Geography-XI

For class, Eleventh

Punjab School Education Board

Sahibzada Ajit Singh Nagar

First Edition 2016..... 10,000 copies

Writers

Aruna Dogra Sharma *M.sc. Geography, B.Ed.*
Tejinder Singh *M.sc. Geography, M.A History, B. Ed.*
Navjot Singh *M.sc. Geography, B.Ed., M. Phil., P.G.D.C.A*

Co-ordinator and Editor

Raminderjit Singh Wasu *Co-ordinator (Social Sciences) and Subject Expert (Media Studies and Geography)*

Maps and Graphics

Tejinder Singh *M.sc. Geography, M.A History, B. Ed.*
Manjit Singh Dhillon *Artist (P.S.E.B)*

Translation

Satinderpal Singh *M.A. (Journalism and Mass Communication), Diploma in Horticulture, Translator/Sub-Editor, Punjabi Tribune.*

Price : Rs.

Published by: Secretary, Punjab School Education Board, Vidya Bhavan Phase-8 Sahibzada Ajit Singh Nagar-160062, **Printed at Mikado Offset Printers, Jalandhar.**

FOREWORD

Punjab Curriculum Framework (PCF)-2013 and National Cirriculum Framework (NCF)-2005 emphasizes on reducing curricular burden and stress of the students. Both PCF and NCF lay stress on connecting knowledge of the child to life outside the school and to ensure that learning is shifted away from rote method. It provides for the overall development of children rather than remain text-book centric.

While taking into consideration these guiding principles, Punjab School Education Board, has for the first time taken the initiative to provide quality text-book of geography to class eleven students of the state, from session 2016-17. Significance of the subject is in creating awareness among young minds about positive and negative processes taking place around us, making them conscious about benefits and harms being meeted out of natural resources so that they may be encouraged towards taking effective remedial measures in favour of the same. With this objective the book in hand includes various spheres necessary for human kind and knowledge/information their of has also been put forward in unique manner.

The book is the outcome of sincere and dedication hard work of the writers who have put in their efforts after understanding the children's developmental levels. The book is strictly in accordance to the prescribed syllabus of the Board yet it shall be beneficial for aspirants of various competitive examinations.

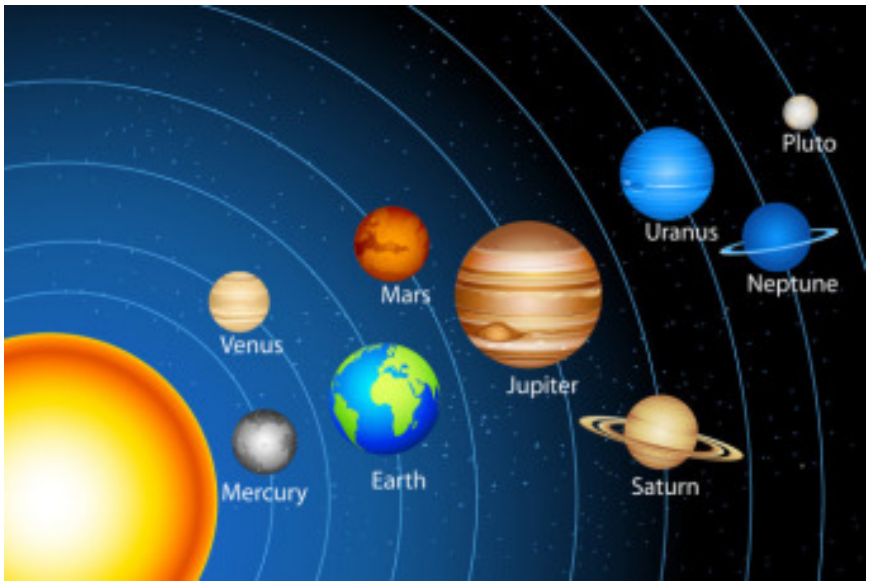
Every effort has been made to make the book error free, but 'to err is human'. keeping this view, all valuable comments and suggestion are welcome.

Chairperson

Punjab School Education Board

Contents

Unit-I
Solar System

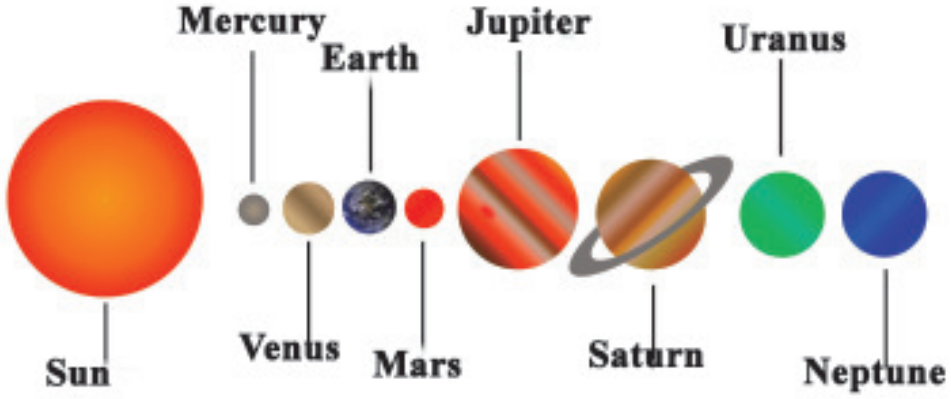


CHAPTER – 1

(i) EARTH

Our Earth is aged about 2/3 of the age of the Universe. Scientific indicators put the age of earth nearly 4.54 billion years while life on Earth originated around 1 billion years ago. Life on our Earth is combination of around 26 chemical elements. Out of these six basic chemical elements are Carbon, Hydrogen, Nitrogen, Oxygen, Phosphorus and Sulphur which are responsible for 95% part of total constitution of life. Meaning there by that these six elements are bases of life on Earth.

As a student of Geography, our relation with Universe begins with the query that what is the position of Earth in the Universe because definition of Geography itself is related to the Earth. Earth is one of the eight planets of this universe where life is possible. These eight planets have around 150 satellites also which revolve round their respective planets.



Solar System

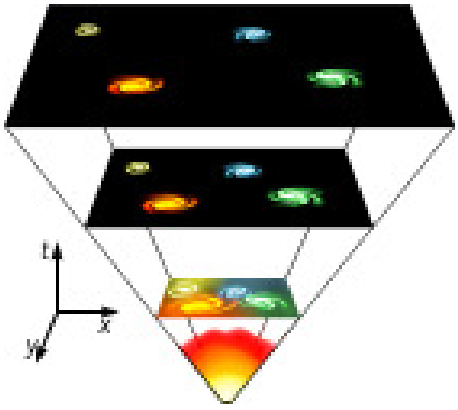
Origin of Earth is incomplete just as that of the Universe. It is presumed that Universe was created after the great explosion, known as Big Bang. This explosion occurred around 13.7 billion years back. Another theory about the origin of Universe goes as a big dust and gas laiden cloud called Nebula got condensed about 4.5 to 5 billion years

ago. This condensation caused revolution of Nebula and it further cooled down due to convectional activity. As it condensed and shrank, bulges got created in it and they got separated in shape of rings which are found as planets. Sun is also one of such rings. All the planets now revolve round the sun while rings separated from planets which are known as satellites revolve round their respective planets. Nebula theory was presented by French mathematician, Marquis de Laplace (23 March 1749 – 5 March 1827) in 1796 A.D. According to which sun, planets and satellites have come into form out of Nebula only.

The thinkers other than Laplace who gave their own theories about formation of Universe are; Emmanuel Kant, Chamberlane & Molten. James Jeans and Harold Jaffery supported Chamberlane's theory. By 1950 Otto Schmidt of Russia and Carl Friedrich von Weizsäcker of Germany made some changes in Nebula Hypothesis and gave an idea that sun was surrounded by Nebula which was constituted by Hydrogen, Helium and Dust particles principally. These particles gradually formed a saucer shaped cloud. But most recognised theory about evolution of Earth remains Big Bang Theory only.

Graphic of Horse Nebula

Edwin Powell Hubble (November 20, 1889 – September 28, 1953) gave proofs of continuous expansion of Universe in 1920. By 1950 to 1960 this theory was recognised and it was proved by 1972. The Cosmic Background Explorer (CoBE) gave evidences that all the constituents of Universe were stationery in form of tiny ball type dots and a great explosion occurred around



Big Bang

13.7 Billion (Around 1375 crore) years ago. It was with in three minutes of first Big Bang that first ever cell was formed. Great explosion gave birth to Galaxies, Stars and Planets. As universe expanded, galaxies (like Milky Way), stars and planets withered away from one another. All these celestial bodies owe their birth to single ball of fire.

Do You Know ?

- Solar system is small part of galaxy named Milky Way which is visible in sky at night.
- Group of stars is known as galaxy and various galaxies form Universe.

Statistical data of the Earth :

Our Earth is fifth largest planet in the solar system.

1.	Diameter	
	Equatorial Diameter	– 12,756 km
	Polar Diameter	– 12,714 km
2.	Circumference	
	Equatorial Circumference	– 40,077 km
	Polar Circumference	– 40,009 km
3.	Surface Area	
	Total	– 510 million (51 crore) sq. Km
		– 29% covered by continents
		– 71% covered by oceans
4.	Volume	– 10,00,000 million cu. Km
5.	Mass	– 5.98 x 10^{21} metric ton
6.	Density	– 5.52g/cm^3
7.	Rotation Period	– 23 hours, 56 minutes & 4.09 seconds
8.	Orbit Period	– 365 days & 6 hours

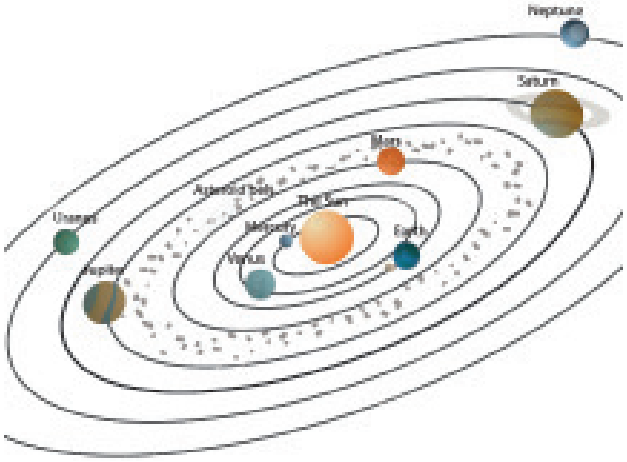
A scientist names Eratosthenes made first ever attempt to measure size of the Earth.

Solar system consists of Sun and those celestial bodies which form common family because of gravitational force. This family however includes eight planets, 166 satellites, 5 dwarf planets, billions of small celestial bodies and various comets, shooting stars, asteroids and other particles etc.

Table – Solar System

Sr. No.	Name of Planet	Circumfrence Diameter (Kilometers)	Distance from Sun (Million Kilometers)	Number of Satellites
1	Mercury	4,878	58	None
2	Venus	12,103	108	None
3	Earth	12,756	149	1
4	Mars	6,786	227	2
5	Jupiter	1,42,984	778	63
6	Saturn	1,20,536	1,426	62
7	Uranus	51,118	2,870	27
8	Neptune	49,528	4,497	13

Early thinkers were of the view that not only Earth but all the planets owe their origin to Sun. There are various stars resembling to Sun in the Universe. All these stars have their respective planets revolving round them. On same pattern Sun also has various planets. The early thinkers named these celestial bodies as 'wanderers'. They named these wandering planets after various Roman gods and goddesses.



Our Solar System

Jupiter – King of gods
Mars – God of war
Mercury – Messenger of the gods
Venus – Goddess of love and beauty
Saturn – Father of Jupiter & God of Agriculture

(Planets mentioned above are easily visible from earth while those mentioned next may be seen with telescopic help only)

Uranus – Located in 1781, God of Heavens
Neptune – Located in 1846, God of Seas
Pluto – Located in 1930, now declared dwarf planet

Density= Mass x Gravity
D= Mass per Unit / Volume

Our Universe contains 176 billion (one billion = 100 crores) constellations (group of stars) and each constellation includes hundreds of billion stars. The constellation in which Sun exists, is so big that from the core of constellation, light takes around 27 thousand years to reach up to sun. The solar system which is part of Milky Way galaxy is in disc-shaped spiral form.

Light Year :
Light Year is a distance that light travels in one year at velocity of 3,00,000 km/sec.

Thus a light year means; 3,00,000 x 365 (days) x 24 (hours) x 60 (minutes0 x 60 (seconds) = 94,60,80,00,000 km.

A ray of Light of sun takes 8 minutes to reach our Earth.

Find Out :
- What is Hubble Space Telescope? Where is it installed ?

Sun : Sun rotates round its axis from West to East. About 99.85% mass of solar system lies with sun only whereas planets constitute – 0.135%, comets – 0.01%, satellites – 0.00005%, dwarf planets – 0.000002%, shooting stars – 0.0000001% and inter planetary medium consists of 0.0000001% of the rest of mass.

As already mentioned sun is not stationery and completes one rotation round its own axis in 25 days. One rotation of sun takes 25 days (of Earth) if observed from the equator while if we observe it from its poles, each rotation of sun takes 36 days. The rotation of sun was observed by Galileo first of all.

Star Profile of Sun

Age = 4.6 billion years

Type = Yellow dwarf

Diameter = 13,92,684 km

Circumference at its Equator = 43,70,005.6 km

Mass = 3,33,060 x Earth

Surface temp = 5500°C

One million Earths may fit inside a sun.

Sun is source of light, heat, energy and life on our Earth. Normally looking pale, this spherical ball of fire has 13 lakh multiples more volume than that of Earth and 3.25 lakh times more weight. Pressure of gaseous material on its centre is 200 billion multiples more than the pressure of air, Earth experiences while density of gases is 150 times more than that of water. Temperature of sun is 50 lakh degrees Kelvin (one Kelvin is equal to one degree on Celsius scale).

Do you know ?
Each black spot on sun is 25 to 30 times bigger thn the size of Earth and 10 thousand times more powerful magnet than that of Earth.

Hydrogen in form of Plasma turns into Helium at this temperature. This fusion gives birth to energy. The quantum of such produced energy may be imagined from the fact that fusion produced energy in one second is more than as much mankind has used on Earth till date. This fusion is continuous process on the surface of Sun. Gravity of Sun is 28 times more than that of earth and black spots visible on sun are actually very powerful magnetic regions. Each magnetic regions of sun is more than 10 thousand times more powerful than magnetic power of Earth. Actual size of each black spot may be lakhs of square kilometers. Temperature at photosphere of sun is only 6000^{o} Kelvin while ends of chromospheres experience it 10 thousand degree. At corona this temperature varies from 10 lakh Kelvin to 50 lakh Kelvin. Continuous winds blow at the surface of sun at speed of

800 to 900 kilometer per second and these may prove dangerous for Earth at times. These winds have their fatal affect on Ionosphere. Solar storms disturb communication system on Earth. Many a times, power grids get destroyed or seized because of disturbance at the surface of Sun.

Optical telescope at Udaipur and Kodyekanal along with Radio telescope at Pune keep continuous watch over happenings related to Sun.

Planets :

Planet is a Greek word which means, Wanderer. All the planets are spherical and are total eight in number. We can group these planets in two, that is:-

* **Inner planets** are those planets which are nearer to sun as compared to others. Secondly their relief constitution includes rocks and metals. These planets are known as terrestrial planets also. Namely these planets are; Mercury, Venus, Earth & Mars.

* **Outer planets** are beyond asteroids and are constituted of gases, popularly known as Gas Giants. These are; Jupiter, Saturn, Uranus and Neptune.

Mercury	
Venus	
Earth	*Inner Planets*
Mars	
The Asteroids	
Jupiter	
Saturn	*Outer Planets*
Uranus	
Neptune	

The planets do not have any light of their own but these illuminate by reflecting sunlight and are visible at night. In the sequence of their distance from sun, these may be retented from initial alphabets of words in this sentence; My Very Efficient Mother Just Served Us Nuts.

1. Mercury : This planet is not only smallest one but also lies closest

to Sun. It does not have atmosphere of its own and is engulfed by blasts taking place because of Sun. Its core is made of iron and has this part larger than crust. It is presumed that this crust reduced due to some comet accident. Mercury lies some 579 million (57crore 90 lakh) kilometer away from Sun and its average temperature varies between 420°C during day to -180°C at night. It completes its revolution around Sun in 88 days while takes 58 days and 16 hours to complete its one rotation on its axis. Galileo founded Mercury in 1631 which has no satellite.

2. **Venus :** This is a rocky celestial body like Earth and second planet if counted serial vise from Sun. It completes its revolution round sun is 224.7 days while takes 243 long days to complete its rotation round its own axis from East to West. All the other planets rotate around their axis from West to East. This hottest planet is second most glittering celestial body, first being the Moon. Also known as sister planet of Earth, Venus resembles to it in shape, size and gravity. It has a number of volcanoes just like Earth and its surface has been formed because of volcanic eruptions. Its atmosphere consists of Carbon dioxide (96.5%) and Nitrogen. That is why it is called 'Veiled planet' also. Venus lies nearly1082 million kilometers away from Sun.

3. **Earth :** Our mother planet's name has not been derived from Greek or Roman language but from old English and Germanic. According to International Astronomical Union (IAU) biggest among Inner planets, Earth is only planet which has Geological activity taking place in its core. Its atmosphere is also quite different to that of other planets as it consists of 77% Nitrogen and 21% Oxygen which gives it a name of 'blue planet'. Earth is only planet where life exists. Situated nearly 14.96 crore kilometers away from sun. The earth completes a rotation round its axis in 23 hours, 56 minutes and 4.09 seconds (approximately 24 hours) while to revolve around the sun, it takes 365 days 5 hours and 48 minutes. It has a satellite named Moon.

4. **Mars :** Known as the Red Planet, Mars is fourth planet of our solar system as counted from Sun. Its soil has very rich iron content and because of Ferrus content it looks red. As far its rotation on axis is

concerned, it has similarity with Earth and it supports various seasons also. Mars is a cold planet which has thin atmosphere. Its one rotation on its axis is completed in 24 hours, 37 minutes and 23 seconds while its revolution against sun takes 687 days. Having two satellites, Mars is pleaced around 2279 lakh kilometer away from sun.

Do you know?

ISRO's Mars Orbiter Mission got rare success on 24th day of September, 2014 when its Orbiter set itself as artificial satellite of Mars. India spent just 450 crores on the mission which is 10th part of what U.S. spent on its first Mars mission.

Indian Mars Mission

The success of India to plant its Orbiter in orbit of Mars in its just first attempt has made it a pioneer and an exceptional one. Mars is only planet other than Earth which has ice-caps on its poles which have been named as Planum Boreum (North Pole) and Planum Australe (South Pole) or Southern Cap. The spacecraft that reached in the orbit of Mars is named 440 Newton Liquid Apogee Motor (LAM).

5. **Jupiter :** First beyond the Asteroids, Jupiter is fifth planet of our solar system and is the biggest planet. This planet is one of the Gas Giants and has 1280 kilometer wide atmosphere composed of gases like Methane, Ammonia, Hydrogen and Helium. It revolves a round the sun in anti-clockwise direction and completes one revolution in 12 years. Its rotation on its axis is very fast and completes one in just

10 hours causing severely blowing winds. These winds look like multi-coloured cloud belts. Jupiter is tilted on its axis at 3.1^0 and has more than 60 satellites. Most of the satellites are unknown for mankind as far information about them is concerned.

6. **Saturn :** The sixth from sun and second largest planet in solar system is Saturn. Situated some 1,431 million kilometers (More than 143 crore km) away from Sun, it is constituted of iron and nickel principally. Completing its rotation on its axis in 10 hours and 41 minutes, it makes one revolution around Sun in 29.5 years. Its swift rotation gives rise to winds at the speed of 1800 kilometers per hour. Speed of winds on Saturn is higher than that on Jupiter but lesser than that on Neptune. There are nine rings around Saturn which from three arcs around it. These rings are made of frozen ice and rocks. It has around 62 satellites and biggest among them is Titan which is almost double the size of Moon. The atmosphere of Titan is thicker than that of Earth.

7. **Uranus :** This is seventh planet of our Solar System and third largest planet. Its size is 63 multiples bigger than earth but in weight it is only 14.5 multiples than that of Earth. Constituted of gases, Uranus has coldest atmosphere as compared to all the planets and has an average temperature of –223°C. Many layers of clouds are found on Uranus. Higher cloud formation consists of Methane gas while lower formation consists of water. Speed of winds on this planet is 250 meters per second while it is tilted at 97.77° on its axis. Revolving round sun in anti-clockwise direction, it completes one revolution in 84 years while for completing one rotation around its axis, it takes 10 hours and 48 minutes.

8. **Neptune :** Neptune resembles to Uranus as seen in the Solar System. But it is smaller than Uranus and its surface is more condense. Presence of Methane gas makes it look green. Winds blow at speed of 2100 kilometers per hour in the atmosphere of this planet. The planet consists of around 900 full circles and various incomplete arcs. Situated approximately 4,498 million kilometer away from Sun, it completes one rotation its axis in 16 hours and a revolution around sun in 164.8 years. Neptune has 13 satellites while Triton and Neried are two main satellites.

Do you know ?

When Hydrogen gas turns into heavier atoms of helium as constituent of a star, its density increases to the extent that it blasts, turns into ash and vanishes.

There are various dwarf planets in our solar system, out of which only five have been recognised.

1. Pluto (Earlier know as ninth planet, was declared dwarf in August, 2006)
2. Ceres
3. Eris
4. Make make
5. Heumea

Satellites :

Satellites are of two types, manmade and natural. Satellites are actually celestial objects that revolve around some other celestial object. Natural satellites rotate on their axis also. They neither have atmosphere nor light of their own but due to reflection of sunlight, they look illuminated.

Manmade satellites are made of aluminium or plastic and are hardened with help of carbonic sheets. They travel at the speed which is 10 to 30 multiples more than that of an aircraft. Humankind has been benefitted extremely by manmade satellites in fields of telecommunications, weather forecasting, geological activities and atmospheric activities among other fields. India fired its first satellite named Arya Bhat in 1975 and since than, we have sent more than 75 satellites into the orbit.

Moon is natural satellite of our Earth. It is around 3,84,403 kilometers away from Earth and takes 27.3 days to complete its revolution around Earth. As yet mankind has touched only this celestial body i.e. Moon on 21st July 1969. Atmosphere of Moon is so thin that it weighs only104 kilograms and gravity is only one sixth part of the gravity of Earth.

Earth's view from Moon **Moon**

Do you know?

Lunar eclipse is a state of Sun, Earth and Moon, when shadow of earth falls on Moon. This condition happens on full moon days only. We had an important full moon day and total eclipse on 8th October, 2014. Moon looked red (Blood Moon) on that day but this characteristic was visible in North and North-East India, North America and Australia only. This celestial fete shall again be visible in 2018.

Asteroids or Planetoids :

These are small planets, too smaller than planets of Solar System but bigger than Asteroids. These celestial bodies revolve round the sun in anti-clockwise direction. These rocky bodies are numerous and most of these are concentrated between Mars and Jupiter. Five of them namely Ceres, Pallas, Vesta, Hypiea and Euphrosyne have been recognised. European Space Agency has found water vapour on Ceres on 22nd January, 2014.

Asteroids

<u>Comets</u> :

The word comet is derived from Latin word 'Stella Cometa' which means 'hairy star'. These celestial bodies were part of sun earlier and are made of frozen gases, ice and small rocky substances. Head of comet is 16 million kilometers in diameter and is followed by cloud of misty substance looking like a tail. This tail is also lakhs of kilometer long. Tail is never towards sun facing side of comet and shines with rays from Sun. Comet which passed through Solar System was first seen in 1705 and it passes close to sun after every 75.5 years. English scientist Edmond Halley founded it and it was therefore named Halley's Comet. Comets are being traced regularly. Their total number was 5,186 in August, 2014. Halley's Comet was seen in 1910, then in 1986 and next it shall be sighted in 2062. Nucleus of Halley's Comet is 16 x 8 x 8 kilometers and it is the darkest object in solar system. This comet is periodical one and may be sighted at specific intervals but all the comets are not periodical.

The Graphic of **Meteors**

Meteors or Meteorites :

One can see a streak of star light in the sky sometimes, it gives an impression that any part of star has broken away. These are actually meteorites. Parts of meteorites that remain unburnt and reach our Earth in small parts are named as meteorites. When these enter the atmosphere of Earth, burn out immediately and vanish in shape of ash most of times. A part of Arizona desert in U.S. is known to have come into form due to striking of some meteor. There are, however, various principles about formation of meteors. Some thinkers part them parts of planet which has vanished while others say these are parts of Sun, Earth and Moon only.

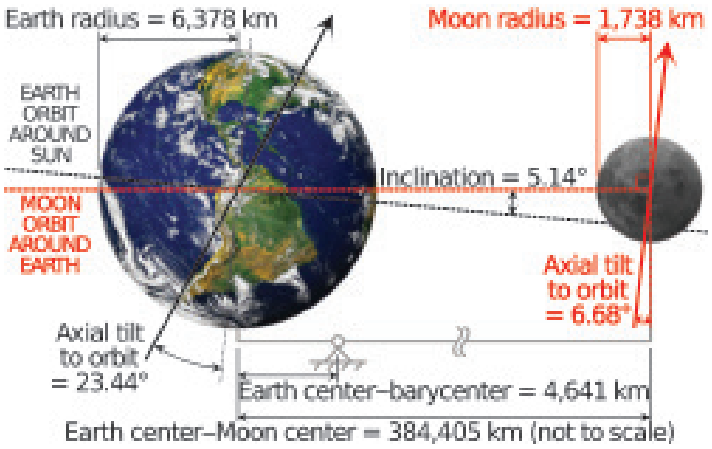
Indian Museum at Kolkata is known for preserving remains of meteors. Biggest such museum in Asia, it has 468 meteor parts. Their study has concluded that meteors are made of metals like iron, nickel, aluminium, oxygen and tin. These get attracted towards Earth because of gravity of Earth. On April 21, 2013 a meteor shower was observed in many parts of the world in which more than 20 shooting stars were seen within an hour. This shower is known as Orionid Meteor Shower. Such wonderful sights are very common in our solar system.

Let us do something :

Gather information about UFOs (Unidentified Flying Objects) and prepare a report about them.

(ii) SHAPE AND SIZE OF EARTH

Our Earth is fifth biggest planet and is placed third as counted from sun. Ours is only planet where life is possible. It is spherical object with a diameter of around 13,000 kilometers. As compared to other celestial bodies, Earth has a smaller entity while for mankind it is far much bigger. It may be divided in various physiographic units. Highest point on the Earth is Mount Everest (8,848 meters) while deepest point is Mariana Trench (11,030 meters) in Pacific Ocean.



The Radius of the Earth and the Moon

Do you know ?

'Geodesy' is a branch of science, responsible for measuring the Earth's size & shape with the help of surveys and mathematical calculations etc.

Some 2600 years back, Greek thinkers gave an idea for the first time that Earth is spherical. Earlier Babylonian thought put its shape as crescent while Thales gave an idea in 600 B.C. as if earth was like round table top and floating over water. Eingremendore condemned table top idea and put it as cylindrical object which is rotating on its axis. Philnolsh was first philosopher who gave an idea that Earth is round while Eratosthenes, the Director of Greek Library measured the circumference of Earth with the help of Sun rays. He checked the angle of Sunrays at city of Alexandria in the noon and then angle of Sunrays at city of Syene which is 960 kilometers away. From these readings he came to the conclusion that circumference of Earth is around 43,000

kilometers. This measurement is quite close to the exact measurement of 40,000 kilometers.

Earth is not exact sphere. Its cross section at equator divides it exactly but cross section from poles does not bring same results which prove that it is a bit flat at poles. Therefore it is oblate spheroid and is known as Geoid. Indian mathematician Arya Bhat (476 A.D. to 556 A.D.) also was of the view that Earth is spherical and its circumference is 4,967 yajnas, which of calculated at present measures to 39,968 kilometers and more exact to present day calculations.

Shape of earth proves more clear by some other ways and simple experiments also which are given as:-

1. **Experiment of sailing ship :** As we observe an approaching ship in some sea, we cannot see whole of it at first sight, rather we see its top first of all i.e. chimney portion then central portion and gradually whole of the ship appears. It happens so because Earth is round and not flat. Had our Earth been flat, we could have seen whole of approaching ship at first sight itself.

Do you know ?

Italian sailor Christopher Columbus practically gave first proofs of Earth's shape i.e. round.

2. **Shadow of Earth during Lunar eclipse :** Lunar eclipse is a celestial stage when shadow of Earth covers moon. This shadow is visibly round, proving that earth is spherically round. It was Greek thinkers who draw attention of the world towards this fact.

3. **Time of Sunrise :** Time of sun rise varies with the change of place, means sunrise in eastern nations is earlier than that of western nations. Had our Earth been flat, Sun would have risen at same time at all the places. This proves that Earth is round.

4. **Size of shadows:** If we install two or various poles in right angled position, we find that sizes of their shadows differ as compared to the distance of poles itself. This proves that Earth is geoid as had been flat, size of shadows would have been same.

International Date line

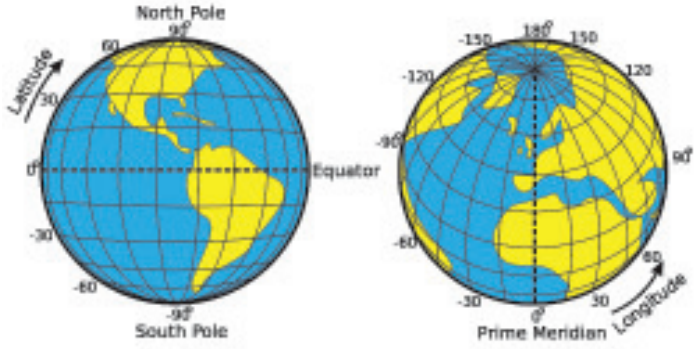
5. **<u>Times Zones</u>:** We have 24 different time zones on our Earth. When there is noon in Hawaii islands, Middle East nations experience midnight at that moment, proving the shape of Earth.

6. **<u>Pictures from space</u>:** We have various pictures of Earth which have been taken from the space, directly proving that Earth is geoid.

7. **<u>Going round the Earth</u>:** If a person starts going round the Earth from a point, having not changed his direction reaches the same place on completing his journey. Had the Earth flat, one would have needed to change his directions many a times. It proves that Earth is geoid.

8. **<u>Size of horizon</u>:** While standing in an open ground, we can observe horizon where Earth and sky seem to meet. When we look at same horizon from some height, it looks broader and farther also. It proves that Earth is geoid, had it been flat size of horizon would not have changed.

9. **<u>Positioning of Sun rays</u> :** According to a simple observation, persons living near the Equator find high temperature of sunrays while those living near poles find lesser temperature as sunrays lie slanting for Polar Regions. This happens only in geoid shapes and cannot happen so in case of flat shapes.



The graphics of Longitudes and Latitudes

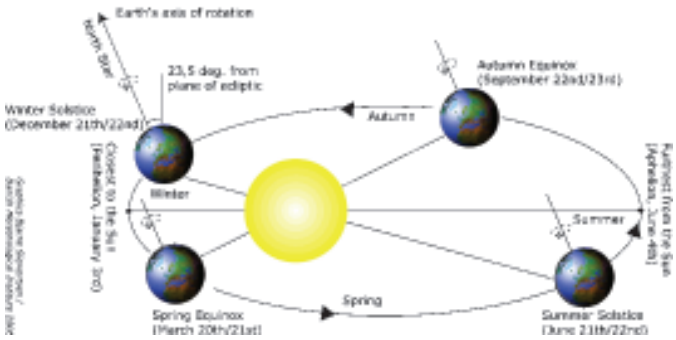
Earth had its 71% portion covered with water and therefore when observed from the space, it looks blue. This fact makes it unique and it is known as 'Blue Planet' which is only planet known till date, supporting life, vegetation and temperature.

MOTIONS OF THE EARTH

Life exists on Earth due to rays of Sun only. The solar energy has very deep connection with life on the Earth which does not have its position permanent in the solar system due to its motion rather its motions are permanent. Earth rotates on its axis while revolving round the Sun. Hence there are two motions of the Earth :

I. Rotation

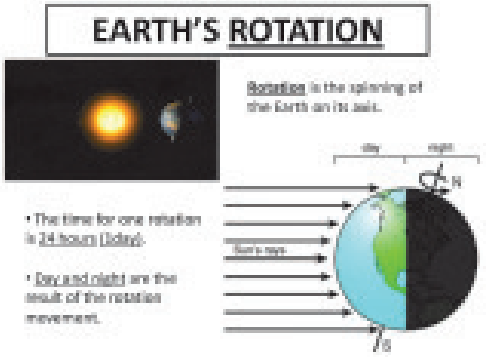
II. Revolution



The graphic of The Motions of Earth

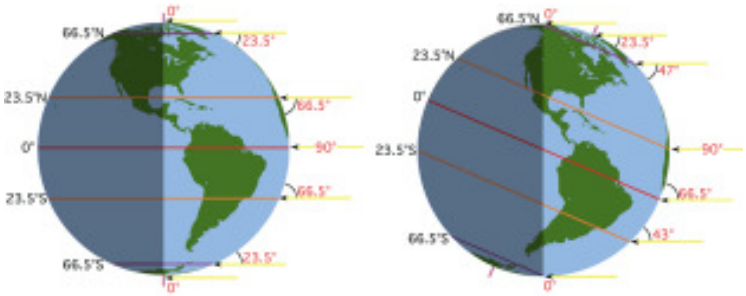
Earth completes its one rotation in 24 hours while one revolution takes place in whole of a year.

I. Rotation of the Earth



Our Earth rotates on its axis from west to east direction, completing one rotation in 24 hours. Process of day and night happens only due to this motion of Earth. Axis of Earth is that imaginary line which joins North and South poles. Speed of Earth while rotating is quite high i.e. 1600 km/hr. It completes its voyage of 40,000 kilometers in 24 hours. While rotating on axis, the portion which faces sun, experiences day and the portion which is away from sun experiences night. Speed of Earth rotation varies with difference in latitudes but as the speed is constant, we cannot feel it moving. It happens in same way as we cannot feel speed of train when it moves constantly but we certainly feel its movement when it starts or stops.

Earth makes an angle of 66½° while moving in its orbit while 23½° angle from its right angled axis. Had there been no rotation, Earth would have remained in one position constantly and it would have affected life quite severely. The axis of Earth is an imaginary line around which the planets spins.



The tilt of the Earth

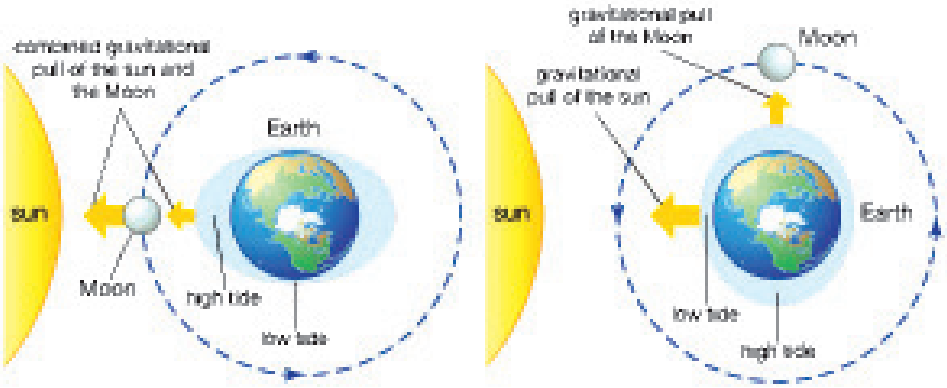
Effects of Earth's rotation

Rotation of Earth has various effects over it, like following :-

1. **Forming day & night :** Formation of days and nights is possible only due to rotation of Earth. This also has effect over local temperature, moisture and direction of winds. These factors have great effect over existence of life on this planet. Our agriculture also depends upon these factors.

2. **Constant direction or circulations :** Earth rotates constantly from West to East which has its impact not only over winds but over ocean currents also. According to Farrel's law, all independent moving bodies tend to deflect towards their right in Northern Hemisphere and towards their left in Southern Hemisphere because of rotation of Earth. This is also known as Coriolis Effect.

3. **Formation of tides :** It is due to rotation that gravitation force varies on different parts of Earth at various moments. This variation causes tidal activity known as high tide and neap tide in oceans, twice a day.



Tidal Activity on the Earth

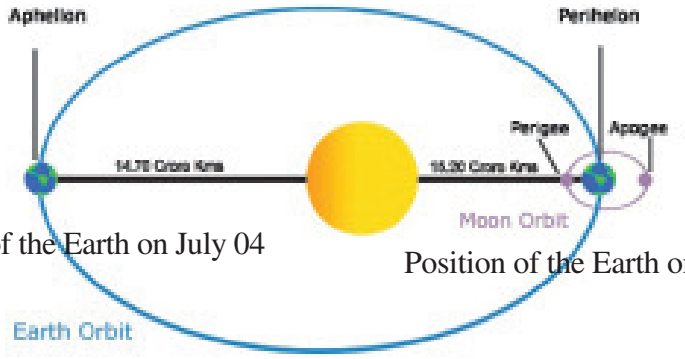
4. **West to East movement :** Earth rotates from west to east which gives an impression as if Sun is moving from east to west. This is due to rotation of our Earth. Had it not happened, what would have been the effect ?

Think and Tell : If we stand facing Sun in the morning, we shall be facing East while West shall be at our back. What directions shall be at our right and left ?

5. **<u>Knowledge about directions and situation</u> :** Sun rises in the East. Eastern places receive sun rays earlier than Western places. The difference in timing gives us an idea about situation of various places. For example, Sun rises earlier in Arunachal Pradesh as compared to Gujarat. Can you calculate the time diffrence ?

II. <u>Revolution of the Earth</u>:

Second motion of Earth is its movement around sun, called revolution of Earth. This movement is on elliptical orbit which completes in 365¼ days. Our calendar year is of 365 days generally leaving 6 hours each for three years but we add a day in our calendars each fourth year, making it a leap year. This day is added in the month of February. Each fourth year when year has 366 days, its February has 29 days.



Position of the Earth on July 04

Position of the Earth on Jan. 03

During its revolution, Earth keeps its bent at 66½° angle and covers its path of 93,98,86,400 kilometers annually in elliptical voyage. This shape and angle bring different effects. On January 3, the Earth reaches closest to Sun and this position is called 'perihelion'. During its revolution, when the Earth is farthest from Sun, that state is known as 'aphelion' and it happens on July 4 every year. Distance of Earth and Sun at aphelion stage is 15,21,71,500 kilometers while distance at

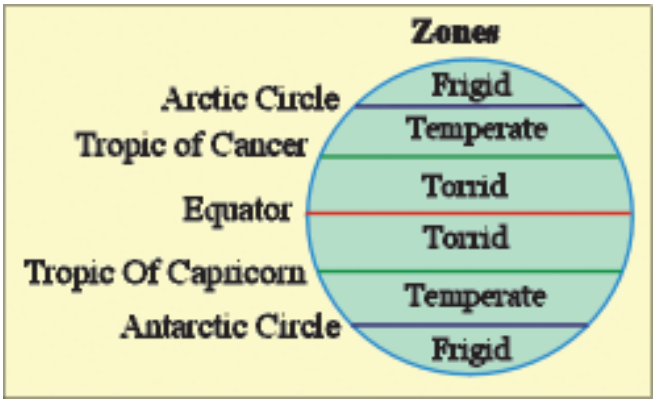
perihelion stage is 14,71,66,480 kilometers where as average distance of Earth from Sun may be put at 14,95,97,892 kilometers. (IAU)

Revolution of Earth brings following effects:-

Effect of tilted axis on Day & Night

Earth is tilted on its axis at an angle of 66½° and during its revolution around sun, it remains tilted towards one side. This characteristic is known as Polarity of Earth's axis also. Had it not been so, length of day and night would have remained constant throughout a year but it is not so as Northern Hemisphere keeps tilted towards sun for six months, resulting into longer span of day as it receives longer sunlight during 24 hours. In those days as Southern Hemisphere is away from sun, it receives shorter span of sunlight during same 24 hours and has longer nights. While this process of varying spans of day and night goes on in both hemispheres, span of day and night is almost constant at Equator. As we move away from Equator variation goes on increasing and at poles, we find six months of day and six months of night in a year. Whole of this process is due to Earth's tilt which takes place during its revolution.

Temperature Zones



Tilt of the Earth along with its revolution causes various temperature zones also. Sun rays fall straight from 23½°N to 23½°S latitudes whole the year long. These latitudes known as Tropic of Cancer and Tropic of Capricorn respectively, give a name, Tropical Zone, to the region falling between these two tropics. Equator passes through the centre of these tropics. The regions lying between 23½°N (Tropic of Cancer) to 66½°N (Arctic Circle) and between 23½°S (Tropic of Capricorn) to 66½°S (Antarctic Circle) never got straight sun rays, nor these regions get away from sun during any part of year.

Slanting sunrays make these regions neither very hot not very cold and hence known as Temperate Zones. Regions above Arctic Circle and up to North Pole and below Antarctic Circle and up to South Pole remain away from sun fairly for months during a year and whenever these regions receive sunrays that also are so slanting that hardly these may be called warm. Therefore these regions are better known as Frigid Zones.

Change of Seasons :

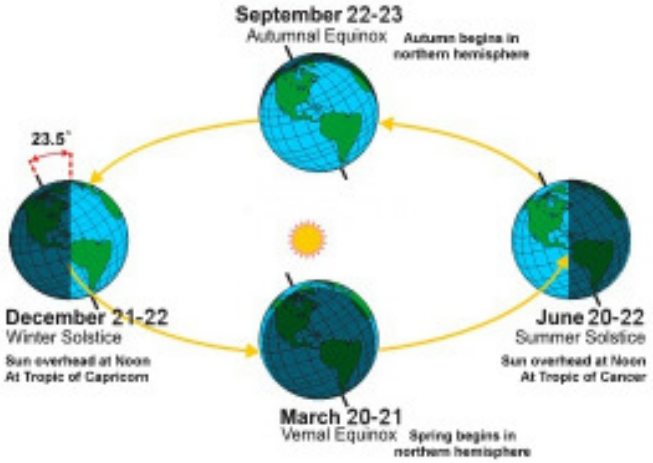
Change of seasons on our Earth takes place due to following seasons:-

(i) Revolution of Earth

(ii) Tilt of Earth at 66½° on its axis

What are the situations and positions in which Earth reaches while its revolution and what results come out of these, is to be studied in detail:-

Position on June 21 : Northern Hemisphere lies tilted towards Sun on June 21, while Southern Hemisphere is away from it. Sun rays fall straight on tropic of Cancer and hence days are longer in Northern Hemisphere. There is summer season in Northern Hemisphere which is quite hot near Equator. June 21 is particularly longest day and shortest night in Northern Hemisphere. This is also known as June solstice or summer solstice for Northern Hemisphere and winter solstice for Southern Hemisphere.



Movement of the Earth around the sun

Position on September 23 : Three months after June solstice, Sunrays fall straight on Equator. This is the position when despite tilt of Earth on its axis position is so that no hemisphere is comparatively tilted towards sun which results into equal spam of day and night i.e. of 12 hours each, known as Equinox. (Equinox is a Latin word which means equal day and night). Equator is a place on Earth where span of day and night does not change much whole the year long. In September when this situation happens on 23rd day, it is known as Autumn Equinox in Northern Hemisphere and Vernal Equinox in Southern Hemisphere.

Position on December 22 : In this position Southern Hemisphere is tilted towards sun while Northern Hemisphere is away from it. Sunrays fall straight on 23½°S that is Tropic of Capricorn and days are longer in Southern Hemisphere while nights are shorter. Situation of day and night is exactly opposite in Northern Hemisphere where nights are longer than days. This position is known as December solstice or summer solstice in Southern Hemisphere and winter solstice in Northern Hemisphere.

Position on March 21 : Three months after, on March 21, Sunrays again fall straight on Equator and this situation is known as March Equinox. This situation is exactly opposite to that on September 23. Days and nights are equal at Equator. This position is known as Autumn Equinox in Southern Hemisphere and Spring Equinox in Northern Hemisphere.

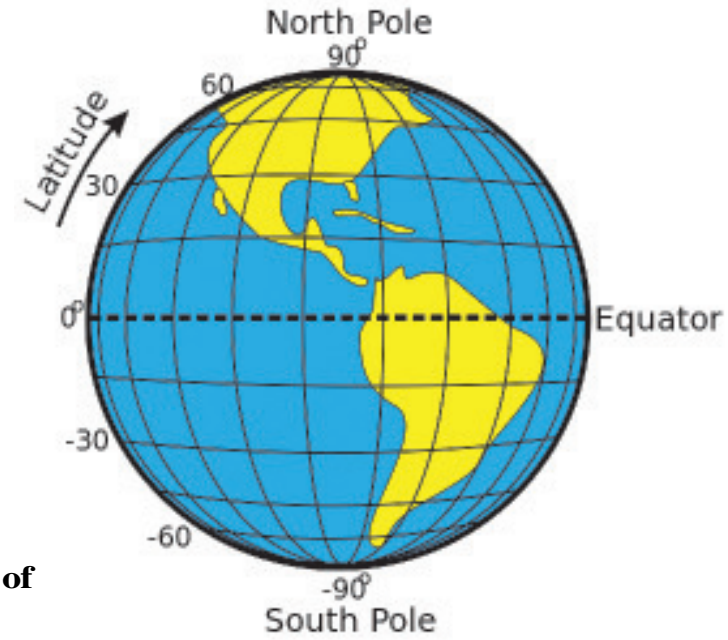
Generally speaking March 21 and September 23 have equal span of days and nights.

