected and start rotating in the Northern Hemisphere. In the Northern Hemisphere it rotates spirally in the anticlockwise direction while in southern Hemisphere in clockwise direction.

* The tropical cyclones move from sea to land by the rotation of the earth so most of the tropical cyclones occurs on east coast than the west coast. the tropical cyclones also moved by wind system in its direction. But these tropical cyclones do not moved by themselves.

Structure/role associated with Tropical Cyclones

* Ideally tropical cyclones is consist of 4 parts :-

- Eye - the central part of the cyclone is called Eye which is charaeterized by low pressure, Here, sky is free, cloud free, descent of air, no rainfall.
- Eye-wall - It is a vertical column where warm moist air arises vertically upward

and it leads to heavy precipitation or rainfall that leads to coastal flooding.

- Anvil clouds :- It is a cumbulous - Nimbulus cloud type where wind is moving spirally upward that will causes high rainfall.
- Rainband :- Series of ascent and descent of air takes place that result into series of cloud and cloud free areas wherever ascent of air takes place there it will cause rainfall else no rainfall.
- Annular Ring :- the outermost part of tropical cyclones where wind speed and cloudiness decreases.
- Eyth of tropical cyclones :- Tropical cyclones approaching the land lies few km within the coast due to cutoff from moisture supply from the sea and the super - cyclone may reach to 100 km.
- Distribution :- these names are decided by Regional metalogical department.

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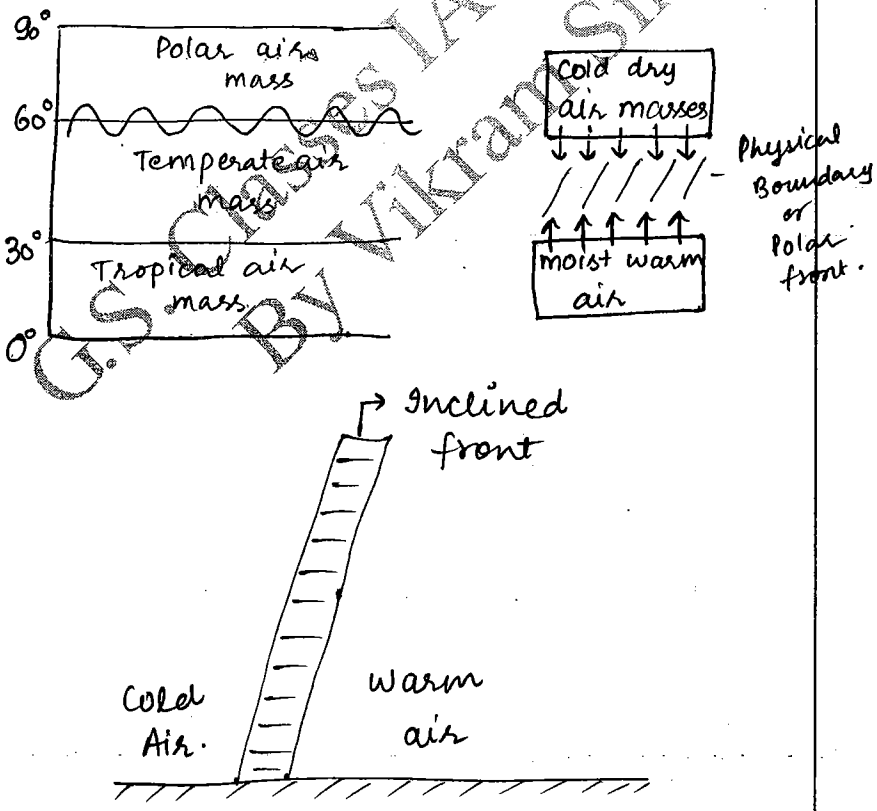
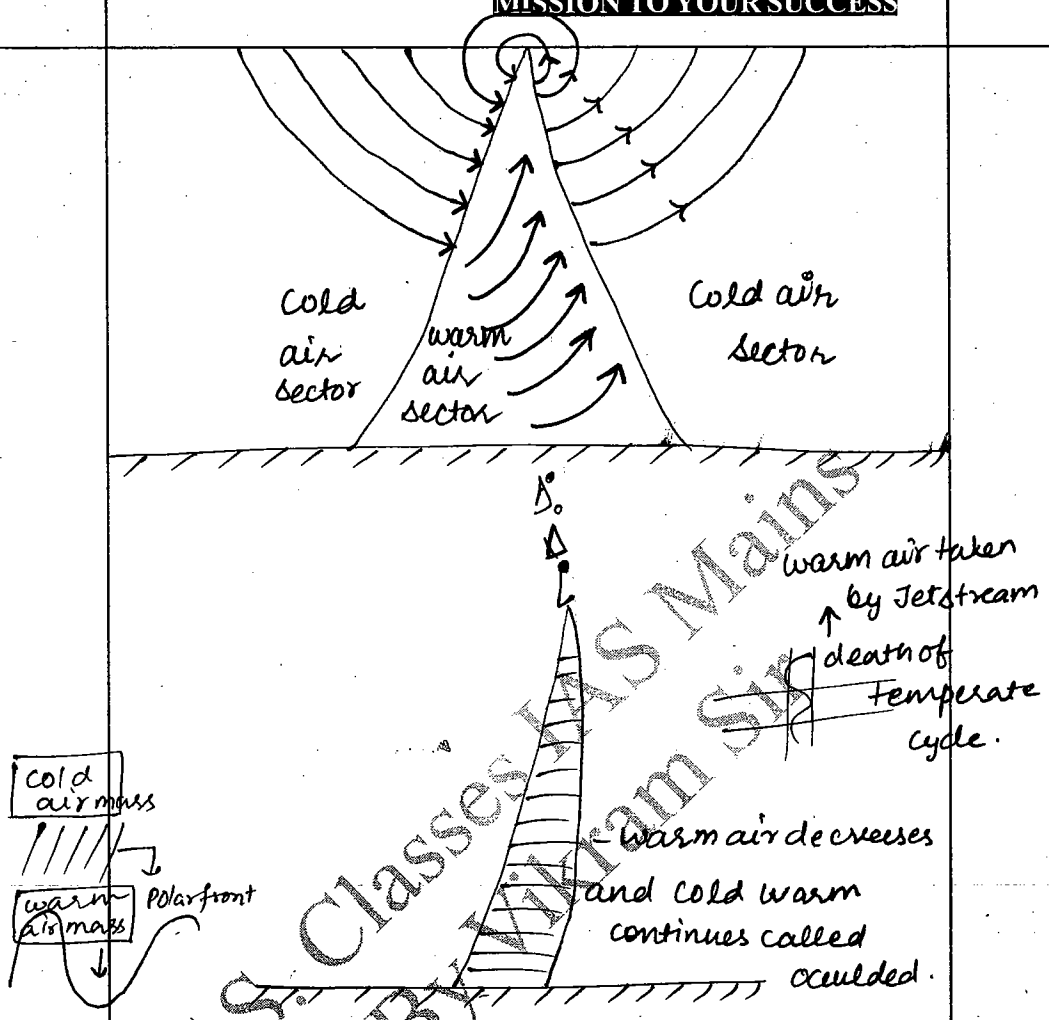
Geographical Names:-