(iii) LATITUDES AND LONGITUDES

Literary meaning of the word 'Geography' is to know the details of some location, distribution of facts, populations etc. Details of some location from the climatic aspect and time cannot be explained if we do not take help of latitudinal and longitudinal measures of particular place. In other words, distance from Equator is most important fact for some place while seeking its details. Earth continues two motions all the time i.e. rotation and revolution. The imaginary line drawn on the earth which divides it into two parts known as northern and southern hemispheres is known as Equator. Physical location, climate, vegetation etc. may be known more thoroughly depending upon the factual distance of some region from the Equator. The cartography of longitudes has made things more easy for marine explorers during their oceanic navigation.

Various experiments have been carried out to settle longitudinal cartography :-

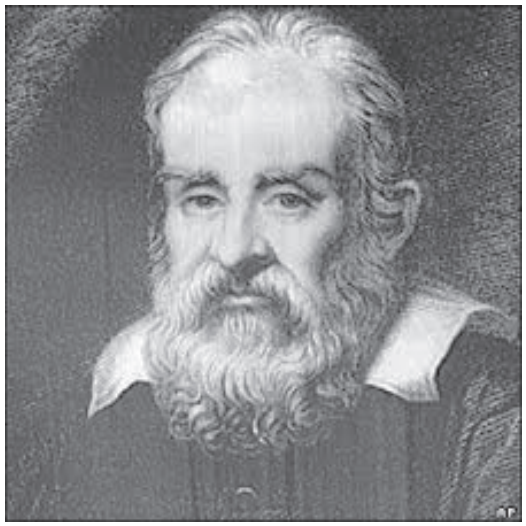
Measurement of Latitudes



Amerigo Vespucci faced a lot of problems when he tried to measure expansion of Earth, east to west i.e. horizontally on 23rd August 1499. He sought help of Almanac measurements to find relation with various other celestial bodies and concluded that position of Moon is at 3½° East of Mars. This conclusion of his has made basis for drawing longitudes. His experimentation and results however could not find favour with various thinkers of his times. It did not suit according to Almanac Calender even as there was no stable platform on which his theory could be raised.

Amerigo Vespucci

Galileo Galilei gave a theory in 1612 A.D. that orbits of Moon and Jupiter may be used as clock. He proved it by experimentation but in 18th century a lot of incidents happened on earth in which exact location in the oceans could not be found. In this situation, the British Government set up a Board of Longitudes in 1714 A.D. and motivated experimentation and research on the issue by announcing various prizes for it.



Galileo Galilei

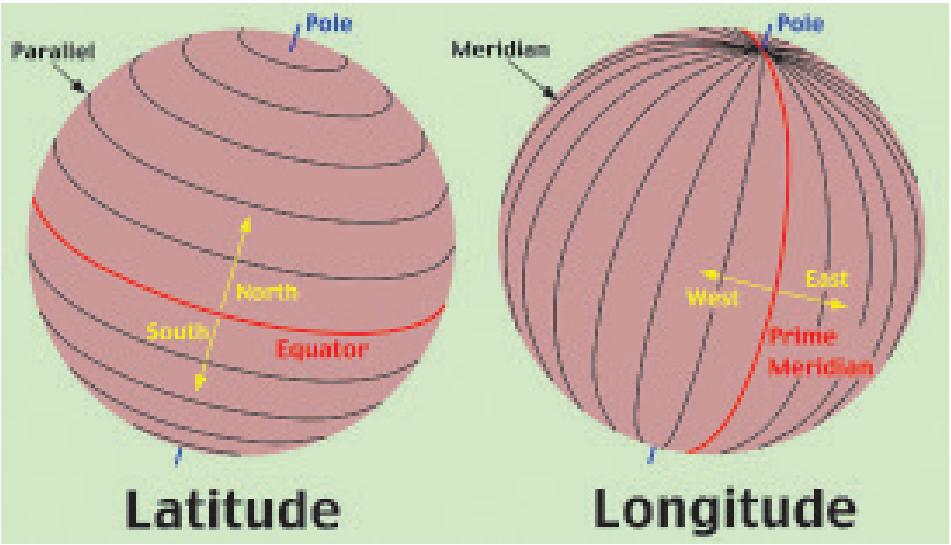
Important Meridians

John Harrison, an English clockmaker brought out a marine Chronometer which could study longitudinal positions in Oceans. This instrument however, was very costly and beyond reach of many, financially. Therefore Lunar Distance Method of Amerigo Vespucci remained popular for many decades. It was in 20th century, wireless telegraph went more popular than lunar distance method. Starting point for latitudes was equator uncontestedly but emergence of longitudes saw various experiments.

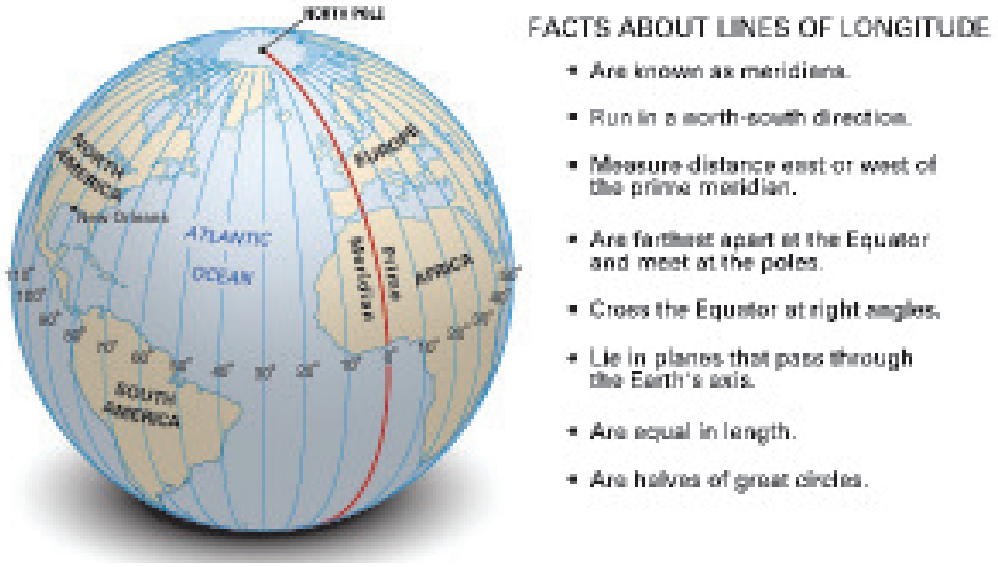
Hipparcus brought out a grid of latitudes and longitudes in 300 B.C. and various maps were drawn with the help of local time and absolute time. He contributed in setting up of starting longitude. His measurements were however more clarified 75 years later i.e. in 225 B.C., Eratostheres, a Greek Mathematician and Space scientist, measured circumference of Earth and prepared maps of the world. Another explorer Al-Birunie gave theory that Earth rotates round its axis which results into direct relation between longitudes and time. After all this experimentation, the International Community proposed Greenwich longitude as starting longitude in 1884 A.D. and it was accepted world over.

1. <u>Latitudes or Parallels</u> :

The angular distance of any place falling in north or south of Equator is known as its latitude. These latitudes or parallels are measured in degrees, minutes and seconds. Geometrically, a circle is measured at 360 degrees (°) and same is for equator. Each degree is divide in 60 minutes (') and each minute is further divided in 60 seconds ("). An imaginery straight line joining North and South poles when intersects Equator, it divides circle in four parts, each of 90°. Hence earth is divided in 90° parallels in Northern Hemisphere and 90° parallels in Southern Hemisphere. The places in the north of Equator are represented with latitudinal degrees followed by 'N' and those in south, with latitudinal degree, followed by 'S' while equator remains 0°. As it is very clear that a place situated at 1° angle from Equator shall be at 1° parallel, in kilometers each degree in 111 kilometers away from the other.

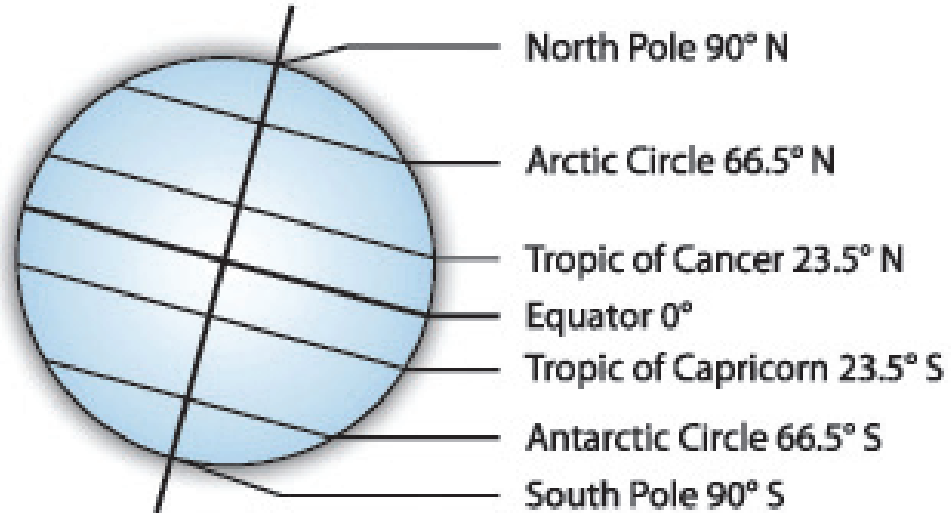


Lines of Latitudes and longitudes



Prime Meridian

Latitudinal lines are those imaginary lines which join all the places on globe which are at same angular distance from equator. Equator is known as 'Great Circle' also which divides the earth in two equal parts. Parallels or Latitudes are not straight lines but circular lines drawn parallel to equator horizontally. These circles have same centre i.e. axis and 90° N and 90° S are more points.



Some important latitudes or parallels

Some important latitudes or parallels are as under :-

(i) Equator - 0°

(ii) Tropic of Cancer – 23½°N

(iii) Tropic of Capricorn - 23½°S

(iv) Arctic Circle - 66½°N

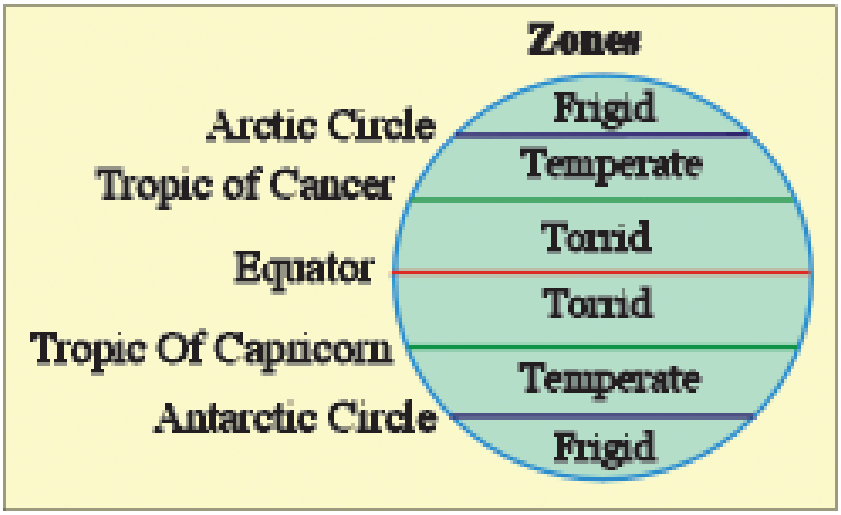
(v) Antarctic Circle - 66½°S

(vi) North Pole - 90°N

(vii) South Pole - 90°S

Latitudes or parallels have very important and close relation with sunlight, revolution, tilt at 23½° angle and so on. Sun shines straight over Tropic of Cancer (23½°N) on 21st June and over Tropic of Capricorn (23½°S) on 22nd December. It results in making June 21 the longest day in Northern Hemisphere while December 22 the longest day in Southern Hemisphere. Arctic Circle (66½°N) region does not experience high temperature in June while sunrays reach across North Pole in this period of the yearly voyage. Same way in December when Southern Hemisphere is tilted towards Sun, the sunrays cross South Pole to reach 66½°S latitude i.e. Antarctic Circle. Hence Polar Regions have continuous days and nights whole the year long.

The tilts of Earth and approach of sunrays allows us to divide the Earth into various temperature zones also. Regions lying 0° to 23½°N and 0° to 23½°S are known as Tropical regions while regions lying between 23½°N to 66½°N and 23½°S to 66½°S are known as Temperate regions. Regions falling above 66½°N to North Pole or 66½°S to South Pole, are known as Polar Regions or Polar Regions or Frigid Zones.



Various zones on Earth

Distance from Equator i.e. latitudinal situation and distance above sea level are two major factors which have their effect over climate of some place. Any place situated near the Equator shall remain hot as such region shall remain under direct sunlight whole the year long where as places near poles which never receive straight sunrays shall remain cold in control to equatorial regions.

Do you know ?

Circumference of the Equator is 40075.85 kilometers.

Circumference of Prime Meridian is 4008.29 kilometers.

Measuring latitudinal position of some place : It is necessary to know declination of the sun if we want to know latitudinal positioning. Zenith is a place exactly overhead in space. The zenith distance and declination of sun or angular distance from Equator at a particular place and time, if calculated, tells us our latitudinal position. When a person moves from a place, his/her zenith distance also changes and that changes latitudinal positioning.

Any point on the surface of the earth can be located in terms of its latitude and longitude (angles measured from the equator and Prime Meridian).

Point P for example is at 30° north, 20° west.

Latitude varies from 0° to 90° north or south.

Longitude varies from from 0° to 180° east or west.

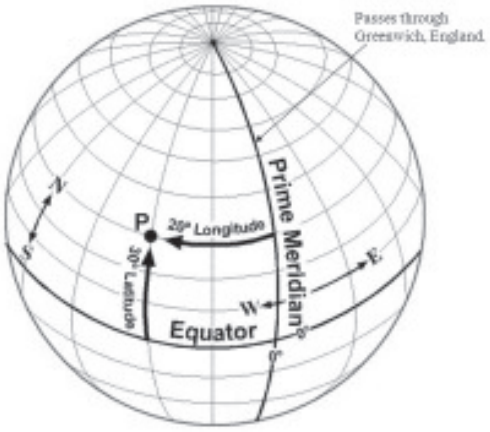


Figure courtesy of Anthony P. Kirvan, and *NCGIA Core Curriculum in GIScience*.

Harry Williams, Cartography 2

Prime Meridian

North Pole lies exactly beneath North Star which we may find with the help of pointers of Great Bear. At night, angular distance from North Star can conclude of our latitudinal position. Chandigarh is at 30°.42'N latitude.

Something to do :

Find out latitudinal position of various district headquarters in Punjab.

Find out latitudinal position of the place where you stay.

2. <u>Longitudes or Meridians</u> :

Geographical location is not very feasible to find with a single geographical factor. Location and time surely need latitudinal measurement to conclude measurement while what needs more or in addition to it, is longitudinal position. More precisely we can say that location and time may be found out not only by knowing north-south position but east-west position also. Longitudes are those imaginary lines drawn on a globe which join North and South poles. These lines are also circular actually, intersecting at North and South poles but at first sight these look like arcs. We take 0° longitude as Prime Meridian,

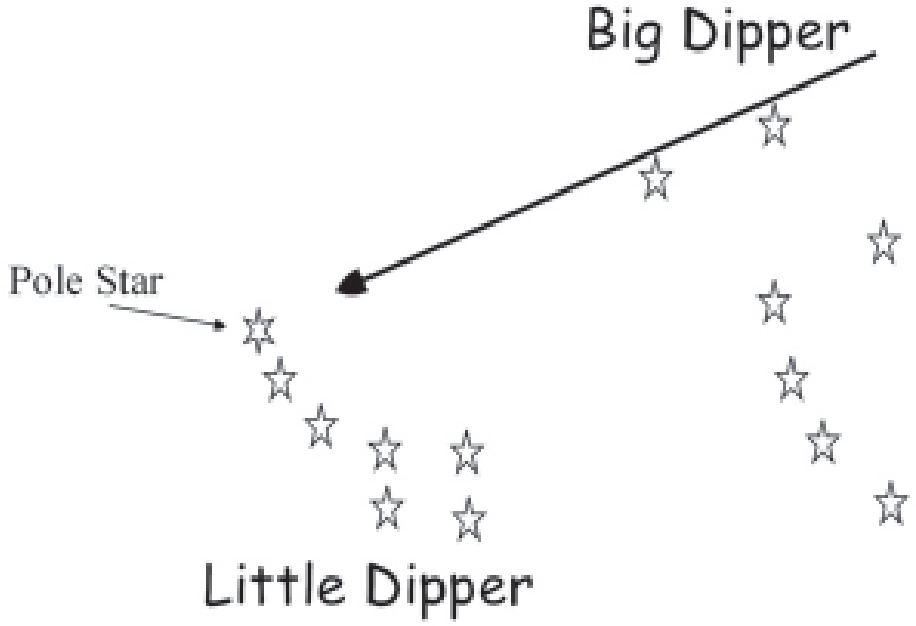
which passes through a place known as Greenwich near London. There are 180° longitudes towards east of Prime Meridian and same number is there towards west of Prime Meridian. 180° Meridian which falls exactly opposite to Prime Meridian is again a common Meridian from east or west and technically known as International Date Line. The full circle of 0° & 180° longitudes divides the Earth in two parts known as Eastern Hemisphere and Western Hemisphere respectively. Distance of a place east or west of Prime Meridian are measured as an angle and this angular distance is called the longitude of that particular place.

Prime Meridians

India is situated in Eastern Hemisphere. Longitudes are always of equal size and are around 69 miles away from each other at the Equator. Longitudes or Meridians are also measured in degrees, minutes and seconds.

Find Out what is Geoid?

In simple language the Zenith refers to an imaginery point directly "above" a particular location on the imaginery celestial sphere. The Zenith is the highest point on the celestial's sphere.



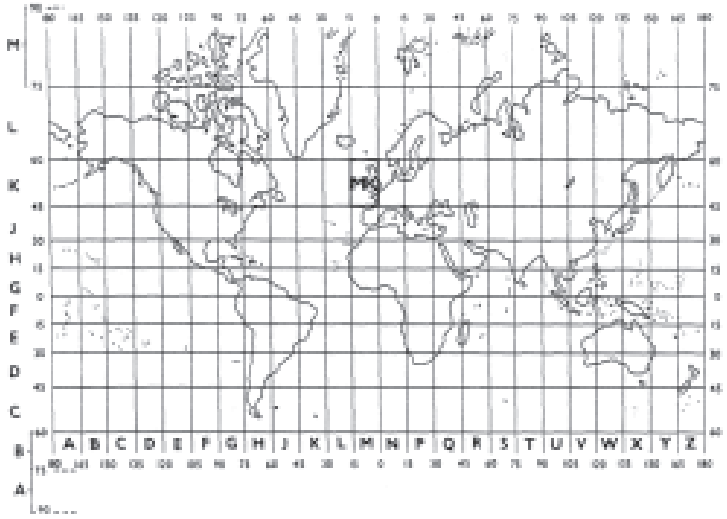
Location of pole star

The North Pole also known as the Geographic North Pole is defined as the point in the Northern Hemisphere where the Earth's axis of rotation meets its surface. North Pole is the northern most point on the Earth, lying diametrically opposite the south pole. It is also called true North. A Pole star is a visible star, preferably a prominent one, that is approximately alignes with the Earth's axis of rotation, that is a star whose apparent position is close to one of the celestial poles, and which lies approximately directly overhead when viewed from the Earth's North Pole or South Pole and Geoid is the shape that the surface of the oceans would take under the influence of Earth's gravitation and ratation alone, in the absence of other influences such as winds and tides. All points on the Geoid have the same gravity, potential energy. The force of gravity acts everywhere perpendicular to the Geoid, meaning that plumb lines points perpendicular in water levels parellel to the Geoid.

Grid system of Latitudes and Longitudes : As we draw longitudes and latitudes on a globe, it looks like a full fledged net or grid, therefore drawing of longitudes and latitudes is known as Grid System. If we are to find location of some place on globe or map and we have its

longitudinal and latitudinal position. For example Patiala (Punjab) is located at 30°.23' North latitude and 76°.21' East longitude. While trying to find it on a map, it shall lie at the place where these two latitudinal and longitudinal lines intersect one another.

Try to find out Patiala and other places on the map of Punjab with the help of your teacher.



Grid System

<u>Longitude and Time</u> : Longitudes help us calculate local time of a place which in turn helps us about timing of sun rise and sun set. Greenwich Meridian is first longitude and it is presumed universally that when sun is shining above this longitude, that is to be called noon 12:00 GMT (Greenwich Mean Time). The Earth rotates round its axis one full circle in 24 hours means 360° cross in that span of a day. On calculating it further, we conclude that 15 degrees face sun in an hour and one degree in 4 minutes. As we proceed eastwards from Greenwich Meridian, we add up time at rate of 4 minutes per degree while proceeding westwards we have to deduct time at same rate. India and U.S. have a difference of 9 hours 30 minutes as India falls in Eastern

Greenwich London

Hemisphere while U.S. falls in Western Hemisphere.

In other words, when Greenwich has noon, means when clocks strike 12 at Greenwich, clocks at 15°E shall strike 1 p.m. while clocks at 15°W shall strike 11 a.m. At the same rate clocks at places 30°E shall strike 2 p.m. while at 30°W shall strike 10 a.m. It shows that if we know longitudinal location of a place, we can find time easily. For example; India has set its standard time at 82½°E longitude which passes near Allahabad. The time at Allahabad or 82½°E shall be calculated like this:-

Indian Standard Time

Greenwich longitude = 0°

Allahabad longitude = 82°.30'

Difference of longitudes = 82°.30' - 0° = 82°.30'

Difference of time = 82.5 x 4 minutes = 330 minutes or 5 hours 30 minutes

As Allahabad falls in east of Greenwich, 5.30 hours shall be

added to the time at Greenwich or popularly we say that time in India is +5.30 hours to Greenwich Time.

Indian Standard Time :

Each place has its own local time which is due to longitudinal difference of each place. Recognition of local time of each place brings variation of time to the extent that it cannot be cured for setting time for various systems such as transport, offices and so on. To overcome this problem, each nation has set its time according to some standard longitude. Such a time is known as 'standard time' which is based upon some Central Meridian of each nation.

India has set 82½°E longitude as its Standard Meridian which passes close to Allahabad. This longitude divides India in two parts vertically. Standard time for whole the world is calculated from Greenwich Meridian and time is known as Greenwich Mean Time i.e. G.M.T. whereas that of India, it is known as Indian Standard Time i.e. IST.

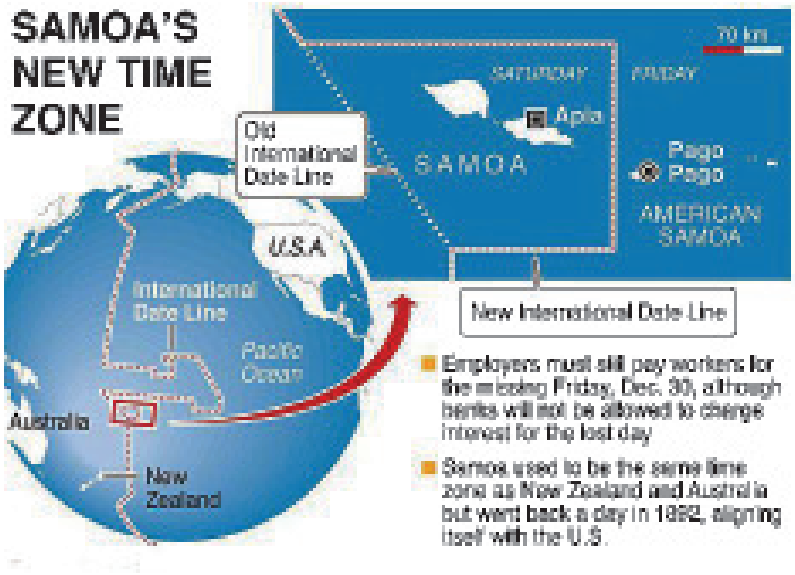
Time difference of local times of Dwarka (Gujarat) in west of India and Dibrugarh (Assam) in east is of 1 hour and 45 minutes. Farthest extent of India towards East lies in Andaman and Nicobar islands.

Some big nations i.e. with broad East-West extent, have more than one standard times. Russia has 11 standard times while U.S.A. and Canada have 9 and 6 respectively and as many time zones of their own.

International Date-Line :

Emergence of longitudes and distribution of time on the Earth according to longitudes left one problem unsolved that at which longitude, date shall change. To table with the issue, International Meridian Conference was held at Washington in 1884 A.D. and 180° longitude was finalised as International Date Line (IDL) which passes through Pacific Ocean and separates two dates. Tango and American Samoa are two islands places located quite close in Pacific Ocean but Tango lies in Eastern Hemisphere and American Samoa in Western Hemisphere and therefore there is a difference of full one day in dates of these two islands. Fiji lies in the East of Tongo and its time trails for an hour as compared to Tongo. On the other hand Hawaii islands are in

the west of Samoa and its time in one hour ahead of Samoa. There are many island nations or places in Pacific which have to tinker with time.



New Time Zones of Samoa Island

We divide the world in 24 standard time zones. Each time zone contains 15 Meridians. As 180° Meridian of International Date Line falls exactly opposite to Greenwich Meridian (0°), the time difference between these two longitudes is of 12 hours. Immediately to the left of

the International Date Line, the date is always one day ahead of the date (or day) to the right of the International Date Line in Western Hemisphere.

What is Globe Positioning System (GPS) ? Try to find out.

In simple words, date changes at International Date Line. As we proceed towards east, a day is deducted but as we travel towards west, a day is added. For example if a traveller crosses International Date Line while travelling towards east, a day needs to be deducted but when that traveller crosses back International Date Line towards west, a day needs to be added. International Date Line passes through Pacific Ocean that saves many people from changing calendars frequently because had it been passing through land area, people would have faced trouble of frequent change in calendars.

Activity :

- Show IDL and 180° longitude on a world map.
- Make a grid map of Longitudes and Latitudes to present it in your class.

EXERCISE

1. Answer the following questions in few words :

(a) Which thinker gave the theory of Nabula first of all ?

(b) What is the difference between East-West and North-South diameter of Earth ?

(c) Which planets represent gods of war, love and heavens according to Roman Study ?

(d) Which planets of 'Solar System' are gas giants ?

(e) Write full form of ISRO.

(f) Which are the highest and lowest places on the Earth ?

(g) Name first longitude and latitude.

(h) Great Meridian divides the Earth in which hemispheres ?

(i) Write full form of GMT and IST.

(j) What is time difference between Fiji and Samoa ?

2. Answer the following questions in few sentences :

(a) How many natural satellites each planet of Solar System has ?

(b) Name the thinkers who gave theories about origin of Earth.

(c) In how much time does Earth complete its motions ?

(d) Difference of time in Sunrise proves that Earth is round, how ?

(e) Which scientists were involved in settling Longitudes & Latitudes ?

(f) What is Zenith ?

(g) What do you understand by horizon ?

(h) Longitudes are circles, how ?

3. Answer the following questions in a paragraph :

(a) Earth is not flat but a sphere, give three positive points of this shape.

(b) How can we find direction during day and night with help of celestial bodies ?

(c) Put light upon temperature zones on basis of important latitudes.

(d) Write a note on 'Commets'.

(e) What is a Light year ? What is measured with its help ?

(f) Write any three facts related to Statistics of Earth.

(g) Draw a graphic showing four Stages of revolution of Earth.

(h) Which planets are, 'Blue, Red and Veiled' planets ?

4. Answer the following in 150 to 250 words :

(a) Write graphical notes on both motions of Earth.

(b) Write note on planets in Solar System.

(c) Give examples and prove that Earth is round.

(d) How and Why do seasons change ? explain.

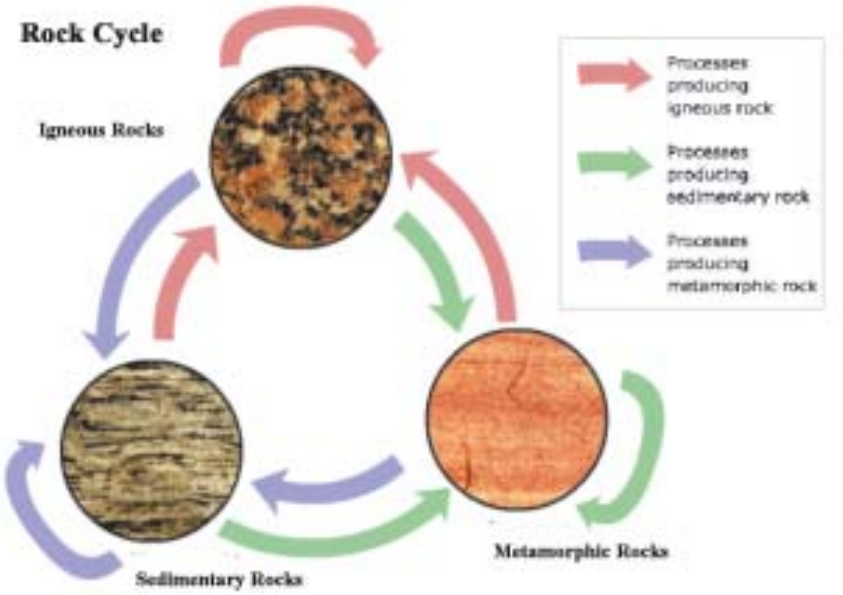
(e) Write notes on Northern, Southern, Eastern and Western Hemispheres.

(f) Write in detail how Earth orignated.

CHAPTER - 2

ROCKS

Since stone age, rocks have been used as tools. Actually since origin and then development of ancient civilisation is related with rocks. Rock is a naturally occuring aggregate of one or more minerals. The Earth's outer solid layer, the lithosphere, is made of rocks (Lithosphere means Rocksphere). A rock may be made of a single element/meta/or mineral and are known by the name of that element/meta/or mineral, these are made of. The size of rocks varies and so vary their characteristics as these may be hard or soft. A minute particle of sand and a big stone, both are known as Rocks. These might be hard as Granite and soft as Grafite. They might be porous like Limestone and non-porous like Slate. Earth's crust has been formed with 2000 minerals but mainly 20 minerals are immensely important.



The graphic of Rock Cycle

Average Composition of Crustal Rocks: In terms of elements

Name of Element	Percentage of Element
Oxygen	46.60
Silicon	27.72
Alluminium	8.13

Iron	5.00
Calcium	3.63
Sodium	2.83
Potassium	2.59
Magnesium	2.09
Titanium	0.44
Hydrogen	0.14
Phosphorous	0.12
Total	**99.29**

Actually 12 elements have been considered as major elements in composition of rocks. These are also known as 'Rock-formers'. It includes Iron 35%, Oxygen 30%, Silicon 15%, Magnesium 13%, Nickel 2.4%, Sulphur 1.9%, Calcium 1.1% and Aluminium 1.1%. In this way they form 99% of the Earth mass. Out of this also Iron, Oxygen, Silicon and Magnesium contribute 93% part in constitution. Oxygen, Silicon, Alluminium, Iron, Magnesium, Calcium, Postassium and Sodium are the major elements of the crust's composition.

Definition of Rocks : "A Rock can be defined as an aggregate of minerals. Sometimes chiefly or entirely of single mineral species, as in case of rock salt and limestone but more commonly of two or more different minerals."

-Tars and Martin

- Minerals are aggregate of elements these are inorganic natural susbtances.
- **Petrology :** It is the branch of geology that studies the origin, composition, distribution and structure of Rocks.
- Try to find out difference between rocks and minerals.

Types of Rocks : Rocks are aggregate of one or more minerals. They might be soft or hard and have various colours. On the bases of composition and origin, rocks can be divided into three groups :

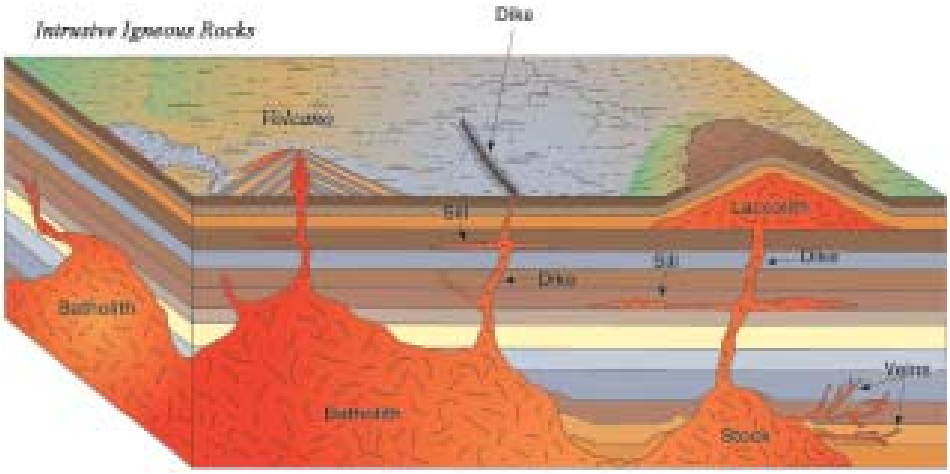
(1) Igneous Rocks

(2) Sedimentary Rocks

(3) Metamorphic Rocks

1. Igneous Rocks : Word Igneous is derived from the Latin word 'ignis' which means 'fire'. These rocks originate through the cooling and solidification of magma or lava. These may be crystalised or non-crystalised. These may form on the surface of the Earth or beneath the surface of Earth's crust. There are near about 700 types of Igneous Rocks and most of them are found beneath the surface of the earth.

These are also known as Primitive Rocks because these are the oldest rocks. Earlier Earth was hot and in melted form. Igneous Rocks were formed by the cooling and solidification of magma or lava. After the blast in the soft and weaker parts of the Earth, the lava comes out with gases. After the cooling and solidification of lava, igneous rocks are formed.



Intrusive Igneous Features

• Shivalik Himalaya in Punjab is divided into three parts :

→ Lower Shivalik

→ Middle Shivalik

→ Upper Shivalik

The rocks of lower and middle shivalik are exposed as NW-SE trending

'ridges' in the north-eastern parts of Gurdaspur district. The Lower group is composed of fine to medium grained, sporadically pebbly sandstone and chocolate to maroon sandstone. The Middle Shivalik group comprises 'Dhok Pathar' and 'Nagri Formations'. The former consists of poorly sorted massive, grey coarse grained. The Nagri Formation comprises alternating, conglomerate and reg clay. The Upper Shivalik group is made up of coarse gravel and boulder conglomerate altering with clay bonds and sandstone.

Classification of Igneous Rocks :

Where, Why and in What type of conditions, does cooling and solidification process of lava take place, plays an important role in the formation of igneous rocks. For example, slow cooling process results in coarse grained texture and on the other hand fast cooling results in fine grained texture. All this leads to the formation of various types of igneous rocks. Basically these are divided into two parts :

- Extrusive Igneous Rocks
- Intrusive Igneous Rocks

Extrusive Igneous Rocks : These rocks are formed by the cooling of molten magma on Earth's surface.When molten magma comes out of Earth's surface, the gases present in it evaporate at fast rate because of which molten magma spreads on Earth's surface like shield and cooling takes place. Southern Plateau region (Deccan Plateau) of India is the biggest example of such formations. Basalt is extrusive Igneous rock which has fine particles. Black soil of Deccan plateau of India is formed by weathering of these rocks. Basalt rocks are used for the construction of roads.

Density of lava depends upon its silica content. If the silica content is high, then the lava will be more dense and won't be able to spread up to large area. The layer of this type of lava is also very thick. Thus, the lava forms soft and even too hard and uneven rocks. The outer layer of Earth i.e. Sial is made of these acidic rocks. Felsic; Felspan (Fe) and Silica (Si) are one of the best examples of these types of rocks. These have light colours.

On the other hand, the lava in which silica content is low and magnesium (Ma), Ferrous (Fe) Iron, are present, the density of that lava is low and it is not thick. Because of this it spreads upto large area. The rocks formed from this type of lava are soft and have deep colour. 'Mafic' rocks are one of the best examples of these types of rocks.

- Igneous rocks are hard and they do not have layers. Moreover fossils are not found.

Lava

Extrusive Rocks

Intrusive Igneous Rocks : These rocks are formed of magma that cools and solidifies within the crust of planet. These are intesive igneous rocks. We distinguish these rodes in two categories further i.e. (a) Plutonic rocks (b) Hypabyssal rocks.

(a) Plutonic Rocks : This word is derived from the Greek word 'Pluto' which means "God of Under World". These rocks are formed deep within the Earth. The cooling and solidificaton of magma takes long time and it forms in large size crystals. It has various colours; Grey, Red, Pink, White etc. In India, it is found in Deccan Plateau, Chhatisgarh, Chhota Nagpur (Jharkhand), Rajasthan and in some parts of Himalayas. It has been generally used in construction of various buildings, temples and most importantly, castles.

(b) Hypabyssal Rocks : These are formed due to cooling and soldification of rising magma in 'cracks' and 'joints' just beneath the Earth surface, means not as deep as plutonic rocks. Their crystals are small in size. 'Dolesite' and 'Pegmatic' rocks are the major examples of these types.

These are further classified on the bases of place and structure:

(i) **Laccoliths :** It is a sheet intrusion of lava that cools horizontally between two layers of sedimetary rock. The pressure of magma is high enough that the over lying strata are forced upward, giving the laccolith a dome or mushroom-like form with a generally plane base. Such formations are found in western part of North America.

(ii) **Batholiths :** Thses are big intrusive Igneous rocks which may cover an area, larger than 100 kilometers long. Because of their thickness it is hard to see their base. These are formed when magma solidifies beneath the layers of Earth in an irregular way. They might have irregular shape or may have shape of dome. That is also a reason that such type of rocks have been named as batholiths. These get exposed to surface through

the process of erosion of overhead portion. At times their breadth is 50 to 80 Kilometers and generally such rocks are base of mountains. Granite rocks are such large batholith rocks. Low lying mountains around Chennai are fine examples of Batholith rocks which have come visible because of erosion and are generally dome shaped.

(iii) **Lapolith :** When magma solidifies beneath the Earth's surface in shape of a saucer with a depressed central region, are called Lapolith. This type is an other form of Batholith. We find its examples in North America, in shape of Duluth Gabbro shield in Canada which extends to approximately 2 lakh sq. km in area.

(iv) **Phacolith :** Magma solidified beneath the surface of earth in the tidal shape is called Phacolith.

(v) **Stock :** Small size dome shaped or round batholith is called stock. The area covered by stocks is less than 100 sq. km.

(vi) **Sills :** When magma solidifies horizontally between the folds of rocks, it is called Sill. These rocks may be upto 100 meters in length while if their breadth is not much, sills are called sheets.

(vii) **Dyke/Dike :** Magma solidified in the vertical position is called dike or dyke. Their length varies from few meters to kilometers and breadth from a few centimeter to meters. In India, its examples are found in Tamil Nadu and Andhra Pradesh.

(viii) **Volcanic Neck :** It is a vertical landform created when magma hardens within a vent or neck (an opening in the Earth's crust from which lava, ash and hot gases flow or are ejected during an eruption) of an active volcano. A neck can cause an extreme build-up of pressure if rising volatile-charged magma is trapped beneath it and this can sometimes lead to an explosive eruption.

Characteristics of Igneous Rocks :

1. These rocks are formed by cooling and solidification of lava that is why most of the minerals are found in these types of rocks. Iron, Nickel, Copper, Caromite, Magneese, Diamond, Zinc, Platinum and Mica are found in huge quantities in these rocks.

2. These are hard rocks and they do not have layers.

3. Mostly these rocks are crystallite but if lava cools down quickly, these rocks attain non crystallite characteristic.

4. These are found in both vertical and horizontal shapes.

5. Almost 85 percent of Earth's surface is made up of igneous rocks.

6. Texture of these rocks depends upon the cooling process of lava.

7. These are not porous and water does not seve in such rocks therefore these are used for construction purposes. Their non-erodic character makes them useful.

IGNEOUS ROCKS (INDIA)				
Intrusive Rocks (Coarse grained)	**Granite**	**Granodiorite**	**Diorite**	**Gabbro**
	Mt. Aabu Chitardurg Jalore Closepet	**Bastar Dongargarh**	**Bastar Dongargarh**	**Bastar Dongargarh**
Extrusive Rocks (Fine grained)	Rhyolite	Docite	Anderite	Basalt (Deccan traps)
	Bastar Dongargarh Mumbai	Bastar Dongargarh	Bastar Dongargarh	Maharashtra Gujarat, Madhya Pradesh, Andhra Pradesh

Sedimentary Rocks : Sedimentary rocks cover 75% to 80% of the lithosphere while only about 5% of Earth's crust comprises of Sedimentary rocks.. The word 'Sedimentary' has been derived from Latin word 'Sedimentum' which means 'settle down'. Its definition runs as 'Sedimentary rocks are formed through consolidation of accumulated sediment deposits in oceans, seas, rivers or lakes'. Almost 95% part of Earth is covered by igneous and Sedimentary rocks. Sedimetary rocks are formed by the deposition of mineral and organic particles created or formed by weathering and erosion in a source area and then transported to the place of deposition by water, wind, ice, mass movement or glaciers. These are also known as Strat Rocks. Basically these rocks originate from the igneous rocks as these are formed by the deposition of the particles produced by the weathering and erosion on igneous rocks. These are

important sources of natural resources like coal, fossil-fuels etc. The lower layers of these rocks have large pieces while upper layer are made of small pieces in collective form.

The layers of these rocks get formed when small stones, sand, fossils and biowaste etc. deposits exert pressure on each other while cementing agents like silica, calcium, carbonate, iron oxide slowly mix with deposits to solidify them. Both pressure and cementation plays vital role in the formation of layers. Rocks thus formed are also known as fossil rocks or secondary rocks.

Sediments & Sedimentary Rocks

Fossils in Sedimentary Rocks

Relative quantum of various elements in sedimentary types of rocks is as under :

Shale - 60% (Found in Spiti)

Sand Stone: 20% (Formed by the combination of small sand particles)

Carbonate: 15%

All other: 5%

Do you know :

Study of Sedimentation encompasses the study of layers, deposition processes and specialities of sedimentary rocks. This subject is a part of Physical Geography and Geology.

Sedimentary rocks are important source of natural resources like coal, gas, oil (Fossil Fuels), Fresh water and various other minerals like Aluminium and Iron. Different layers of these rocks help in the scientific study of history of Earth, Stone age and Scientific research. On the basis of formation these are divided into following parts **:**

1. Clastic Rocks : The word 'clastic' has been derived from the Greek word 'Klastos' which means 'broken part'. These rocks are broken part of parent rocks and are formed by weathering processes which break rocks into pebbles, sand or clay particles by exposure to wind, ice and water. These may be further classified as :

(a) **Alluvial Rocks :** Small broken parts of parent rock which get deposited at some place in layers, having been transported by by rivers, glaciers and wind are called Alluvial Rocks. Such rocks are inorganic rocks. On the bases of parent rocks these may be further divided in various types :

(i) Marine or Aqueous Rocks : Such rocks are formed when material (debris) transported by rivers settles down on the sea bed. Big rocks settle close to the coast line while sand and other organic materials settle on continental shelf. Deposition on the shelf year by year turns the material into sedimentary rocks.

(**ii) Arenaceous Sedimentary Rocks :** Those aqueous rocks which have sand as principal constituent of sediments are known as Arenaceous sedimentary rocks. these rocks fall in abiotic rocks category also. Example of such rocks is sand stone.

(iii) Argillaceous Sedimentary Rocks : The rocks which have soil as principal

constituent of their sediment are known as Argillaceous sedimentary rocks. 'Shale' is its example while these rocks fall in category of biotic rocks.

(iv) Riverine Deposit Rocks : River deposits debris (sediments) in plains before falling into sea. From these sediments Riverine Deposit rocks are formed. Such rocks are commonly found in flood plains.

(v) Lacustrine Rocks : When sediments brought down by rivers fall into lakes and with slow and continuous deposition layers are formed, this situation gives birth to lacustrine rocks. Gypsum is example of each formations.

(vi) Aeolian Rocks : These rocks are formed by winds. High speed winds remove soil particles from one place and deposit them at another place. This depostion results in formation of Aeolian Rocks. Kachh and Kathiawar in India and northwestern regions of China are good examples of such rock formations.

(vii) Glacial Rocks : Glacial activity is responsible form formation of this type of rocks. Glaciers transport good amount of debris while moving and when these glaciers cross snowline, they get melted and debris gets deposited on those spots. Layers of such materials form Glacial Rocks.

(2) Mechanically Formed Sedimentary Rocks :

Soft rocks, Sand particles, Mud or clay soil solidifies with passage of time in layers, these soft rocks get compacted and with the help of cementing agents like calcite or silica, take form of these rocks e.g. sand stone, shale, corglomerate and breccia. Corglomerate is found in Mt. Kailash, Talchir and Shivalik hills near Chandigarh. In other words these are the rocks formed by accumulation of materials from other rocks which are cemented together.