* China - Typhoons.
* Philippines - Baiguo.
* Japan - Taifo.
* South Asia - Cyclones
* Gulf of mexico - Hurricanes.

Temperate Cyclones

* occur in the high or mid-latitude above than 30°.





the cyclones that found in the mid-lattitudes & higher lattitudes due to polar front. when the cold dry air mass meets with warm air moist mass at around 60° lattitude then the boundary between them is called front or polar front, across the polar front there exist pressure gradient, temperature gradient and humidity gradient. Due to gradient difference across the front air start moving.

the cold air sink and try to replace warm air mass but the warm air mass rises itself. In this process front become inclined and the warm air get enclosed by the cold air from all sides that resulted into a typical circular Isobars which is characterized by low pressure inside and high pressure outside.

Ideal temperate cyclone consist of 4 parts:-

(i) warm sector
(ii) cold sector
(iii) warm front
(iv) cold front.

i) warm sector:- Here low pressure and the air rises upward slowly by convection process and leads to rainfall but well distributed. Here, wind is calm & slope.

ii) cold sector:- Associated with cold air mass where pressure increases, temperature decreases and the wind direction reverse it is associated with anti-cyclonic conditions and no rainfall.

iii) Cold front :- Here, cold sector is more active and pushing the warm air upward this boundary between cold sector and warm sector called cold front Here cumbulous- Nimblus cloud type formed leading to heavy rainfall, lightening and thundering.

iv) warm front :- Here, warm air is more active and the boundary b/w the warm sector and cold sector is called warm front. They resulted a series of cloud only Nimbo- stratus cloud cause rainfall. Here, rainfall is more well distributed.

Decay of temperate cyclones

* With the passage of time, the warm sector uplifted and the warm sector decreases then from the top cold front and warm front merge together to form a occulded front. further this occulded front extended, downward to ground and the warm sector decreases and become the part of upper atmosphere and the cold air take over the ground this situation is called dissipation of temperate cyclones or death of temperate cyclones.

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Humidity

Amount of moisture present in the air is called Humidity. Absolute Humidity is the maximum amount of water vapour present in the air at a given temperature. Absolute Humidity is constant because it is not affected by increasing or decreasing of temperature.

But the normal humidity is effected by temperature, evaporation, wind & vapour pressure.

* the ratio of actual water vapour present to the maximum water vapour it can hold it is expressed in %age.
* High Relative Humidity leads to the uneasiness, diseases, drainage process slowdown.
* when relative humidity is 100%. then condensation will occur.

$$\text{Relative Humidity} = \frac{\text{Actual water vapour}}{\text{Absolute (max}^{m}\text{) vapour}} \times 100.$$

Anti-Cyclones

It is a rotatory wind system characterized by inside high pressure and outside low pressure. Here wind move downward and outward spirally in the Northern Hemisphere it rotates clockwise while in the southern Hemisphere, it rotates to anti-clockwise. They occur at three locations:-

(i) Cold anti-cyclones that occurs over the polar high pressure around 90°.

(ii) warm anti-cyclones occurs over sub-tropical high pressure around 30° latitude over the hot desert.

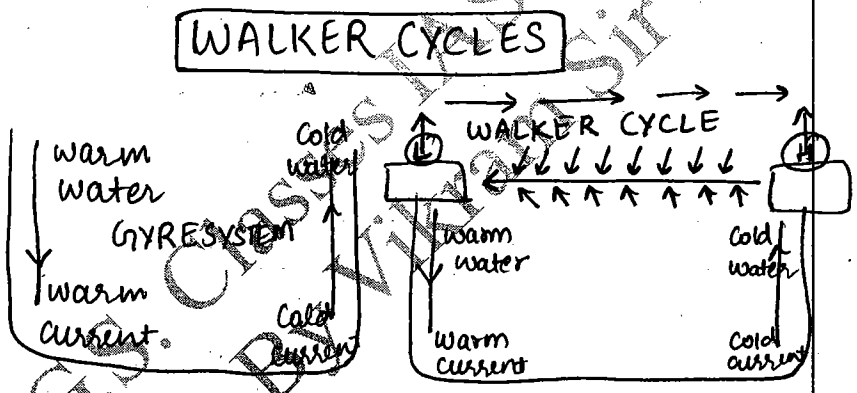
(iii) warm anticyclones occurs over sub-tropical high pressure around 30° latitude over the hot desert.

(iii) In the winter seasons over the interior of the continent due to descent or subsidence of cold air high pressure is developed producing anti-cyclones.

Mechanism

* there is descent of air and the wind rotate outward.

* Due to no ascent of air, no rainfall, no cloud formation and no condensation occurs. The permanent anti-cyclones produces desert and the seasonal anti-cyclones produces dryness in that season.
* Cyclones and anti-cyclones are inter-connected producing air circulation system or atmospheric circulation system.



The climatologist & metalogist Gyl walker observed the relationship b/w the atmospheric circulation system and oceanic circulation system. since he found east and west part of the ocean as alternate temp. conditions i.e, if eastern side have cold water then western side may have warm water.

Every Ocean, Indian, Pacific and

Atlantic ocean experience the walker cycle and that effect the weather phenomena. In the Pacific ocean, walker cycle that the other oceans walker cycles.

1. Normal Walker Cycles:- In the south pacific ocean the american coast has cold water due to cold or Humboldt current while East Australia has warm water due to East Australian warm current. these condition is maintained by the South Pacific Gyre System. this oceanic circulation produces alternate pressure system on East and west side. Here, on the American coast, high pressure is developed due to cold water and on the Indonesia & Australia side, low pressure is developed due to warm water zone. this result into surface wind from East to west, this result into ~~surface~~ further pushed the trade winds leading to normal monsoon on East Indonesia and East Australia coast. At the low pressure air rises upward and at the high pressure air move downward forming