(3) Organic Rock : These rocks are formed by the remains of plants and animals. When these remains keep buried for a long time, they change their form. This is a continous process which takes place with the help of heat and pressure which finally, results into formation of organic rocks. 'Peat coal' is a good example of organic rocks, it is formed with the little change in the remains of plants and animals, that's why its use is limited. Good quality organic rocks are formed with the passage of long time. Lignite and Bituminous (coal) are fine quality organic rocks which get formed when the remains of plants and animals keep buried for long time and their form changes a lot. We get petroleum also from organic rocks.

Organic rocks are further divided into two types :

(a) **Calcareous Sedimentary Rocks :** Calcium content is very high in this type of rocks and these are formed with the depositiion of bones and shells of animals. In simple words, these are formed with the combination of remains of animals and water. At first step Calcium Hydroxide is formed, after this with reaction to Carbondioxide, Calcium Carbonate is formed. Examples of this type of rocks are Limestone, Chalks, Dolomite, Talc etc. Chalk and Dolomite are found at Mt. Everest, Jaisalmer, Shahbad, Viashnoo Devi and Pithoragarh.

(b) **Carbonaceous Sedimentary Rocks :** These rocks have high carbon content. When dense forests and high planted areas get buried because of various activities of Earth, they change their form due to the internal heat and various layers continously exert pressure on them which change their actual form and results in the formation of carbonaceous Sedimentary Rocks. Coal is biggest example of such rock formations.

(4) **Chemically formed Sedimentary Rocks :** These rocks get formed by various chemical reactions. There are various chemicals in the sea, when water evaporates due to heat, these chemicals result in the formation of rocks. Like in a lime stone region, water calcium hydroxide and whole process results in the formation of chemically formed sedimentary rocks. like Stalegmite, Stalactic, Rock Salt, Gypsum and Saltpetre etc. In simple words water evaporates leaving behind the sediments and with the passage of time rocks are formed of such sediments.

Characteristics of Sedimentary Rocks :

1. These rocks have layers.

2. Fossils are found in the rocks.

3. These rocks do not have crystals like igneous rocks.

4. These rocks are porous and water can easily pass through them.

5. These are not hard like igneous rocks, that’s why they get easily eroded.

6. Himalayan mountains in Asia, Alps mountains in Europe, Western Cordillera of North America and Andies of South America are examples of these rocks. In India, Ganga-Brahmaputra plains are the example of these rocks.

7. Being easily eroding type, Sedimentary rocks have marks known as ‘Ripples’ on them. Deltas of Mahanadi, Godavari, Krishna and Kaveri are examples of such rocks.

8. These rocks are the sources of oil, coal and natural gas.

9. Such rocks like small stones are combined by some cementing agent are of two types (i) **Corglomerate :** These are formed by round stones (ii) **Breccia :** These are formed by Angular stones.

Metamorphic Rocks

The word Metamorphic has been derived from the Greek word ‘Metamorphosis’ which means ‘Change’. The formation process of these rocks takes place 12 to 16 kilometers deep beneath the Earth surface. Chemical and physical form of sedimentary and igneous rocks changes because of internal heat of Earth, pressure of rock layers over them and exposure to various materials. After this process, the rocks which are formed with different chemical and physical properties are known as metamorphic rocks. These are not porous. Metamorphic rocks have highly compressed layers. Gold, Silver, Diamonds and other precious stones are found in these rocks. The process of change which results in the formation of metamorphic rocks, known as metamorphism is of three types :

1. **Dynamic Metamorphism :** The ‘changing’ process which takes place because of extreme pressure is called dynamic metamorphism. The process takes place deep beneath the Earth in which ‘Granite’ converts into ‘Nice’ and ‘Shale’ converts into ‘Schist’.

Example of Metamorphic Rock

2. Thermal/Contact Metamorphism : This process takes place because of extreme heat present in the internal parts of Earth. The rocks formed by this process are known as Thermal/Contact metamorphic rocks. When magma comes into contact with igneous and sedimentary rocks, they melt because of high temperature. This results in the reformation of crystals or change in crystals. Limestone and Chalk changes into Marble, Clay soil into Slate and Coal changes into Graphite and Graphite further changes into Diamond. 'Slate' rocks are found in Kangra and Chamba districts of Himachal Pradesh and Rewari in Haryana. The tip of Mt. Everest is also formed of converted lime stone.

3. Regional Metamorphism : Deep beneath the Earth when changing process takes places in large area because of compression and friction combined and results in conversion of rocks that is called Regional Metamorphism and rocks formed by this process are known as Regional Metamorphic Rocks. Quartzite is the example of regional metamorphic rocks. These are found in Rajasthan, Bihar, Madhya Pradesh.

Examples of metamorphism of rocks :

Name of the Parent Rock		**Metamorphic Rock**
Lime stone	——————————→	Marble
Sand stone	——————————→	Quartzite
Clay and shale	——————————→	Slate
Granite	——————————→	Gneiss
Basalt	——————————→	Schist
Coal	——————————→	Graphite
Graphite	——————————→	Diamond

Picture of various Metamorphic Rocks

Characteristics of Metamorphic Rocks :

1. Some metamorphic rocks get more strong and harder than their parent rocks e.g. Marble and Quartize formed from Lime stone and Sand Stone making erosion process is very tough on them.

2. Changing process takes place because of Heat, Pressure and Friction.

3. These are found in various colours.

4. These may originate from any type of rock.

5. Precious stones like Diamonds, Ruby, Sapphires are found in these rocks.

6. Gnesis rocks are used for construction and quartzite is used for 'glass making'.

7. Many famous buildings have been constructed of these rocks like 'Taj Mahal' in Agra is made of Marble, Fort of Tughlabad, Fort of Agra and Red Fort of Delhi are the other examples. Graphite is used for pencils and crucibles. It is found in Odisha and Andhra Pradesh.

Rock Cycle

Distribution of rocks is very unequal on the crust or outer most layer of Earth. Deep in the interior of our Earth, rocks are found in liquid form called 'magma'. Cooling and solidification of magma results in the formation of 'igneous rocks'. Igneous rocks break down into small rocks and sediments. With the deposition of these sediments in the form of layers 'sedimetary' rocks are formed. Because of heat compression and pressure, igneous and sedimentary rocks change their physical and chemical properties resulting in the formation of metamorphic rocks. After sometime these rocks start changing their form because of erosion process. The process of changing of rocks from one form to another is known as 'Rock Cycle'.

In simple words, rock cycle mixes up the outer and internal layers of rocks. Chemical reactions leads to conjugation and separation of various particle. Physical form of rocks also changes Rock cycle exists on our Earth since stone age. Because of this the matter exists on Earth and changes from one form to another. Rock cycle is continously on going process.

Activity :

(i) Prepare a graphic of Rock Cycle.

(ii) Prepare a list of metamorphied rocks to show it as exhibit board in your class.

EXERCISE

1. Answer the following questions in few words :

(a) In which era tools were made of stone ?

(b) Distinguish rocks on the basis of their character of Seving water.

(c) What other name is given to outer most layer of Earth ?

(d) Patarology is known as Science of What else ?

(e) Cristals may be a property of rocks of what type ?

(f) Mafic is combination of which elements ?

(g) In which type of rocks, fossils are found the most ?

(h) Which type of minerals are found most in metamorphic rocks ?

(i) Limestone changes into what rock after mentaphism ?

(j) Where do we find Shale in India ?

2. Answer the following questions in few sentences :

(a) In how many parts can we divide Shiwalik Himalayas of Punjab ?

(b) How many and what main types of rocks are there ?

(c) What are two main elements that constitute crust of Earth.

(d) What are Minerals ?

(e) What type of rocks constitute better part of crust of Earth ?

(f) Which rocks form maximum part of Lithosphere and how much ?

(g) Where does metamorphism take place ?

(h) What forms does coal attain at morphism ?

3. Answer the following questions in a paragraph or two :

(a) Write any three characteristics of Igneous rocks.

(b) Define a rock.

(c) What are mushroom type rocks ? Write a note.

(d) Why do we find marble and graphie mostly in Rajasthan ?

(e) Name any three rocks which take new form at morphism.

(f) In which type of rocks power mineral are found and why ?

(g) Define Sedimentary rocks.

(h) What is science of rocks ? Explain in a note.

4. Answer the following in approximately 250 words :

(a) What is a rock ? Classify them and explain any one type.

(b) Explain difference between; Intrusive and Extrusive igneous rocks, rock & mineral, heat and regional metamorphism.

(c) What is rock cycle ? Explain with graphics and examples.

(d) On the basis of characteristics, explain which rocks Sedimentary or metamorphic are more beneficial for human beings.

(e) Explain Sedimentary rocks formed by alluviums.

(f) Explain Hypabyssal igneous rocks on basis of shape and positioning.

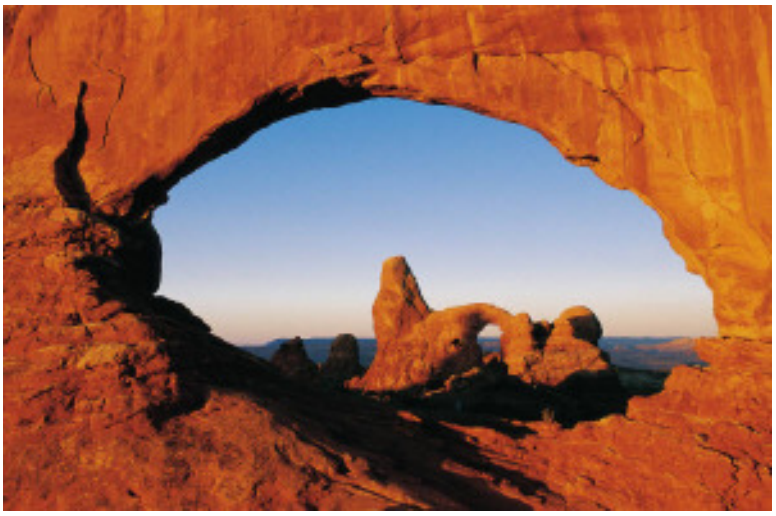
CHAPTER - 3

AGENTS OF CHANGE: DENUDATION AND TRANSPORTATION

The structure of Earth continuously changes by both, internal forces (volcanoes, earth quakes etc.) and external forces (weathering, erosion, levelling of Earth's surface etc.)

Denudation : External forces work continuously on levelling of outer surface of Earth and this activity is known as denudation. Eroded materials settle down in lower areas, leading to levelling up of earth's surface which is technically known as aggredation.

When external forces erode the level of outer surface of Earth the process, is known as degradation. When these two activities of erosion and deposition occur simultaneously, it is known as Gradation.



Denudation

Denudation takes place because of heat of sun and gravitationak pull. Weather changes because of Sun's heat which results in the break down of rocks. Rivers flow from higher level to lower level because of gravitation. This is known as Mass Wasting. Both weathering and erosion are the tools of denudation.

Let us discuss in detail :

Weathering : Weather plays an important roles in changing the structure of Earth. It works deep beneath the Earth's surface and also occurs over the crust of Earth and

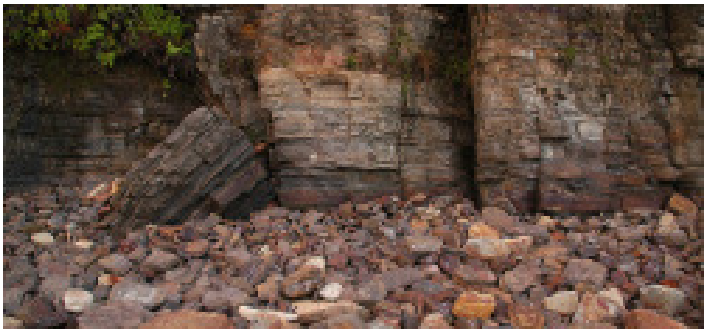
all surfaces in different forms. Actually, the breakage of rocks because of weather on the surface of Earth is known as weathering.

In other words, weathering is the breaking of rocks by static agents of weather which include rain, frost, temperature changes etc. According to B. Sparks, "Weathering is the mechanical fracturing and chemical decomposition of rocks by the natuaral agents at the surface of Earth".

Climate of a place, composition of Rocks, Flora etc. have huge effect on the process of weathering. Humidity, rains, frost are the important elements of weather, beceause of these the breaking, fracturing, expansion and contaction (shrinking) of rocks takes place. Process of weathering may be divided into three parts :–

1. Physical Weathering/Mechanical Weathering :

In this type of weathering rocks are divided/disintegrated into different parts without any chemical change that is why it is known as mechanical weathering. Three agents work on this type of activity :–



Granular

(a) **<u>Insolation</u> :** This process takes place mostly in deserts as during day time rocks expand due to high temperature and contract during night with fall in temperature. Repetition of this activity results in disintegration of rocks. Sometimes rocks disintegrate into small pieces, which is known as Granular disintegration. Although main reason for physical weathering is heat of sun yet winds and air pressures can also cause such process.

Freeze and Thaw Process

(b) **Frost-heaving :** Due to heat when cracks appear on rocks, rain water is filled in those cracks. At night, water freezes because of low temperature and expands due to which breakdown of rocks starts and they disintegrate into smaller parts. Mostly this process takes place in mountainous regions. Sometime small stones comes out from soil because of frost heaving and these stones make ring like structure.

Exfoliation

(c) **Exfoliation :** This activity takes place in desert areas. Rise and fall in temperature on daily basis leads to disintegration of layers of rocks and due to high speed winds these fine eroded layers get transported to far-flunged areas. This process is known as exfoliation.

2. **Chemical Weathering :** In this weathering chemical structure of rock changes. Gases in Atmosphere and rain lead to disintegration of rocks which brings physical as well as chemical changes. This process is known as chemical weathering. Chemical weathering also has various types :

The Types of Chemical Weathering

(a) **Oxidation :** In this process oxygen reacts with the iron particles present in rocks because of which ferrous (rust) is formed. Due to oxidation, rocks attain red or yellow colour. Rust leads to the disintegration of rocks in small particals.

(b) **Carbonation :** When regions with high lime content receive rainfall, the carbondioxide present in water reacts with lime and carbonic acid is formed. Because of carbonic acid cracks turn into enlarged deeps on rocks and continuity of this process disintegration of rocks takes place.

(c) **Hydration :** In this process in which rocks having metallic content absorb water which makes structural change in type of rocks. Some rocks expand due to water absorption like Feldspar changes into Kaolin. Vindheya Mountains situated near Jabalpur are formed by this process.

(d) **Solution :** Some minerals are easily dissolvable in water and rock salt, silica and gypsum like soft rocks does not lose vanish by dissolving in water. Rock salt which is mostly found in desert areas, carries on its identity because of less or negligible rainfall in desert regions. Gypsum, which is not as dissolvable as salt continues with its identity in humid regions where rock salt dissolves.

3. **Biological Weathering :** If activities of plants, animals and human beings result in to disintegration of rocks, weathering caused is known as biological weathering.

Biological Weathering

(a) **Plants :** Plants contribute important type in physical and chemical weathering. Expansion of roots with growth of plants, leads to cracking of rocks. Further expansion results in disintegration of rocks.

(b) **Bacterial Action :** Decomposition of leaves and roots form organic and nitric acids which on reaction cause chemical weathering. 'Humus' is also formed in such process only.

(c) **Weathering by Animals :** Cracks appear on rocks because of 'burrows' of animals. Many animals make their 'Funnels' by breaking rocks. All this results in the disintegration of rocks. Common animals and insects performing such acts are; Foxes, Rats, Rabbits, Earthworms, Mites, Ants etc.

(d) **Human Actions :** Activities like search for minerals, construction of buildings, leveling of land for agriculture, construction of roads results in disintegration of rocks. Deep quarrying for fulfilling need of stones is also one of the agents that causes weathering results.

Weathering effect is not same or similar for all types of rocks. Various factors like weather, atmosphere, structure etc. affect their process.

Mass Wasting or Mass Movement

Mass Wasting (Land Slide)

Mass wasting is also known as slope movement or mass movement, is a process by which soil, sand and rocks move downslope. This brings change in the structure of rocks. The structure itself indicates the change which weathering brings in parent rock. Weathering process may be quite fast on some rocks while slow on others.

Sometimes due to gravitational pull, the debris stops at higher spot on a slope. 'Creep' is the type when debris is creeping downslope while fall at high speed is known as 'Fall'. Falling big parts of broken rocks are known as 'Talus' and smaller ones as 'Scree'.

Talus cones

When these broken rocks fall at high speed, huge loss of life and property occurs. During rainfall these activities are very common in hilly regions. Mud flows downslopes at the speed of 80 km/hr/50 mph. This process is known as mud flow. In other words, movement of soil and regolith that more resembles fluid behaviour is called a 'flow'.

Mud flow

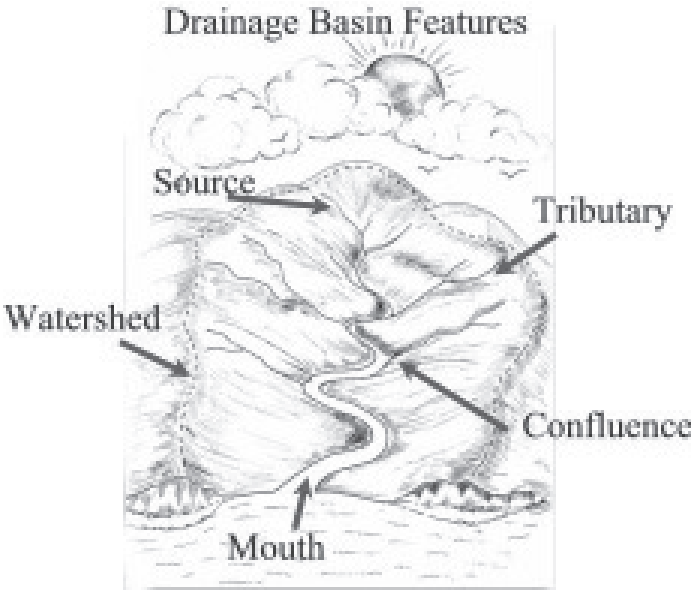
Erosion : Word 'erosion' has been derived from the word 'erodese' of Latin Language, which means 'to gnaw'. In simple words, it is a process in which rivers, glaciers, winds, undergroud water removes soil and rocks from one place and transport them to another place, where they are deposited. Weathering, Erosion and Denudation are deeply related to each other and depend on each other for their accomplishment. Means of erosion perform three task i.e. Removal, Transportation and Deposition.

(i) Denudation Works of River

Structure of Earth changes continously due to erosion. Water which is near omni present, plays most important role in the process of erosion, even more than air. That is why it is so important that at first step we should known about works of rivers.

When it rains or when ice melts on mountains, some part of water seeps down into Earth and rest of it starts flowing on the Earth surface through rivers. The starting point of river is known as source and the last point of river is known as mouth. For example, the source of river Ganga is Gangotari Glacier (Uttarakhand) and its mouth is its delta in Bay of Bengal. This is a perennial river. Perennial rivers are those rivers which flow throughout the year and their source is ice (Glacier). On the other hand, those rivers which flow only during rainy season, are known as 'seasonal rivers'. Rivers flow from high to low altitudes and act as 'means' of erosion, transportation and deposition of various particles.

- Source of river Beas is Beas Kund in Himachal Pradesh while mouth is Satluj river.
- What are the sources of rivers of Punjab. Prepare a list.



(River) Drainage Basin

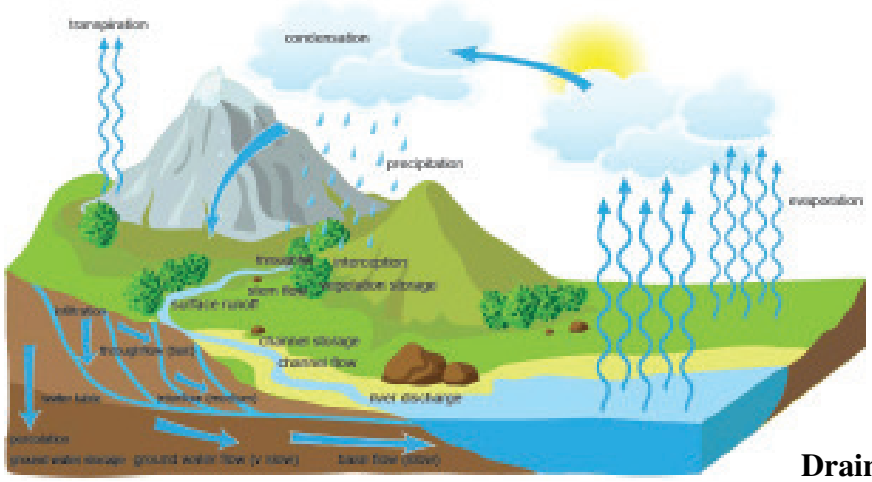
Small rivulets or streams falling in a river are known as tributaries. The drainage basin or watershed of a particular stream is whole the area that contributes overland

flow, stream flow and groundwater to that stream.

Denudational work of River :

(A) **Erosion :** Erosion by any river is very important aspect for mankind. Rate of erosion is higher in mountains as compared to that in plains. Rivers carry the particles/ debris formed by weathering and deposit it at another place. The particles that rivers carry are stones, rocks, sand particles etc., which help in erosional process. According to William Morris Davis the cycle of erosion is, "the period of time during which an uplifted land mass undergoes its transformation by the process of land sculpture ending into a low featureless plain".

Erosion may be divided into two parts :



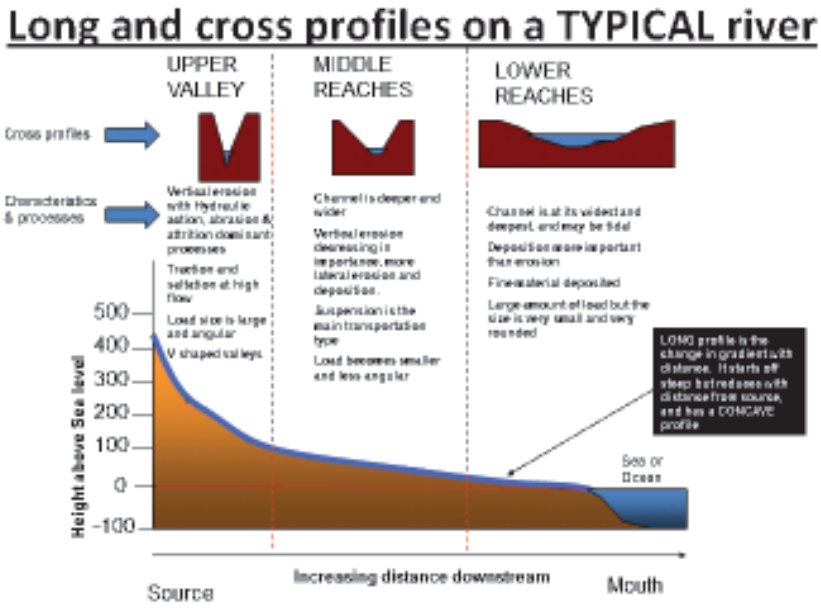
Drainage Basin

1. Vertical Erosion : This is also known as downward (cutt) erosion, which results in deepening of valley. This, erosional activity is dominantly verticle. Rivers flow from mountains to low slopes, eroding the bed rocks vertically. Because the flow is fast and slope (gradient) are steep, this process goes on, till the river reaches its mouth and results in formation of 'V' shaped valleys.

V- ShapeValley

2. Lateral Erosion : This is a sideway erosional process. It starts when river enters from mountains to plains. Speed of water/flow decreases and river starts 'sideway'

erosion and further it leads to widening of valley.



Cross Profile of the River

<u>Factors controlling Erosion</u> :

(i) **<u>Velocity of Running water</u> :** Process of erosion depends upon the velocity of river. If the gradient is steep, velocity of river will be higher which leads to more erosion. In plains, the velocity of river is low, erosion is also comparatively less. There is a law about erosional capacity of running water, if the velocity of river is doubled or multiplied by two its capacity of carrying the material rises by 64 times of its original capacity. This is known as 'Gilbert's sixth power law'. Erosion Capacity increases during flooding while it lies low in dry patch of weather.

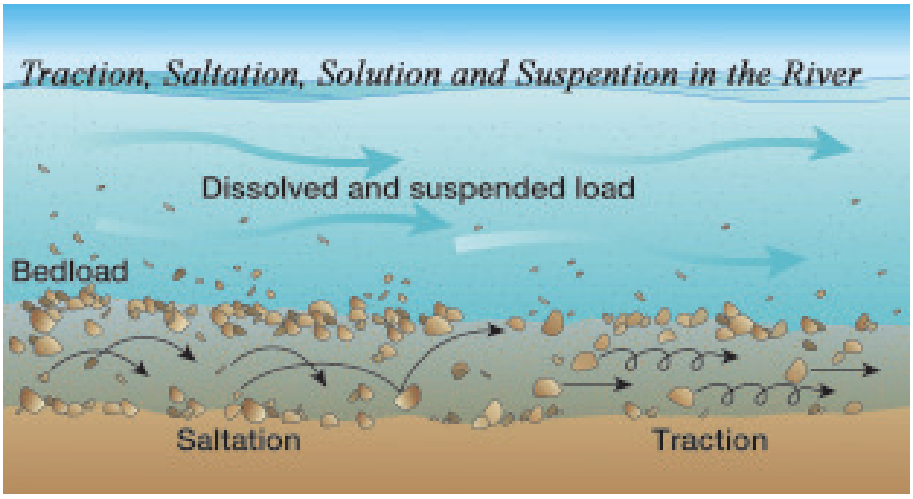
(ii) **<u>Volume of water in river</u> :** Higher the volume of water in river, more will be erosion. As the volume increases the presence of rocks, stones, soil particles, debris etc. also rises. Higher volume results in deepening of river beds and broadening of banks. All this leads to widerning of valley by eroding river bed and walls or sides of river.

(iii) **<u>Load of River</u> :** If the amount of rocks, stones, soil particles is high in rivers, it will accelerate the process of erosion and friction.

(iv) **<u>Nature of Rocks</u> :** Erosion process on limestones and sand stones rocks is faster as these are soft rocks. On the other hand, the erosion process on Granite and Basalt

is slow and tougher comparatively, these being hard rocks. Rivers carry out the process of erosion and friction on the basis of load, gradient and type of rocks.

B. <u>Transportation</u> : River carries rocks, stones, soil particles etc. from one place to another. This process of carrying materials is known as transportation. Basically it is carried out in middle course of a river.

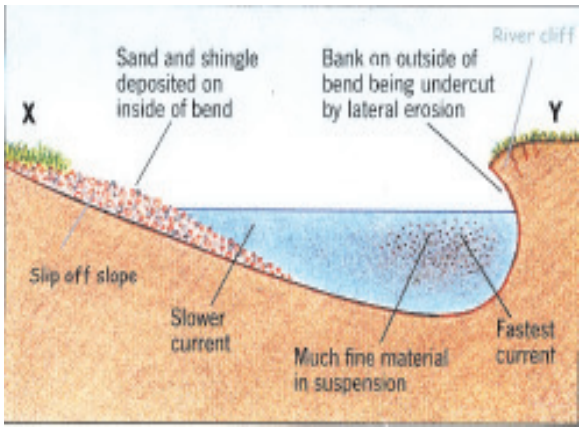


<u>Rivers carry out debris in different ways</u> :

(i) **<u>Traction</u> :** Large material such as boulders are rolled and pushed along the river bed by the force of river water.

(ii) **<u>Solution</u> :** Dissolved material are also carried by a river. This happens often in areas where the lime stone is dissolved by slightly acidic water. Some chemicals and salt also dissolve in river waters.

(iii) **<u>Load in suspension / Suspended load</u> :** When materials made of very fine particles such as clay and silt is lifted as the result of turbulence and transported by river. Faster flowing turbulent river carry more suspended materials, that is why rivers appear muddy. Transportation of fine material is faster than coarse material.



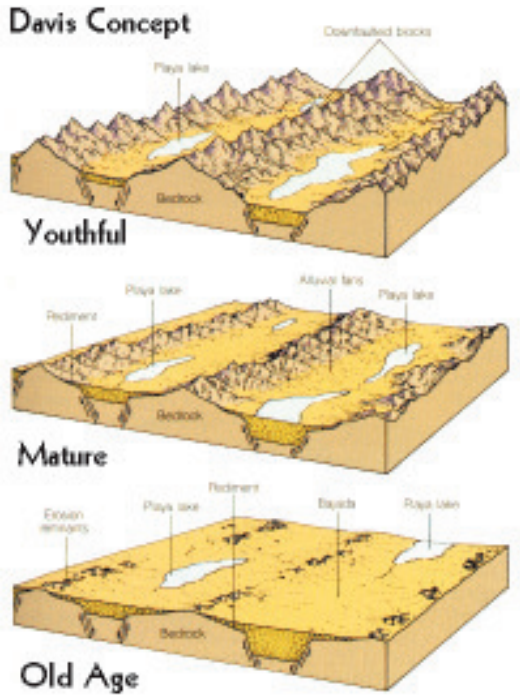
Transportation Processes in River

(c) **Deposition :** This process begins when gradients are low and velocity of river water decreases. At this stage deposition of materials carried by river take place, which helps in leveling of low lying areas. The process of erosion and deposition is completed at this stage. Fast flowing rivers carry the material for longer time and distance. On the other hand, rivers which flow slow, start the deposition work on their way. Sometimes when rivers change their directions, deposition process begins.

Parts of River and Cycle of Erosion

The erosion power of river varies from source to mouth. During this process various landforms are formed. Diagram showing all the parts of river is known as 'Long Profile'.

The first part is known as the Upper Course or Mountainous Course or youthful stage. Second part is known as Valley Stage or mature stage or Middle Course. Third part is known as Plain Stage or old age or Lower Course. The river course from source to its mouth is known as River Valley which may attain a depth ranging from some meters to 500 meters and even more than that.



River Profile: Showing three distinct section - the upper, middle and lower courses.

1. The Upper Course/Mountain Course/ Youth Stage : It starts from the source of river. River flows from steep gradients to low gradients. In this part velocity of river water is high, erosion and friction power is also high. River carries the debris formed by weathering. Various stones roll on the sea bed and moreover friction between these moving rocks results in formation of round shape rocks. Gravitational Pull and Rain water plays an important role at this part/

View of the Gorge

stage of river. Rain water starts flowing downwards because of gravitational pull. Because of 'down cutting' erosion process at this stage various landforms are formed. The process of 'land form' formation is high in areas having soft rocks and in mountains rocks are hard therefore down cutting is possible. Down cutting forms tight steep-side vallies and gorges.

Gorges/Canyons : Rivers like Satluj, Indus, Brahmaputra, Gandak, Kosi etc. form gorges in Himalayan mountains. In dry areas, canyons are formed by rivers. Canyons like letter 'I" and these are steep and narrow. Canyon made by Colorado river in U.S.A. is one of the finest examples. This is the largest canyon of world. It is 480 kilometers long, 1828 kilometers deep and 6 to 16 kilometers wide.

I- Shape Gorge/Canyon

(ii) **<u>V-Shaped Valley</u> :** Mostly the rivers formed 'V' shape valleys. Because of high rainfall, along with down cutting erosion, sides are also eroded. Due to this narrow valleys look like letter 'V' with the passage of time they become wider. We can easily understand this process from the figure .

Development of 'V' shape valley

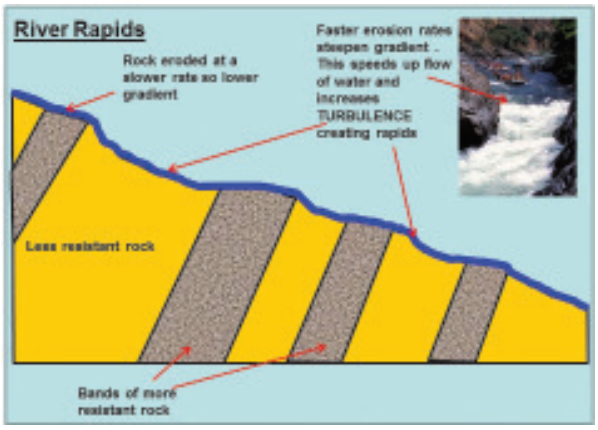
(iii) **Water Falls :** River water flowing through a steep gradient area and falls from vertical gradient at high speed/velocity is known as water fall. Shiva Sundram (91 mtrs) and Jog (260 mtrs) on river Kaveri, while Dhuandhar (9 mtrs) on river Narmada are famous water falls in India. At time water from the fall lands on soft rock creating a deep on the spot.

Waterfall

Do you know ?

Where are Niagara Falls and Victoria Falls are situated.

(iv) **Rapids :** These are the reactions of a river where the bed has a relatively steep gradient, causing an increase in water velocity and turbulence. When a river flows through an area of alternating bonds of resistant and less resistant rocks, the less resistant rocks are eroded more quickly. Therefore, the soft rocks are at lower level compared to hard rocks which results in river falling in series of step along the



River Rapids

bonds of hard rocks to form 'rapids'. Rapids which are in a series of very short and fast falls are known as cascades. River Nile is a good example of rapid formation.

(v) **Pot hole :** When river flows it creates holes of various sizes. Some rocks are soft and they get eroded easily, resulting in deepening of holes. When water fills in the holes new landforms called 'Pot holes' are formed. They have 'cylindrical' shape and sometimes they look like 'discs'. Their diameter may vary from centimeters to meters and they may be upto a few meters deep. These are considered very dangerous because it is very hard to come out of these deeps. Because of this, these are also known as 'Devil Punch Bowls'.

Potholes on the Bed of a River

2. The Middle Course : As river enters in plains from mountains, it starts deposition along with erosion because the volume of water is high but velocity decreases. This process results in formation of various landforms:

(i) **Alluvial Cones :** As the velocity of river decreases, its transportation capacity also decreases. Due to this decline deposition starts in Foot Hills. This deposition forms Alluvial Cones. This is the first landform/pasture which a river makes with deposition. Mostly the Alluvial Cones have stones, rocks and sand (coarse debris).

Alluvial Fan

Alluvial Cone

(ii) **Alluvial Fans :** While passing through alluvial cones, river is divided into various channels and alluvial cones convert into alluvial fans. Their size varies from some meters to various kilometers and they have semi circular shape. Cedar creek alluvial fan of U.S.A. and Kosi Megafan are its best examples. Alluvial fan of river Kosi is situated in foot hills of Himalayas and it is 151 kilometer long and 143 kilometer wide. Kosi river has recorded a continous westward shifting of around 113 KM in last 228 years.

(iii) **Alluvial Plains :** These plains are formed by deposition of soil by rivers. Rivers bring soil particles of various rocks. With the continuous deposition of these soil particles layers are formed which further forms the fertile alluvial plains.

(iv) **Natural Levees :** With the continuous depositon of soil on the banks by the river, the level of banks rises and they look like natural dams. These dams might rise upto 2 meters. Sometimes artificial Levees are also formed for the protection from floods.

Natural Levees

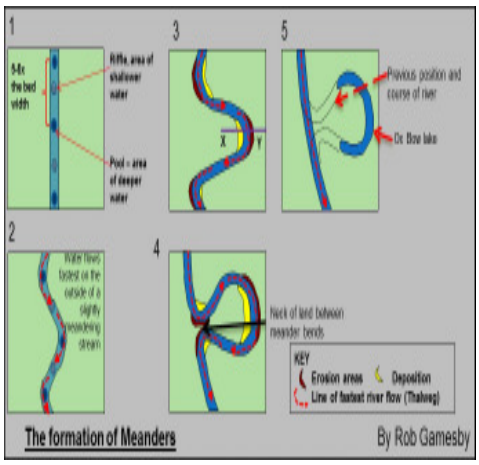
(v) **Flood Plains :** "A flood plain is a feature of low relief build adjacent to stream channel by the unconsolidated material derived from the related river". In simple words, it is because of floods that layer of soil is depostied on the low lying areas near to the river. With the repetition of this process flood plains are formed. This process of flood plains formation is repeated annually, bi-annually or tri-annually.

View of the Flood Plains

3. <u>Lower course of the river</u> : At this stage river flows very slowly and almost there is no erosion and friction procedure. At this stage river starts deposition on its bed because of this the level of these parts rises. At this stage river meets its mouth forming follwoing land forms :

(i) **<u>Ox-bow Lakes and Meanders</u> :** Word 'Meander' is basically related to Turkish language which means 'small windling river'. A river never flows completely straight, it flows in 'S' shaped (meanders). At low gradients, the deposition process is very common and width of river also increases. Due to obstacle in its way, river take turns with which meanders are formed.

River Meandors



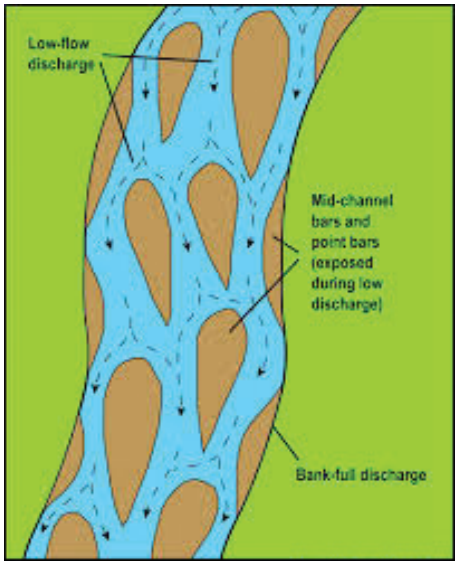
Developement of the River Meandors

Mississippi river of U.S.A., Ganga of India and Po of Italy are famous for 'meanders' and 'ox-bow' lakes.

An Ox-bow lake is a U-shaped body of water which is formed when a river creates a meander, due to the erosion of bank through abrasion. After a long period of time, meanders become very curved and eventually the neck of the meander becomes narrower and the river cuts through the neck during a flood, cutting of the meander and forming an 'ox-bow lake'.

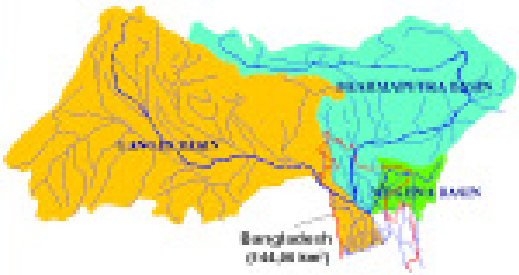
(ii) **<u>Braided Stream</u> :** According to Miller, "A braided stream is one which does not flow in a single definite channel but rather a network of everchanging, branching and reuniting channels. At lower course, river starts depositing soil on its bed. Continuous deposition forms soil layers. Because of this river is divided into small channels. With further deposition small 'Bars' or 'Islands' are formed which results in formation of

'Braided Stream'.

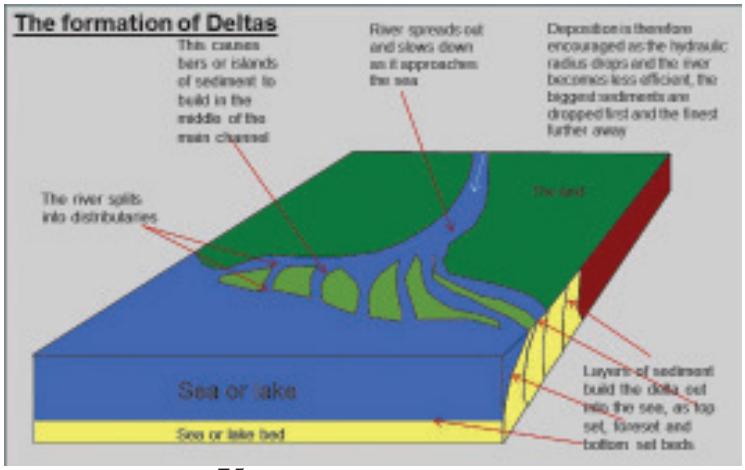


Graphic of the Braided Stream

(ii) **<u>Delta</u> :** Greek historian 'Herodotus' (485 to 425 B.C.) used word 'Delta' for the delta of river Nile (Egypt) for the first type. This delta resembles the fourth word of Greek language i.e. 'Δ'. When river flow reaches at its 'mouth', it is divided into various small channels. Deltas are formed with deposition of sediments carried by a river as the flow leaves its mouth. Its shape look like triangle 'Δ', that's why it is called 'delta'.



Ganga and Brahmaputra Delta



Formation of Delta

The total area of Ganga-Brahmaputra delta is 1,25,000 sq. km. and is biggest delta on the Earth. All the rivers of world do not form deltas because for such formation, certain necessities are there :

(i) Volume of water should be high at the first stage of river so that erosion and friction process also be high.

(ii) Some other rivers or streams i.e. tributaries should conjugate with the main river so that amount of debris increases.

(iii) There should not be any obstacle at first stage of river like lake etc. so that river has a long bed.

(iv) Gradient should be low at last stage.

(v) Sea waves or Esturies should not act as obstacle in the natural flow and deposition process of river.

The rivers which do not form delta, they form 'esturies'. This type of deltas are formed in those rivers which have volcanic soil at its mouth. The mouth of such rivers get submerged into the sea. No river flowing to weatern coast of India forms delta.

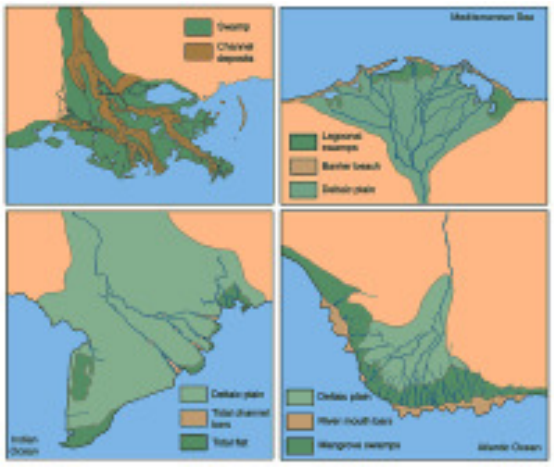
Types of Delta :

(i) Estuary : Examples are Rhine, and Amazon rivers.

(ii) Arcurate (Fan shaped) : Examples are Nile & Niger rivers.

(iii) Cuspete (Pointed like tooth) : Examples are Ebro & Tiber rivers.

(iv) Bird's Foot (with fingering branches) : Examples is Mississippi river.



Various types of Deltas

Activity :

Name source of a river that flows in Punjab. Prepare a report on the regions it passes through, and name its mouth also.

EXERCISE

1. What do you mean by Denudation? What is the difference between Degradation and Aggradation, explain in detail.

2. Give the answer to the following in 60-80 words.

(a) Physical weathering

(b) Oxidation

(c) Biological weathering

(d) Erosion

(e) Effect of human activities on weathering

(f) What do you mean by weathering ? Explain in detail.

3. Answer the following questions in a sentence or two :

(a) Which is the largest delta of the world ?

(b) Which is the largest canyon of the world ?

(c) From where the word 'Delta' and 'Meander' have been derived ?

(d) What is the length and breadth of alluvial fan of river Kosi ?

(e) What is known as delta, write with example ?

4. Write the answer of the following in detail :

(a) What is the first stage of river and which land forms are formed at this stage?

(b) What is the effect of river on topography during the proces of deposition? Explain in detail.

(c) Write in detail about the factors effecting erosional work .

5. What is the difference between the following :

1. Waterfall - Rapids
2. Alluvial Cone - Alluvial Fan
3. Reservoir - Natural Levees
4. Flood Plains - Delta

(ii) Denudation Works of Glacier

World distribution of Glacial Ice today

Glaciers are the important source of denudation. If we look at history of the Earth, we find that thousands of years ago, during Ice age, 20% part of Earth was covered by glaciers which has confined to only 10% part now. Global climate change is responsible for this. About 96% part of glaciers of the world is found in Antarctica and Greenland only. In Antarctica, thickness of glacial ice varies from 1500 meters to 4000 meters.

According to the research of NASA, the temperature of Antarctica has been increasing by 0.12° per decade in last 50 years, owing to this, the layers of ice sheet are breaking continuously. This activity has resulted in rise of sea level by 73 meters.

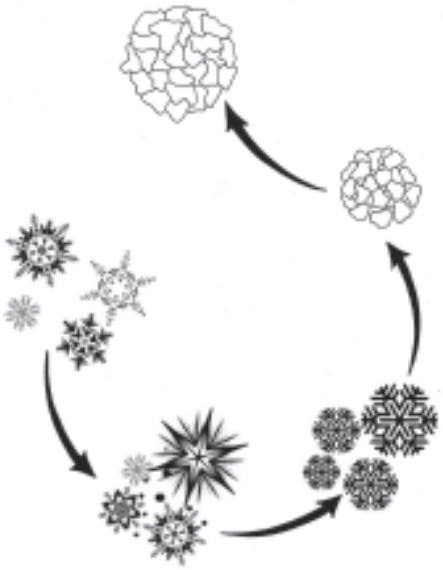
Glaciers are found in mountains or near to high latitudes or at poles because temperature at these regions is below freezing point. These regions receive snowfall continuously even in shape of snow flakes. Because of continuous snowfall and low temperature the lower layers of snow get hardened and is known as glacier.

Most of the regions in our world receive snowfall in winters. Snow melts because of high temperature and when snow starts shifting because of rise in temperature and melted parts start moving that is known as glacial movement.