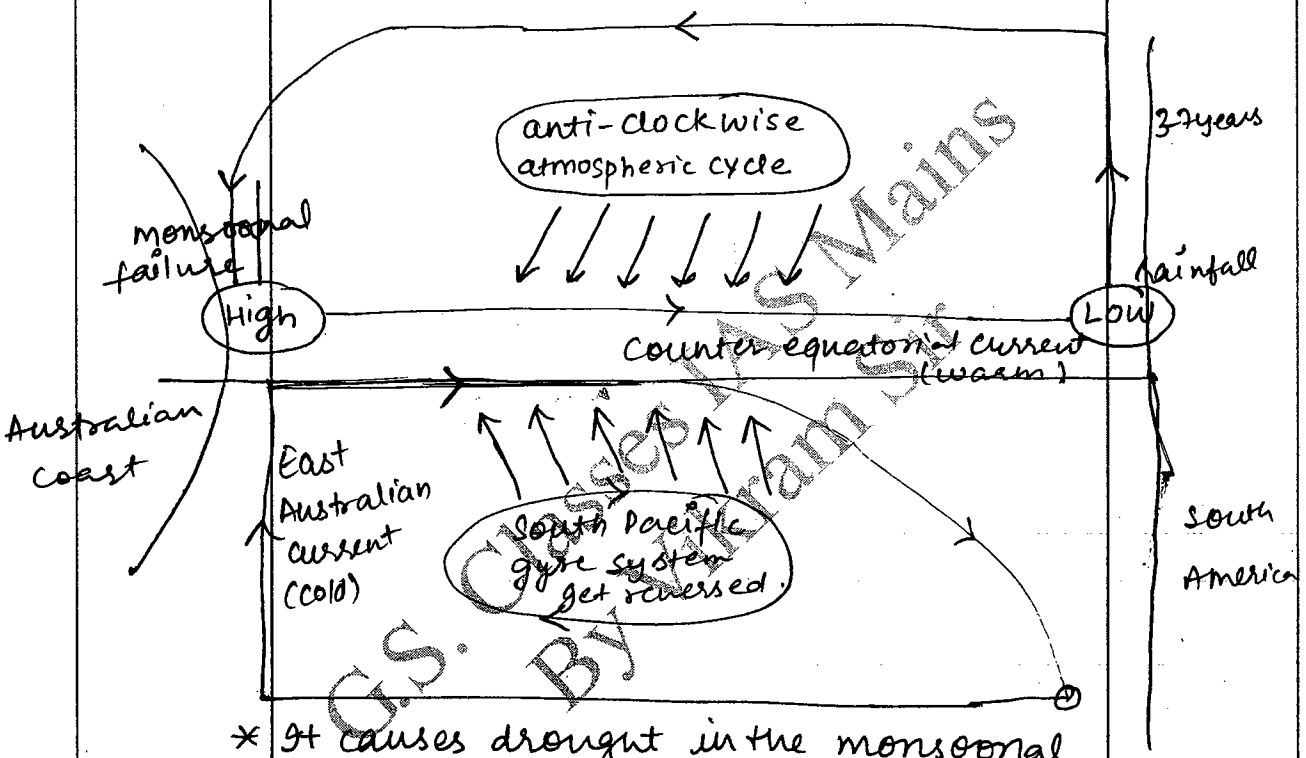
a clockwise atmospheric circulation in East-West direction called the Normal Walker Cycle.

Impacts:

* Normal Condition:- Southern Oscillation Index (SOI) value is sum positive constant then walker cycle is normal.
* when SOI value is more positive than the normal then walker cycle accelerate in the same direction resulting into excessive monsoonal rainfall & flooding. It occurs due to the substitution of East Australian warm current by La Nina further warm current.
* when the SOI value is negative, it means pressure gradient get reversed and walker cycle also reversed. This retard the trade winds and monsoonal wind resulting into delay in monsoon or early withdrawl of monsoon. or less amount of rainfall causes drought and famines. This occurs when cold Peru current on the South Asian coast is substituted by a warm EL-Nino current. This reverse

the South Pacific gyre system. This effect is called El-Nino effect or ENSO effect.

ENSO CYCLE



* It causes drought in the monsoonal climates of Asia and the monsoonal cycles of ~~Asia~~ India.
* On the American coast rainfall occurs in their deserts and support vegetation
* The fish catch on the south american coast decrease that result in decline in Guano bird fertilizer that feed on anchiones fish on peru coast.
* Enso cycle become more frequent and leads to global warming.

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CLIMATIC REGIONS

* Equatorial: Tropical Rainforest Climate

→ It is characterised by High temperature and rainfall and humidity.

→ Annual average temperature is 27-28°C. Always >200cm every year.

→ Annual range of temperature is smaller than diurnal range of temperature resulting into nights as winter.

→ Rainfall is well distributed throughout the year and convectional type. Everyday rainfall due to Cumbulo-Nimbus type associated with thunderstorm lightening.

→ Humidity is high more than 77% always.

→ It consist of 5 layers of trees from 45m to 30m to 15m to 10m till 5m.

→ It is also associated with Liannas, Epiphytes.

→ these jungles are dark, sunlight do not reach to the ground so underneath growth of grass are absent.

→ Here, plant biodiversity and animal bio-diversity is highest, consisting of large.

variety of tree canopies, thick and dark. So, economically not viable used for dumbering in diversity.

→ Here, trees are ever green and soft wood.

* Tropical Monsoonal Type (Indian Type):-

→ find between 10° to 30° lattitude both in Northern Hemisphere and Southern hemisphere.

→ It arises due to ITCZ.

→ It is characterized by seasonal reversal of wind in summer move from sea to land while in winter from land to sea areas as South East Asia, South Asia, North Australia, East Africa, Western Madgascar, North East of Brazil, Gulf of mexico in USA.