View of the Glacier

According to Penguin Dictionary of Geography, "A glacier is an extensive body of land ice which exhibits evidence of downslope movement under the influence of gravity and which forms from the recrystallization of neve and firn.". Holmes has defined glacier as "masses of ice which, under the influence of gravity, flow out from snowfields where they originate". It makes clear that only a huge piece of ice/ snow is not a glacier, nor is that frozen huge only which melts at increase of temperature.

Transformation of Snow into Ice



Lious Agarriz proved in 1834 that the central part of glacier moves faster than its sides.

Transformation of Snow into Glacier :

At snowfall, snow is very soft single ice crystal or aggregation of ice crystals is known as snowflakes. with the continous process of combination of flakes, formation of granular snow begins. Water vapours start turning into solid form and low temperature helps in unifying of (firn) crystalized ice which further takes form of hardened snow. This is known as ice of glacier. Pores disappear at this stage and when this ice starts moving its solid form puts effect upon its speed also .

Sometimes it takes years to form of snow flakes firm and transformation of snow into glacier may take three to five years.

The speed of glacier depends on the following aspects :

1. Bigger the size of glacier, faster it will move.

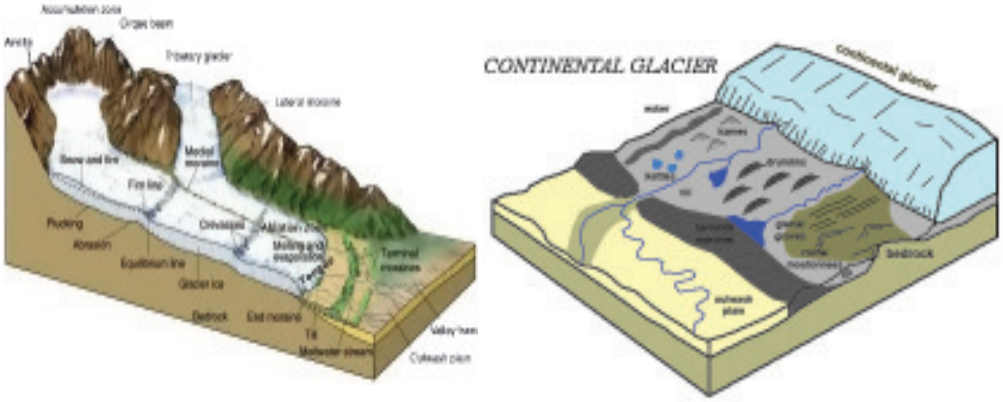
2. Glaciers may move at speed varing between some centimeters to 40 centimeters.

3. They move fast on steep gradients.

4. Their speed is high during summer.

<u>Snow Fields and Snow Line</u> :–

Regions which are always covered by snow are known as snow fields. Glaciers start from snow fields. All the continents have snow feilds except Australia. The line above which, the rain water falls (as) in the form of snow is known as snow line. In hot areas the height of snow line extends upto 5000 meters. In cold areas, it is even upto sea level. This line is also low in steep gradients of mountains.



Valley Glacier and Continental Glacier

<u>Types of Glaciers</u> :

Glaciers are of various types on the bases of their size and structure. All the glaciers are divided/categorised on the bases of structure and temperature. Ahlmann (1948) has divided glaciers into three categories:

1. **<u>Continental Glacier</u> :** Earlier, thousands of years back, North Europe, Asia and northern parts of America were covered long & wide by large glaciers but today their size has decreased. Presently such glaciers are found in Antarctica and Greenland. Their size is very large and they cover the whole continent. These are slow moving

glaciers.

2. **Valley Glaciers :** These glaciers start from snow covered mountains (ice caps). These are long but their breadth is less. These are also known as Alpine glaciers also. Because of their erosion process they create ups and downs. These type of glaciers are found in upper hills of Himalaya. The largest glacier of India is situated in Siachen (72 km) in Karakoram Mountain range. Another important glacier of India is Gangotari (25.5 km-Uttarakhand). Valley glaciers are found in mountain valleys only. World's largest glacier is situated in Alaska, i.e. 'Hubbard Glacier' (130 km).

3. Piedmont Glacier: Glaciers which conjugate and form a sheet like structure at the base of montains or in low lying areas are known as Piedmont glaciers. These are found at high altitudes. 'Melaspina' glacier of southern Alaska is the finest example of Piedmont Glacier.

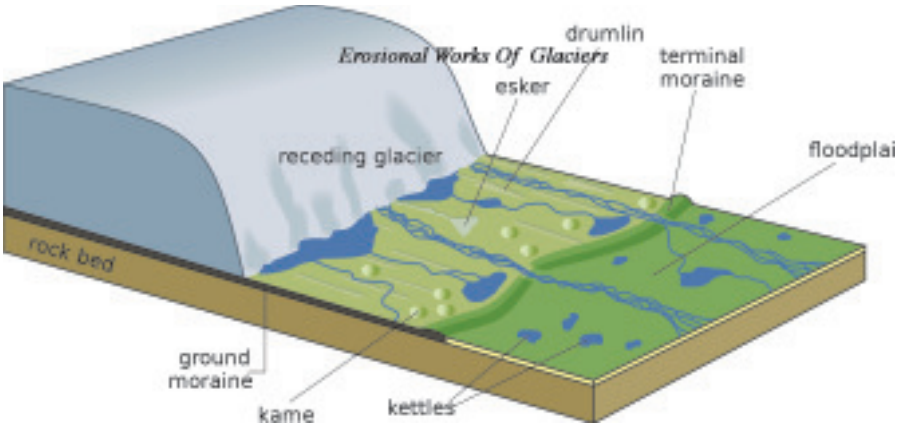
• Broken parts of glacier are known as ice bergs. These are formed during calving process. Calving is a process, in which front portion of glacier (Snout) break from main glacier near the sea.

Works of Glacier : Glacier is a form of hard ice, which move and expands continuously. It can move at speed of some centimeters in a year to 100 meters in a week. Their speed varies and it is different from each other. Some of the glaciers reach upto the sea while others melt before reaching there. Glaciers play an imporant role in changing the structure of land/Earth. Glaciers also perform erosion, transportation and deposition activities. When they move they carry stones, rocks, soil, vegetation etc. along with them. If the glacier is made up of ice only then its erosion capacity is nil. On the other hand glaciers having debris perform erosion activity more abundently. The erosion process by glaciers is carried out in following ways :

(i) **Plucking or Quarrying :** This is the process in which glaciers move the rocks broken by weathering from one place to another. This activity is more vibrant at leeward slopes i.e. slopes facing away from the direction of ice movement.

(ii) **Abrasion :** Glaciers get power of erosion and friction when they carry debris with them. Big rocks move beneath the layers of ice and with the movement of glaciers these big rocks performs the friction acitivity on the banks and bed of valley, resulting in the increase of depth and breadth of valley.

(iii) **Attrition :** This is a process in which size of broken rocks decreases, because of their friction with each other or with Earth. Such frictional activity is called attrition.



Erosional Works of the Glacier

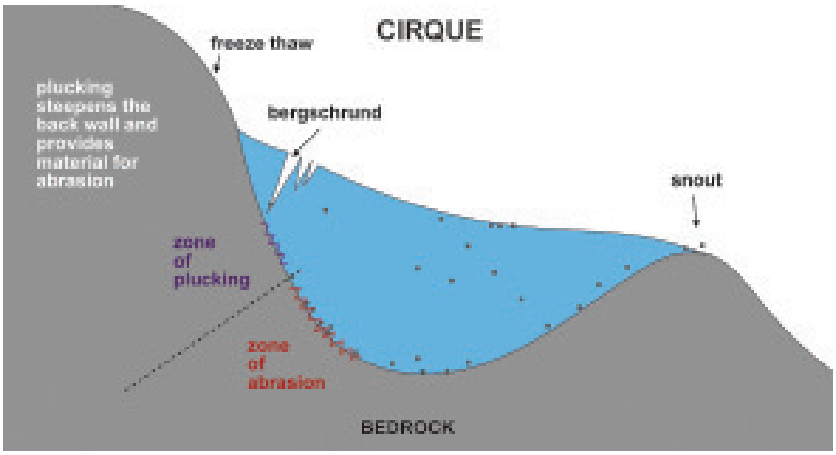
Following land forms are formed due to the erosion process of glaciers :

Crevasses

1. <u>Crevasses</u> : When a glacier moves, the speed is higher at central part as compared to its outer parts i.e. sides. The path on which glacier moves eroding it while moving, is known as pavement. During its movemet as glacier approaches some higher hindrance, it climbs over and then proceeds climbing down. In this process the upper layer of glacier develops vertical cracks which expand with passage of time. Such cracks are known as Crevasses. As a glacier proceeds further average or steep slope, these crevasses enjoin each other and glacier takes smooth form. These crevasses are very dangerous for tourists, because when these are covered by fresh snow, no one can judge that they might be 2 meter broad and 50 to 200 meters deep.

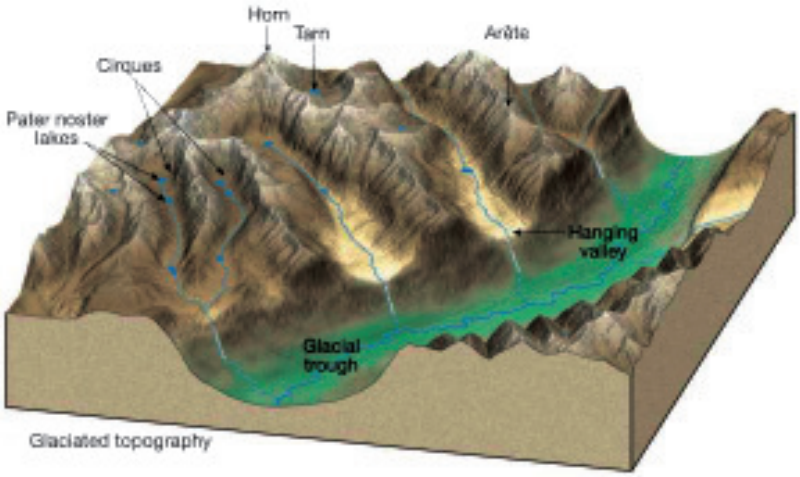
2. <u>Cirque</u> : 'Cirque' is a word from French language. If pits are formed by rivers on steep gradients, their size is increased by erosion process of glaciers. Further they are filled by ice and hence known as ice reservoirs. Their shape looks like 'resting chair'. These are also known as Berg-Schrund. Their size increases further because of freezing of 'Frost' and Snow. Sometimes a lake is formed in the centre of cirques, known as Torn. 'Cirque-de-Cavernic' is the world famous cirque. In Scotland, cirques are known as 'Corrie', in Germany as 'Karren', is Norway as 'Cron' and in

Scandenevia these are known as ‘Kessel’.



Cirque

3. **<u>Horn</u> :** As ice accumulates in a cirque at a particular height and takes form of huge ice reservoir, the breadth of cirque increases because of freezing of ice, resulting in erosion of rocks which fall in its path. In such conditions, sides of central point erodes and only the central point is left uneroded, which looks like a ‘horn’. ‘Matter horn Peak’ of Switzerland is the finest example of horn. When the ice of horn melts, a steep rock appears which is known as ‘Nunatak’. These forms are found in Greenland and Antarctica.



Glacial Topography

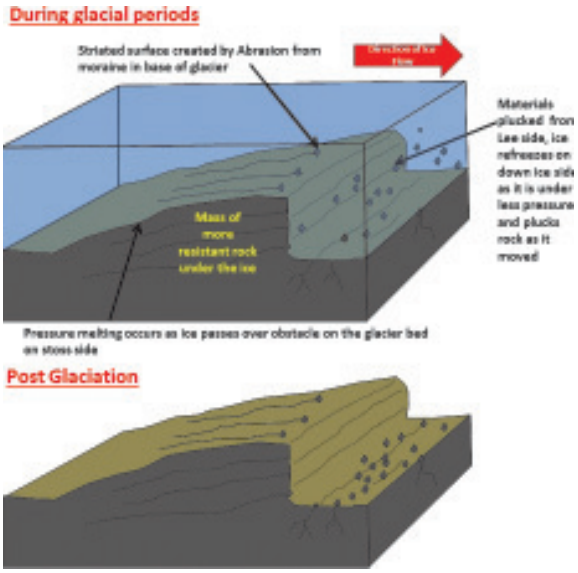
4. **Col or Pass :** When cirques are formed on both sides of mountain, some part of central Ridge also falls down with passage of time forming way/path which is known as 'Pass'. In Alpas mountains various passes have been formed by glacial activity. These are used for transportation purposes. 'Indira Col', situated in the nothern India, has big strategic importance for India, Pakistan, Afghanistan, Tajakistan and China.

5. Comb Ridge or Arete : When, on the both sides of ridge of the mountain, cirques have formed several horns and they look like Comb, that is known as Comb Ridge. Sometimes tips of high mountains also look extremely sharp and are known as Arete.

6. U-shaped Valley : When glacier moves in a pre-formed valley, the breadth of valley increases because of the erosion by the glacier. Due to this process valley looks like the shape of Roman alphabet 'U'. That is why it is known as U-shaped Valley.

7. Hanging Valley : Like rivers, glaciers too have tributaries. Main glacier increases the depth and breadth of its valley, the other glaciers moving towards this valley conjugate with main glacier, and form a steep gradient. After melting of ice, the level of valley formed by main glacier decreases as compared to that of glacial tributaries. Tributaries conjugate with main glacier as 'fall'. In this situation valley of tributary seems to be hanging in the valley of main glacier. It is known as hanging valley.

8. Sheep Rocks or Roche Moutonnes : 'Roche Moutonnes' is a word of French language which means 'Fleecy Rock'. Sometimes there are big rock forms in the path of a moving glacier, which cannot be broken easily. Glacier moves up on this rock and with erosion and friction, decreases its height without stopping at this point. This whole process results in the leveling of the windward side of rock and the leeward side becomes rough and steep. Due to this it looks like a sheep and is known as 'Sheep Rock'. From a distance it looks like back of a sitting sheep.

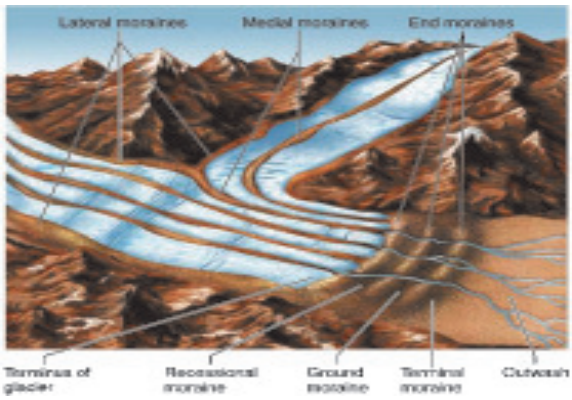


Transportation

Glaciers carry rocks, stones, soil, vegetation etc. along with them. The erosion process of glacier depends upon the debris it is carrying. Glacier performs the task of transportation in several ways. Debris comes on the surface of glacier because of weathering. The heavy part of debris moves down through the cracks. Due to the formation of other layers of ice on the top heavy debris keeps deposited in the lower layers but it also moves with the movement of glacier while moving various types of erosion and friction process are carried out by the glacier. Glacier can move heavy rocks weighing upto several tonnes, from one place to another.

Depositional work of a Glacier : As glacier melts or stops moving, it deposits the debris on the surface and its sides, which is known as glacier drift. When glacier looses its capability of carrying 'glacier drift', the debris is deposited which results in formation of various land forms :–

1. Moraines : On melting, glacier deposits its debris in the form of a heap. Rocks deposited are not uniform, and are of several types and different colours e.g. Soft rocks, which are also known as glacier flour, triangular shaped pieces, big rocks, whose diameter varies from some centimeters to 20 meters, are found in this debris. This debris is known as Till or Morains. Following are the types of Moraines :



Types of Moraines

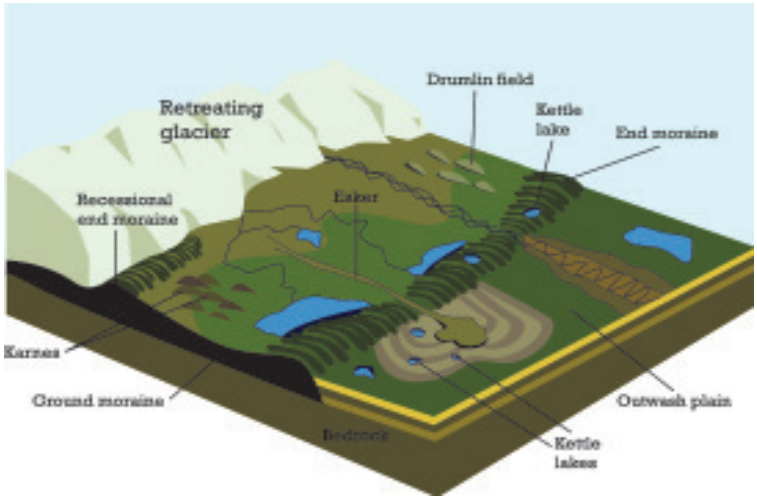
(a) **Lateral Moraines :** When pieces of rocks are deposited on the both sides of the glacier and are sometimes higher than even 100 feet. This form is known as Lateral Moraines. The thickness of moraines in Alaska, extends upto 350 meters.

(b) **Medial Moraines :** When two glaciers conjugate, the moraines of their sides also conjugate forming a single moraine. Huge variation is found in the width of these moraines.

2. Esker : Sometimes, ice melts at the lower parts of the glacier and water starts flowing beneath the ice forming tunnels in the glacier. Debris gets deposited in these tunnels. With the passage of time both water and ice disappears, leaving behind the

debris in the shape of long lines. This is known as 'Esker'. Its length varies from 10 meters to 100 kilometers and their breadth also varies from some meters to kilometers. These are found in Finland, Sweden, North England and Scotland.

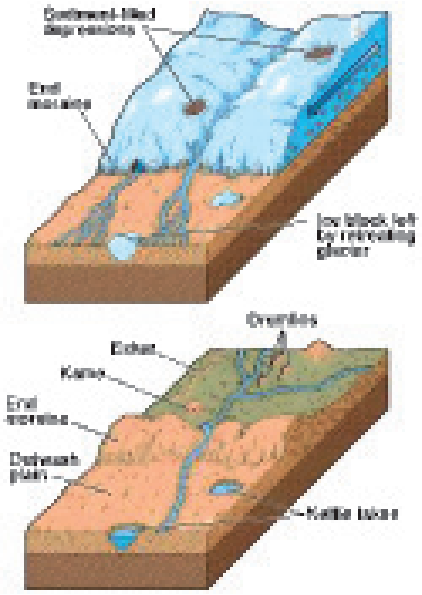
Esker



3. <u>Kettle Holes</u> : When glacier moves, pieces of rocks or stones fell on it. After sometimes with the melting of ice, small holes are formed in glacier. These holes are known as 'Kettle Holes'. These are found in North American Prairies.

4. <u>Kame</u> : When glacier melts, the soil and other items of debris deposited in the cracks, get deposited in form of mound. It is known as Kame. Examples of these are found in the parts of Scotland, Finland and Canada.

Graphic of Glacial Topography



5. <u>Outwash Plain</u> : When a glacier passes through the ice tunnels and deposits the sediments at a distance or in simple words when a glacier make its last moraine, the melted part of the glacier takes away light soil and deposits it in the form of layers and such deposits attain the form of plains. This is known as 'Outwash Plain'. This particular name is given to this landform because all the material has been taken from the last moraine. In Icelands these are known as 'Sandur'.

Are we still living in 'Ice Age' or it has been finished ? (The time Period of 25 lakh years ago is accepted as 'Ice age'). Presently also, the region covered with snow/ ice give us the answer 'Yes'. But if the human activities continously act as a reason behind the melting of ice then definitely we will loose the glaciers. Global warming and Green house gases are major cause of melting of ice.

In India, Himalayan mountains are house of snow. Total area of Himalayas is 5 Lakh Km^2 out of which 33,000Km^2 is covered by snow. This mountain region has 15,000 glaciers 'Siachin' glacier which is situated in Nurba valley, is the largest glacier (after poles). It covers the area of 450 sqaure kilometers. Gangotari glacier is the source of river Ganga. Baltoru and Godwin Austin are also big and important glaciers.

Activity :

Write the names of seven biggest glaciers of the world and paste their pictures in your note book.

EXERCISE

1. Answer these in a sentence or two :

(a) Which is the largest glacier in India ?

(b) Which is the largest glacier in the world ?

(c) How much area out of total area in Himalayas is covered by glaciers ?

(d) Where is 'Indira Pass' situated ?

(e) What is the increase rate of temperature of Antarctica per decade ?

2. Explain the difference :–

(a) Lateral — Medial Moraines

(b) Drumlines — Esker

(c) Cirque — 'U' shaped valley

3. Give the answer to the following questions in detail :

(a) What is a glacier and what are its types ?

(b) Glacier is an important source of denudation. How ?

(c) What forms come up with alluvial deposition of a glacier ? Write in detail.

(d) What are the landforms that take shape by erosion process of glaciers, Explain.

(iii) Denudation Works of Wind

Air moves because of atmospheric pressure and this moving air is known as wind. Winds blows because of variations in air pressure. Wind always blows from high pressure to low pressure. The direction from which wind is coming gives it the name of same direction. Winds perform denudation activity also but their erosion and transportation capacity is low as compared to water. They work well in dry and desert areas. Desert areas receive rainfall less than 25 centimeters annually and have high temperature. Because of these conditions these areas do not have any vegetation and moreover there are not many obstacles in the flow of wind. Most of the deserts of the world are situated on the western side of continents (20° to 30° N & S latitudes). The south western semi-arid part of Punjab also resembles to desert region. Winds help in the process of denudation in desert areas generally because of following reasons :

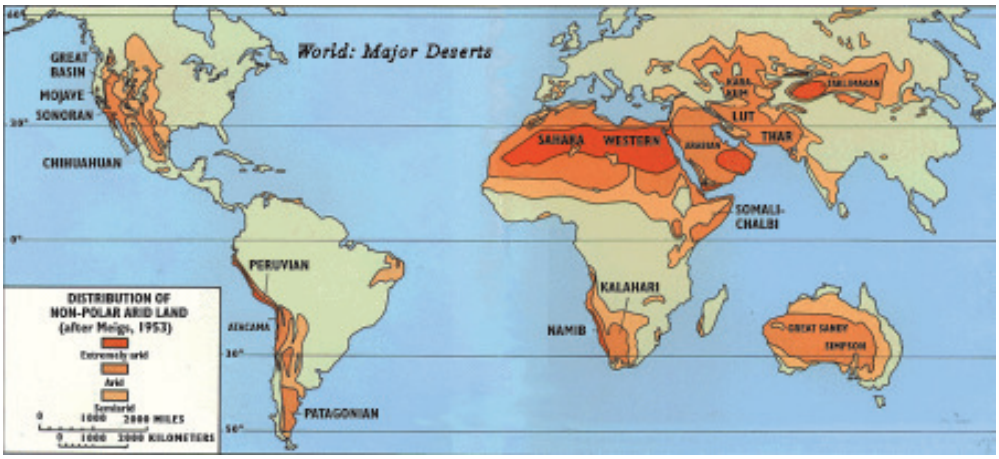
(i) Deserts are completely different to moist regions. Chemical weathering is common in moist or wet areas but in dry areas only regional weathering is possible. 'Salt wedging' is one of its example.

(ii) Desert regions which receive low rainfall and have low vegetation, help winds to carry out denudation process easily.

(iii) Large regions in deserts are impermeable because of which the underneath layer of Earth has no moisture.

(iv) Deserts which have high soil content, expand because of heavy winds and scanty rain. Their size increases continuously.

(v) Most of the rivers of such regions are seasonal or ephemeral. They flow during rainfall sessions and for short span of time. So, because of less rainfall, vegetation in desert areas is very less and winds feel free play important role in denudation process. Only thorns and shrubs are found in desert areas.



World Distribution of Deserts

On the basis of erosional and depositional works by winds, deserts may be classified into three types :

(1) **Soil Desert :** Sand in the major constituent in such deserts. Wind easily transports sand particles. In Sahara, these are known as 'Ergs'. In Turkmeinistan, these are known as 'Koun'. The biggest erg is situated in Khalis, Saudi Arabia. Its area is 5,60,000 sq. km.

(2) Stony Desert : These are formed by rocks, stones etc. Reg in Algeria is its finest example.

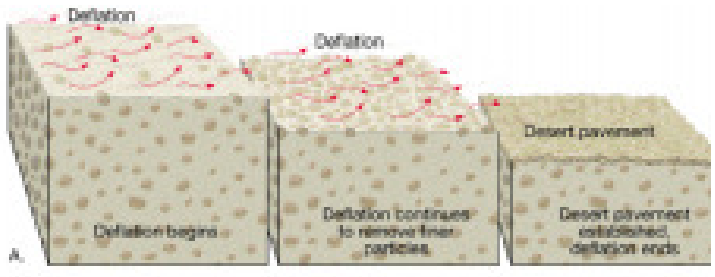
(3) Rocky Desert : These are barren regions, where the upper soft layer vanishes, leaving behind only rock heights/rocks and barren land. Hammada (Barren Bed Rock) in Sahara is its example. Its name 'Hammada' also originates from Sahara.

Rocky Desert

Sahara is the largest desert of world which is situated in Africa. Thar desert of India is a hot desert which includes parts of Rajasthan, Gujarat, South West Punjab and Pakistan (Punjab and Sindh). Some cold deserts are also found in Central Asia. Atacama desert of South Africa is the driest desert of world, it receives annual rainfall less than 1mm.

Wind Erosion : Like other means of denudation, winds also perform erosion and friction activity. Winds carry rock and soil particles from one place and when their speed reduces they deposit those particles. Erosion process may be divided into three stages:

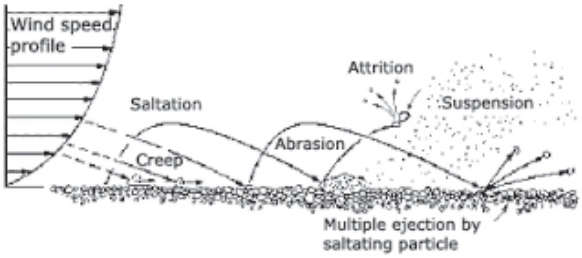
1. <u>Deflation</u> : High speed winds pick up soil and rock particles, resulting in the decrease or shrinking of upper layers. This process is known as deflation. Sometimes due to this process hollows are formed, which are mostly small in size but their diameter may extend from 1 to 15 kms.



Deflation

2. <u>Abrasion</u> : High speed winds carry soil and rock particles, small pieces of rocks etcs. This debris act as 'sand paper' and performs erosion and friction activity on other rocks which is known as abrasion. These are also known as tools of wind.

3. <u>Attrition</u> : Sand particles carried by winds, start friction process with in itself and because of this their size reduces. This is known as attrition. Erosion process of high speed winds is also fast. Soft rocks break down easily but on the other hand erosional process is long in case of hard rocks. Small particles are transported upto long distances but big rocks and stones (of 5 to 8 centimeter radius) cover only small distance. Wind erosion results in the formation of various land forms, which are as follows :



<u>Abrasion and Attrition</u>

1. <u>Oasis</u> : During deflation the upper layers of stones are eroded by high speed winds and rocks having water appear on the surface. Because of this underground water oozes out (comes out) which is known as Oasis. Any type of vegetation and human life is possible around oasis. These landforms are found in desert regions of Algeria, Libya and Thar in India.

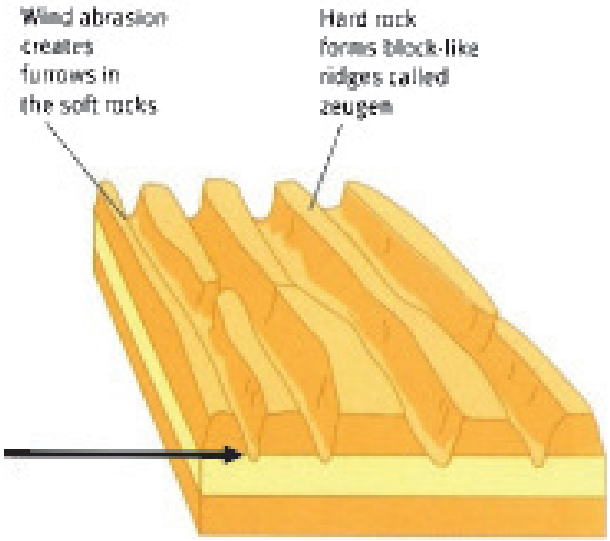
Formation of Oasis

2. <u>Needles</u> : Complete to erosion of soft rocks by high speed winds allows steep gradient rocks stand uneroded and still. They look like needles and therefore known as rocky Needles.

3. <u>Mushroom or Pedstal rocks</u> : Wind erosion takes place at the average height of 1 meter from the Earth's surface. While above height of average 2 meters, erosional process is again very low. Resultently middle portion of vertical rocks is eroded by high speed winds and after erosion rocks look like mushrooms. In Sahara desert such land forms are known as 'Gaur' and in Germany these are known as 'Pitzfelsen'. In India, these are found in 'North-West' Jaisalmer (Rajasthan) generally.

Mushroom Rock

4. <u>Zeugen</u> : 'Zeugen' is a word from German language which means 'Like Table'. When soft rocks covered by hard rocks are eroded by winds, hard rocks left behind looks like table and known as 'Zeugen'. Their length may vary from 1 meter to 30 meters. Along with winds, rainfall and weathering also help in formation of 'Zeugen'.



Zeugen

5. <u>Yardangs</u> : Winds blowing continuously in one direction result in the erosion of zeugen in one direction/ side only. Zeugens are eroded much from winward side and less from leeward side. This process forms a very queer structure of these rocks. The ratio of these structures (length and breadth) varies from 3:1 and 4:1 and average height is around 8 meters. In India such landforms are found in Jaisalmer (Rajasthan).

Yardangs

6. <u>Stone Lattice</u> : At times rocks are formed by the combination of both soft and hard types of stones. Soft rocks and soft parts of such formations get eroded by winds and only hard parts are left behind which make formations look like 'net'. These are known as Stone Lattice.

Driekanter

7. Driekanter : The direction of winds is never fixed and in the absence of vegetation in a desert, various rocks get eroded continuously in the direction of wind. With such continuous and all directional erosion, rocks attain a triangular shape and these are known as Driekanter.

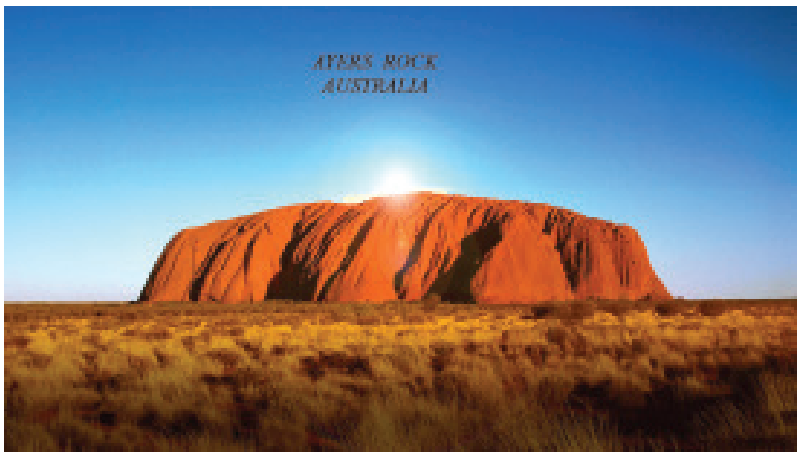
8. Window & Bridge : Continuous erosion by high velocity winds forms holes in the rocks. Such holes are called Wind Windows. Further, the combined action of deflation and abrasion makes the wind windows larger and wider which assumes an arch like shape with solid roof over them. Such land forms are called Wind Bridges.

Utah Rainbow Bridge (U.S.A.)

9. Demoislle : Some hard rocks are wrapped all round by soft rocks. With the continuous wind erosion soft rocks get vanished leaving behind the hard rock, which looks like a pillar. This pillar formation is known as Dermoislle.

10. Lag Deposits : Fast blowing wind carries lighter particles like sand, small pebbles and stones with it. While heavier stones and other big particles lag behind. These particles look like a layer of heavy stones and rubble. Such layers are very common in desert regions. In Sahara desert such lag deposits are known as 'Hamada' in local language.

11. Inselberg : Wind erosion makes desert appear/look like plain but at some places some small mountains of solid rocks are found. These mountains are kwnon as Inselbergs. Mt. Aabu (Graynite Inselberg) and Sendra near Pali are the finest examples.



Ayers Rock
Australia

Transportation by Winds : Wind transports pieces of rocks, soil, stones etc., like rivers and glaciers, from one place to another. Although winds erosion is less effective as compare to that by rivers but it may be seen clearly in deserts. Transportation of particles takes place in different ways. High velocity winds can transport heavy debris from one place to another but on the other hand slow speed winds transport light weight particles only. Sometimes heavy and large pieces of rocks are not picked by winds but they roll on ground along the wind direction.

A dust storm having diameter of 500 km can pick up 100 million (10 Crore) tons of soil. It has a capacity of forming a 30 meters high mountain with a base of 3 kilometers. Delhi experienced a dust storm on November 14, 2014. Its speed was 90mph and resulted in loss of life and property. Thick dust storms in Thar, sometimes reduce the visibility to hardly three feet and the particles being transported by such storms cause heavy losses also. The size of particles moving with high vilocity winds decreases because of friction produced in itself. When the speed of wind decreases, debris starts depositing.

Shifting of Sand Dunes : Direction of wind is not fixed because of this sand dunes are not stable, they shift according to the direction of wind. Shifting sand dunes is harmful for fertile plains. Fast growing and deep root plants are planted in desert regions to control this process. They may shift from 5 to 30 meters per year.

Depositional Work of Wind : Deposition work of wind may be divided into two parts namely :

1. Sand Deposition and 2. Clay Deposition.

(1) Sand Deposition : Following landforms comeup under this head :–

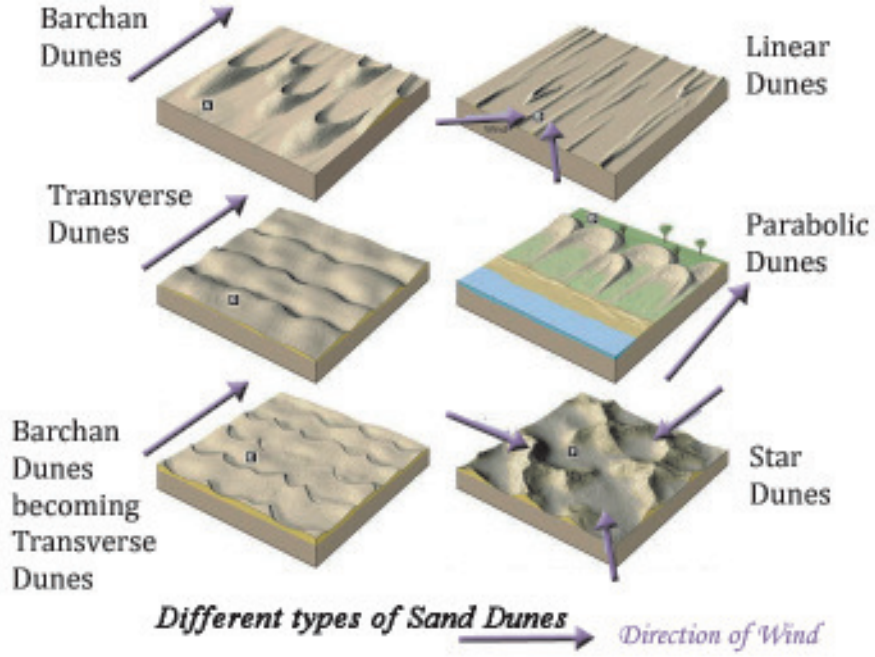
(a) **Ripples :** Low speed winds deposit the particles in the shape of waves, which are known as layers of sands or sand ripples. The inter-difference between these waves may vary from few centimeters to few meters. The windward side of Ripples is generally angular at 8° to 10° while leeward side is angular at 20° to 30°. Their height rises to a few centimeters only.

Sand Ripples

(b) **Sand Dunes :** Velocity of wind carrying sand decreases when it faces some obstacle and therefore wind it starts depositing the sand particles on the spot of obstacle only. Resulting in the formation of sand dunes. Any shrub, big rock, skeleton of an animal, upland area can act as such obstacle. The height of sand dunes may vary from some meters to 150 meters and their length may vary between 3 kilometers to 150 kilometers. Sand dunes may be of many types :–

Sand Dunes

(i) **Barkhan :** Half moon and crescent shaped sand dunes are known as Barkhans. These are convex on windward side and steeper and concave on leeward side. They might be high upto 30 meters and their length varies from 150 meters to 200 meters.



(ii) **Seif or Longitudinal Sand Dunes :** Seif is an Arabic word which means 'Sword'. These sand dunes are generally oriented in a direction parallel to prevailing wind but when the dunes blow out, sand gets deposited in parallel forms. These may raise to 100 meter high and their breadth varies from 500 to 600 meters. These are not shifting sand

dunes. These are found in areas where high velocity winds blow. These are found in Sahara Desert (Africa), Thar Desert (India).

(iii) **Coastal Dunes :** High velocity winds blow in coastal areas because of this, waves deposit sand on the coasts of oceans. Blowing wind gives it a form of 'Sand Dune'. With the growth of vegetation in these areas, curved sand dunes are formed and sometimes they also look like Barkhans. These are found in Atlantic coastal regions. In Southern France, there is 240 kilometers long dune along the coast covering 3 to 10 kilometers in inland areas. On the Western coast of India, sand dunes (coastal areas) of Goa are famous for their beauty.

2. Loess Plains : Winds deposit light and soft soil over a large area like a blanket, these are known as plains of Loess. 'Loess' is a word of German language which means yellow colour, porous soil with very soft particles. Generally, these particles are of same size.This soil does not have layers and it is friable. When we press it crumbles easily. During rainfall it becomes very sticky, on the other hand in summer it becomes very dry. Loess is found in China, Europe, North America, South America and Africa. The name "Yellow river" in China is also given on the basis of their soil because when it mixes with river water, water appears to be yellow in colour.

Loess Deposits in China

Wheat and Maize is grown in Loess plains and more over soil erosion is also very (low/less) in these plains. In India this soil is found in Kashmir and in Pakistan it is found in Potwar plateau.

Activity :

- Show the 'Thar Desert' in the map of India
- Make a model of Landform that is made by winds.

EXERCISE

1. Answer the following in few words only :

(a) Which is the largest desert of world ?

(b) How many types of deserts are there ? Write their name also ?

(c) What is an 'Arg' ?

(d) Are the sand dunes always stable ?

(e) What is the colour of Loess soil and which crops are grown in this soil ?

(f) What is the difference between air and wind ?

(g) What do you mean by porous rocks ?

(h) How the coastal sand dunes are formed ?

2. What is the difference between the following :

(a) Barkhan — Loess

(b) Stone Lattice — Driekanter

(c) Zeugen — Yardang

(d) Oasis — Inselberg

(e) Rocky desert — Stony desert

3. Write the answer of the following in 100 words :

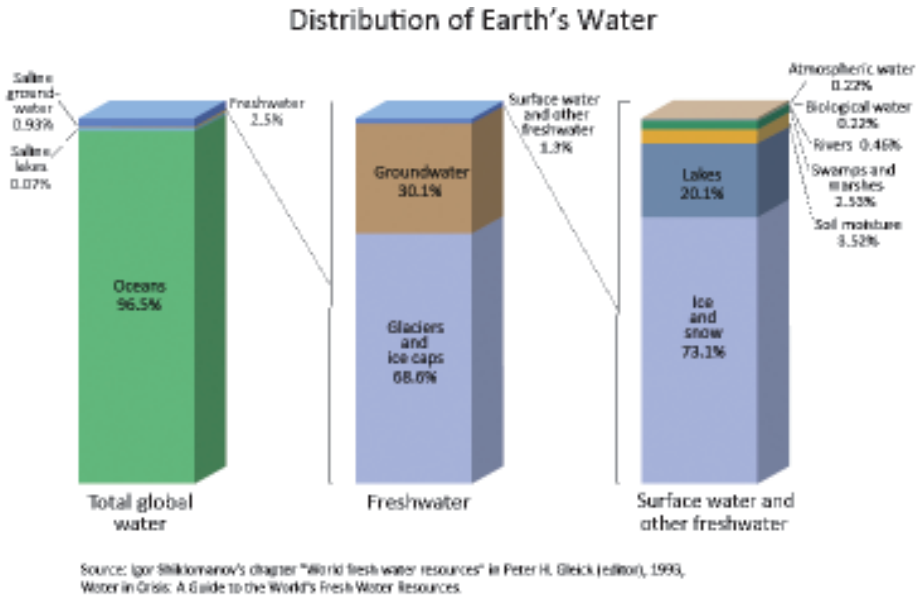
(a) Winds are the source of erosion in deserts, Explain.

(b) Which are the landforms that are made by soils during erosion process ? Explain.

(c) Write in detail about the deposition process of winds.

(iv) Denudation works of Underground Water

Water plays an important role in changing shapes over the land although. Its amount is not uniform at all places. At some places it is found an abundance and at other its quantity is very small. When Surface water seeps into Earth through porus rocks, it is known as underground water. Although flow of underground water is similar to that of overground water yet, the speed of flow of underground water is too less and because of this its geographical weathering activity is also low while chemical weathering activity is high. Moreover, clean water does not involve in any activity but while seving into Earth various chemicals get mixed in it. We find the work of underground water in the regions with rich chalk, Limestone and Dolomite contents.



Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources

A geographical distribution of the location of water on earth :

Works of underground water are not much visible on the upper layer of Earth. Mankind extracts it out to fulfill their various needs. e.g. Agricultural and house hold, etc. Sometimes it naturally comes out from Earth through natural openings like springs, wells, Geysers, etc.

* If in any region, rainfall is high and rate of evaporation is low then the level of underground water will be high.

(A) Springs : When the water oozes out naturally from Earth i.e. on the upper and outer most surface, that flow is known as 'spring'. Mostly springs are found at the junction or fissures and joints of Porus and Nonporus rocks. In India these are found in hilly regions of Jammu Kashmir, Manikaran (Himachal Pradesh), Bihar and Assam. There are various kinds of springs :

(i) **Hot water spring / Thermal water spring :** These springs have hot water and are found in volconic regions. In Himachal Pradesh, langar is cooked with the help of heat generated by such springs at Manikaran Sahib.

India is planning to install its first geothermal plant, which will produce power upto 3 to 5 MW.

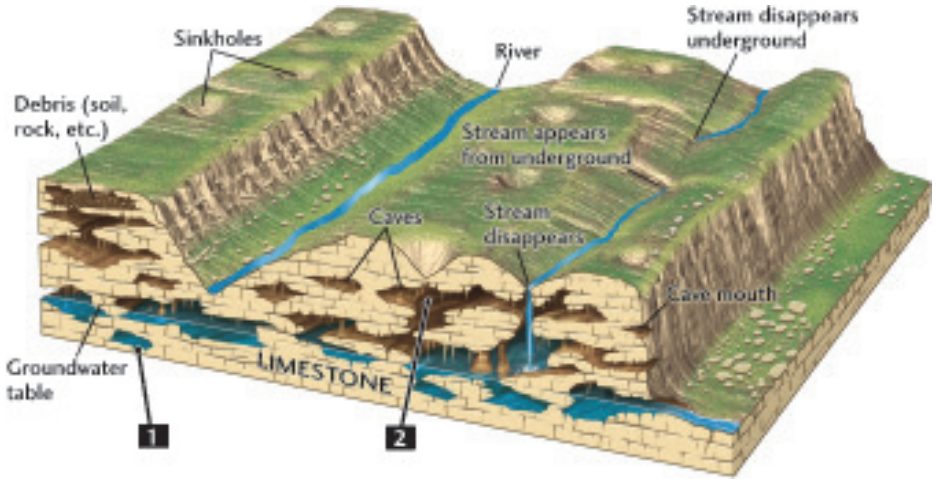
(ii) **Cold Water Springs :** These springs provide cold water and are mainly found in Himalayas, Western Ghats and Mountains of Chhota Nagpur Plateau.

(iii) **Mineral Springs :** These springs have mineral and salts in their water. These are very helpful in the treatment of skin discases. Such springs are found in Manikaran, Manali (District Kullu), Sahashtradhara (Dehradun), Tilsma Rajasthan when water flows continuously from a spring, it is known as Permanent spring.

(iv) **Geysers :** When lots of steam oozes out as fountain alongwith hot water, such form is known as geyser. These might raise 30 to 60 meters high. The old faithful geysers of Yellow Stone National Park, Situated in Rocky Mountains of USA, comes active for four minutes after sleeping for 65 minutes at average. Iceland, parts of Rocky Mountains of USA, North Island of Newzealand and Yellow stone park of wayoming state in USA are known for Geysers and Hot water springs. Total number of geysers in the world is 425 and out of these, 225 are situated in Yellow Stone Park of (USA America) This region has 24000 springs of hot water and around 100 geysers.

Some Geysers continuously ooze out on the Earth's surface and their temperature is 100^0C (or 212^0F). Some Geysers collect very less debris and some of them make a cone like nozzle. Most of the Geysers spread mineral deposits on the area around them.

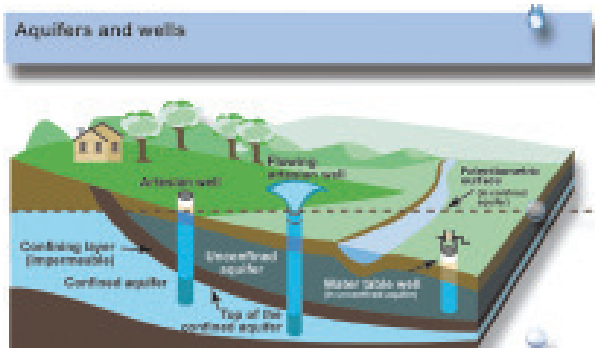
(B) Well : When underground water flows beneath the surface through a hole, that is known as 'well'. If the well is not deep then the water does not come out continuously and that is known as 'Intermittent well'



Works of Underground Water

Old Faithful Gyser Yellow Stone National Park (U.S.A.)

(C) Aquifer : This is a word of Latin language which means 'to bear water'. An underground permeable rock is present which contains water and an impremeable rock is situated below the permeable rock, thus a reserviour of underground water is created. 'Aquifer' is a natural filter which purifies various types of



Ground Water Aquifers

sediments and bacteria. 'Aquifers' get polluted if waste material is thrown in them and moreover septic tanks, medical waste (Injections, Medicine), Fertilizers etc. also create problems if constructed or piled near the aquifers.

(D) <u>Artesian Well</u> : The word Artesian has been derived from the word 'Artois', which was the name of a province of France where first Artesian well on the Earth was dug in 1126. It is a limited Aquifer in which water comes out through well because of pressure even without using a pump. Great Artesian basin is the world's largest and deepest Artesian basin, which extends over 23% part of Australian continent. Australia has 9000 Artesian wells, maximum in the world. In India these are found in Indora Tehsil of District Kangra (HP), Mukerian Tehsil of District Hoshiarpur (Punjab), Tarai, Pudduchery, Tamilnadu, Alluvial soil areas of Gujrat etc.

Underground water as an agent of denudation

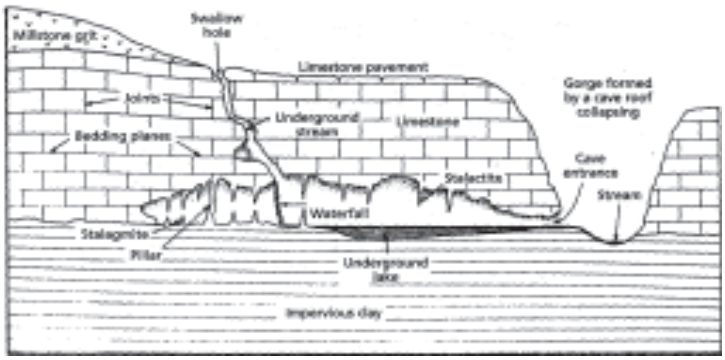
Underground water also performs erosion, transportation and deposition activities. The speed of underground water is very low. If 'KM/Hr' unit is used for speed of river then 'meter per day' is used for underground water. Because of this its activities may be seen only in regions having soft rocks or regions with Limestone, Dolomite etc. As topography, underground water forms 'Karst topography' in areas which have limestones. In India this is found in Chirapoonji, Jammu-Kashmir, Himachal Pradesh, Panch Marhi (M.P.), Bastar (Chattisgarh and Coastal areas near Vishakhapatnam.

*Karst means barren land. This word has been derived from Kars or Kua, which is a plateau region situated in Slovenia (former Yogoslavia).

'Karst topography' is also found in the areas having Dolomite, Gypsum or Halite, (Rock-salt).

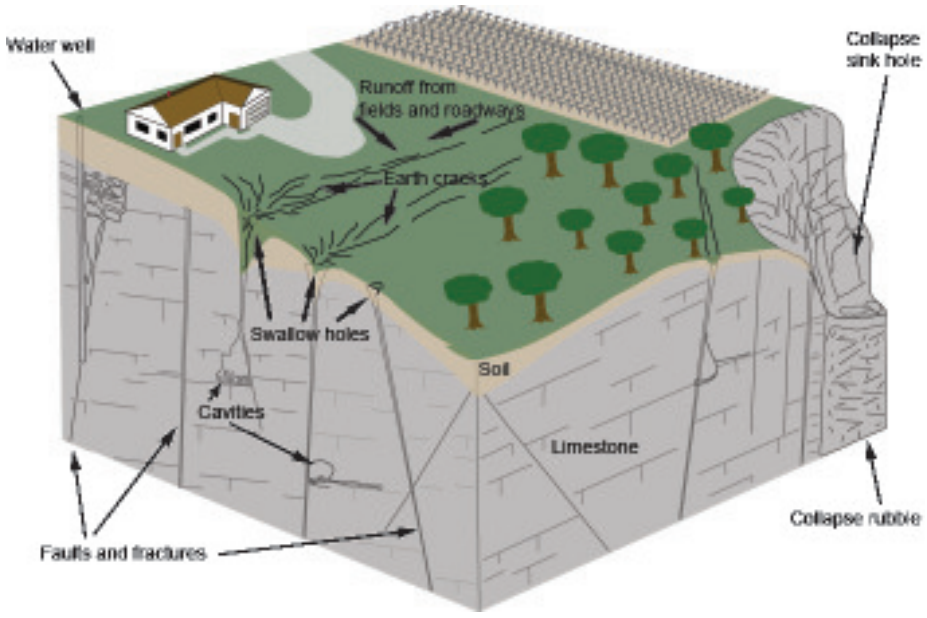
Following land forms are formed by denudation activity of underground water :

1. Lapies : In German language these are known as 'Karren' and in English these are



Erosional work of Underground Water

known as 'clint' while Lapies is a french word. When underground water contains Carbondioxide in it, dissolving process of 'lime stone' rocks begins. Because of this breadth of cracks and joints increases, which are known as 'Lapies'.



Sink Holes and Swallow Holes

2. Sink holes : Sometimes Lapies gets deep like funnel forming a sink hole. Its depth may vary from a few centimeters to some meters.

3. Swallow holes : When the size of sink holes increases, these are called swallow holes.

4. Doline : Due to high chemcial activity on swallow holes, their size and depth increases. Its diameter may extend upto some kilometers and depth may run upto 100 meters. Mostly such forms are found in tropical regions.

5. Karst Lakes : When the lower part of Dolite is blocked because of debris formed by its own erosion, water gets collected as reservoir. This is known as 'Karst Lake'.

6. Uvalas : A reservoir is formed with the conjugation of many sink holes. This is known an Uvala.

7. Ponar : When Uvalas are filled with water, high erosion activity converts it into a tunnel like structure, which is known as ponar.

8. Caverns : In lime stone regions the flow of rivers are not outwards but is inwards. it dissolves its own bed and forms a large cave called 'cavern'. The roofs of such structures are called Chambers. In India these are found in Chattisgarh and Chirapoonji.

9. Natural bridge : When roofs of caverns collapse, some of its parts are left behind, which look like a bridge. This is called natural bridge.

Depositional work of Underground Water :

Underground water dissolves the rocks but when it deposits this dissolved materials various types of forms are created :-

1. Stalactite and Stalagmite : These are fromed in a region rich with lime stone, where caverns have been formed. Lime water seeps down-ward from these caverns during this activity some of drops hang with the ceiling of cavern. Due to evoporation, water gets evaporated and the hanging structure of lime is left, which is known as 'stalactite'. Its breadth is more near the ceiling as compared to its tip.

The drops of lime water which fell on ground, get evaporated and only a structure made of lime is left behind. This is known as 'Stalagmite'. Its width on the ground is more as compare to its tip. Sometimes both stalactite and stalagmite combine to form a pillar which gives an impression of a cavern on the whole. 'Zenolan lane' in Sydney (Australia) is its fine example which is around 100 kms deep. Another natural cave or cavern is at Tirlokpur falling on Pathankot-Dharmshala Highway, which is thousands of years old.

China, India and USA are top three nations which use underground water for agriculture the most. Central Ground Water Board, established in 1970, has carried out 21 pilot projects to recharge the underground water artifically in Amritsar, Jalandhar, Patiala and Sangrur districts of Punjab.

Underground water is very important and it must be used properly. In Punjab the level of underground water is decreasing day by day (continuously). Its level is extremely down in 85% part of the state. Low rainfall is one of the primary reaons behind the situation. Annual average rainfall has been decreased upto 45-50%. Annual rainfall in 1990 was 755 mm. which has come down to 375 mm in year 2004. In 2009 it was 420 mm and in 2014 it was recorded 600 mm.

Cultivation of 'Rice' is another reason. Rice is planted on 2/3 part of Punjab before June 15 ever year, which increases the need of irrigation and moreover during this

period evaporation is also fast due to hot weather. In these conditions underground water is used to fulfill the requirement of water, Around 73% Irrigation depends on the underground water and all this has resulted in banning of use of underground water at a few places. Hence it is our duty to use underground water properly.

Activity : What can we do to save underground water for our future generation? Discuss this in the your class with the help of your teacher and also collect the information about the number of wells and tubewells in your area.

EXERCISE

1. Give the answer to the following questions in one or two words :

(a) In which State of France, first ever Artesian well was dug ?

(b) Write the names of hot water springs of Kullu Valley.

(c) In which country 'Old Faithfull Geyser' is situated ?

(d) At which places of India, cold water springs are found ?

(e) What was the Annual/Monsoon rainfall of Punab in 2014?

2. Write the answer of the following questions in detail :-

(a) Underground water is a source of denudation, How? Write in detail.

(b) What is the depositional process of underground water and what landforms are created by this process ? Explain with Illustrations.

3. What is the difference between the following :

a. Lapies - Doliane

b. Stalactite - Stalagmite

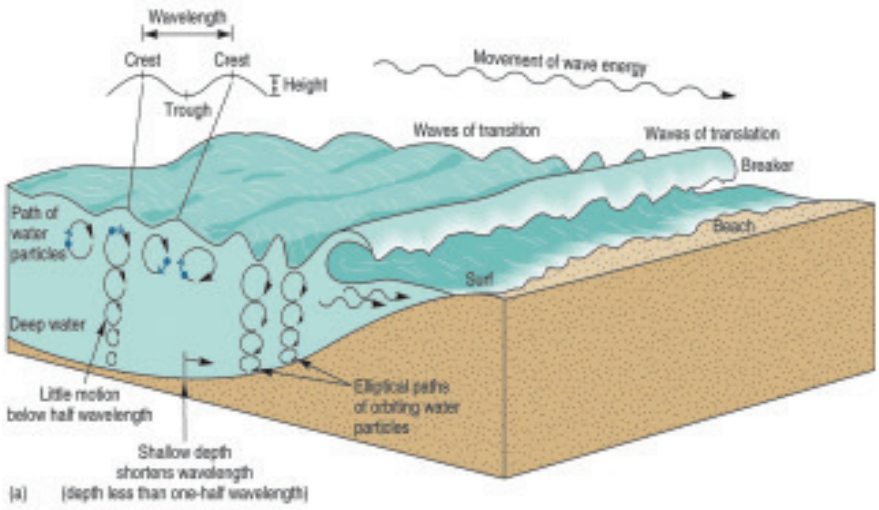
c. Well - Artesian Well

d. Geyser - Spring

(v) Denudation Works of Sea

Like river water, sea water also performs denudation acitivity in the form of waves, currents and tides. Because of this various landforms are formed but obviously this process takes place only in coastal regions. Coastal regions are totally different to non-coastal regions.

The speed and velocity of waves depends on the speed of winds. Sea water rises because of direction, pressure and friction of winds. The part of water, which rises is 'crest' and the lower one is known as 'trough'. Rocks, stones, sand, soil etc., present in high speed waves increase the erosion capacity of waves. Sea water also performs erosion, transportation and deposition activities.



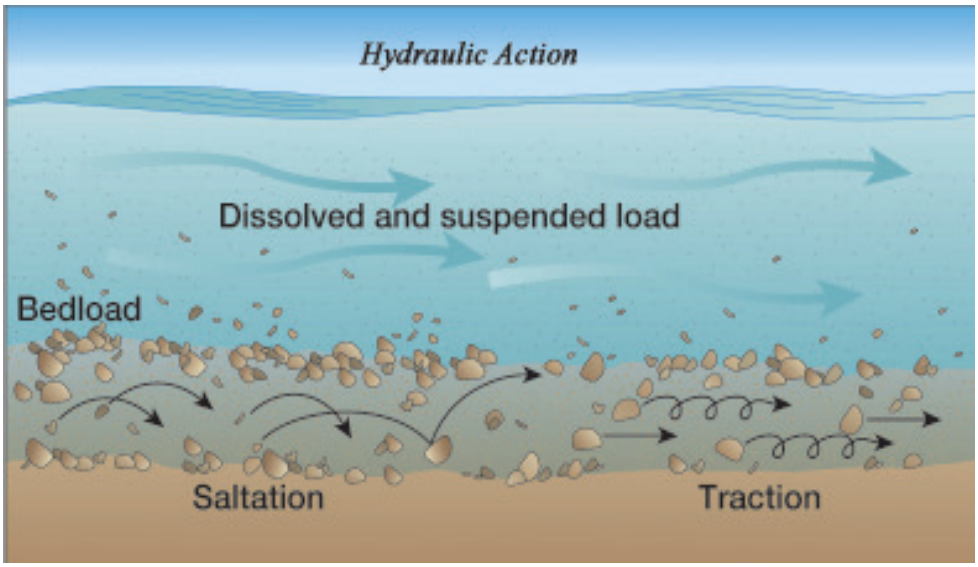
The Graphic of Sea Waves

- Coastline is a place where Hydrosphere, Lithosphere and Atmosphere meet.

Erosional work of Sea Waves: Erosional work depends on the speed and power of waves, gradient and height of the coast and moreover depth of sea. Erosion process is not uniform at all the places.

Erosion of hard rocks is slow but in case of soft rocks it is very fast. During rainfall water level increases which accelerates erosion. Plants and animals reduce the strength of rocks by making holes in them. Presence of sand, soil, rocks, stones etc. in waves increases the erosion. Any hindrance in the way of waves gives it the name as 'braker waves'. A number of braker waves when flow towards coast, these are known as 'surfing waves'. At times the 'might' of these surfing waves is to such an extent that

these exert a presence of 3000 kilometers per square meter to 30,000 km per sq. meter on the costal rocks.



Hydraulic Action in River

Waves can perform erosion activity in four ways :

(a) **Hydraulic Action:** Rocks are broken when waves having debris (rocks, soil, sand, stones etc.) strike with huge force.

(b) **Abrasion:** When both waves and currents break the rocks this happens when waves strike with rocks again and again. It is a frictional force and known as abrasion.

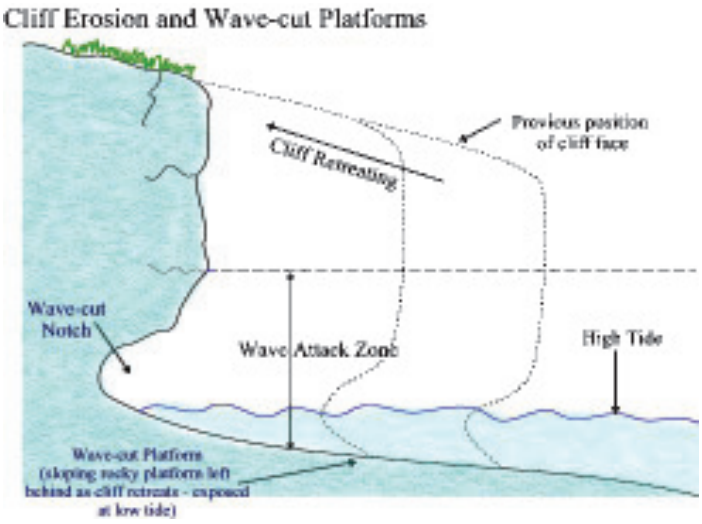
(c) **Attrition:** It is because of waves, when the size of pieces of rocks decreases or they are grained, this process is known as Attrition.

(d) Solution: Soluble rocks like limestone, dolomite, chalk etc. dissolve in sea water. This solvent action is limited to certain areas only.

When a wave strikes it starts erosion process, resulting in the formation of following forms:

1. Sea Cliff: Waves erode the lower part of the coastal rocks, first because these are at sea level. Sometimes the lower parts of rocks are soft and get easily eroded. The upper part of these rocks look 'high', which is known as cliff. It has a steep gradient.

Sometimes waves make a hole in lower part of the cliff with erosion activity, know as 'notch'. The size of notch increases with the passage of time and sea caves are formed.

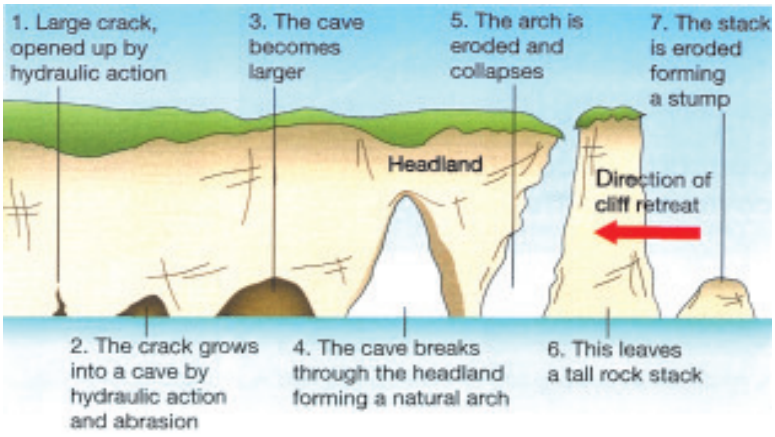


Cliff Formation

Cliffs situated on the western coast of India are the finest examples.

2. Sea Caves: With the passage of time, size of 'Notch' increases due to erosion and a large pit is formed in the lower part of cliff. This is known as sea cave.

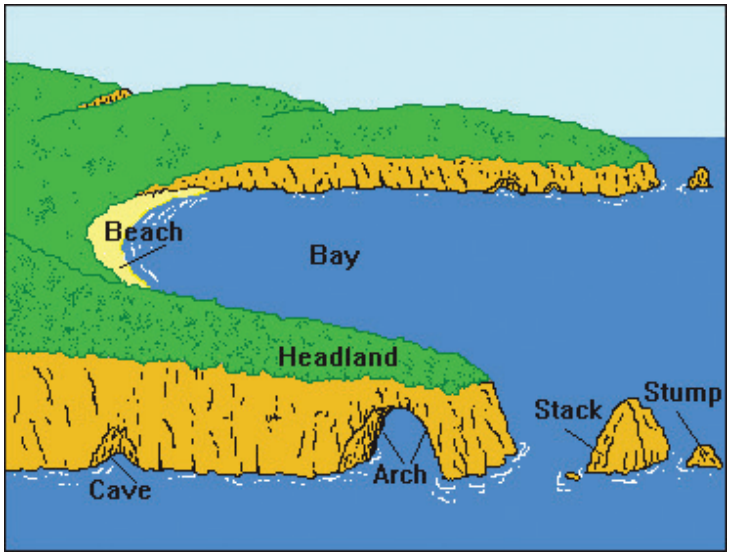
3. Arch or Natural Bridges: If at any coast,Waves strike on both sides of caves and form a hole, such structure is known as sea arch, moreover it looks like a natural bridge.



Natural Bridge or Arch

4. Stack: Natural arch collapses due to erosion, leaving steep and often vertical columns of rock, which is known as 'stack'.

5. Stumps: When stacks get eroded by the waves, they collapses, leaving behind a stump. Stump usually forms a small rock island, low enough for a big tide to submerge.



Sea Stump

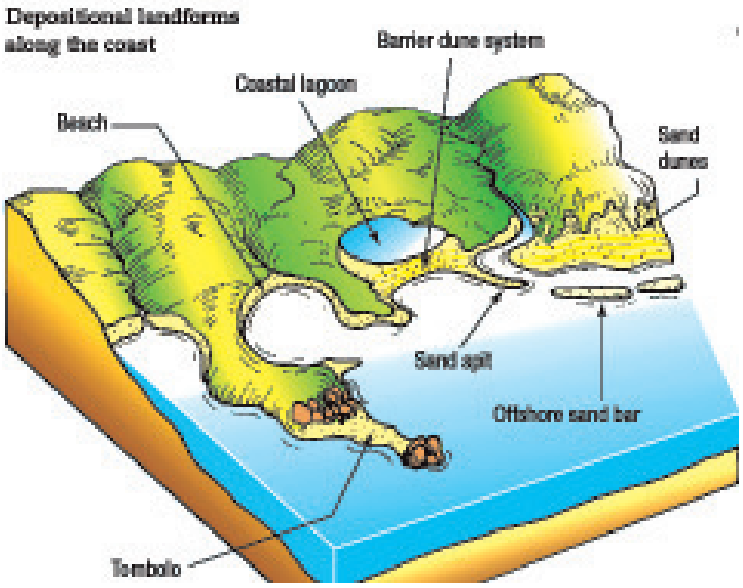
6. Spouting horns or Blow holes: Due to erosion, the cracks of sea caves form a hole in the roof of the cave, which is known as spouting horn or blow hole. Actually when the water rises into sea cave, already available air starts dashing out through the hole in cave roof, creating whistling sound. This sound gives it the name, Spouting horn

Blow Hole

7. Breaking of Sea caves: When high speed waves strike with huge force on cave, they create pressure on the internal air upto such extent that cave break down into pieces. Inspite of this sometimes large number of blow holes are formed in caves because of which it losses its strength and collapses. With the break down of cave a narrow inlet is formed which is known as '**geo**'.

8. Caves: Sometimes on the coast, soft and hard rocks are situated parallel to each other. When soft rocks are eroded faster with the hard rocks surrounding them, small gulfs are formed which are known as caves.

9. **Creeks and Bays**: When soft and hard rocks are situated in vertical positionand continous erosion by waves erodes soft part of these rocks resulting in formation of deep and narrow inlets known as 'creek'. With the passage of time their depth and breadth increases which is known as 'Bay'.



Creek and Bay

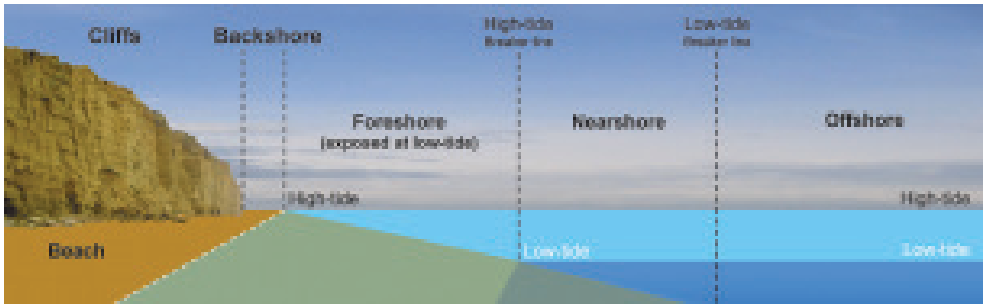
10. Headland or Cape: Sometimes a hard rock is surrounded by soft rocks and erosional activity of waves leaves only hard rock standing vertically ahead of it surrounding. Such form is known as headland or cape.

Transportation by Sea Waves :

Waves pick up the rocks, stones, soil etc. formed by the process of weathering and bring them in sea water. High speed waves bring shells and other materials on the coast, people collect these for manufacturing of material used for decoration purposes.

Shells are direct source of Calcium Carbonate and it is used for increasing the level of calcium in the soil, manufacturing of musical instruments, poultry feed and for making ornamens.

Depositional work : While transporting the debris, as carrying capacity of waves reduces, debris is deposited on the coast. Because of which various forms take shape.



Sea Beach

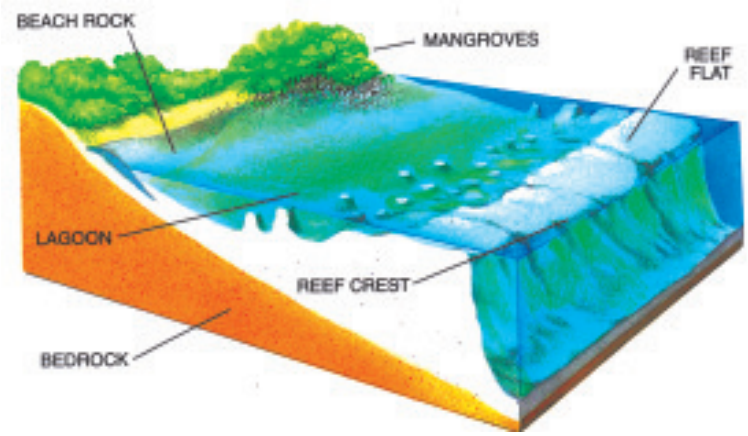
1. Sea Beach : Beaches are formed by deposition of soil, rocks, stones etc. on the coast by sea wavess. The size of a beach depends upon the debris deposited, more the debris, larger will be the beach. Beaches may be of various types. life curp beach, Gokarna and Kovalam, Linear Beaches; Marina beach Chennai, Rock beaches and Sand beaches. Marina beach is second longest beach in the world. Beach formation is possible during low velocity of waves or swift moving wave or thunder storms destroy beach deposits.

2. Sandbar : Sand bars are formed if sand gets deposited parallel to the waves. These are extended parallel on the front side of the hard rocks near the coast. When its size increases it is called as offshore or longshore sandbar. Sometimes gulf is blocked due to the huge deposition of soil, offshore bars which act or blockers, get combined with each other and are known as Tied Island. The Islands also have various types e.g. Bay bar, Tombolo, Hook, Loop etc.

3. Spit : Deposition of sand and rocks at some distance from sea coast is known as spit. According to O.F. Evans, (1942), as pit is a "Ridge of embankment of sediment attached to land at one end and terminating in open at other"

Spits are commonly found on the eastern and western coast of India. Around 50 KM long spit is situated on the mouth of Chilka lake and 60 KM long spit is situated in the east of Policot lake. When two spits conjine, it is known as 'Looped bar'.

4. Lagoon : Water collected between the sand bar and coast is known as Lagoon. These are very common in low coasts. 'Chilka' on the easter coast and 'Vembanad' situated on the coast of Kerala are the important examples of 'lagoons'



Graphic of Lagoons

5. Dunes : Sand dunes are also get formed in coastal areas. Waves deposit the sand and winds transport this sand and deposit it at another place because of which sand dunes are formed. Such sand dunes are found on eastern and western coasts of India.

Sea waters carry unimaginable energy. Various land forms of the eastern and western coasts of India, formed by Oceanic waters are its biggest example. Total length of Indian coast is 7,516.6 kilometers, including Andeman and Nicobar (Bay of Bengal) and Lakshdweep (Arabian Sea).

EXERCISE

1. Give the answer to the following questions in one or two words :

(a) What are the higher parts of waves known as?

(b) What is the length of Indian coast?

(c) Which is the second longest beach of the world ?

(d) What is the name of formation developed as conjugation of two spits ?

2. Write a note on the following :

(a) Spit (b) Sea Beach

(c) Sea Caves (d) Hydrolic Action

(e) **What is the difference between the following :**

1. Crest - Trough

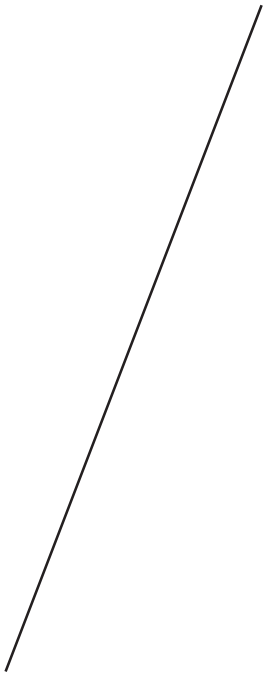
2. Sandbar-Lagoon

3**. Give the answer to the following questions in detail :**

(a) Explain Erosional of work of sea and which land forms are created by such erosion ?

Unit –II

Chapter-4



CHAPTER-4

LANDFORMS

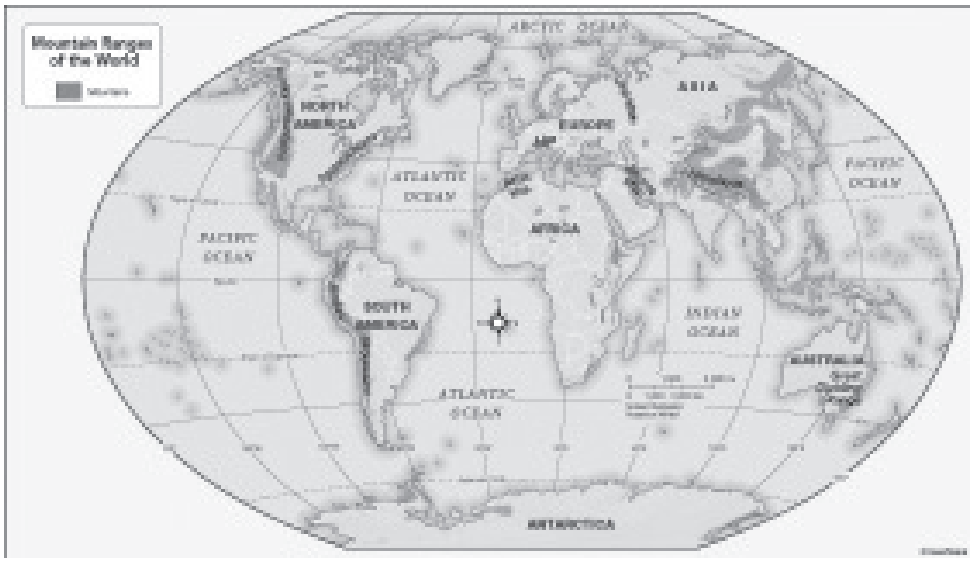
Plains, Mountains and Plateaus :

In order to make a systematic study and also for the sake of convenience, Geographers have divided the landforms into three orders of relief. A brief description of the first, second and third orders of relief has been given below:-

First order Relief Features	Second order Relief Features	Third Order Relief Features
1. Vast Continents	1. Mountains	1. Peaks
2. Oceans	2. Plateaus	2. Cliffs
3. Continental Shelf	3. Plains	3. Valleys
4. Sea Coast	4. Lowlands	4. Hills
	5. Continental Slopes	5. Spurs
	6. Abyssal Plains	6. Gores
	7. Mid-Oceanic Ridges	7. Zengens
	8. Submarine Trenches	8. Yardangs
		9. Sand dunes
		10. Caves, Uvalas
		11. Morains
		12. Sea Stacks
		13. Cirques
		14. Beaches
		15. Submarine Canyons

We shall study relief features of Second order in detail.

Mountains : Mountains are significants relief features of the second order on the Earth's surface.



Major Mountain Ranges of the World

We can divide the mountains in five categories as under:

Forms of Mountains

1	2	3	4	5
Mountain Ridge	Mountain Range	Mountain System	Mountain Group	Cordillera

1. Mountain Ridge : A Mountain ridge is a system of long, narrow and high hills. Generally, the slope of one side of a ridge is steep while the other side is of moderate slope but a ridge may also have symmetrical slopes on both the sides.

2. Mountain Range : A Mountain range is a system of mountains & hills having several ridges, Peaks and summits and valleys. Infact, a mountain range stretches in a linear manner. In other words, a mountain range represent a long but narrow strip of mountains and hills. All of the

hills of a mountain range are of the same age but there are structural variations in different members of the range.

3. Mountain System : A Mountain chain consists of several parallel long and narrow mountains of different periods. Sometimes, the mountain ranges are separated by flat uplands or plateaus while Mountain System consists of different mountain ranges of the same period. Different Mountain ranges are separated by valleys.

4. Mountain Group & Cordillera : A mountain group consists of several unsystematic patterns of different mountain systems. Cordillera consists of several mountain groups and systems. Infect, cordillera is a community of mountains having different ridges, ranges, mountain chains and mountain systems. The mountainous system of the western part of North America is the best example of a Cordillera.

Classification of Mountains

1. On the Basis of Height :

(a) Low Mountains; height ranges between 700 to 1000 meters.

(b) Rough mountains (less height) – 1000 to 1500 meters.

(c) Rugged Mountains (medium height)- 1500 to 2000 meters.

(d) High Mountains; height above 2000 meters.

2. On the Basis of location :

Continental Mountains.

(a) Coastal Mountains: Applachian, Rockies, Alpine mountain chains, Western and Eastern Ghats of India etc.

(b) Inland Mountains: Himalayas, Aravallies Urals

(c) Coastal Mountains: Mauna kea, Hawaii Islands.

(d) Oceanic Mountain: Most of the oceanic mountains are below water suface. E.g. Mauna Kea (Hawaii Islands)

3. On the basis of Origin :

(a) Original or Tectonic Mountains : These Mountains are formed due to tectonic forces e.g compressive and tensile forces motored by endogenetic forces coming from deep with in the earth. These Mountains are further divided into 4 types on the basic of orogenetic forces responsible for the origin of a particular type of mountains.

1	2	3	4
Folded Mountains	Block Mountains	Dome Mountains	Mountains of Accumulation
(a) Young folded Mountains (b) Nature folded Mountains (c) Old folded Mountains	Originated by tensile forces leading to the formation of Rift valleys	Originated by magmatic instrusions and unwrapping of crustal surface eg. Normal Dome, Lava domes etc.	Due to Accumulation of volcanic material.

(b) **Circum erosional or relict mountains :** Such mountains came into from because of erosion, millions of years back. In India, example of such mountains is; Vindhayachal range, Aravallies, Satpura, Eastern Ghats, Western Ghats etc.

4.On the basis of period of origin :

(a) **Pre-Cambrian mountains :-** These mountains are 4.6 billion years old; examples, Laurentian, Algoman and Kilarean mountains (All in North America).

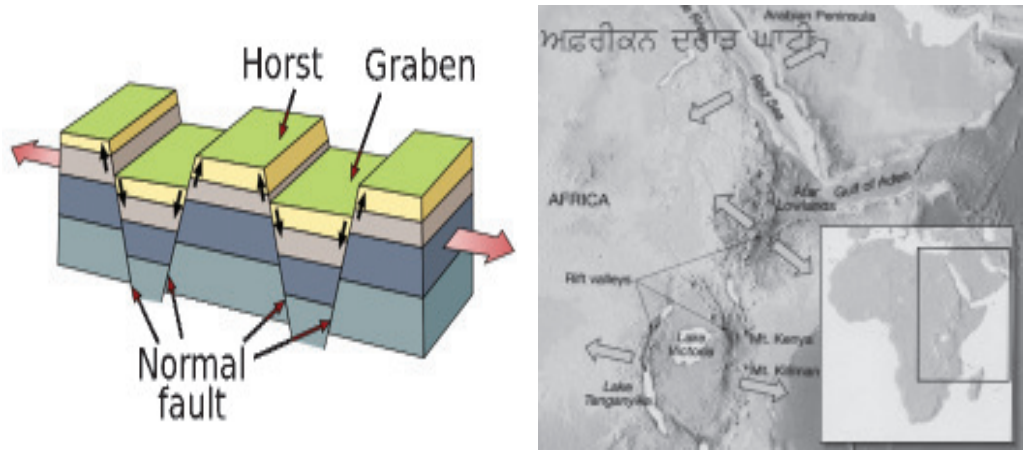
(b) **Caledonian mountains :-** Formed during Silurian period and devonian period, 44 to 40 crore years back. examples; Taconic mountains of the Applechian system, mountains of Scottland, Ireland and Scandinavia (Europe) Brazilies of South America, Aravallis, Mahadeo, Satpura etc. of India.

(c) Hercynian Mountains :- Mountains formed during Permian and permocarboniferous periods, examples mountains of Iberian Peninsula, Spanish Messeta and Brittany of France, Tarim basin etc.

Explanation and Details of Some more types of mountains

(d) Alpine Mountains :- Mountains formed during tertiary period, some 6 crore years to 25 lakh years old; examples; Rockies (North America) Andies (South America), Alpine System of Europe (Main Alps, Carpathians, Pyrehess Balkans, Cancasus), Atlas Mountains (N.W. Africa) Himalyas and Mountains coming out of Pamir Knot of Asia (Taurus, Pountic, Zagros, Elburz, Kunlun etc.)

<u>Block Mountains</u> : Block mountains, also known as **faultblock mountains,** are the result of faulting caused by tensile and compressive forces motored by endogenetic forces emerging from within the Earth. Block mountains represent the upstanding parts of the grounds between two faults on either sides of a rift valley or a graben. Essentially, block mountains are formed due to faulting in the ground surface.

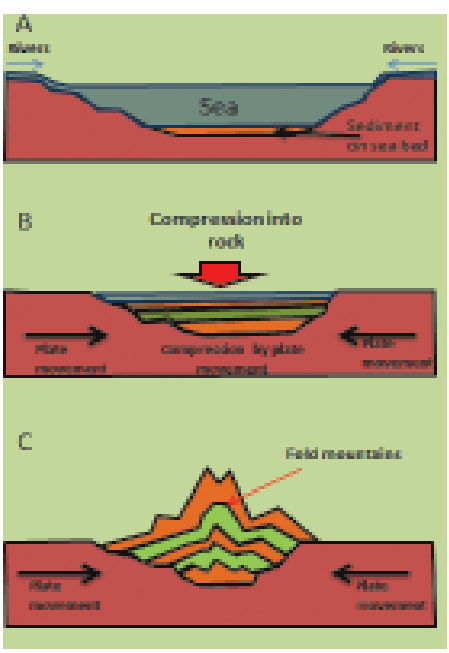


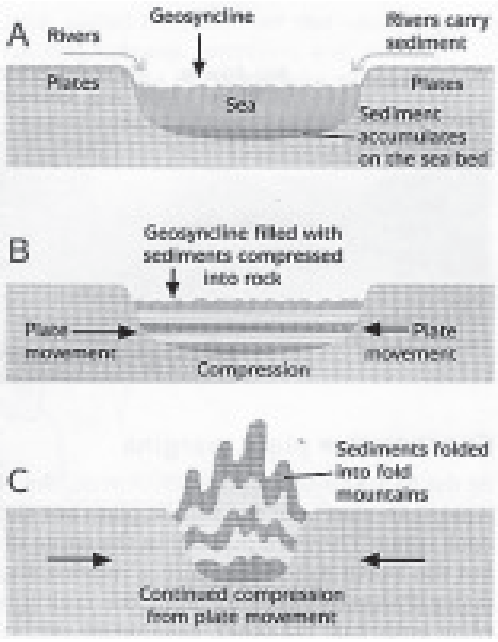
Block Mountain and Rift Valley of Africa

Represented by (i) fault scrap and one gentle side and (ii) lifted block mountains represent real horst and are characteriased by flattened summit of tabular shape and very steep sides slopes represented by two boundary fault scraps. Block mountains are also called Horst mountains. Sierra Navada mountains of California (USA) is considered to be the most extensive block mountain of the world. Salt range of Pakistan, Rhine rift valley in Europe are other examples of Block mountains.

Folded Mountains :- Folded mountains are formed due to folding of crustal rocks by compressive forces generated by endogenetic forces emerging from within the Earth. These are highest and most extensive mountains of the world and are found in all the continents. They are generally found along the margins of the continents either in North South direction or east-west direction. Rockies, Andes, Alps, Himalayas, Atlas etc. are the examples of folded mountains. Folded mountains are classified on various bases a follows:-

(a) **Simple folded mountains :-** Such mountains are characterised by well developed system of anticlines and synclines wherein folds are arranged in wave-like patterns. These mountains have open and relatively simple folds anticline.





Formation of Fold Mountains

(b) **Complex folded mountains :-** These mountains represent very complex structure of intensely compressed folds such as 'nappe' in fact, complex folded mountains are formed due to the formation of recumbent folds caused by powerful compressive forces.

Folded mountains are also classified into two categories; (i) Young folded mountains for example Alps in Europe and Himalayas in Indian sub continent and (ii) Mature folded moutains for example Aravallies, Vindheyachal etc.

Geosynclines Meaning:- The geological history of the continents and ocean basins denotes the fact that in beginning our globe was characterised by two important features (i) **Rigid Masses** and (ii) **geosynclines.** Rigid masses representing the ancient nuclli of the present containts, have remained stable for considerably longer period of time.These rigid masses are supposed to have been surrounded by mobile zones of water characterised by extensive sedimentation. These mobile zones of water have been termed 'geosynclines' which have now been converted by compressive forces into folded mountains. The geosynclines are long but narrow and shallow water depressions characterized by sedimentation and subsidence.

Orogeny

Orogeny refers to force and events leading to a large structural deformation of the Earth's lithosphere which constitute mountains ranges. Most orogenic belts arises on the sites of Geosynclines and the resulting mountains therefore consist of sediments and volcanic rocks deformed and metamorphosed to a greater or lesser extent according to their position and depth in the orogenic belts.

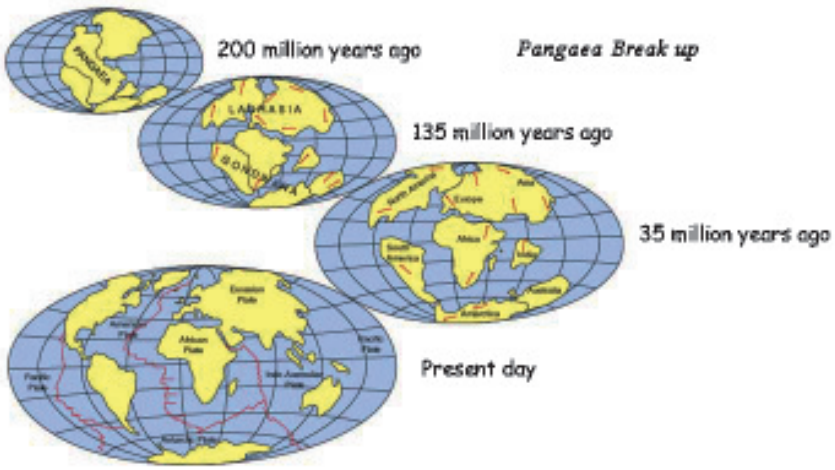
Generally speaking, high-standing mountain masses (other than volcanic mountains) are elevated by one of two basic tectonic processes: Compression and extension.

Compressional tectonic activity- "squeezing together" or "crushing"- acts at convergent plate boundaries; extensional tectonic activity – "Pulling apart" – occurs where oceanic plate is undergoing break-up into fragments.

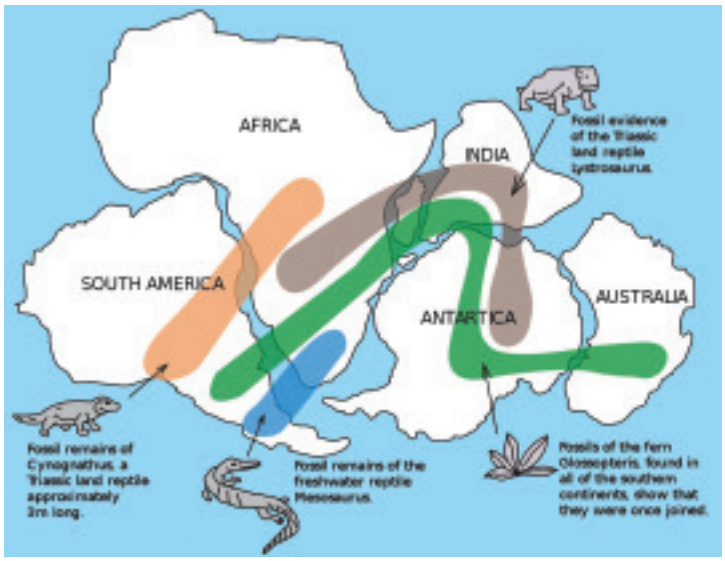
Continental Drift and Plate Tectonics

Continental Drift Theory

The theory of continental drift is an attempt to explain the present arrangement of continents and ocean basins. The idea of continental drift is very old as Abraham Ortelius in 1596. The concept was independently and more fully developed by Alfred Wegner, a German meteorologist and geophysicist, in his book 'Origin of Continents and Oceans' published in 1915. In his theory it is presumed that in the geological past all the continents were 'united' together. This Parent continent was known as Pangea (Pan = All + gea = Earth). The Pangea was surrounded by a huge sea 'Panthalassa (Pan = All + thalassa = ocean) representing Primaeval Pacific Ocean. Wegner hypothesized that the surface of super continent (Pangea) broke up to form: 1. Lurasia (North America, Greenland and whole Eurasia, North of Indian sub-continent) and (ii) The Gondwana Land (S. America, Africa, Madagascar). Now Malagasy, Peninsular India, Australia and Antarctica, in the carboniferous period about 300 million (30 crore) years back. He opined that continents are made up of SIAL (Sillicon and Aluminium) and ocean basins of SIMA (Sillicon and Magnesium).



Drifting of Continents



Super Continent-Pangea

Wegnar developed this concept while trying to explain the climate of the past. The puzzling questions in his mind were:

(1) Why should tropical ferns (vegetation) have grown in temperate countries like England, Germany, France and Greenland ?

(2) Why the Glaciers have covered parts of Brazil, Peninsular India, Australia and Congo Basin? These climate changes may be explained in two ways:

(a) If the continents reclaimed stationery at their places, the climate zones might have shifted from one region to another.