→ In Summer, temperature increase upto 45-48°c and avg. summer temp - 30°c. Average winter temperature is 10°c.

→ Average annual range of temp is ~20°c.

→ Rainfall is also highly seasonal.
(i) Summer - wet
(ii) winter - dry.

→ Rainfall is 100cm - 200cm /-year.

→ Rainfall is both orographic and convectional and also cyclonic type.

→ Here, Humidity is high during wet summer more than 80%.

→ In the rest of season, it is 50%.

Vegetation characteristics:

→ Tropical deciduous forest - Hard wood. trees that shed there leaves in dry or early spring season. So they are economically and comercially exported. Mayanmar is largest exporter of the Hardwood.
eg. Indian Trees Names.

→ 4 layes of trees are present.

→ Less dense canopy.

→ undergrowth of grasses.

* Tropical Savana type of climate:

→ 5°-30° N/S → climate region found.

→ <100cm/yr - 25cm/yr - called Savanna (25-100cm).

→ Dry winter (8 months).

→ Wet summer.

→ temperature varies 10°C to 30°C

→ this climate covers the regions:-

* In b/w Congo basin & Sahara desert in Africa.

* South America.

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- Brazil → campos b/w Brazil coast & Amazon Desert.
- Venezula → west lies b/w equatorial rainforest and monsoonal region.
  ↳ these regions are called as Lalanos.
- Northern plains of India (man-made)
- It is lies in the interior of continents.
- Max^m rainfall in summer.
- Characterised by three seasons:-
  - Dry winter
  - wet summer
  - Dry summer.

→ Its natural vegetation is called tropical grassland. It is having large and long grasses during wet summer seasons and (scattered and short scattered) trees and the grassland is typically known by different names in the respective region.
- In Africa called Savana in b/w Congo basin & Sahara desert.
- South America.
- Northern Plains.

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* Tropical Desert Climate:-
→ Subtropical High pressure regions (20-30°C) eg. Thar desert.
→ rainfall is <25cm/yr. & seasonal.
→ Diagonal ranges is very high in any climatic region.
→ eg. Thar desert in India and Pak borders
- Nefud in Saudi-Arabia & Rub-Al-khali.
- Dast-e-lastar & Dast-e-Kavir in Iran.
- Sahara desert in Northern Central Africa (Hot desert).
- Saharan desert in North America.
- Major in USA.
- Arizona in USA and Mexico.
- Atacama desert in west-coast of Chile world
- 5 desert of Australia:-
  - Laibson
  - ~~Gibson~~ Simson
  - Stuart
  - Namib in America
  - West Australian Desert.
  - Kalahar in South Africa.

Vegetation :-

- thorny vegetic vegetation it is adopted to less and occasional rainfall called xerophytes.
- xerophytes :- Adaptive features :-
  → Shunken stormata.
  → leaves turn into spines (thorn
  → stem appear green due to chlorophyll to do photosynthesis :-
  → root system - deep (vap.)
  → short germination on period.
- long dormant period in dry season.

eg. of xerophytes.
- Cacffi
- Acacias.

- Here Animal biodiversity more than plant bio-diversity.

* Mediterrian type of climate :-
- Narrow type
- 30-45° latitude in coastal regions.
- It is characterized by summer → dry winters → wet because of shifting of sub-tropical High pressure belt b/w land and sea.

Regions:→

* Medeterian coast in Europe, westAsia, North Africa.
* California coast in USA.
* Chilean coast of south of Atacama desert
* Capetown provinces in South Africa.
* South East Coast & south West of Australia.
* Annual average ranges - 100cm/yr.

vegetation characterstics:-

* Xerophytes.
* Shrubs → chapparal of California.
* Fynbos of South Africa.
* Matorral of Chile coast.
* Mallee in Australia.
* Maurities in germany (Europe)
* these region is known for specialize Agriculture called viticulture (grapes and wines).

* Temperate Desert:-
* Around 30-60°C lattitude any where in the interior of the continent.
* Less moisture <25cm/yr.

* these desert forms due to continental effect.
* eg. Central Asian Deserts.
  - Karakoram.
  - Kyzl-kum (Uzbekistan, Turkmenistan Kzakstan).

→ Mongolian.
→ West china → eg. Taklamakan desert due to rain shadow effect
→ Siberian desert.
→ Pentogonia.

* temperature -20-25°C and winters temperature below 0°.
* Rainfall <25cm/year.
* vegetation :- Specially shrubs.
* British Type (NW types):-
* 45-60°C Lattitude
* Average annual temperature - 15-20°C.
* Rainfall = 100cm/year.
* Maximum in winter - Snowfall.
* Minimum Summer.
* temperate cyclone (frontal).
* Orographic cyclone.
* Temperature Maritime effect

* regions
- North West Continents.
- North America in Washington &
- Some part of Argetina in South America
- Tasmania & Australia and New Zealand
- It influenced by westerlies temperate cyclones.

eg. NW Europe- Britain, Ireland, Scotland, Northern France, Netherland, germany, Poland, Scandvian countries.