(b) If the climatic zones remained stationery, the landmasses might have been displaced and drifted. Since climatic zones are controlled by the heat from the sun, their shift cannot be explained. It is more probable that the landmass have changed their position. According to Wegner, the continents drifted in two directions: towards Equator and towards West.

<u>Evidence in support of Continental Drift</u>

(1) Geographical similarities in opposing coast of the Atlantic Ocean. 'Jigsaw-fit' of the opposing coasts of Atlantic ocean.

(2) Fossils of glossopteris (a fern-likeplant) have been found in rocks of the same age from South America, India and Australia. Fossils of Lystrosaurus (Lizard type animal) have been found in South Africa, India, and Antarctica. There is no way that such huge animals travelled across oceans if lands were not adjoining earlier.

(3) Folded Mountain ranges at Cape of Good Hope and rocks of Buenos Aires (Argentina) resemble.

Wegner was however, criticized for failing to explain the forces that would permit continents to plough through the ocean of rocks. Wegner died in Greenland in 1930. The idea of continental drift got revived in 1950s and 1960s. In 1940, seismologist Hugo Benioff plotted the location of deep earthquakes at the edges of Pacific ocean. He plotted 30,000 earthquakes and established the ring of fire. The Continental Drift Theory became basis of Plate Tectonic Theory.

Before we leave this page are you able to answer :-

1. What is Continental Drift Theory ?

2. Describe observations Wegner used to support Continental Drift.

3. Discuss why the hypothesis was not widely accepted?

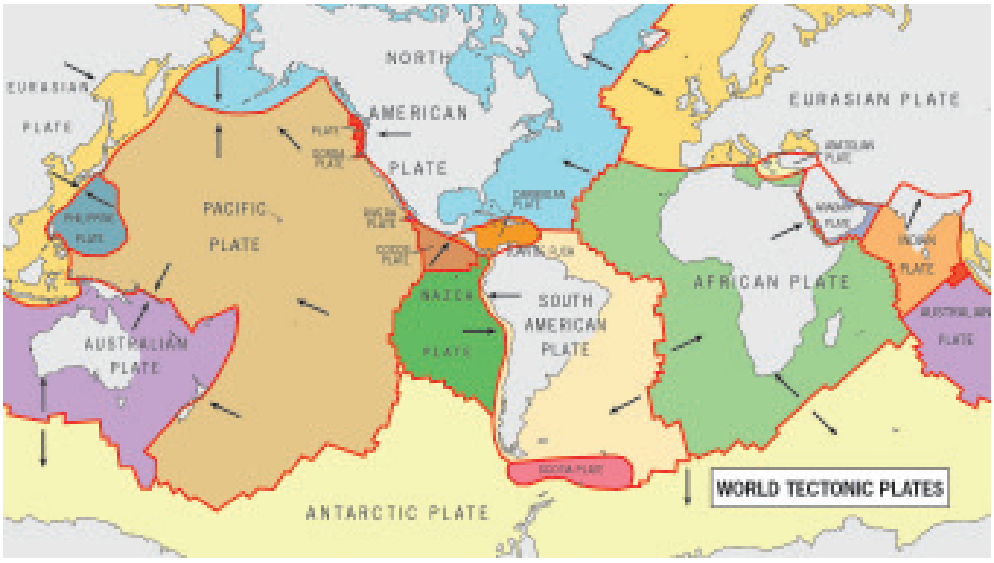
Plate Tectonic Theory

Plate Tectonic Theory is a comprehensive theory which offers explanations for various relief features and tectonic events viz. mountain building, folding and faulting, continental drift, vulcanicity, seismic events (earthquakes) etc.

Base of the Theory

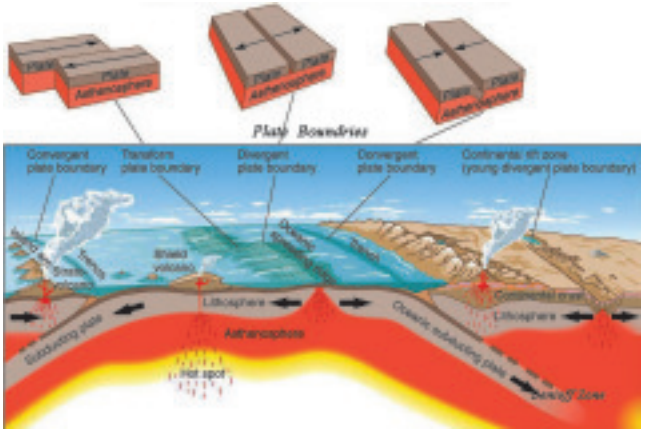
The rigid lithospheric slabs or rigid and solid landmasses having a thicknes of about 100 km composed of Earth's crust and some portion of upper mantle are technically called 'Plates'. The term '**plate**' was first used by Canadian Geologist **John Tuzo Wilson** in 1965. The whole mechanism of the evolution, nature and motion and resultant reactions of plates is called '**Plate Tectonics**'. Plate tectonic theory is a great scientific achievement of the decade of 1960s is based on two major scientific evidences e.g. (i) evidence of Palaeo magnetism and (ii)

evidences of sea floor spreading six major and 20 minor plates have been identified so far.



Distribution of Plates

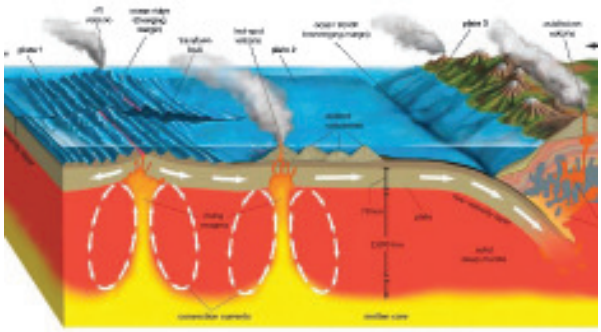
Mckenzie and Parker discussed in detail the mechanism of plate motions on the basis of Euler's Geometrical Theorem in 1967. Prof. Hary Hess (1960) elaborated the mechanism of Plate movement on the basis of the evidences of sea floor spreading. W.J. Morgan and Le Pichon elaborated the various aspects of plate tectonics in 1968.



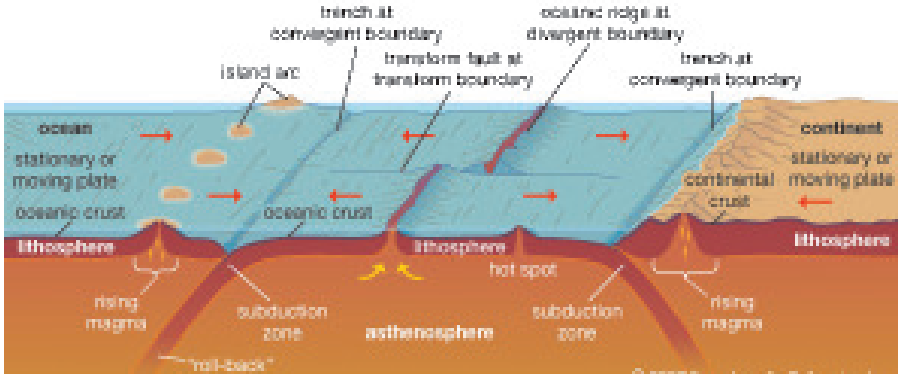
Different Types of Plate Boundries

Three types of Plate Boundries on the origin of continents and ocean basins have been identified e.g. (i) Constructive plate boundaries (ii) Destructive plate boundaries (iii) Conservative plate boundaries.

1. <u>Constructive Plate Boundries</u> are also called as '**divergent plate boundary', spreading boundary, or accreting plate boundary,** represent zones of divergence along the mid oceanic ridges and are characterised by continuous addition (accretion) of materials as there is constant upwelling of motion materials (basaltic lava) from below the mid-oceanic ridges. These basaltc lavas are cooled and solidified and are added to the trailing margins of the divergent plates and thus new oceanic crust is continously formed. In fact, oceanic plates split apart along the mid-oceanic ridges and moves in opposite directions and thus transform faults are formed.



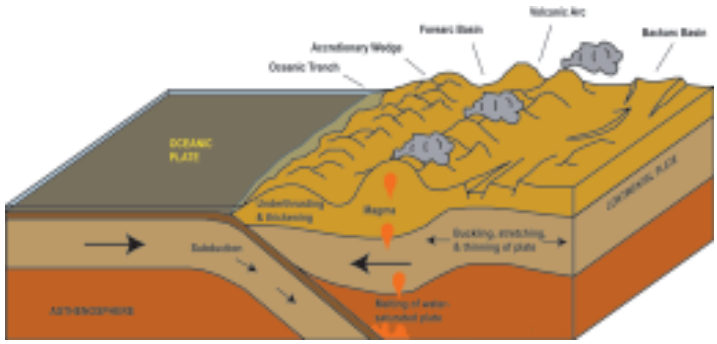
Constructive Plate Boundries



Types of Plate Boundries

2. Destructive Plate Boundaries are also known as 'Cosuming Plate Boundaries' or **'**Convergent Plate Boundary' are those where two plates collide against each other and the leading edge of one plate having relatively lighter material overrides the other plate and the overridden

plate boundary of relative denser material is subducted or thrust into the upper mantle and thus a part of the crsut in lost in the mental. This is why convergent plate margins are called destructive margins, Collision zone, subduction zone and 'Benioff Zone'. See Fig.

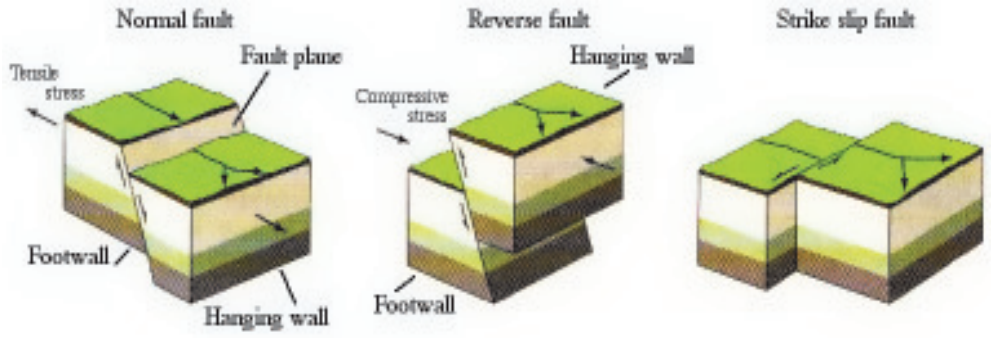


Destructive Plate Boundary

3. Conservative Plate Boundaries are also known as Sheer Plate Boundaries, and Transform Boundaries. Transform faults are those where two plates slip past each other without any collision along the transform fault and thus crust is neither created nor destroyed.

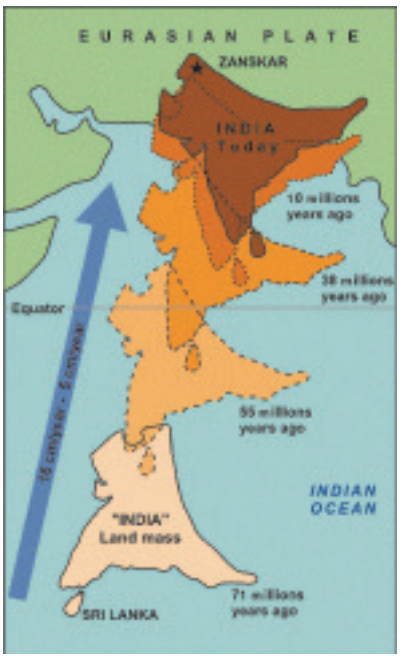
Mechanism of the Theory

According to Plate Tectonic Theory, mountains are formed due to collision of two convergent plates. Mountains are always formed along



Conservative Plate Boundaries

the destructive plate boundaries. It is obvious that the process of mountain buiding is associated with destructive plate boundaries of two convergent plates. The Plate Tectonic Theory envisages the formation of mountains due to compression of sediments caused by the collision of two convergent plate boundaries. Two plates moving together under the impact of thermal convective currents collide against each other and the plate boundary having relatively denser material is subducted under the other plate boundary of relatively lighter materials. This subduction zone is also called Benioff Zone. The subduction of plate boundaries causes lateral compressive force which ultimately squeezes and folds the sediments and material of the margins at the plates and thus mountains are formed. Rockie mountains find their origin in collision of American and Pacific Plates while Andies again are result of same collision. Himalayas rose out of collision of Indo-Australian plate against that of Eurasian. Indian plate is still in process of insertion under Eurasian plate and Himalayas are rising.



Formation of Himalayas

Mountains for Mankind :

1. Mountain region has covered 27% part of total land area of the Earth while it houses 22% population of the world.

2. Mountains fulfill various necessities of non-mountainous dwellers like fresh water which flows down mountains through rapids, falls and rivers. Hydroelectricity, Wood, Medicinal plants, wild animals/ insects, fruits and various other products which are available in and through forests only.

3. Mountainous ecology is home for many forest animals, insects and birds which do not find their habitat other than mountainous forests. Dense forests on mountains help in balancing healthy ecosystem and

biological diversity.

4. Mountains are source of attraction for tourism related activities. Big number of people visit mountainous regions as tourists. Cultural and religion heritage in India provides spiritual touch to mountainous centres since times immemorial. Many religion centres have been set up in vallies of Himalayas particularly.

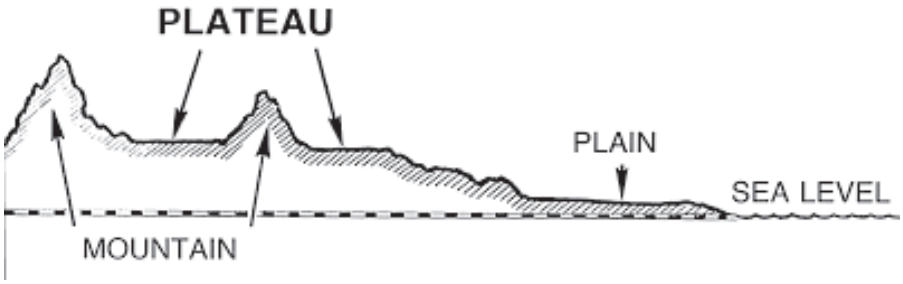
5. Mountains have their lasting effect over climate of any region. In India, the Himalayas contribute very importantly for rainfall not only through Monsoonic winds but through cyclones also. Uncontestidly the rainfall is lifeline for agriculture in our nation.

Plateaus

Plateau is an elevated tract of relatively flat land, usually limited on at least one side by a steep slope falling abruptly to lower land, it may also be delimited in places by abrupt slopes rising to residual mountains or mountain ranges, as in the Tibetan Plateau, where it occurs as an intermontane Plateau. The term is also used to refer to a structural surface such as Meseta of Spain, in which case it is a tectonic Plateau. The surface of Plateaus may be plain-like in quality, very flat, rolling or hilly, or may be so dissected by streams and Glaciers that it is difficult to recognise their original Plateau Characterstics. Great Plateaus and some of the small ones are closely associated with mountains and are primarily the products of diastrophism or volcanism. Many small Plateaus are merely remmants, left standing above the surrounding land as a result of erosion.

Diastrophism & Classification of Plateaus :

The large scale deformation of the Earth's crust which produces Continents, Ocean Basins and Mountain ranges, etc. is known as diastrophism. Since their uplifts they have been modified by various agents of erosion and in many cases by volcanism and minor Earth movements. For convenience and on the bases of geographical relief formation, weather and development plateus may be classified as under :



Cross Section of Plateau

1. <u>Intermontane Plateaus</u>

These include the highest, largest and in many respect most complex Plateaus of the world. Their surfaces show an extraordinary variety of topographic features. Some plateaus of this type are as under :

(i) <u>Plateau of Tibet :</u> The great highland of Tibet, called the Heart of Asia, is the largest and highest Plateau ever known. Its area is between 7 to 8 lakh square miles and average elevation is more than 4500 meters (14800 feet) with many parts rising to more than 5538 meters (18000 feet) above the sea level. It is bounded in the North by the Kunlun mountains, and in the south by the mighty Himalayas.

(ii) <u>The Plateau of Bolivia and Peru</u>

This is another excellent example of an intermontane Plateau which lies largely in Bolivia at an average elevation of more than 1350 meters above the sea sevel. There is abundant evidence that highland was uplifted during tertiary period when the Andies were formed. Great Andies mountain ranges surround the Plateau. At present, the main part of the Plateau has no exterior drainage.

(iii) <u>The Mexican Plateau</u>

The Mexican Plateau stands between the eastern and western Sierra Madre Mountains. The surface of the Plateau slopes gently northward from near Mexico City with elevation, 1800 meters to 2300 meters of Large parts of this Plateau are very dry. Moreover, several Volcanic Mountains stand on the south end of the Plateau near Mexico city.

2. Piedmont or Border Plateaus

Many Plateaus border mountain ranges and owe their present position to the same uplifts that raised the mountains. Piedmont Plateau is an example of border Plateaus. This Plateau is a strip of land that stand between the Atlantic Coastal Plains and the Appalachian Mountains. Its eastern side is marked by a more or less definite fall-line where the gradient of the rivers is steepest. On the west it terminates against the mountains of the Blue ridgde. Patagonia is another example of such plateaus in South America.

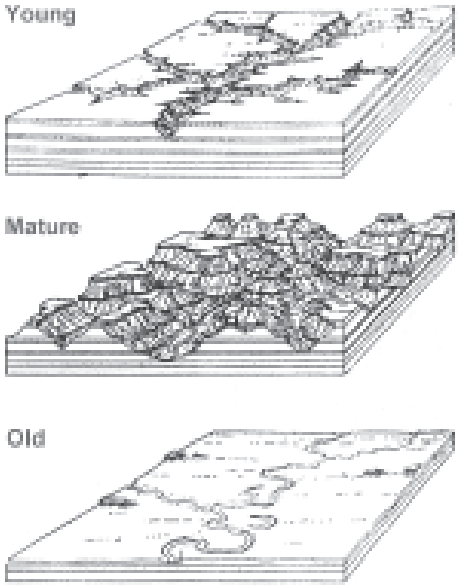
3. Domed Plateaus

The plateau of Ozark (USA) is a good example of domed plateau. Ozark Plateaus was uplifted by folding and faulting into a broad dome some 65,000 square km (40,000 sq. miles) in area. Entrenched meanders are significant features of many of the upland streams.

4. Volcanic Plateaus

Volcanoes also forms several varieties of Plateaus, built by the Lava flow. Smaller, degraded Plateaus are formed by the resistant lava caps that protect the land from erosion and maintain its high elevation after the surrounding land has been worm away. Deccan Plateau in India is the best example of Volcanic Plateau while other good example is North Island, Volcanic Plateau in New Zeland.

5. Erosional Plateaus: Such Plateaus are formed particularly in semi-arid regions where streams it cut away portions of high mountain, leaving broad, nearly flat inter-valley highlands. Allegeny Plateau area in western and central New York and Cumberland. Plateau, the part of Appalachian Plateau region in United States of America are examples of Erosional Plateaus.



Cycle of Erosion acco. to W.M.Davis

Life History of Plateaus :

The life history of Plateaus, like that of any other highland, depends upon a number of factors, of which diastrophism and climate are the most important. Assuming that the land stands still, Plateaus of humid regions will pass through the typical successive strages of a cycle of erosion and will be reduced to Peneplains. Plateaus of Arid regions,

although worn away much more slowly, must eventually go through the various stages of an arid cycle of erosion. The ultimate result will be dissection and loss of all the original characteristics. Plateaus on coasts are subject to the attack of both sub-aerial agents and of waves and currents.

Importance of Plateaus for Mankind :

1. Plateaus keep mineral wealth lapped in them. Various minerals like Gold, Iron, Copper, Diamond, Maganeese, Mica etc. are solid base of industrial development of any nation.

2. Plateaus are have more plain regions as compared to pure mountainous regions which helps in development of means of transport. Rail and road transport is lesser costly in plateau regions as compared to mountainous regions.

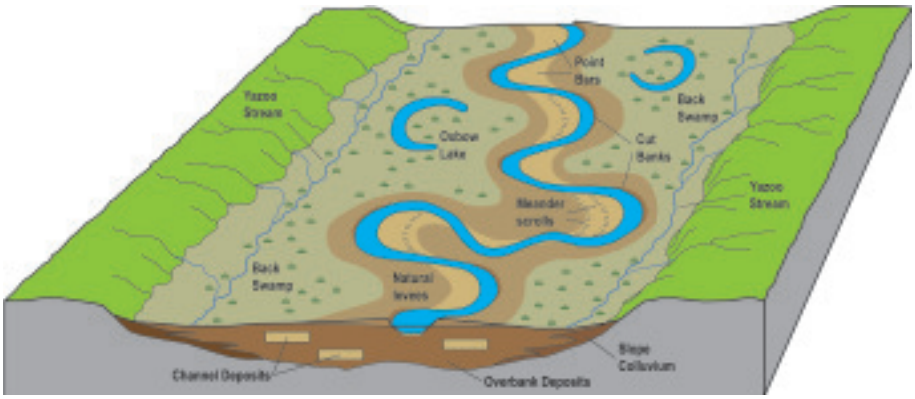
3. Plateau regions support abrupt slops which are beneficial for setting up hydoelectrical centres.

4. Plateaus are instrumental in making effect over climate. As an example; Tibet plateau divides western Jet Stream in two parts while in summer helps in creating low pressure which results into attraction for Monsoons in Indian Sub-contiennt.

5. Plateau regions are beneficial for its own types of agricultural products. Deccan Plateau in India provides black soil which is unmatchable for production of Cotton and Sugarcane.

PLAINS

Plain is an extensive tract of flat and or a gently undulating terrain without prominent hills or depressions. Plains, the lowlands of the Earth, may be very flat, moderately rolling, or even hilly. They are formed both by internal forces of the Earth and by external processes of aggradation and degradation. They range in size from very small to a very large areas. The great centres of population of the world are on plains. For more people live on plains than on Plateaus and mountains combines. Development of means of communications and transportation facilities is easier in the plains.



Graphic of Flood Plains

Origin of Plains:

Like other major relief features, Plains are best classified according to their origin. On the basis of their origin the plains may be classified under following categories:
1. Diastrophic Plains 2. Peneplains, 3. Flood Plains, 4. Delta Plains. 5.Glaciated Plains and 6 Aeolian Plains.

(1) Diastrophic Plains: Nearly all the great plains of the world are regions that were once submerged by epicontinental seas. Some were uplifted long ago and have been modified by many agents of gradation. Others have been raised above sea level in comparatively recent times and have had correspondingly shorter and less complex life history.

The great plains of U.S.A. are the example of plains formed due to upliftment or emergence of submerged landmasses under epicontinental seas. The Great Plains are bordered by Rockies in the west, by central lowlands (Mississippi-Missouri Plains) in the east and by Rio-Grande River in the south. The plain further extend northward to Canada. It is believed that the great plains remained under water in cretaceous period for a fairly long period and hence horizontal thick beds of Marine sediments were deposited. The submerged landmass began to rise due to diastrophic movement and the landmass appeared above the sea level by the end of crefaceous period, and thus the plains were formed.

(2) Peneplains: Peneplain is an undulating surface of low relief, interspersed with occasional residual hills, known as MONADNOCKS, and claimed to have been formed by the widening of flood plains and the wearing doen of interfluves by sub-aerial denudation. It is regarded as the end-product of the normal cycle of erosion. Although there are few large Peneplains at base level today, many uplifted peneplains, particularly in Scottish Highlands, Appalachians and Rocky Mountains may be seen. One of the most perfect uplifted peneplains is in East Central Africa.

(3) Flood Plains : Flood Plain is that part of river valley adjacent to the channel, over which a river flows in times of floods. It is a zone of low relief and gentle gradient and may incorporate or bow lakes, point bars, abandoned channels, scrolls, all indicative of the fact that the river channel has shifted its position continuously during the present regime of stream. The floodplain is composed of Alluvium, which generally buries the rock floor of the valley to variable depths. The Indo-Gangetic plain and the plains of Mississipi, Amazon, Nile, Hwang-Ho, Yangtze Kiang, Ob, Yenesi, Lena, Volga rivers are good examples of flood plains.

(4) Delta Plains : As rivers draw near seas to disappear in them, their flow goes dead slow. It necessities the waters to deposit all types of materials being carried by it. Such depositions are made in triangular shape which resembles to Greek word 'Delta'. Thus formed plains are known to be best furtile plains of the world. Their examples are Sunderbans of Ganga and Brahmputra deltas of Nile and Mississippi etc.

(5) Glaciated Plains: In general, the great glaciated plains of Central North America and Western Europe were plainsbefore they were Glaciated. However, the glaciers superimposed a new topography on the old. Drumlins, eskers, morains of different types, lakes, basins, Marshes and lacustrine plains dominate the present relief. Important changes have been made in the Pre-Glacier Drainage.

(6) Aeolian or Minor Plains:

In this group may be included the wind swept plains of bolsons, playas, bajada sediments, lava and ash plains, lacustrine, lagoon and marsh plains and uplifted wave-cut plains-all of which are distinctive in their mode of origin and present characteristics. Sahara and Thar are examples of aeolian plains while plains formed by filling of lakes in

Kashmir, in Manitoba of Canada, lava plains of Idaho (U.S.A.) and plains of Macca & Madina also fall in same category.

Major Plains of the World

Importance of plains for mankind :

1. Plains are often referred to as the 'cradles of civilizations' and the 'food baskets' of the world. Around 80% population lives in great plains of the world, i.e., Praries (U.S.A), Steppes, Pustaz (Europe), Veld (S.Africa), Great Indo-Gangetic Plains of India, Downs (Australia), Canterburry plains of NewZealand are famous for their fertile soils.

2. Undulating and fertile land of plains is beneficial for conducting agricultural activities and irrigation. Crops are grown in plains in abundance.

3. Developing means of transport like building roads, lying railways, preparing air strips etc. is possible and easy in plains.

4. Commercial facilities are more abundant to promote industry and trade in plains.

EXERCISE

1. Answer the following questions in few words :

(a) Which is the common example of inland mountains in India ?

(b) What tenure or period is known as Post Cambrian period ?

(c) What was the name of Super Continent prior to the drift ?

(d) What are the two parts of Earth's top plate ?

(e) Which landform is known as 'Heart of Asia' ?

(f) Which is the best example of dommed plateau in the world ?

(g) Which river in Africa forms 'flood plains' ?

(h) What name is given to river (alluvial) plains in Austraia.

(i) What are Praries, Pampas and Canterbury ?

(j) From which point the height is measured on the Earth ?

2. Answer the following in a sentnence or two :

(a) In which categories (portions) relief may be divied ?

(b) Classify mountains on the basis of size.

(c) Define Fold Mountains.

(d) When and in which book did Alferd Wagner present his continental theory ?

(e) Which region was known as Luresia earlier ?

(f) What is a border plateau ?

(g) Name the rivers of China and Russia known for, their alluvial plains.

3. Answer the following in 60 to 80 words :

(a) Define Block Mountains.

(b) If you are living in a region having facilities of agriculture,

irrigation and transport, which geograhical (relief) region it may be ? Name such regions of the world.

(c) Which geographical region has abundance of mineal resources, explain citing examples from world over.

(d) Explain theory of Plate Tectonic.

(e) Which geographical (relief) region supports water falls, rare and costly wood and thick forests ? Explain in short citing examples.

(f) What do you understand by mountain building or Orogeny ?

4. Answer the following in 150-250 words:

(a) What may be various bases of classification of mountains ? Give details of classification on basis of origin.

(b) Classify plateaus and write short note on each type.

(c) Compare the facilities and problems that people living in plains may enjoy and face in contrast to those living in mountainous region.

(d) Explain various types of plains on the basis of origin.

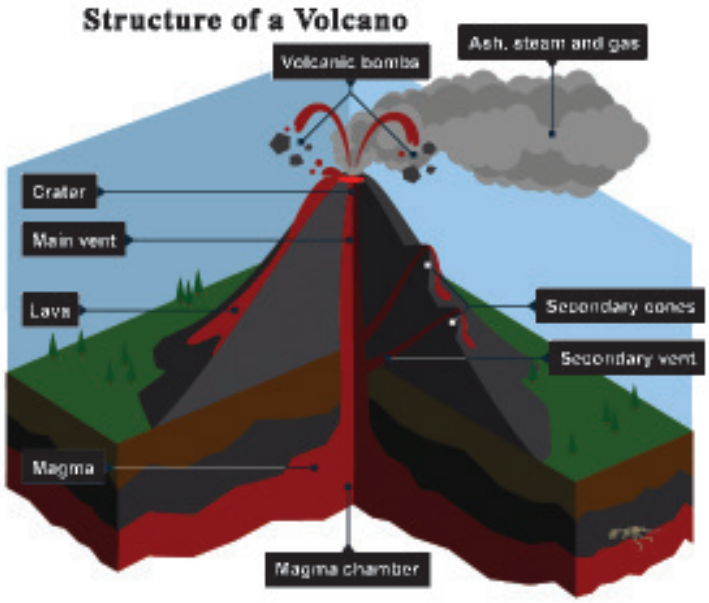
(e) How the people living in Chhota Nagpur Plateau region may experience difference to the people living in Kerala and Himachal Praesh, respectively. Explain.

Chapter-5

VOLCANOES AND EARTHQUAKES

(i) Volcanoes

Volcano is an opening in the crust of the earth, connected by a conduit to an underlying magma chamber, from which molten lava, volcanic gases, steam and pyroclastic material are ejected. It is usually in the form of a peak, which may be cone shaped or dome shaped, according to the character of the material ejected. The vulcauicity covers all those processes and mechanism which are related to the origin of magmas, gases, and vapours, their ascent and appearance on the earth's surface in various forms.

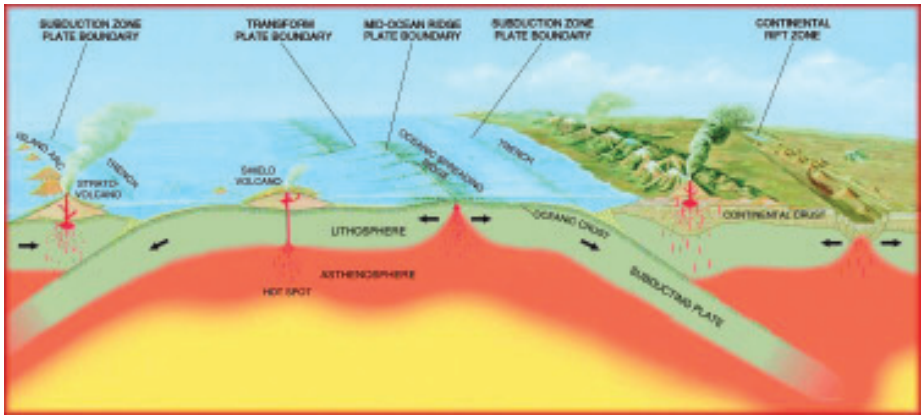


Structure of Volcano

Causes of Vulcanism : Knowledge and information about vulcanism was quite restricted to lava and some other molten materials prior to modern research. Now we can cite following reasons for volcanic activity :

1. Theory of Plate Tectonic : The volcanic eruptions are closely associated with sea-floor spreading plate tectonics and mountain building processes. The type of volcanic system depends on the type of

plate-tectonic settings. Basaltic magma is generated at divergent plate boundaries by partial melting of rising asthenosphere. It is extruded mostly in quite fissure eruptions. Most of active volcanoes of the world are found in circum pacific belt and Mid Continental belt.



Different Types of Plate Boundaries

2. Increasing Temperature of Interior : There is gradual increase in temperature with increasing depth at the rate of 1°C per 32 meters. The main cause of this increase in temperature is the disintegration of radioactive elements deep within the earth. Origin of Magma because of lowering of melting point inside the Earth caused by reduction in the pressure due to splitting of plates and their movement in opposite directions.

3. Formation of Gases and Steam : Origin of gases and vapour due to heating of water which reaches underground through percolation of rain water and snow-melt water. On being in contact with magma various elements turn into water vapours and steam resulting into 80 to 95 percent presence of vapours and steam. Other gases that cause erruptions are carbondioxide, Hydrogen, Amonea, Sulphuroxide etc.

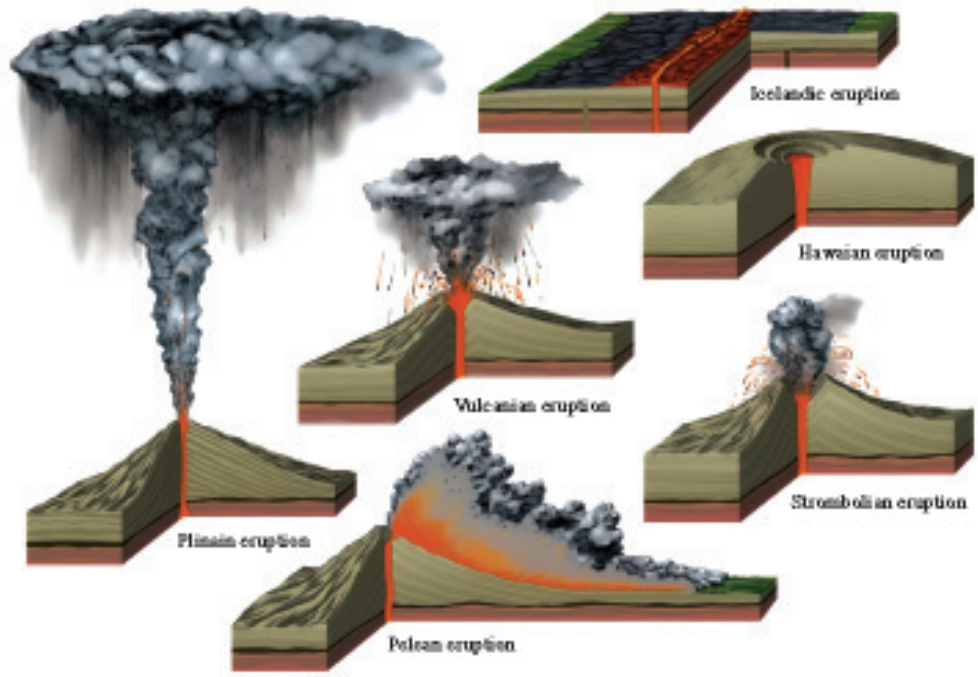
Effects of Folds :

Sedimentary rocks get compressed due to orgenetic force in the interior of earth causing folds. This situation gives chance to relief to rise which results into releasing pressure over lava and softer parts of Earth, finally encouraging volcanic eruptions.

Types of Volcanic Activity :

During the eruption, a volcano may behave in several different ways. The primary factors on determining an eruption type are; the chemistry of its magma and its viscosity means magma's thickness, resistance to flow, or degree of fluidity.

Types of Eruptions



(1) **Hawaiian Type Eruption :** It is an eruption in which great quantities of extremely fluid basic lava flow out from a fissure or a central vent to form a typical shield volcano. In this type of volcano, explosive activity is rare while its spread is extensive. This type of volcanic eruptions are common of Hawai Islands in Pacific Ocean, for example, Kilavea volcano of the southern Hawaii island.

(2) **Strombolian Eruption :** In this type of volcanic eruption the basic lava (basaltic) is less fluid than that at Hawaiian type. Consequently, explosions are more common and more fragmental material is ejected. It is named after the Stromboli volcano on the Lipari island of north Sicily. Strombolian Volcano eruption in Mediterranean Sea is also known as **'Light house to the Mediterranean'.**

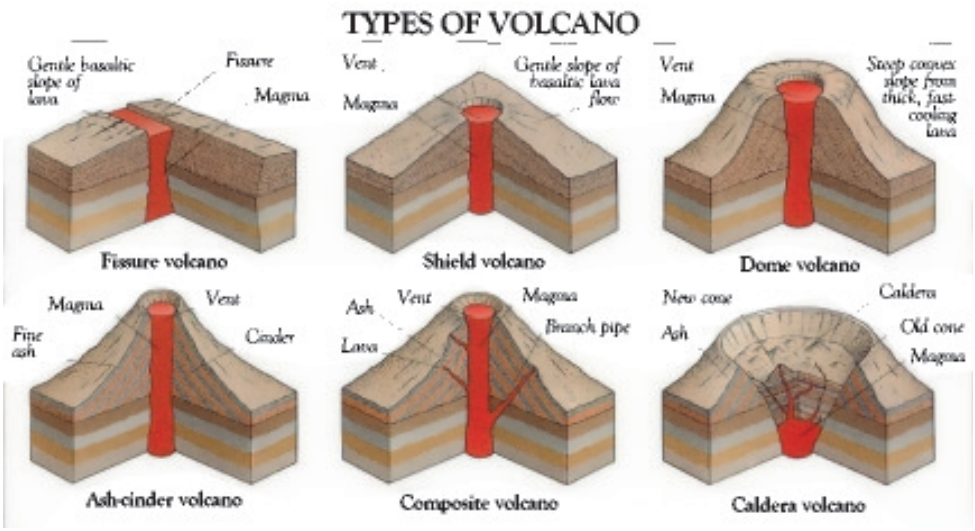
(3) **Vulcanian Eruption :** Such volcano erupts with great force and intensity. In this type of eruption, lava surface solidifies rapidly because of its very high viscosity. The solidification results in a build-up of pressure beneath the lava crust and a continous series of violent explosion takes place, during which large quantities of Pyroclastic material are ejected violently from the vent. Large dark cauliflower like clouds take form over eruption..

(4) **Pelinian Eruption :** In a Peleean eruption the lava is extremely viscous. It has the characteristics in the formation of **'nuee ardeutes'** (glowing cloud). This type of volcanic eruption is named from Mt. Pelee (West Indies) where extremely violent eruptions have occured. Besides another eruption known as Pelinian or Pelean eruption, is of great violence in which the explosion cloud towers to considerable height in the shape of Pine tree.These are most violent eruptions.

Types of Volcano

On the basis of material erupted the volcanoes may be classified into five major types :

(1) **Basalt cones**: Basalt cones are rare. They are likely to be low rather than high cones because of the fludity of basaltic lava. The Rangitoto (New Zealand) is a suitable example.



Types of Volcano

(2) **Basalt Dome or Shield:** The Hawaiian volcanoes are the excellent examples of basalt domes or shield volcanoes as are Mt. Etna and many of the volcanoes of Iceland. Basalt domes are formed where fluid basaltic lava is extruded. They often attain great height for example: Mauna Loa has an altitude of 4,219 meter.

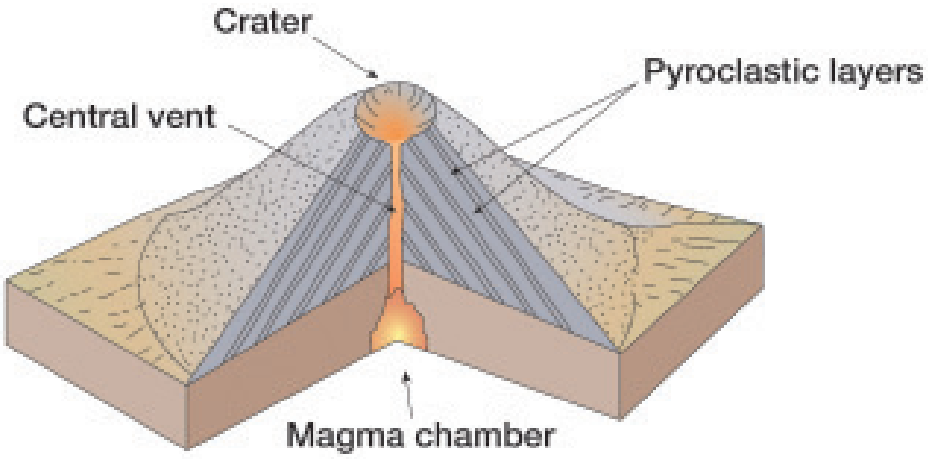
(3) **Cinder Cones or Ash Cone :** These are usually of low height and are formed of volcanic dusts and ashes and pyroclastic matter (fragmental material). The formation of cinder cones is initiated due to accumulation of finer particles around volcanic vent in the form of tiny mound, say 'ant mount' which varies in height from a few centimeter to a few meters. The volcanic cone of Mt. Jurullo of Mexico and Mt. Izalok of El Selvader are good examples.

(4) **Composite Cone :** Such Volcanoes are the heightest of all volcanic cones. These are formed due to accumulation of different layers of various volcanic materials and hence these are also called as **strato cones.** Most of the world's larger volcanoes such as Fujiyama (Japan), Vesuviun (Italy), Cotopaxi (Ecuador), Mt. Shasta, Mt. Ravier (U.S.A), are typical examples of composite volcanoes.

(5) **Acid Lava Cones :** Such cones are formed due to Silica rich thick lava. Such lavas have very low mobility and hence they are immediately cooled and solidified lavas around the volcanic vents. Such volcanos have steep heights. Stromboli volcano is example of this type volcano.

Depressed forms/Valcanic Topography :

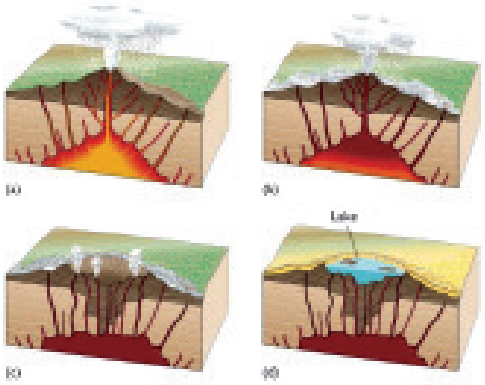
(1) Volcanic Craters : The depression formed at the mouth of a volcanic vent is called crater or a volcanic mouth, which is usually funnel shaped. It is surrounded by very streep inward facing cliffs and may be several hundred meters in depth. Its floor may contain lava lake or may be composed of layers of ejected material. It is formed by either a major eruption or the collapse of a volcanic cone (engulfment). St. Anna Crater of El. Selvador is its good example.



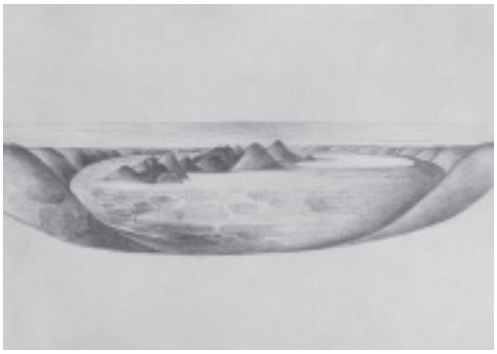
Volcanic Crater

(2) Calderas : Generally, enlarged form of a crater is called caldera. There are two parallel concepts for the origin of caldera. According to first group of scientists a caldera is an enlarged form of a crater and it is surrounded by steep walls from all sides. The caldera is formed due to subsidence of a crater. This concept has been propounded by the U.S. Geological survey. The second group of scientists has opined that the caldera are formed due to vioent and explosive eruptions of volcanoes.

The significant calderas of the world are,Lake Toba of Sumatra (50 km x 50 km), Aira (25 km x 24 km) in Japan, Crater Lake (10 km x 10 km) in U.S.A. etc. Smaller calderas housed in a big caldera are called nested calderas or grouped calderas.



Types of Calderas



Nested Caldera

Intrusive Topography :

When gases and vapour are not very much strong during volcanic activity, the ascending magma do not erupt as lava rather these are intruded in Viods below the crystal surface and after cooling and solidification assume several interesting forms like: **Batholith, Laccolith, Phacolith, Lapolith, Sills, Dykes etc.**

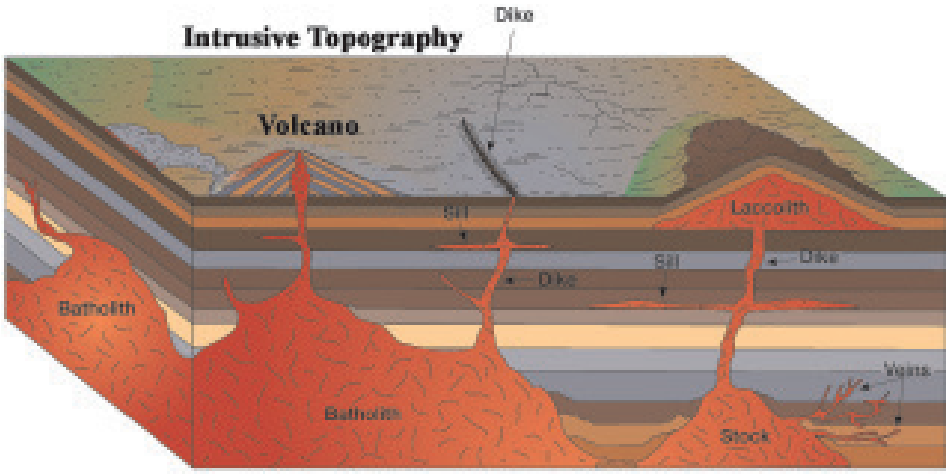
1. **Batholith :** Batholiths are very deep and are composed of Granite, Quartz monozite or Diorite principally. Batholiths are dome shaped. Bolder batholiths and Idaho batholiths of U.S.A. and Aswan granite of Africa are examples.

2. **Laccolith :** Laccoliths are formed when megma solidifes in cracks of sediments and take convex shape. As hot lava solidifies between two straps of sediments, upper layer rises upwards.

3. **Phacolith :** Phacoliths are formed when magma is filled in antichines and syclines of folded mountains.

4. **Lapolith :** Lapolitho take shape when magma solidifies on cooling in concave layers of sedimentary rocks in the interions.

5. **Sill :** Sills are parallely solidified lava layers in intrusive sedimentary rocks.



Intrusive Volcanic Topographic

6. **Dyke :** Longitudinally solidified magma in rocks is known as dyke.

7. **Geysers :** Geyser, infact is a special type of hot spring which spouts hot water and vapour from time to time. The word 'geyser' which means gusher or spouter. This word was used to indicate the spouting water of a hot spring of Iceland known as Great Geyser. Old faithful geyser of Yellow Stone National Park in the Wyoming (U.S.A.), is the good example. If may throw water upto 100 feet. There are around 1000 geysers world over. KamchatkaValley in Russia and Manikaran in Himachal Pradesh are other examples of geysers.

8. **Fumaroles :** Fumaroles (Latin fumus, smoke) means such a vent through which there is emission of gases and water vapour. It appears from a distant place that there is emission of enormous volume of smokes from a particular centre. Thus, smoke or gas emitting vents are called Fumaroles. Fumaroles are often in the neighbourhood of volcanoes. A fumaroles field is an area of thermal springs and gas vents where magma or hot igneous rocks at shallow depth are releasing gases or interacting with ground water. The gases thus emitted are Carbondioxide, Sulphurdioxide, Hydrogen Chloride, Hydrosulphur oxide etc. Numerous fumaroles are found in groups near Katmai Volcano of Alaska (U.S.A.). **'The valley of Ten Thousand Smokes'** is a good example, which was formed during the 1912 eruption of Novarupta in Alaska (U.S.A.).

Geyser

Fumaroles

Classification on the basis of Periodicity of Eruption

Volcanoes are divided into three types on the basis of periodicity of eruptions:

(1) Active Volcanoes are those which constantly eject volcanic lava, gases, ashes, and fragmental material. There are about 600 active volcanoes in the world, most of which being in the Pacific Ocean, around 'Ring of Fire' and in the Atlantic islands. Mt. St. Helen (U.S.A.), Stromboli and Etna (Mediterranean Sea) are the most significant volcanoes in this category. Stromboli volcano is known as **'Light House of the Mediterranean'** because of continous emission of burning and luminous incandescent gases. All these are known for more than 100 years.

(2) Dormant Volcanoes are those which become quiet after their eruption for some time and there is no indication for future eruption but suddenly they erupt very violently and cause enormous damage to human health and wealth. Visuvious volcano is the best example of dormant volcano which erupted in 79 A.D., then it kept quiet upto 1631 A.D. when it suddenly exploded with great force destroying Popi and Harculanion cities. Mt. Pinatubo in Phillipines is another example of dormant volcano. People living around it, never knew about it prior to 1991.

(3) Extinct Volcanoes are considered extinct when there is no indication of future explosion. The crater is filled with water and lakes are formed. Edinbourgh Castle of Scotland and Shipark of Nethersland are good examples of this type. It may be pointed out that no volcano can be declared permanently dead as no one knows, what is happening below the ground surface!

Volcanic Materials (ejected out)

(1) Vapours and Gases : Steam and vapours constitute 60% to 90% (percent) of total gases discharged during a volcanic eruption. Gases include carbon dioxide, nitrogen oxide, sulphur dioxide, hydrogen, carbom monoxide, sulphurate hydrogen, hydrochloric acid etc.

(2) Magma and Lava : Generally, molten rock materials are called magma below the earth surface while they are called lava when they

come out the earth's surface. Lava and magma are divided on the basis of silica percentage into two groups e.g. (i) **Acidic Lava** (higher percentage of silica and (ii) **Basic lava** (low percentage of silica).

(3) Fragmental or Pyroclastic materials : Pyroclastic material thrown during explosive type of eruption are grouped into three categories:**1**. Volcanic dust (finest particals) ,live lava, tephra **2.**(Volcanic ash - size upto 2mm),lapilli (of the size of peas) and **3.** volcanic bombs (6 cm or more in size). The volcanic bombs can be the size of baseball or basket ball to giant size. Some time the volcanic bombs weigh 100 tonnes in weight and are thrown upto distance of 10 km.

Pyroclastic materials

World Distribution of Volcanoes :

Volcanoes occur in many regions of the world, including the islands of the oceans, the young mountain ranges and plateaus of the continents. Like earthquakes, the spatial distribution of volcanoes over the globe is well marked and well understood because volcanoes are found in well defined belt or zone.

World Distribution of Volcanoes

If we look at the world distribution of the volcanoes it appeares that the volcanoes are associated with the weaker zones of the Earth's crust and these are closely associated with seismic events say earthquakes. The weaker zones of the Earth are represented by folded mountains (Western Cordillera of North America, Andes, Mountains of East Asia and East Indies) with the exceptions of the Alps and the Himalayas, and fault zones of the continents and oceans. Volcanoes are also associated with the meeting zones of continents and oceans. Following are the three main belts of volcanic eruptions.

Convergent Plate Margins or Boundary

The Circum Pacific Belt (Ring of Fire) also known as the 'volcanic zones of the convergent oceanic Plate Margins', includes the volcanoes of the eastern and western coastal areas of the Pacific Ocean, of island arc and festoons off the east coast of Asia and at the volcanic island scattered over the Pacific Ocean. This volcanic belt is also called as the 'Fire Gridle of the Pacific' or the fire ring of the Pacific.

This belt begins from Erebus Mountain of Antarctica and runs northward through Andes and Rocky Mountains of South and North America to reach Alaska from where this belt turns towards eastern Asiatic coast to include the volcanoes of island arcs and festoons (e.g. Sakhalin, Kamchatka, Japan, Philippines etc.). The belt ultimately merges with the mid-continental belt in the East Indies. Most of the volcanoes are found in chains e.g. the volcanoes of the Aleutian island, Hawaii island, Japan etc., Cotopaxi is the highest volcanic mountain of the world (19,613 feet). The other significant volcanoes are Fujiyama (Japan), Shasta, Rainer and Hood (Western Cordillera of North America), a valley of ten thousand smokes (Alaska), Mt. St. Helens (Washington, U.S.A.), Kilavea (Hawaii island), Mt. Taal, Pinatubo and Mayon of Philippines etc. Hekla and Heggafall volcanoes erupted in 1974 and 1973 respectively.

Intra-Plate Volcanoes :

Besides the aforesaid zones of volcanoes, scattered volcanoes are also found in the inner parts of the continets. Such distributional patterns of volcanoes are called as interplate volcanoes, the mechanism of their

eruption is not yet precisely known. The location of volcanoes is in Antarctica, Indian Ocean, Medgaskar island etc.

EXCERCISE

1. Describe Volcano.

2. What are the causes of Vulcanism?

3. On the basis of type of eruption, classify the volcanoes ?

4. What is a Volcano Crater ? How is it formed ?

5. What is a Caldera ?

6. What is difference between Batholith and Laccolith ?

7. Differentiate between Geyser and Fumaroles ?

8. In how many types can we classify volcanoes on basis of perodicity of eruption ? Describe.

9. Describe the volcanic material comes out of volcanoes ?

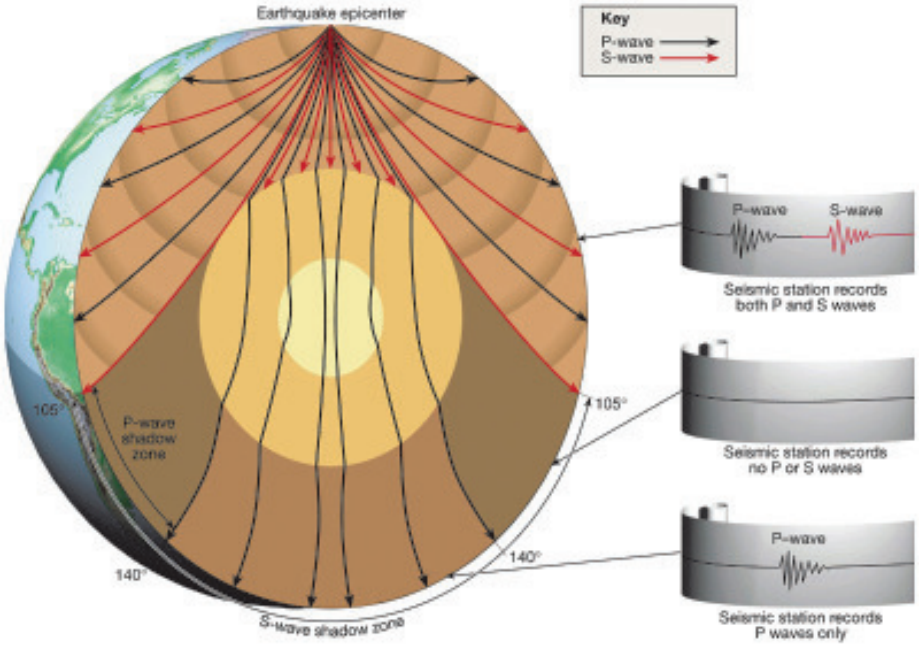
10. Describe in detail the distribution of Volcanoes in the world.

Map work:

Mark distribution of volcanos on the world map.

(ii) Earthquake

Earthquakes are vibration of Earth caused by ruptures and sudden movement of rocks that have been strained beyond their elastic limits. Earthquakes are movements within the earth caused by natural or man-made stresses. In other words "an earthquake is motion at ground surface ranging from faint tremor to a wild motion capable of shaking building apart".

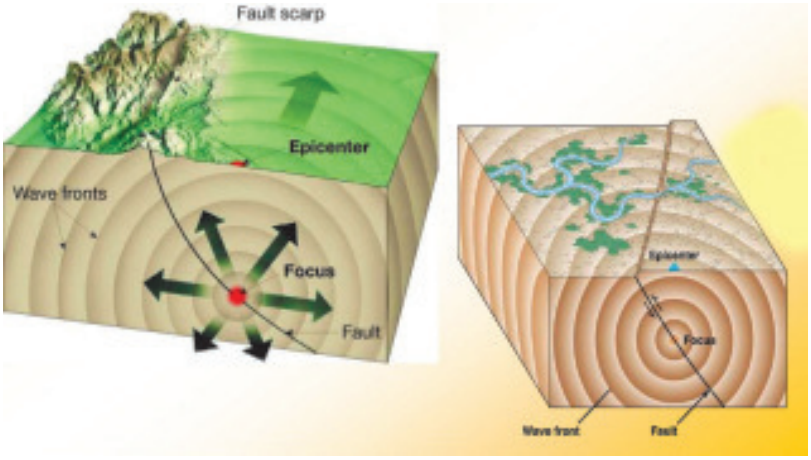


Earthquake Waves

Earthquake is a form of energy of wave motion transmitted through the surface layer of the Earth. Earthquake has also been defined as a shock or series of shocks due to a sudden movement of crystal rocks, generated at a point known as '**Focus' or 'Hypocentre**' with in the crust or the depth of the focus generally varies from about 10 km to 700 km below the surface of the Earth. **The magnitude of the earthquake is inversely proportional to the depth of focus.** The largest earthquakes occurs at shallower depths in the Earth's crust but smaller earthquakes can and do occur at the depth down to about 700 kilomeners.

The point where the shock waves (seismic waves) reach the surface is termed as **Epicentre**, around which lives of equal seismic

intensiy can be drawn (isoseismal lines). The waves generated by an earthquake are recorded by an instrument called **'seismography'** or 'seismometer'. The science of earthquakes is known as **seismology.**



Focus & Epicentre

Causes of Earthquakes :

The main causes of earthquakes are as under :

1. Volcanic Eruption

2. Rupture and sudden movements of rocks (folding and faulting)

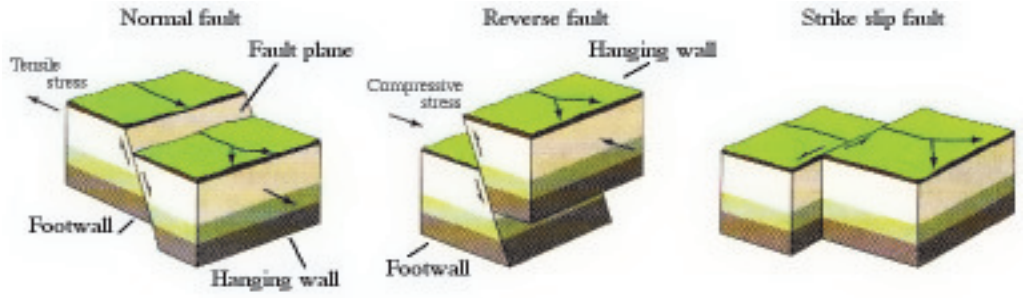
3. Plate Tectonics

4. Anthropogenic factors (Man made reasons)

1. Volcanic Eruptions : Volcanic eruption is one of the main causes of earthquakes. Volcanic earthquakes are caused by gas explosions or the up doming and fissuring of volcanic structures. Such earthquakes occur either simultaneously with eruption or more commonly in the period preceding an eruption. They are generally of shallow origin and their area of disturbance is relatively small and rarely exceeds a few hundred square kilometer. Their intensity may be high near the volcano. The violent eruption of Krakatoa Volcano (between Sumatra and Java island) caused such a sever earthquake that its impact was experienced at Cape Horn, Chile (South America, 12,800 km away). The Krakatoa earthquake

generated 30 to 40 meters high Tsunamis (sea waves), which killed over 36,000 people in the coastal areas of Jave and Sumatra. The ash cloud reached into the mesosphere, and sounds of blast were heard in Central Australia, the Philippines and even 4,800 km (3,000 miles) away in the Indian ocean. Such volcanic eruptions always result into severe earthquakes of hazordous nature.

2. <u>Faulting</u> : A fracture in a rock along which there has been an observable amount of displacement is known as fault. Earthquake occur when movementof the earth takes place along a line of fracture called a fault. Fault can be found in rocks of all ages. Its effect can be maximum near the active Plate boundary.



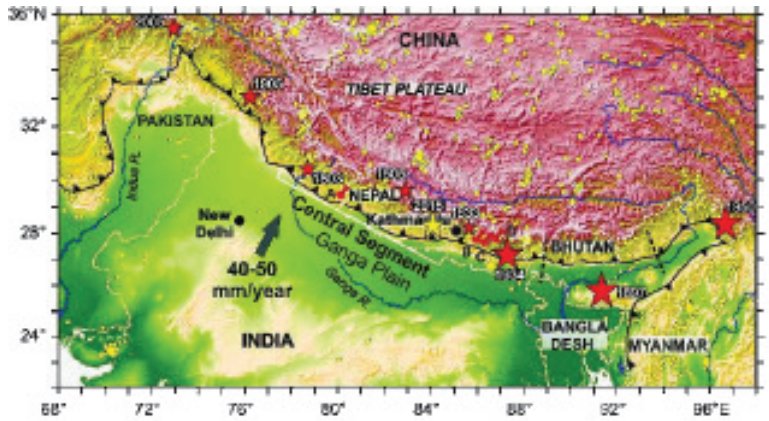
Types of Faults

The San Andreas fault of California is a typical example which led to earthquake in 1906. This fault passes about 60 km (36 miles) inland of Los Angeles, placing the densely populated Metropolitan Los Angeles region in great jeopardy.

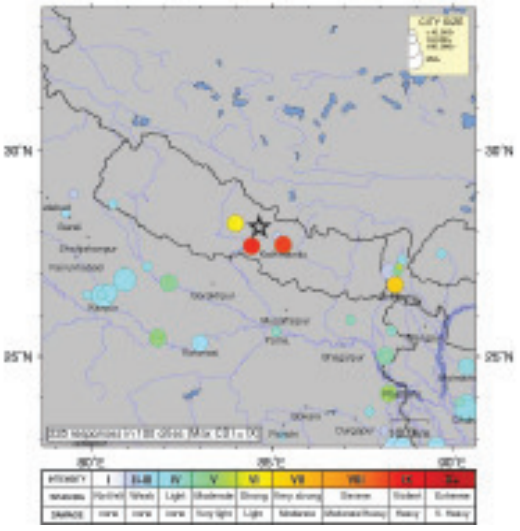
San Andreas Fault U.S.A.

Himalayan Earthquake & Destruction in Nepal

The Nepal Earth, which occured on April 25, 2015, and was measured 7.9 on the Richter scale destroyed not only parts of Nepal, but also the plains of Northern Bihar in India. According to UN and Nepal Governments own estimates more than 8600 people were killed and over 21,000 injured in the tremors. over 5,30,000 houses were damaged. This includes over 20,000 school buildings.

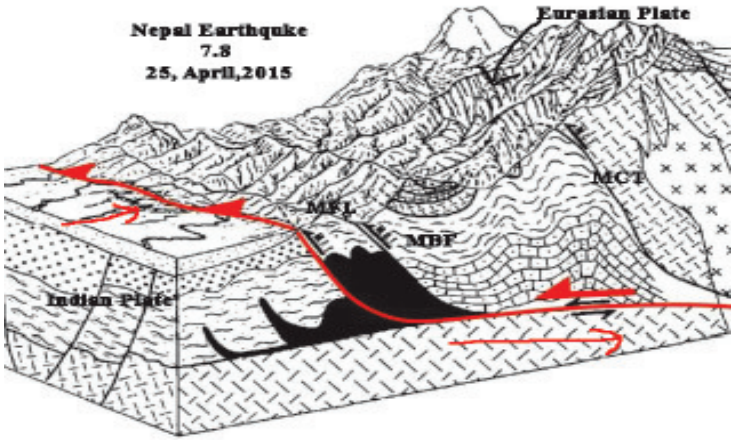


The Location of Nepal Earthquake



Epicentre of the Earthquake was beneath Gorkha- Lamjung 83 Kilometer North-West of Karhmandu. Like other Himalayan quakes, the Nepal temblor is a dramatic manifestation of the ongoing tectonic convergence between the Indo-Australian and Asian tectonic plates that have built the Himalayas over the last 50 million years. A product of millions of years of crustal shortening, the Himalayas are under immense tectonic stress and occasional temblors. The last 200 years in the region have seen four great earthquakes. But central Himalaya has been an exception, researchers warns, and is considered to be susceptible to great temblors. This earthquake was caused by thrust faulting "on or near the main frontal thrust" where the Indian plate

is pushed under the Eurasian plate. The India plate is converging with the Eurasian plate at a rate of 4.5-5 cm per year.



Graphic of Indian Plate Subducting under the Eurasian plate

According to Professor Michael P. Searle, Professor of Earth Sciences at Oxford University, one of the leading geologists working in the Himalayas, and the author of *Colliding Continents: A Geological Exploration of the Himalaya, Karakoram and Tibet.* explains the nature of the quake and its relevance in a larger narrative of continents, oceans and an ever restless earth that fuels it all:

1.The Nepal earthquake was devastating due to many factors. The source of the quake was shallow and the fault plane extended right up to densely populated Kathmandu.

2. Nepal is situated on an ancient lakebed and hence the soil at Kathmandu valley is soft and "liquifies easily." Unlike a rocky terrain where the seismic waves travelling with great velocity can have very good transmission, a terrain with sediments can amplify the seismic waves, thereby amplifying the ground motion, thus transform the sediment into a liquid like substance which would couse intense shaking by surface waves similer to the earthquake that davastated Maxico city in 1985.'

3. The slip of 1 to 3 metres recorded along the 160-km-long rupture showed strain built up over a century.

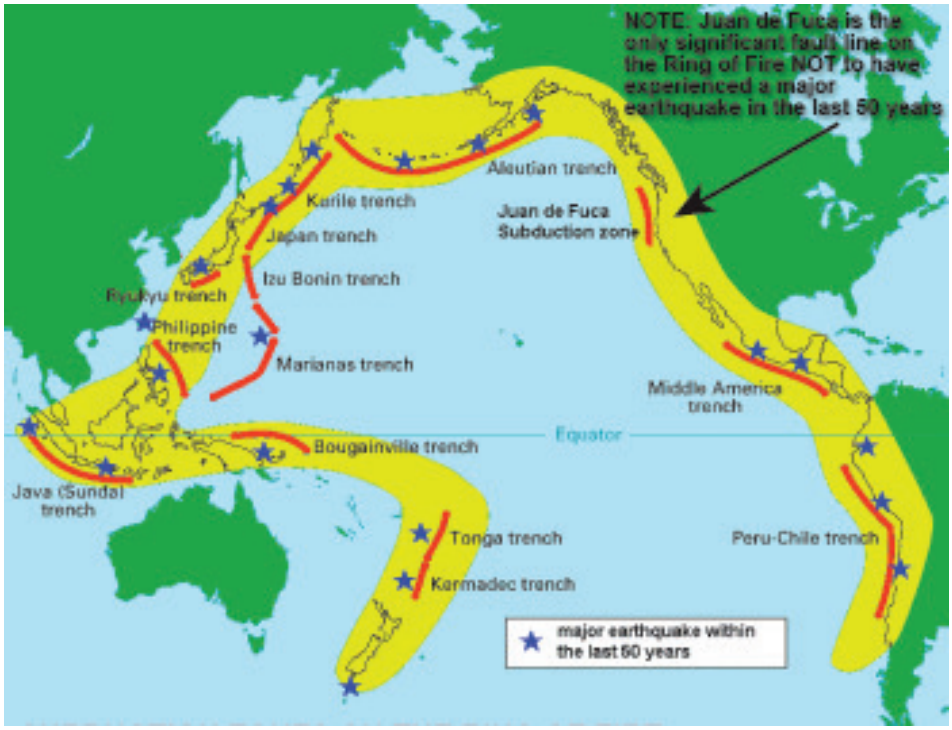
4. Research implies that this segment has seen no great earthquakes in the last 700 years. Thus, the unspent accumulated slip needed to be released through this quake

and will further be released through future quakes. This means that the segment, which includes parts of Uttarakhand, is capable of witnessing more damage.

5. As per latest information, which comes from Europe's Sentinel-1A radar satellite. The devastating earthquake have also shrunk the height of the world's tallest peak — Mount Everest — by about 2.5 cm. The radar images showed that some of the world's tallest peak, according to the non profit UNAVCO, a geoscience research consortium.

Plate Tectonics :

The plate boundaries are the primary location of earthquake and volcanic activity. The **'Ring of fire'**, surrounding the pacific basin, named for the frequent incidence of volcanoes, is most evident. The subduction edge of the Pacific Plate thrusts deep into the crust and upper mantle, producing molten material that makes its way back towards the surface, causing active volcanoes along the **'Pacific Rim'**. These volcanic eruptions are the main cause of earthquakes. Such processes occur similarly at plate boundaries throughout the world.



Pacific Ring of Fire

The global patterns of Earth's seismicity show a narrow belt of shallow-focus earthquakes that coincides almost exactly with the crust of the oceanic ridge and marks the boundaries between divergent plates.

Anthropogenic Factors :

Human over interaction with nature is also one of the main causes of the occurence of many of the earthquakes. The extraction of minerals, deep underground mining, blasting of rocks by dynamites for construction of roads, dams and reservoirs, nuclear explosions, etc., lead to the occurence of earthquakes of various intensity and magnitudes. Many of the earthquakes of the wold in the present century are the result of construction of dams and reservoirs. The earthquake of 1931 in Greece has been attributed to Marathon Dam construction in 1929. The Koyna earthquake of 1967 in Satara district of Maharashtra (India) was due to Koyna reservoir constructed in 1962, which caused more than 180 deaths and 1500 other human casualties.

Magnitude of Earthquakes :

The magnitude of Earthquake is most commonly assessed by Richter Scale which was devised by an eminent seismologist Charles Francis Richter in 1935 and then modified by Richter and his colleague Beno Gutenberg. This scale can be related to the energy released at the earthquake centre, and thus can be used as an estimate of the serverity of a particular earthquake. The Richter magnitude of an earthquake is determined from the Logarithm of the amplitude of waves recorded by seismographs. The Richter magnitude and energy release, as modified by Kanamori, have been given in table:

(1) Circum Pacific Belt :

The most widespread and intense earthquake activity occurs along subduction zones at convergent plate boundaries. The Circum Pacific Belt extends in the west from Alaska to Kurile, Japan, Mariana and the Philippine trenches, beyond which it is divided into two branches, one going towards the Indonesian trench and other towards Keramac-Tonga trench to the north-west of New Zealand. On the eastern side of the Pacific, the earthquake zone follows the west South America.

The Mid-Atlantic Belt :

This belt of earthquakes extends along the mid oceanic ridges and several islands near the ridges of the Atlantic ocean. The sea-floor spreading is the main cause of earthquakes in this belt. Earthquakes of moderate to mild intensity with shallow focus (less than 70 km deep) are recorded in this belt. The Rift Valley of East Africa and the Red Sea are considered as an extension to this belt.

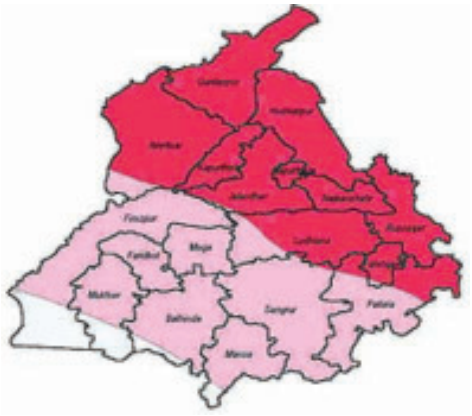
The Mid-Continental Belt :

This earthquake belt extends along the Alpine mountains system of Europe, North America, through Asia Minor, Caucasia, Iran, Afghanistan and Pakistan to the Himalayan mountain system, including Tibet, The Pamir, Tien-Shan, Altai, and the mountains of China, Myanmar and Eastern Siberia. This zone is characterised by larger earthquakes of shallow origin and some of intermediate origin deep focus earthquakes are almost absent in this belt.

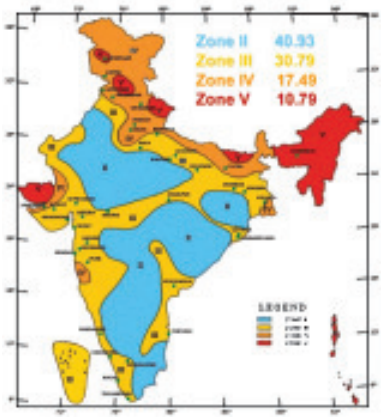
DATE	LOCATION	MAGNITUDE
1819 JUN 16	KUTCH, GUJARAT	8.0
1869 JAN 10	NEAR CACHAR, ASSAM	7.5
1885 MAY 30	SOPOR, J&K	7.0
1897 JUN 12	SHILLONG PLATEAU	8.7
1905 APR 04	KANGRA, H.P	8.0
1918 JUL 08	SRIMANGAL, ASSAM	7.6
1930 JUL 02	DHUBRI, ASSAM	7.1
1934 JAN 15	BIHAR-NEPAL BORDER	8.3
1941 JUN 26	ANDAMAN ISLANDS	8.1
1943 OCT 23	ASSAM	7.2
1950 AUG 15	ARUNACHAL PRADESH-CHINA BORDER	8.5
1956 JUL 21	ANJAR, GUJARAT	7.0
1967 DEC 10	KOYNA, MAHARASHTRA	6.5
1975 JAN 19	KINNAUR, HP	6.2
1988 AUG 06	MANIPUR-MYANMAR BORDER	6.6
1988 AUG 21	BIHAR-NEPAL BORDER	6.4
1991 OCT 20	UTTARKASHI, UP HILLS	6.6
1993 SEP 30	LATUR-OSMANABAD, MAHARASHTRA	6.3
1997 MAY 22	JABALPUR, MP	6.0
1999 MAR 29	CHAMOLI DIST, UP	6.8
2001 JAN 26	BHUJ , GUJARAT	6.9

Earthquakes in India :

Most of the earthquakes in India occur in Himalayan Belt. This is a region of marked instability and is characterised by several thrust planner. The north-western (including Baluchistan and Hindukush and the Pamirs) and the north eastern corners at the Himalayas are particularly vulnerable as there are sharp changes in strikes and rocks are under great stress. The Indo-Gangetic alluvial track is mostly affected by earthquakes originating in the Himalayan belt, but changes appear to be still taking place at the botton of the Gangetic trough giving rise to the occasional earthquakes. The Sindh earthquake of 1819 and the Bihar earthquake of 1934 had their focii in this trough.

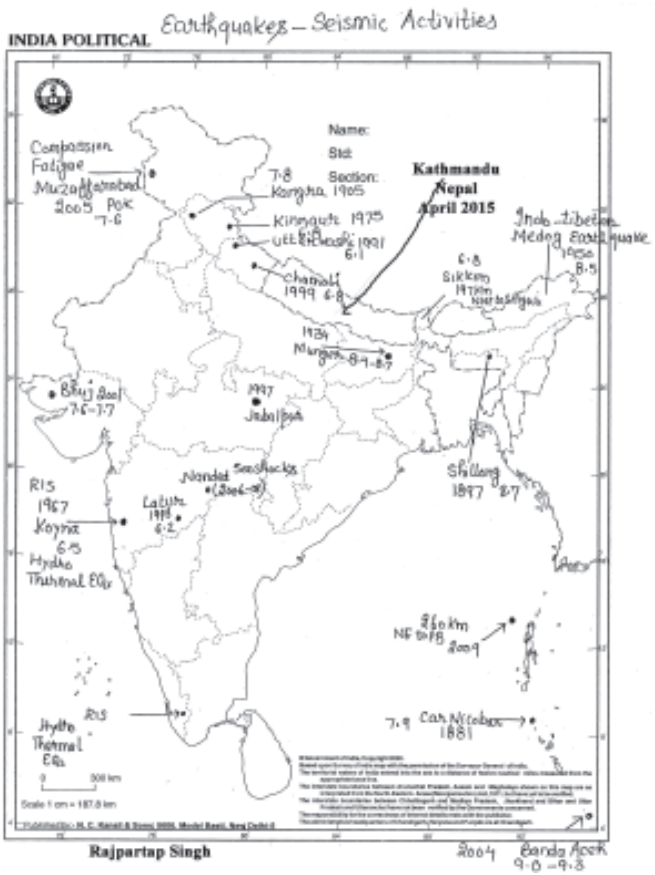


Punjab: Earthquake Zones

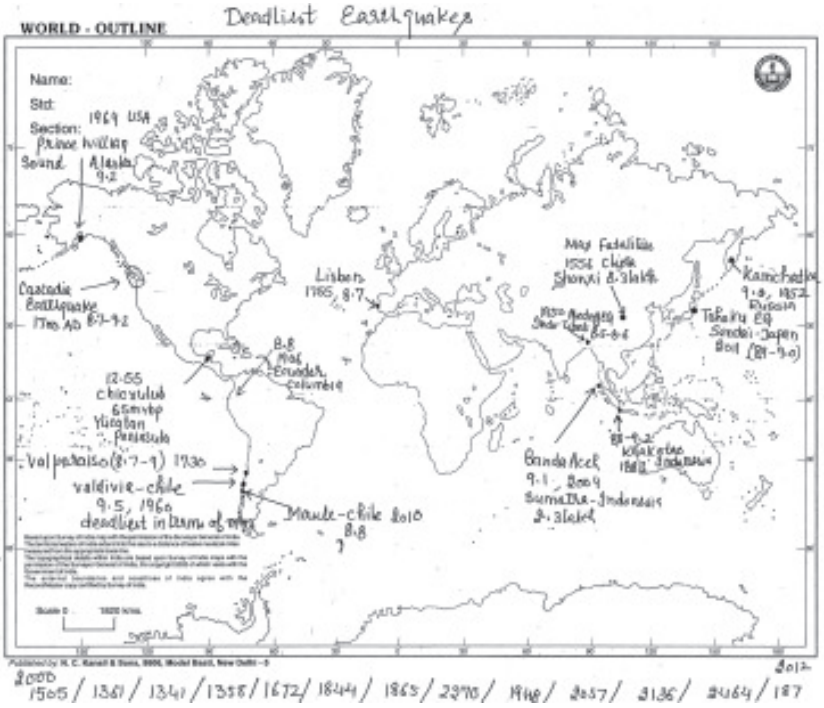


India: Earthquake Zones

The Peninsular India is considered to be a comparatively stable block while earthquakes of Koena (1967) and Latur (1993) are examples of such activity in this region.



Major Earthquake in India



Consequences of Earthquakes :

Throughout the histroy, earthquakes have done great damage to both human lives and property. The major consequence of the earthquakes are:

(1) Landslides : In the young fold mountains like Andes, Rockies, Alps and the Himalayas, the earthquakes result into landslides which damage the human settlements and disturb the transport system. Financial & Commercial distruction is at its most in mountainous regions because of earthquakes.

(2) Loss of Human Lives : It has been estimated that on an average about 15,000 people are killed every year by earthquakes. There had been earthquakes of great magnitudes in the densely populated areas of the world in which over one lakh people lost their lives, such as in Shenshi 1556 China massive earthquake killed 8,30,000 people.

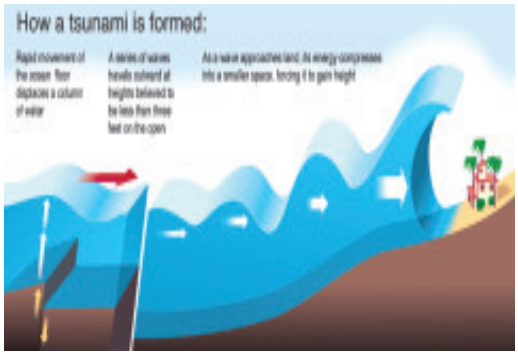
(3) Fire Incidence : Contact of line electrical wire and damage to blast furnaces in factories and other fire related appliances cause devastating fires. Consequently, more damage to life and property occurs from these fires. Control over such incidences also go beyond possible.

(4) Loss of Human Property : Earthquakes pose a significant threat to much of the world population. Earthquakes inflicts great damage to buildings, roads, railways, dams, bridges, etc. The damage to property is more serious in the areas of unconsolidated materials, such as alluvium, colluvium, and artificially filled grounds and depressions. The Gujarat earthquake in 2001 not only killed over 30,000 people, but also damaged property of more than Rs. 2,000 crores. A much bigger destruction has been caused by earthquake in Nepal in 2015.

(5) Flash Floods : Many a times, under the impact of severe earthquakes, the dams and embankments develop fissures, which become the cause of flash floods and big harm to human lives and property.

(6) Tsunami : The seismic waves, travelling through the ocean and sea water, result into high sea waves which are known as Tsunamis.

Graphic of Tsunami



Trunamis formation

'Tsunami' is a Japanese term which was been universally adopted to describe a large seismically generated sea waves which is capable of considerable destruction in certain coastal areas, especially where submarine earthquakes occur. Although in the open ocean the wave height may be less than 1 meter it steepens to heights of 15 meter or more on entering shallow coastal water. The wave length in the open ocean is of the order of 100 to 150 km and rate of travel of a tsunami is between 640 to 960 km/hr (400 - 600 miles/hr). Tsunamis can also be generated by violent volcanic explosion at or below sea level. The Tsunami of 26th December, 2004 as a consequence of the Aceh (Sumatra) earthquake, killed about two lakh people in Indonesia, Thailand, Sri Lanka, Andaman & Nicobar Islands, Tamilnadu (India), Maldives, Somalia, and Myanmar. The loss of property and structure was enormous.

Regions with high risk of Tsunami, typically use 'Tsunami Warning System' to warn the population before the wave reaches land.

Earthquake Forecasting :

Making a forecast about the occurences of an earthquake in a region, place and time is still difficult proposition. One approach for making predictions is to examine the history of each plate boundary, and determine the frequency of earthquakes in the past. Seismologist then construct the maps that provide an estimate of expected earthquake activity.

The Chinese, on the basis of seismographic studies on animal behaviour, made fairly accurate predictions in the seventies. Despite animal behaviour and other phenomena, effective earthquake predictions, which could save many lives and property damage is providing to be an elusive goal.

EXERCISE

1. What do you mean by earthquake ?

2. What is a hypocenter ?

3. What is an epicentre ?

4. What is focus and epicentre ? Draw a diagram to explain.

5. Which instrument is used to measure earthquakes ?

6. What are the causes of earthquakes ?

7. What is principle of Plate Techtonic ?

8. How humans are responsible for generating earthquakes ?

9. What is Richter Scale ? How intensity of earthquake is measured?

10. What is Pacific 'Ring of Fire' ?

11. Describe the distribution of earthquakes world over.

12. Write in detail about earthquake zones in India.

13. What is Tsunami ?

14. Can we make predictions about eartquake? Write note

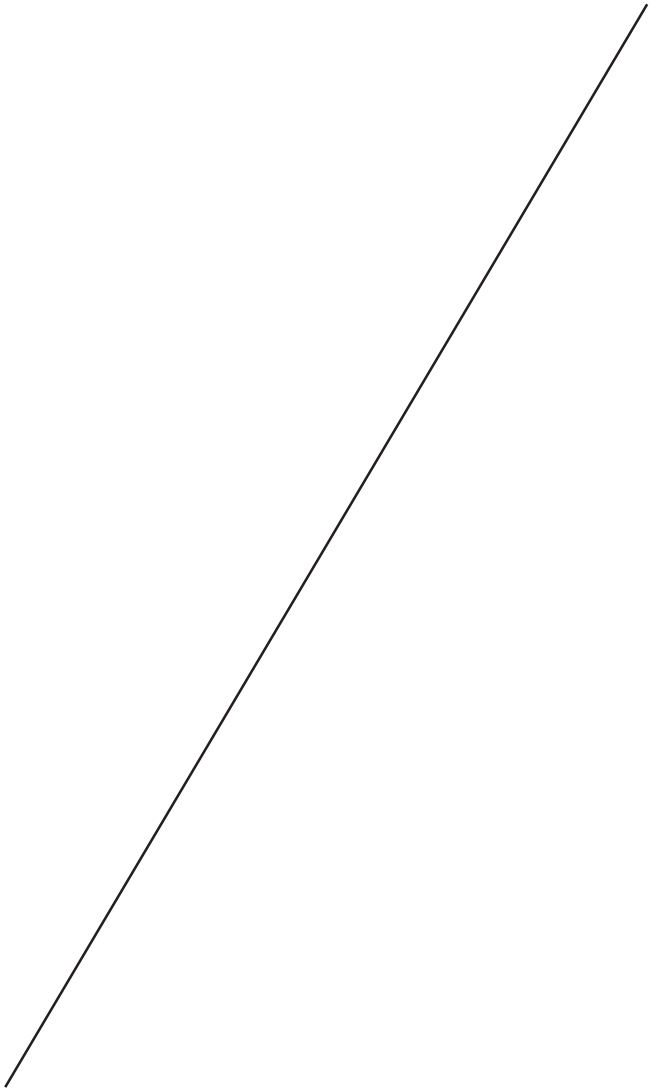
Map work:

1. Show eartquake prone regions of the world on a map.

2. Show earthquake zones of india on an outline map.

UNIT - III

ATMOSPHERE



CHAPTER - 6

FORMATION OF ATMOSPHERE

In our daily life, we often discuss various characteristics about weather. Generally such discussion is limited upto good, bad, dry hot and cold weather. While student of geography has a cruisty to gather more and more information about these aspect. Gathering information about surroundings includes knowing reasons, responsible for these changes and descriptions of the aspects related to atmosphere at different places of the world.

In this series, our discussion begins with the basic information about the important sphere of our mother earth, which is known as 'Atmosphere'. It is also as important as Lithosphere and Hydrosphere are

View of Atmosphere from the Space

Our Earth is engulfed by a mixture of various gases around it which remian glued with Earth becasue of its gravitational power. These gases are tasteless, colourless, odourless and invisible. Apart from this these are always moving, elastic and compressible also. This mixture is not dense and solid as land or liquid like ocean regions but it is a mixture of gases which also has mass/weight, like all physical bodies and has air pressure also. The interesting fact of information about its existance is that

it comes to be known or is falt only when it horizentally means when wind blows.

Definition : Atmosphere is combination of two words 'Atmo' and 'sphere'. It means that region of Earth which has 'air'. Various scientists have defined 'Atmosphere' in their own respective ways.

Gathering of information about Atmosphere is harder as compared to that of hydro and lithospheres because of its inaccessibility. Especially about its upper layers because these extend upto hundreds of kilometers. Presently we have been able to extract quite reasonable information about Atmosphere with the help of technology but earlier this was not possible. Systematic study of atmosphere is knwon as atmospheric science. This is further divided into two parts weather science and climatology.

Weather science is a branch in which study of characteristics and conditions of atmosphere are included. Investigation of forecasting on scientific lines is also a part of it.

On the same lines, purpose of climatology is to study the factors, differences and other characteristics pretaining to Nature in relation to those of human beings.

Historical Timeline :

Information about atmospheric science, like other branches of sciences also begins with the views and principles given by ancient Roman and Greek philospheres. Greek thinkers were first who published documents about atmoshphere in 400 B.C. large information about the existence of wind, effect of climate on health, division of world in different spheres etc. is included in ancient scriptures. There was a 'deadlock' regarding information due to dark age which was broken in 15th and 16th century.

Invention of devices which are used to measure different aspects of weather included; Galileo invented thermometer in 1593, Torricelli invented barometer in 1643 to measure the atmospheric pressure. In 1668, a space scientist Edmund Halley came forward with his views about winds. In 1735 Hedley presented his views about the effect of rotation on the direction of winds. Regular recording of figures about winds started in 18th and 19th century. On the bases of these figures, of weather maps started coming up in Europe. Weather scientist of Germany, Valadimir Koppen brought the thought of climatic classification in 1900. During first and second world wars emphasis was given on collection of information about weather and present day weather predictions find their birth in those days.

After 1960 information sector crossed national political boundaries and carved its

niche at world level platform as weather sattelites provided regular information about atmosphere data at world level. Information provided by weather sattelites like TIROS, NOAA and GOFS helped the scientists in solving atmosphere issues. Moreover, the information provided by these sattelities helps to understand the changes in atmosphere.

Significance : Our mother Earth is most important celestial body in our solar system because it supports life while atmosphere plays a vital role in this aspect. Atmoshpere is present as life saving layer between outer space and land surface. It is the source of important gases which are important for the existance and continuity of life. It also filters the harmfull rays travelling towards Earth and also protects Earth from extensive heat for which might be generated by ultrovidet (UV) rays. It provides essential energy for life cycle also.

Atmosphere helps in distributing solar energy on earth vertically and horizontally as well. Atmospheric conditoins have biggest effect on flora and fauna of Earth. Presently atmospheric changes at local, regional and global level owing to natural and man made conditons extend the importance of its deep study.

Use of air force in second world war brought revolution in the field of air transport and has reduced the world to be a global village which has resulted in making every minutes information about atmosphere crucial for the safety of aeroplanes in particular and mankind in general.

Extent : With the advancement in the field of science, today, we are able to move thousand kilometers above the ground. As compared to the past, we have more information about atmosphere presently but still scientists have various divergent opinions about related facts with the help of sattelities the height of atmosphere has been settled varying between 16000 to 32000 Kms. while portion of atmosphere upto ten kilometers part closest to the Earth is most important for weather and human life.

* Aeroplanes, Baloons and man made sattelities are indirect sources, which provide informaton about atmosphere.

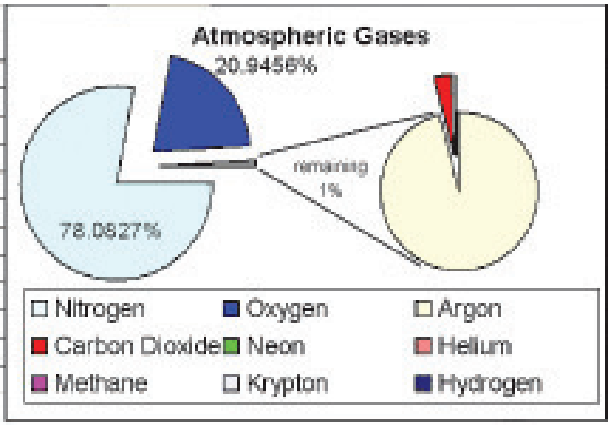
* Density of atmosphere decreases as we move away from the surface of Earth

Structure of Atmosphere :

Definition of atmosphere is addresed as a combination of gases but along with those

gases large number of very fine solid and liquid materials, aerosols and water vapours are the part of atmosphere.

Gas	Reported by NASA	Normalized to 100%
Nitrogen	0.78084000	78.082687%
Oxygen	0.20946000	20.945648%
Argon	0.00934000	0.933984%
Carbon Dioxide	0.00035000	0.034999%
Neon	0.00001818	0.001818%
Helium	0.00000524	0.000524%
Methane	0.00000170	0.000170%
Krypton	0.00000114	0.000114%
Hydrogen	0.00000055	0.000055%
		100.00000%



Composition of Atmosphere

Amount of suspended particles, water vapours and some gases change with time and place but amount of major gases like N, O_2, Av remain same in dry air. Contribution of various gases in the atmosphere is as under :

Nitrogen : Amount of nitrogen (78.03%) is highest in atmosphere as compared to other gases. Although its elements do not match with other particles but it is very important for living organisms because it is an important element of Amino acids which form protein. Living organisms donot use it directly. Its main function in atmosphere is to regulate combustion by diluting oxygen.