* Specially known for wheat production also dairy farming
* caused by conventional and temperate cyclones. This rainfall is sufficient for growth only, dominated by grasslands and trees are only found in near to water bodies.
* Region is know for sugar during summer season due to short growing period and soil in rich in humus. and black in color called the chernozones (Russian Terminology) & vertisols.

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* In India temperate grassland in Himalayas and shola forest in South India. (Nilgiris, Andamans)
* Siberian Types:-
* Around higher Altitudes.
* Extreme cold climate.
* Winters 7-8 months.
* 25-30°C (Low temperature)
* Less rainfall <25cm/yr.
* Snowfall.
* Evaporation rate is low.
* Evergreen.
* Soft in nature.
* Low Plant Biodiversity.
* Larger supplies of paper.

Regions:-

* Some parts of Alaska of USA.
* North Canada.
* Island, greenland (Coastal Areas).
* Scanadinian countries.
* North Siberia of Russia.
* High altitudes regions below the snowline - Himalayas, rockies.

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* Tundra Type (Cold Desert)
→ found 66.5° N/S till 90°.
→ location :-
  a) Polar region (Above arctic and Antarctic).
  b) Higher Altitudes (Himalayas + Andies + Rockies).
→ Parmafrost (snow) line.
→ Pressure - High.
→ wind - away, strong blizards.
→ Moesses + Lichens (Associated of Algae + fungus).
→ Animal biodiversity is more.
* China Type (Sub-tropical Monsoonal Type)
→ found 30-45°, SE parts of Continents.
→ Influence of westerlies.
→ monsoonal winds.
→ temperature - 20-25°C.
→ Maximum / summer - 35-58°C.
→ following temperature in winter - 0°C.
→ In winter temp. below freezing point
→ Region - China (South & East China), Korea, Japan, Florida, SE of South America, SE Part of South Africa, East Australia.
→ mixed natural vegetation i.e tempesate + tropical

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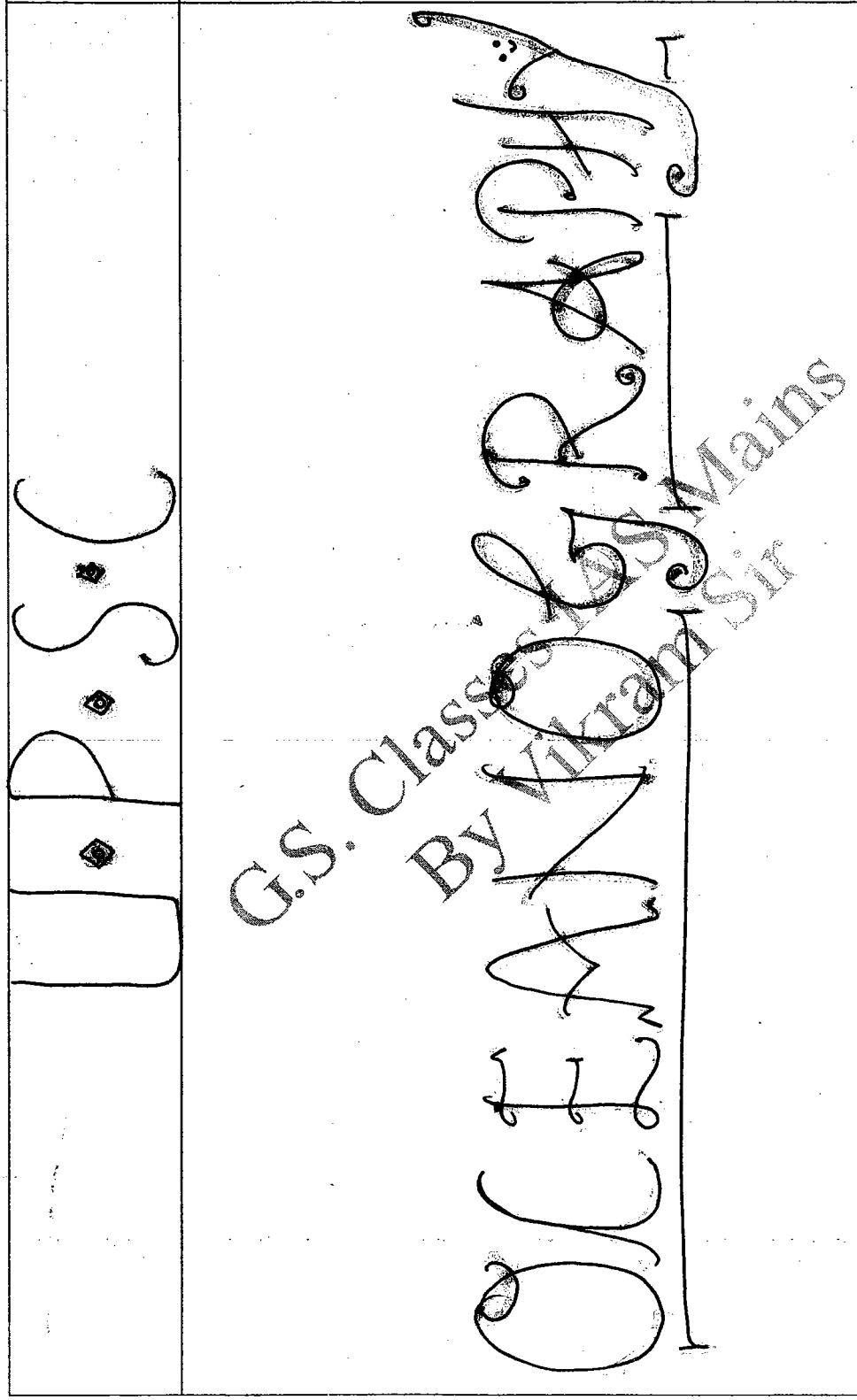

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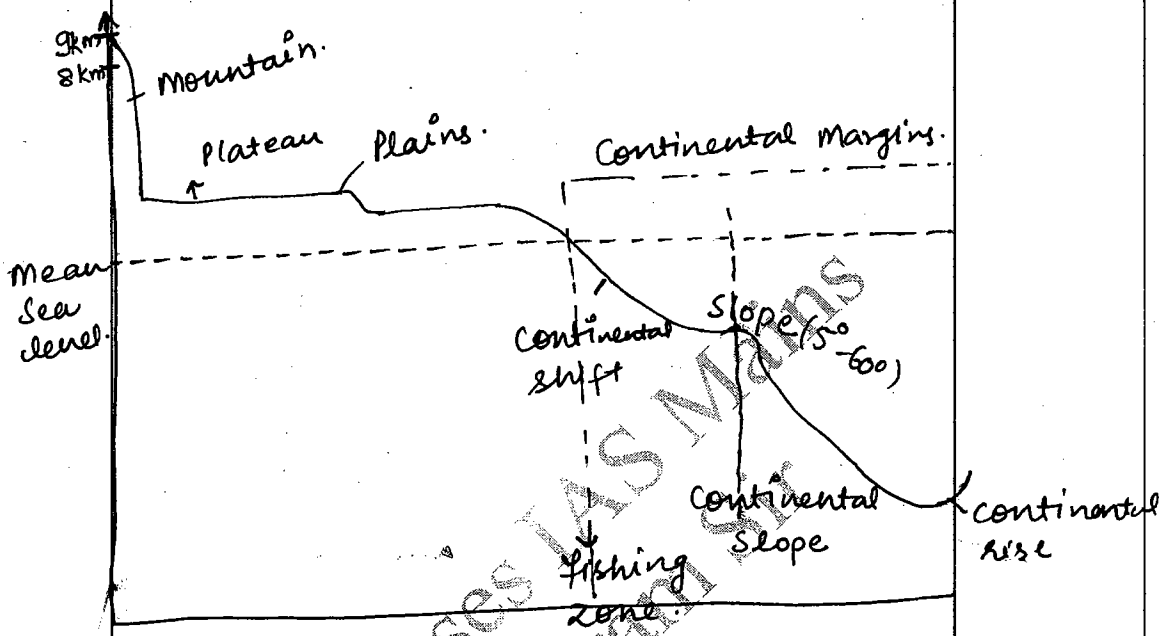
Ocean Bottom Topography:-



the hypsographic or hypsometric curve is used to indicate graphically both the altitude and the depth of the relief features over the land and the sea. this curve contains two categories of features in the ocean:-

(i) continental margins.
(ii) Oceanic floor.

Continental Margins

It is the part of continent or land which is made up of mainly made up of granite it is submerged under water of sea called continental margins.

It consist of the following features.

* Continent Shelf:- the part of continental margins with very gentle slope gradient is less than 5° and depth is around 100 fathom.

Significance: the broader continental shelf contain more nutrient that provide more marine life like Algae or other Photo planktons and higher marine life such as fish resource.

In Europe & America, the best fishing ground Banks such as North Bank, Dogger bank, george and grand banks. In India, we called as "Shols", the west coast of India of shol is more than East Coast of India.

* continental shelf provide hydrocarbon such as oil, gas, coal and even it is a source of Uranium, thorium energy minerals. eg. Mumbai High in India.

* Gulf of combat in India, Carribeen sea.

* West Part of Pacific Ocean.

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* Continent Slope :- It is the steeper part of continental margins where the gradient is more than 5° it may reach upto 60° also. there is very less deposition on it but it is characterised by linear depression called as sub-marine canyons. It is also extended upto continental shelf. Its depth is around 1000 fathoms.

* Continental ~~slope~~ rise : Lower part of the continental margins at the edge of continental slope where the deposition occurs called as rise.

* Oceanic floor

It arise due to sea floor spreading phenomena at the edge of the spreading zone where magma rises vertically upward. Oceanic floor contains the feature mainly made up of Basaltic, Igneous rocks,

(1) Mid Oceanic Ridges :- It is a long linear mountain ridge formed by the deposition of magma. It is formed the longest mountain chains on earth.

Andes is the longest chain. The Atlantic Ocean and Indian Ocean has well developed central ridge system but absent in the Pacific Oceans.

(ii) the deeper features on the oceanic floor called as Abysl. It includes plateau etc. these features are more extensive then the continent.

(iii) Gyots are circular flat top hill. when Abysll hill and gyots emerged above the sea level it become Island.

(iv) At the convergent zone of the two plates, long linear depression is formed called as the trenches & deeps.
eg. west Pacific Oceans.
Carribean sea in Atlantic Ocean.

(v) Marginal Seas:- the ridge systems & the continental boundaries seperate the oceanic water into sub-sea called as marginal seas. It is generally adjoining to the continents.

eg. Bay of Bengal, Andaman sea, Java sea.

Importance of Oceanic floor:-

Oceanic floor contains many metallic and non-metallic minerals that are extracted by deep sea mining more than 2000 m to 7000 m. It contains metallic minerals in the form of constraints called as nodules such as polymetallic nodules contains Copper (Cu), Tin (Sn), Nickel (Ni) & Iron (Fe), Gold (Au) & Silver (Ag), Magnesium crust.

From the hydro-thermal vent in the ocean contains plums (bubble) of gases which acts as resources of sulphur & hydrates.

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Maritime Zones

there exist various maritime disputes related to application of rules of regulations, the sovereignity rights, navigational rights, fishing rights, deep sea mining rights, fiscal laws, criminal laws etc. To resolve the above issues in 1982, UN convention on Laws of Sea was passed & implemented. this International law clearly demarcates and delimit the oceanic water into different zones called Maritime zones.

(1) **Internal water**

the water enclosed between coastal line and baseline is called Internal water. Here, the coastal country has sovereign right over this water zone and all the laws of the nation is applicable and they have complete rights to use for civilians and military purposes.

(ii) **Baseline:-**

It is an imaginary line formed by joining headland (projected towards the sea). this line become the base of all measurement.

(iii) **Territorial water zones**

this water extends 12nm from the baseline. Here many laws of the land is applicable and here coastal country has right to capture the foreign ships or any other criminal activity but some country get innocent passage rule.

(iv) **Contagious zone**

Next 12nm from the territorial water zone this zone exist. Here only some rules and regulations are applicable. This zone is acting as a warning zone to foreign ships but they have navigational rights innocently.

(v) **Explosive Economic zone**

It is extended to 200nm from baseline. Here, coastal country has complete economic rights. that means fishing rights, deep sea mining for oil, fuel etc.

this zone permits both arial & marine type of navigation.
eg. India has 2.2 million sq. km area called EEZ.

(ii) **Continental Shelf**

If the continental shelf extended beyond 200nm then continental shelf is taken as EEZ irrespective of the length. It creates the problem of mutual or conflicting cleaning of water bodies beyond 200 nm.
eg. In Arctic Ocean is claimed by Norway, Russia, USA, Finland, Denmark, Canada.

(iii) **High Sea**

Areas beyond EEZ or continental shelf called High Sea. Here water belongs to all. All has navigational rights, fishing rights and UN gave rights for deep sea mining for mineral resources.
eg. India got 50% rights over the Indian Ocean there rights are given in exchange of royality. This zone become centre of illegal activites such as smuggling, human trafficking,

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piracy, drug trafficking so required maritime security.

(viii) Thalweg Principle

If the countries are closed and above maritime zone demarkation not possible, then there is an equal division of water bodies among the coastal states using the median line.

Conclusion

Due to the existing problems in high seas and the continental shelf such as maritime security, environmental waste disposals, nuclear testings, over fishing especially whaling.

So UNCLOS-2 should be replaced or revised by UNCLOS-3.

Properties of Oceanic Water

* Oceanic temperature depends on two factors:-
  (i) Sources of Heat energy
  (ii) Mechanism of Heat energy transfer

(i) Sources of Heat energy:- the sea is heated from the top by solar energy producing variation at the sea surface temperature. Since insolation & its heat energy varies with latitude & time (day/night or summer/winter).