Oxygen : Amount of oxygen in atmosphere is 20.11 percent chemically it is very active and combines with other elements at fast rate. Our mother Earth is supporting life because of presence of oxygen. All the living organisms use it for breathing. It helps in combustion and it is a source of energy. In living organisms it helps in the convertion of food into energy.

Carbondioxide : It covers 0.03% part of atmosphere and is produced by combustion. It plays a vital role in absorption of energy moving towards atmosphere from land and also keeps the lower atmosphere warm. Plants use this gas for the process of photo synthesis. Its amount has been increased from 290 PPM to 350 PPm i.e. 0.029% to 0.0350% in last 100 years.

Ozone : It is a life saving gas and another form of oxygen. Its amount is very less in atmosphere (0.0005% by volume). Its maximum amount is found between 20 to 30

kms above the earth surface. It is present in a form of layer and protects Earth from harmful rays of sun by absorbing that part their of.

Since the last decade of 20th century scientists are very concerned about the depletion of ozone layer. Majority of scientists presume that halogenated gases such as chlorofloro carbons, halons and nitrogen oxides are responcible for this depletion as these gases change ozone atom into oxygen atom and oxygen molecule, scientifically we put it as $O_3 = O_2 + O$.

Apart of it, hydrogen, Helium Neon, Zenan, Crypton etc. are also present although in less amount in atmosphere. These do not affect the weather of a particular place. On the other hand Oxygen, Carbondioxide and Ozone react very fast therefore these are known as active gases. These gases play an important role in settling the weather of a particular place.

Water Vapours : Water vapours are gaseous form of water present in atmosphere. Although it is a gas but due to its importance in atmosphere it must be discussed as different aspect. Spatial and Temporal variations of water vapours formed by evaporation of water from the water sources situated on Earth, are found in atmosphere. The amount of water vapours is higher in lower layers of atmosphere present near to the Earth. This amount decreases as the height increases.

About 90% of water vapours are found in region extending upto five kilometers above the Earth and vanish fully at and above height of eight kilometers. Distribution of water vapours varies horizentally also like 0.02% of volume of air water vapours are found in cold polar regions and 5% of volume of air water vapours are found in moist temperate zones. Atmosphereic humidity is important for every type of life. Water vapours absorb the long wave radiations of Earth and increase the temperature of lower atmosphere. These are also known as Green house gases. At the time of condensation they release large amount of energy, which act as power of storms. These are the sources of various type of precipitation and condensation i.e. clouds, fog, dew, rain, hail and snow. Water vapours are closely related to temperature. The capacity of wind to acquire water vapours increases with rise in temperature.

Aerosols : Solid and liquid particles of different sizes suspended in air are known as Aerosols. These particles are very minute and are visible to naked eye in light streaks at dark places only. Generally, these are invisible to naked eye. These particles enter in atmosphere from natunal and human sources e.g. dust particles from volcanic erruption, salt particles from sea, polination of various plants and flowers, bacteria and virus from living organisms, smoke and dust particles, particles produced from meteors

etc.

The amount of different particles decreases with the increase in height. Amount of aerosols varies from place to place and it may be 100 per cubic centimeter of air to lakhs per cubic centimeter of air. Although aerosols are principally found in lower layers of atmosphere yet Aerosols may be found in upper layers of atmosphere because of meteors, nuclear experiments, volcanic blasts and high altitude aircraft generating them there. Atmospheric circulations help them all these particles everywhere in atmosphere. The radiation rays origrating from sun also spread these particles at some wave lengths which results into changing colour of sky at dusk, dawn and noon namely red, orange and blue.

Some particles absorb and reflect small amount of radiation rays of sun. These also play an important role in weather, they act as center for humidity acquisation. Water vapours gather around these particles in the form of condensation and reach on Earth in various forms of precipitation and effect the division of water on Earth.

Structure of Atmosphere : Now it is clear that atmosphere starts from Earth surface but scientists have different views about its maximum height. On the basis of inofrmation provided by radars, baloons, rockets, sattelities at present large number of scientists agree on a point that the height of atmosphere is 29000 kilometer and layer upto 800 kilometer is considered as important part of atmosphere.

On the bases of air pressure, temperature and weather phenomena, out of the total amount of major gases in atmosphere 97% are found upto 29 km of height from Earth while 50% are found upto 5.6 kilometers only.

In 20th Century with the help of advanced technical devices, scientists have succeded in solving major mysteries about atmosphere. Teisserence de Bort, S. Petteisun, Sir Napier shaw, Picardy, Kennelly Heaviside, Ferrel etc. have played an important role in this field. Atmosphere may be divided into layers or spheres on the basis of height, every layer having its own importance. Boundaries of these layers are also arbitrarily established as other natural boundaries.

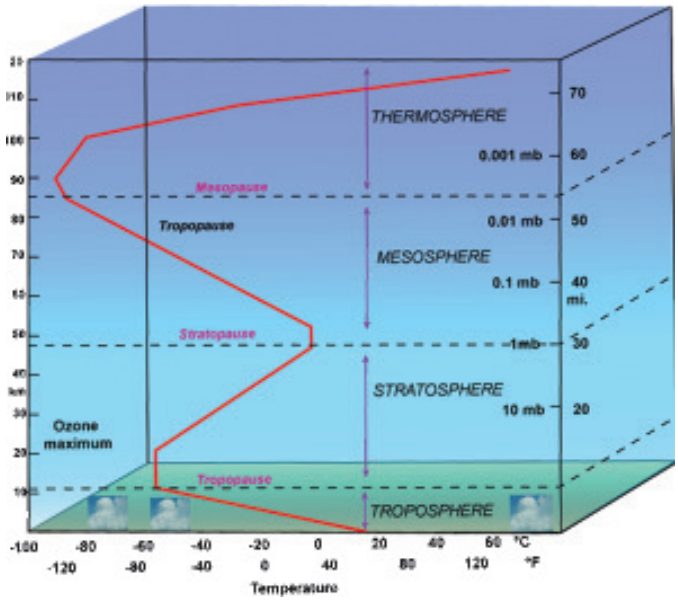
Structure of atmosphere can be divided in two ways; On the basis of temperature and on basis of Chemical Composition.

On the basis of temperature S. Peterson has divided atmosphere into five layers vertically :–

1. Troposphere 2. Stratosphere

3. Mesosphere 4. Inosphere

5. Exosphere (Thermosphere)



Structure of the Atmosphere

1. Troposhere : This is the lowest layer of atmosphere and it is very important for all the living organisms because all the activities and aspects related with weather e.g. Evaporations, condensation, precipitation, storm, lightening etc. originate in this sphere. Around 75% mass of gases and nearly all water vapours and aerosols are present in this layer.

Teissesence de Bort was the first scientist who used this name '...T..ro..po.... sphere' it has been derived from Greek word 'Tropos' which means mixing or Turbulence, overall we can say 'region of mixing'

One of the important feature of this sphere is that in this part of atmosphere, temperature decreases with increase in height. In normal conditions the rate of decrease is 6.5 degree celsius per kilometer or 3.6 degree F per 1000 feet. This is also known as mean temperature fall rate. This happens because of decrease in gases with increase in height, airpressure, decrease in aerosides with increasing height. However, due to local reasons, at some places this phenomena reverses also.

The height of Troposhere changes with change of weather. The change is registered

lesser towards poles as compared to tropical regions and in winters as compared to summers. According to scientists the height of this sphere on Equator is 16 km and on poles it is 8 km. Interesting fact is that the temperature decreases at the upper part of this sphere at Equator not on poles. At average its height is upto 12 kilometer from ground.

Tropopause : The region between Troposphere and Stratosphere which is 1.5 kilometer high, known as boundary of troposphere . The fall in temperature comes to an end in this region named as tropopause. Turbulent mixing of gases, winds, and radiation etc. none of the weather activities take place in this region. The minimum temperature in winters, at Equator (At the height of 17 kilometer) is 70^0 C and in summers over the poles it is - 45^0 C (At the height of 9 kilometer). Air pressure in this region is also between 100 millibar over Equator and 250 millibar over poles.

2. Stratosphere : This sphere starts from 12 to16 kilometers above the Earth surface and extend upto 50 kilometers known for isothermal characterstics also. Although scientists have different views about the height, width and temperature but they all agree on one point that at the lower layer of this sphere temperature does not change with increase in height but at the height of 20 KM in upper stratosphere temperature starts increasing because of absorption of ultra violent rays by ozone gases. At the height of 50 KM it becomes 0^0 celsius (32^0F).

Region where ozone gas is present in abundance is also known as ozone layer. This gas is present in abudance between 15 to 35 kilometers above the Earth surface, which originates when oxygen molecule disintegrates into two atoms of oxygen and then integrating back into a molecule. Molecules of ozone layer are not stable, their origin and disintegration is a gradual and continuous process.

It has been proven that the ozone layer is dipleting day by day because of human activities like spray and syntehtic chemicals used for air conditioning which are stable compounds of clorine, florine and carbon on Earth but when these reach upto outer layers of atmosphere by vertical currents of air they affect the ozone layer.

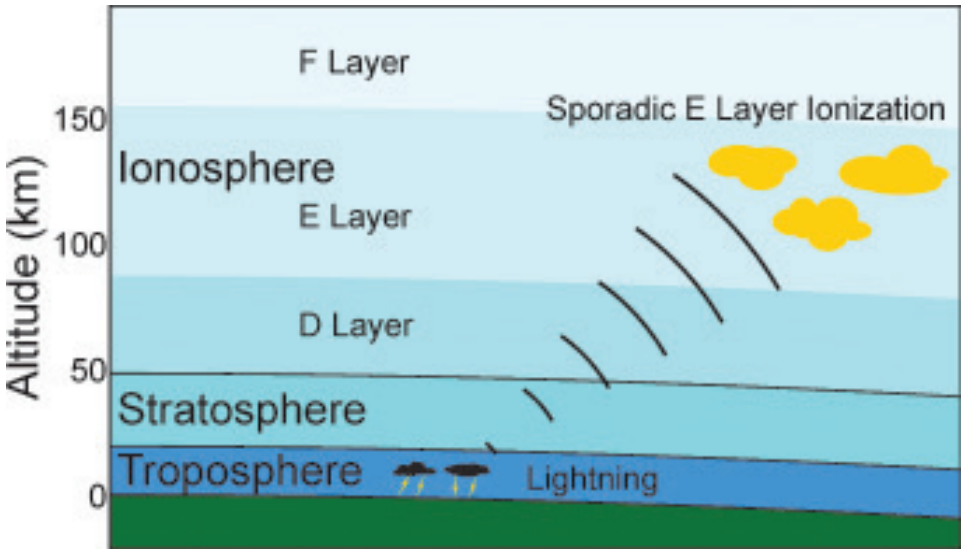
Because of depletion of ozone ultra violent rays are increasing the temperature of Earth. Moreover they cause skin problems, blindness and also kill senstive organisms. Apart from all this, these rays also decrease the process of photosynthesis, supersonic jets fly at the height of 20 km above the land surface and they emit nitrogen oxide which also affects the ozone layer.

2. Mesophere : Above the upper boundary of stratosphere, which extends from 50

kms. above surface of Earth, is mesosphere, upto 80 kms. In this layer temperature again starts decreasing with the increase in height and at the upper boundary of this layer it touches down to -80^{0}C point. Air pressure is very low in this layer. At the height of 50 kms it is 1 mb and at height of 80 kms it drops to 0.01 mb.

4. Ionosphere : The height of this sphere extends from 80 to 640 kms above surface of Earth. Credit of discovering this layer goes to scientists Kennelly and Heaviside who, with the help of radio waves proved that the atoms and molecules of the gases present in this layer get electrically changed by the addition and removal of electrons due to the effect of ultroviolent, Xray and Gama rays.

Short wavelength rays of solar energy (UV, X, L) get absorbed by molecules and atoms of nitrogen and oxygen because of which temperature increases upto 1000^{0}C in this scanty pressure layer of atmosphere. Because of scanty air pressure, temperature here is quite different as compared to the temperature felt at the surface of Earth. On the basis of height ionosphere may be further divided into following layers :



Layers of Inosphere

5. Exosphere : This is the outermost layer of atmosphere and we donot have much information about this layer. It lies above the height of 640 kms. Only Helium and hydrogen are found in this layer. Moreover the density of this layer is very low.

On the basis of chemical composition atmosphere has been divided into two parts :

a) **Homosphere :** It starts from the surface of Earth and extends upto 90 kms. In this sphere all the gases are found in their accurate ratio.

b) **Hetrosphere :** Atmosphere above the homosphere is not constant on the aspect of gaseous composition. On the basis of presence of gases this sphere has been further divided into four layer :-

Oxygen layer = 90 to 200 km

Nitrogen layer = 200 to 1100 km

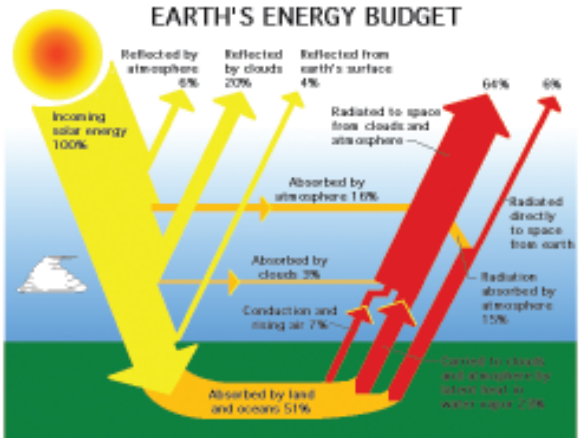
Helium layer = 1100 to 3500 km

Hydrogen layer = 3500 km onwards, upto outermost limit of atmosphere.

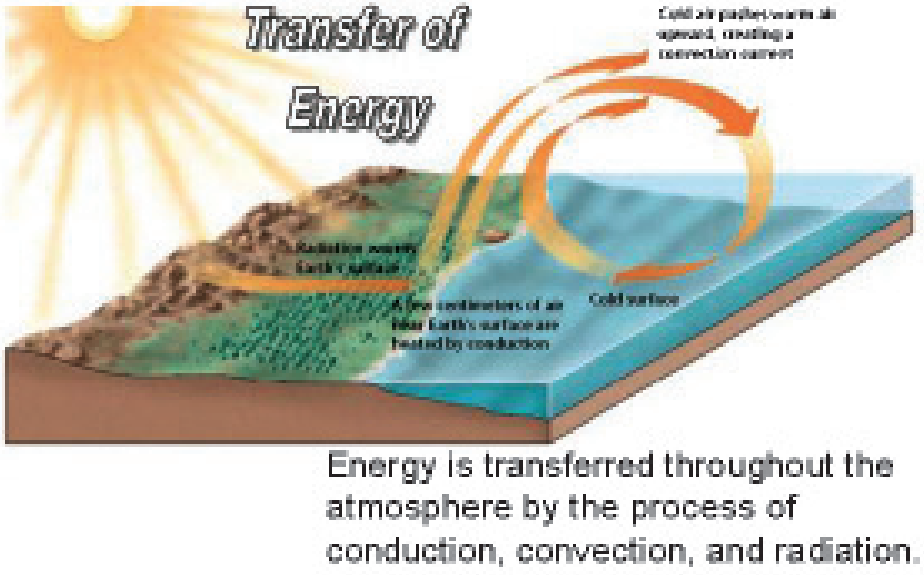
Insoloation

Sun is main source of energy for relief and atmosphere of Earth. It lies around 15 crore kilometer (93 million miles) away from Earth. Surface temperature of this star is 6000^0C ($10,800^0$F) which radiates its energy through low frequency electromagnatic radition rays. The highest layer of atmosphere receives only 1/2 billionth part of energy produced by sun.

The small part of energy that reach at Earth generates the life cycle on the planet. The average energy is 1.94 calorie/cm/minute and yearly it is $520X10^{22}$ Joules. About 51% part of this energy reaches upto Earth and increases the temperature of relief. This energy is known as Insolation and in other words it is a smaller form of incoming solar radiation.



Heat Budget of the Earth



Tranfer of Energy over the Earth

The structural shape of earth is GEOID and it is quite similar to sphere. Earth is inclined at the angle of 66 1/2^0 and it rotates on its own axis and also revolves around sun. This rotation and revolution makes daily and yearly difference in the amount and intensity of heat gained by earth.

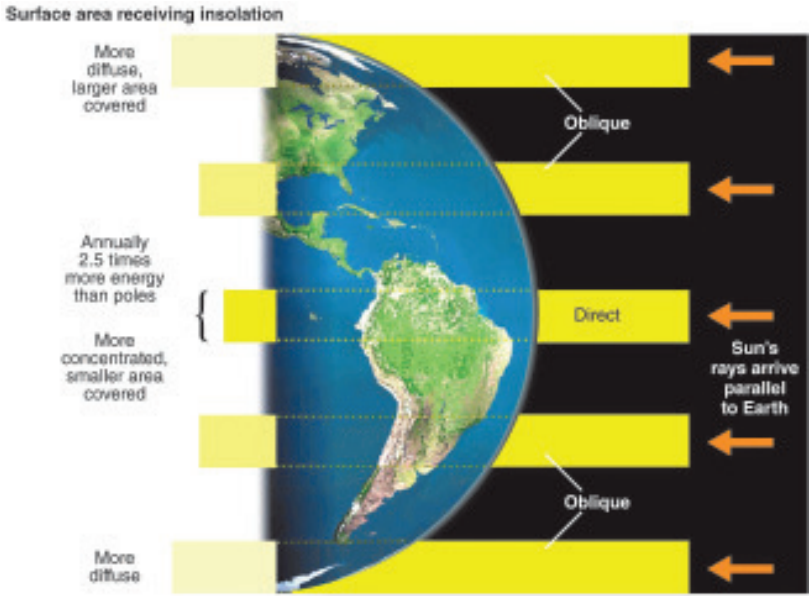
Apart from above mentioned reasons transparency of atmosphere and relief of Earth also effect the heat gaining capacity at a particular place which brings difference between the height at different places of Earth creating difference between air pressure which makes possibility of shifting and transfer of temperature with the help of winds. The winds move the water cycle on Earth in the form of evaporation and precipitation resulting to prove very helpful for the life cycle on Earth.

Heating and Cooling of Atmosphere :

Energy gained by Earth from sun is continously changing. As we know that the temperature of a particular thing represents its heat, increase and decrease in heat means rise and fall of temperature. Difference between the temperature of two things shows us mobility or change in heat. Heat or temperature moves from high temperature to low temperature.

Earth recievs heat from sun by way of radiation and then starts heating atmosphere

through convection. The mobility of heat in this case has three important steps namely. Radiation, Conduction and Convection.



Solar Radiation

Radiation : This is a direct process of transfering energy. No medium is required for the transfer of heat from one thing to another. Heat reaches upto Earth from sun through space and after gaining the heat Earth reflects it towards the atmosphere through waves. Because of this the temperature of lower layers of atmosphere rises first.

Conduction : This is a process in which heat moves from a body having high temperature to a body having low temperature, until the temperature of both bodies comes to equal or two bodies are not seperated. The lowest layer of atmosphere adjoining to earth surface gains heat and they upper layers of atmosphere gains heat from lower layer. Temprature shifts through this process.

Convection : Transfer of heat takes place through convection in liquid and gaseous forms. Convection is the process which represents such transfer. Even in atmosphere, warm air heats upper layers of atmosphere through vertical waves of convection.

Advection : This is an additional form of transfer of heat in which tempratural effect is transfered horizontally. Equatorial region and polar regions transfer heat and cold respectively to adjoining regions through this process.

Yet other important process is evaporation and condensation which creates indirect energy. The heat energy gained by water vapours while evaporation process at a place, are released in atmosphere after vapours turn into rain drops on condensation, transfering heat in atmosphere.

Factors Controlling Temperature :

The average global surface temperature is 14^0Celsius which varies with time at different places. The spatical and temporal differences of temperature are very important because they affect the weather, atmosphere, vegetation and activities of human life. Temperature of a place depends upon the heat gained by that place from sun. The temperature of a place depends on different.

Latitude : The heat gaining capacitity of a particular place depends on the latitude of that place. For example the lower latitudes situated near Equator receive more heat from such as compared to poles because of this air pressure decreases toward poles.

Altitude : Indirectly the temperature of lower part of atmosphere increases due to long waves of heat released by Earth. This is well established fact that convection flows from high to low temperature means from Sun to Earth in short and long waves respectively. As the height increases the temperature decreases at a particular rate i.e. 6.5^0 Celsius per kilometer. Because of this the temperature of mountaineous regions is low as compared to the plain areas situated near sea level.

Distance from Coast : The relation to seas, distance from sea also affect the temperature of any place. e.g. if two regions acquiring same level and amount of heat from sun namely relief and water, get heated and cooled at different ranges. Temperature of hydrosphere is low as compared to lithosphere because the heat moves down deep due to transparency of water and moreover it mingles also due to mobility of water. Regions situated near sea have moderate temperature on the other hand internal parts of continent are aloof from this affect because of which they face extreme heat and extreme cold.

Prevailing winds and Ocean Currents : Horizontally flowing wind on the surface of Earth and the speed of water shifts the temperature/heat at high level. This brings a big change in the temperature of those regions which are affected by these two factors. We can feel the effect of winds in the interior parts of continent on the other hand the effect of ocean currents is limited to the coastal regions. Hot winds increase the temperature and on the other hand cold winds decrease the temperature. Winds blowing from coastal regions to land, carry moderate effect with them while wind

blowing from land areas to coasts take extreme effects or what so ever the cause be, with them. Apart from facts mentioned above, lower layers of atmosphere being more dense gain more water vapours and dust particles as compared to upper layers.

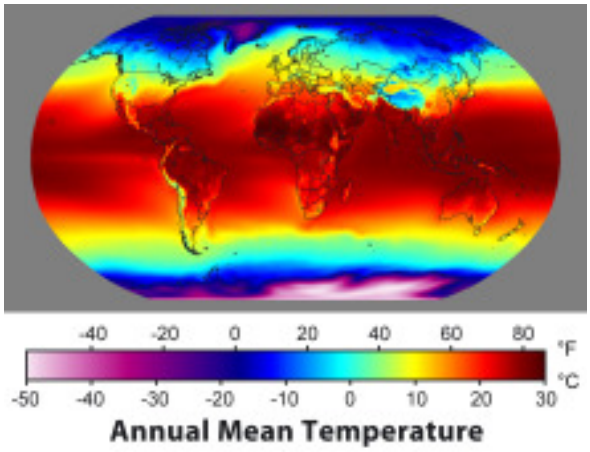
Type of Relief : Colour, vegetation and land use of relief also effects the temperature. Various land surfaces reflect solar heat reaching it in different manners, the process is known as Albido. If the surface is covered with snow, it reflects 70 to 80 percent of solar heat reaching it whereas lands with dark soil absorbs more heat as compared to regions with lighter soil and thick vegetation. Soils of lighter colour and vegetation reflect heat move as compared to dark coloured soil regions.

Clouds : Presence of clouds at a particular place brings change in local temperature. Temperature during clear day is higher than that of a cloudy day. On the other hand temperature during cloudy night is higher than that of a clear night. This happens because on a clear night heat escaping from the Earth at night moves toward atmosphere freely giving ample chance of cooling to lower part of atmosphre whereas on clody night, escaping heat stays in lower part of atmosphere because of hindrance of clouds.

Relief : Like clouds, relief also effects the temperature of a particular place. We can feel this effect specially in the mountaineous regions. e.g. Mountaineous regions situated in northern hemisphere like the southern slopes of Himalayan mountains receive more solar heat and that also for longertime of a year as compared to the northern slopes.

Distribution of Temperature : To understand the difference in temperatures all over the world, study of temperature variation of months of January and June is very important. At any places these are the coldest and hottest months of a year.

Generally in temperature maps the effect of latitude is very clear because isotherms run almost parallel to latitudes. Similarly, the effect of water and land is very clear on the distribution of isotherms because of which isotherms are almost straight in southern hemisphere as most part of this hemisphere is covered by Oceans. Whereas in northern



hemisphere during summer isotherms divert towards Equator while travelling from continental region to oceans and tend to divert a bit towards Equator while showing their voyage from oceanic to continental regions in winter.

Similary the effect of Ocean currents is also very clear. Specially in North Atlantic Ocean where temperature increases due to hot water current, Gulf Stream and Isotherms shift northwards. While moving further they divert southwards as these enter continental parts of Europe having low temperatute. This effect is particularly clear in the plains of Siberia.

Facts about distribution of temperature in January :

1. Isotherms of January are irregular and very close to each other in the Northern hemisphere.

2. In Southern hemisphere isotherms are almost straight lines because of abundance of water bodies.

3. The coldest place in the world is North-Eastern Siberia and the second coldest place is situated in Greenland.

4. The closely situated isotherms over continental regions in Northern hemisphere show steep variation in temperature.

5. Variation in temprature of eastern and western parts of any continent is also found. Heat gradient on eastern regions is 3 times more than that of western regions e.g. 1.5^0C per latitude & 5^0C per latitude.

6. In Southern hemisphere the highest temperatute has been recorded at 30^0 southern latitude.

Facts about distribution of temperature in July :

1. During the month of July, Nothern hemisphere has summer season and Southern hemisphere has winter season.

2. Areas between North Africa to North Western parts of India have highest temperature (32^0C). Similarly North Western parts of U.S.A. also have quite high temperature.

3. In Northen hemisphere, the temperature of continents is higher than the parts of ocean.

4. Heat gradient of eastern regions of continents in Northern hemisphere grows weak where as reglegiable variation is found in western regions while western regions donot experience much variation.

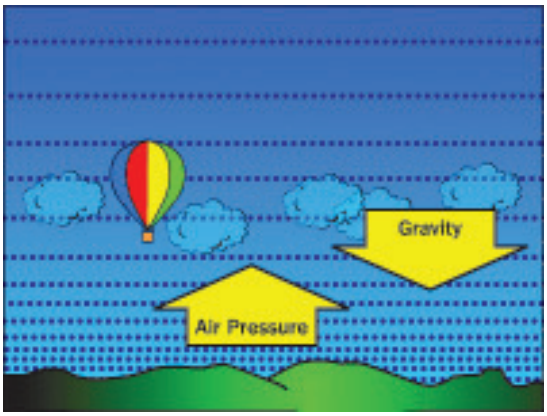
	Technical Terms of Climatology
Isolines (Isopleths)	**Lines of**
Isobars	Equal pressure tendency showing similar changes over a given time.
Isoamplitude	Equal amplitude variation
Isonomly	Equal barometric pressure
Isobar	Same atmospheric pressure
Isobront	Places having thunder storms at same time
Isocryme	Equal lowest mean temperature for specified period.
Isohel	Equal Sunshine
Isohyet	Equal amount of rainfall
Isokeraun	Equal thunderstrom incidence
Isomer	Equal average monthly rainfall expressed as percentage of the annual average.
Isoneph	Equal degree of cloudiness.
Isonif	Equal Snowfall
Isphene	Equal Seasonal phenomena (e.g. flowering of plants)
Isoryme	Equal frost incidence
Isoterp	Equal physiological comfort
Isotherm	Equal temperature
International Meterological Organisation, Warsaw, 1935	

Air Pressure

Distribution of temperature is not similar at all the places on the Earth. Because of difference in temperature, air pressure also varies immencely.

Weight of air is known as air pressure. Air is a composition of various gases therefore it has specific weight. Weight of air on any unit of area on Earth is known as air pressure while it is respresented in Millibar unit. Air expands in summer due to high temperatre and in winter it shrinks due to low temperature. High temperature causes scanty air and less air pressure while low temperature brings thick air and higher air pressure. Thus difference between air pressure creates air movement from high pressure areas to low pressure areas which is known as wind.

Temperature and Air pressure cause expansion and shrinking of air which further results into distribution of heat and moisture in the atmosphere. In normal circumstance average air pressure at sea level is 1013.2 milibar. Instrument used to measure air pressure is known as Barometer.



Air Pressure

Factors affecting air pressure :–

Temperature : As the temperature increases, air expands because of which its density decreases which results in low pressure. On the other hand air shrinks due to low temperature because of which its density increases which creates high pressure. The relation between air pressre and temperature is defined with following quote : "When the mercury of thermometer rises, mercury of barometer falls". Equatorial regions have low pressure because of high temperatures. On the other hand Polar regions have high pressure due to low temperature.

Height from sea level : Air pressure is created dueto weight of air therefore sea level has highest air pressure. As we move upward from sea level leaving behind the heavy

gases at lower layers of atmosphere, air pressure decreases because the upper air is light and its density is low.

There is no fixed rate of fall in air pressure with increase in height but it decreases with increase in height. Air pressure is reduced to half at the height of 5 Kms from seal level and at the height of 11 kms it is reduces to one fourth. It is because of low pressure in mountaineous regions that breathing gets hard.

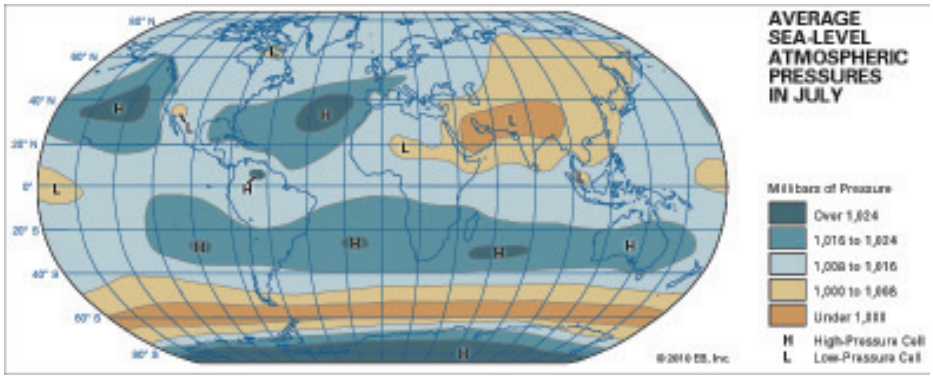
Moisture in air (Humidity) : Conversion of water from liquid state to gaseous state because of evaporation is knwon as atmospheric humidity. Water vapours are light in weight therefore they rise up and pressure of humid air decreases as compared to dry air. Amount of water vapours changes with time and place and because of this the pressure of air also varies.

Gravitation of Earth : Atmosphere glues around the Earth due to its gravitation. The intensity of gravitational pull decreases as we get away from core of Earth. Another fact is that as Earth rotates round its axis, average distance of polar regions and equatorial regions varies from the core of Earth. For example Polar regious are nearer to core of the Earth as compared to Equatorial regions and hence have higher air pressure.

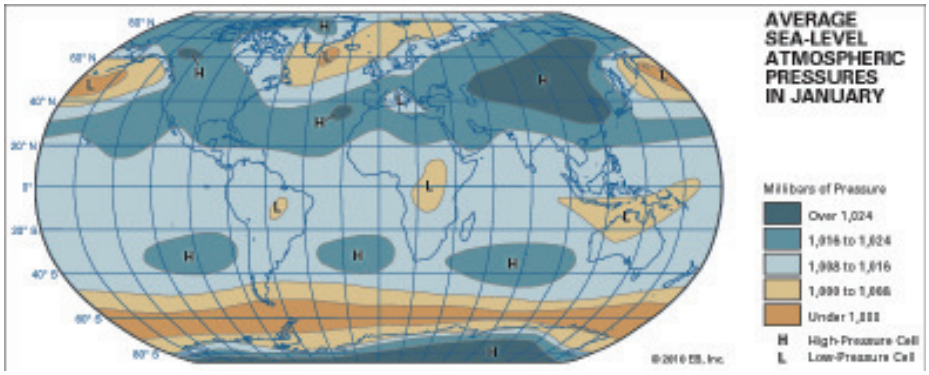
Rotation of Earth : Rotation of Earth produces centrifugal force which has more effect in Equatorial region while lesser effect on Polar regions. Centrifugal force Pushes things away from its core. Same is the effect on air pressure which results into lesser pressure in Equatorial regions as compared to that in polar regions.

Distribution of Air Pressure : As air is present all around the Earth, it may be distributed in to ways namely; horizontally and vertically.

Horizontal Distribution : Air pressure of a particular place changes with day and night, with summer and winter but average air pressure conditions remain same generally. If we study the division of air pressure on Earth then we will come to know there are various high and low pressure regions. On maps these divisions are shown with help of isobars. Generally air pressure is divided into two types :-



Atmospheric Pressure in July



Atmospheric Pressure in January

1. High pressure.

2. Low pressure

On the basis of combined affect of various factors affecting the air pressure on different latitudes seven air pressure belts are found on the Earth.

Equatorial low pressure belt region extending betwen 5^0N latitude of Equator to 5^0S

latitude is known as Equatorial low pressure belt. Following are the reasons which are responsible for its origin :

(i) Rays of sun fall vertically in this region whole the year long and because of this temperature is high which creates low pressure.

(ii) Owing to high temperature, evaporation process is also very fast while large number

of water vapours decrease the weight and density of air resulting in reduction of air pressure.

(iii) Rotation of Earth has its maximum effect on Equator and so is effect of contrifugal force which results into reduction in air pressure.

At about 30^0N and 30^0S latitudes high pressure regions are found in both hemispheres which are formed with decending winds on this latitudes risen up at hot Equatorial regions. Further at 60^0N and 60^0S latitudes low pressure regions are found. At poles high pressure regions are formed because temperature remains low for whole of the year.

It is important to mention that these belts are not stable. They shift according to the situation of sun as on earth. e.g. During winters (December) in northern hemisphere, sun rays fall vertically on the tropic of capricorn. During these pressure belts shift towards south. On the other hand situation is opposite in summer.

Vertical Division : As we already know, air pressure on Earth exists due to pressure of upper layers. Atmosphere extends upto the height of hundred kilometers from the Earth surface. Air pressure is highest at sea level because the density of gases is highest in lower layers. Density changes due to the expansion and the air shrinks because of low temperature. Air pressure and height are reversly proportional to each other, which means airpressure decreases due to increase in height. But the rate of fall in air pressure decreases with increase in height.

Table

Height from Sea level (in Kms)	Air Pressure with volume (in mb)	Temperature (^{0}C)	Comparrison (km/m^3)
0	1013.25	15^0	1.23
0.5	954.61	11	1.17
1.0	898.76	8.5	1.11
2.0	795.01	2.0	1.01
5.0	540.48	–17.5	0.74
10	264.99	–49.9	0.41
20	55.92	–56.5	0.09
30	11.97	–46.5	0.02

Fast blowing winds originate due to the difference between air pressure at earth surface but on the other hand air pressure decreases as the height increases inspite of this we donot feel fast blowing upward winds. The reason behind this is that the gravitational force of Earth also decreases with increase in height.

Isobars : Isobars are those lines drawn on a map which enjoins places with same air pressure. This air pressure is measured, taking average air pressure at sea level as base so that difference created by increase in height may vanish. For this purpose air pressure for isobars is deducted 34 milbars for each 300 meters height.

EXERCISE

1. Answer the following questions in one or two words :

(a) What name is given to the air cover which engulfs the Earth ?

(b) Thermometer was invented by whom and when ?

(c) What is full name of UV rays originating from sun ?

(d) Which gas contains principal portion among atmospheric gases ?

(e) How much %age of atmospheric gases do Oxygen and Carbondioxide combined contain ?

(f) Upto which height, vapours are found in atmosphere ?

(g) What are the upper and lower height limits of Stratosphere ?

(h) What name is given to heat transfer process in liquid and gaseous matters ?

(i) What degree centrigrade is temperature of Sun Surface ?

(j) Which gas is most important to keep up Green house effect ?

2. Answer the following questions in one or two sentences :

(a) Write two characteristics of atmospheric gaseous mixture.

(b) Name two satellites responsible for deceminating atmospheric data.

(c) As what source does oxygen works for human body ?

(d) In what forms do Water Vapours fall on Earth ?

(e) What are any two activities related to weather taking place in atmosphere.

(f) Between which two lyers of atmosphere, Tropopause lie ?

(g) What ailment to human body may excess x-rays cause ?

3. Answer the following in 60 to 80 words :

(a) If a baloon goes upto height of 700 kms, in what sequence shall it cross various layers of atmosphere ?

(b) How Troposphere got this name, write a short note.

(c) Write a note on need of Ozone layer citing its depletion also.

(d) Classify atmosphere on basis of its chemical constitution.

(e) What is insolation ? Write a short note.

(f) Write three causes responsible for creation of Equatorial low pressure belt.

(g) Write a note on Isobars.

4. Answer the following in 150 to 250 words :

(a) Write in detail, factors effecting air pressure.

(b) Write characteristics of temperature distribution in months of January and July.

(c) Write notes on four types of temperature mobility on the Earth.

(d) What are permanent factors effecting upon distribution of temperature on Earth ?

(e) Describe formation of atmosphere on basis of temperature and write notes on each layer.

(f) Various isopleths are used in representing climatological features. name any 10 isopleths describing their representation characteristic also.

Chapter - 7

WINDS

Variation in air pressure at different places gives birth to winds. Atmosphere is a mixture of gases therefore it is highly mobile. This mobility originates out of difference in air pressure of various places, in simple words, known as winds. Winds move from high pressure to low pressure regions. This cycle of winds moves on the whole Earth which divide and distribute the temperature and humidity from Equator to Poles. Winds always try to cover the disimilarities in pressure of air.

According to Coriolis Effect which is known as Ferrel's law also, independently moving flows in Northern Hemisphere tend to turn to their right and in Southern Hemisphere towards their left because of rotation of Earth. This effect is seen in winds also.

Winds are divided into three types on the basis of term and tenure their of :–

1. Planetary or Perennial Winds 2. Seasonal Winds 3. Local Winds.

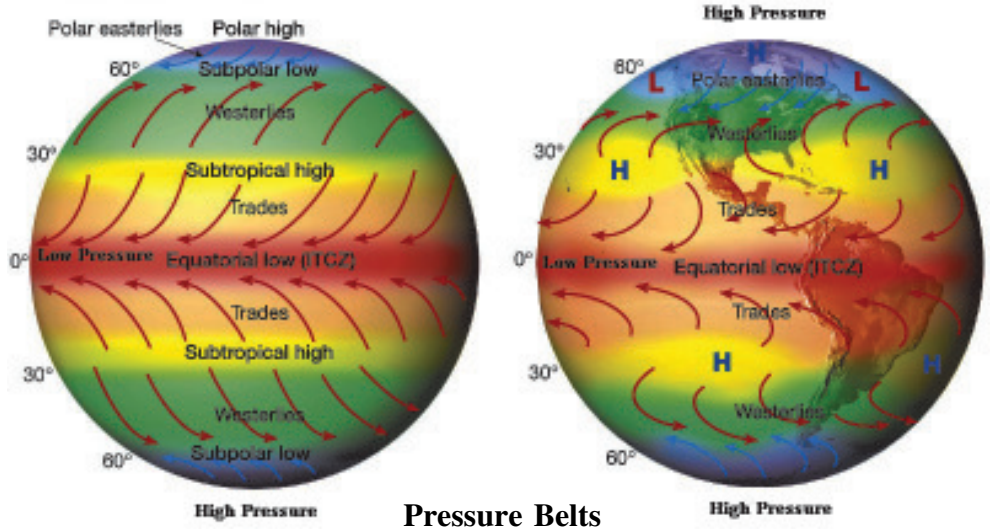
1. Planetary Winds : These winds move in one direction throughout the year. They move from high pressure areas of major pressure belts to low pressure areas. These winds are also known as stable winds. Eastern or Equatorial winds, Tradewinds, Western winds and Polarwinds are examples of these winds.

(a) Eastren or Equatorial Winds : Region between 5^0N latitude to 5^0S latitude is known as Equatorial low pressure belt. This belt receives vertical rays of sun because of which temperture is very high and moreover the temperature of air present near the surface of Earth increases and air starts moving upward. These are known as equatorial winds or Doldrums.

In this belt mostly the winds move vertically and daily in the afternoon they bring heavy thunder showers, this region is also known as Inter-tropical convergence zone (IICZ) because trade winds of both hemispheres join here.

(b) Trade winds : Region of trade winds extends from Equatorial low pressure belt to 30^0 North and South lattitude. In this region winds move from sub tropical high pressure areas to low pressure areas of equatorial low pressure belt.

Earth rotates an its axis from west to east and in northen hemisphere these winds deflect towards right under the coriolis effect and according to the rule/law of Farrel because of which these are known as North-Eastern trade winds. On the other hand in southern hemisphere these winds deflect towards left therefore these are known as south western trade winds.



Pressure Belts

According to the myth the name **'Trade'** winds has been derived from the word **'Track'** of German language which means a definite/particular path. Trade winds blow continously in one direction with a definite speed. In ancient times sailors sail from one place to another with the help of these winds. These winds cross the oceans and bring rainfall in the eastern parts of continents while reaching upto western parts these become dry because of which mostly the deserts are found on the western parts.

(c) Sub-Tropical Equatorial Winds : The region is situated between 30^0 to 35^0 latitudes in both the hemispheres. This region matches to the vertical wind direction of equatorial region winds while in direction being exactly opposite to it. Hot air rises up in the equatorial regions but in this region air begins to descend toward the surface which results in cool and dry weather. This region is also known as **'Horse latitudes'** because according to a myth, in ancient times when sailors were dependent on winds for the movement of ships, they face problem in movement due to the reduction of speed of wind in this region. They used to drop their horses in the sea so that the weight of ship could be reduced and they could save it from sinking.

(d) Westerlies : Westerlies are the prevailing winds in the middle latitudes (i.e. between 35 and 65 degree) in both hemispheres like Trade winds, these winds also change their direction due to Coriollis Effect. In northern hemisphere these blow from south west and in southern hemisphere these blow from north west. These winds bring rainfall in the western parts of continents.

Variations are found in speed and direction of these winds due to the irregular division of water and land in northern hemisphere. On the other hand most of southern hemisphere is covered by water in these latitudes because of which these winds are more strong and regular in this sphere. These winds also have some local names given by sailors like. **Roaring Forties for 40^0 latitude, "Furious Fifties" (50 to 60 degrees south) and Shirking sixties for 60^0 latitude.**

e) Polar winds : Polar winds blow from high pressure polar regions to low pressure sub polar regions. Polar regions have low temperature and these are covered by ice. These winds are dry and donot bring rainfall because these are cold and do not attain moisture. Polar regions are extremely cold and no one is living there because of which we donot have much information about these regions. But still we can say that as westerlies these winds are more regular in southern hemisphere as compare to northern hemisphere.

Shifting of wind belts : Circulation of wind on the earth's relief is quite different from the above mentioned conditions. We all know that earth rotates on its axis and it also revolves around sun and moreover it is inclined at 23 $1/2^0$. Because of this the position of sun on Earth change continously in a year. Sun rays fall vertically on Equator as well as on Tropic of Cancer and Tropic of Capricon.

Commonly we say that sun rays fall vertically on equator but if we study world air pressure maps for the month of January and July, we will come to know that air pressure belts change their position during these months.

On June 21 sun rays fall vertically on Tropic of Cancer. During these days Northern hemisphere has summer season and Southern hemisphere has winter season. Equatorial high temperature and low pressure regions shift towards north. Similarly other air pressure regions in northern hemisphere shit toward north and regions in southern hemisphere shift towards Equator.

Average situations are found twice in a year when sun rays fall directly on the Equator i.e. March 21 and September 23. This region has high temperature and low air pressure. Air pressure belts also shift on December 22 but their direction is opposite

to the direction of June 21.

Due to the change in the situation of Sun and Earth, airpressure and wind belts shift from their definite position because of which various effect have been observed in white world, some of which are as follows :

i. Region which extends from 5^0 to 10^0 latitude on the both sides of equator remians hot and humid due to low air pressure in summer and in winters it remains dry by the effect of trade winds.

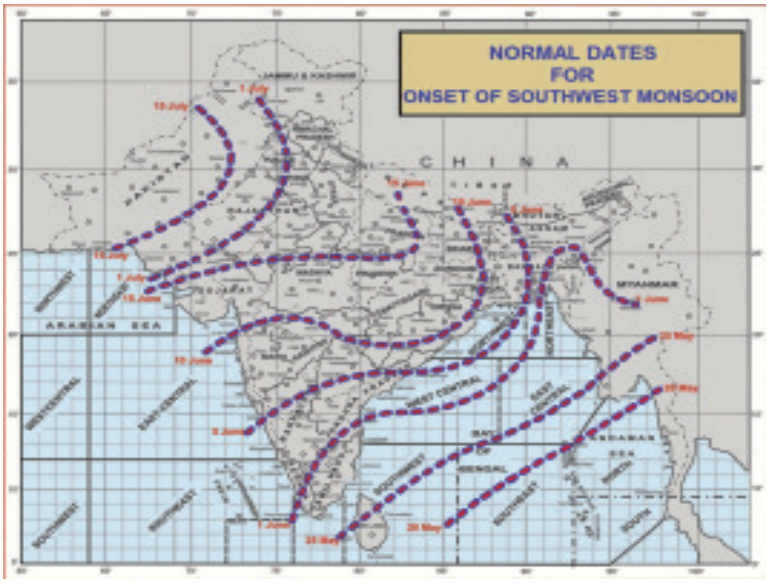
ii. The western parts of the continents which lie between 30° to 45° lattitudes in both the hemispheres remain dry in summers due to effect of north eastern and south eastern Trade winds. When air pressure belts shift towards Equator in Northern hemisphere, Westerlies bring rainfall in the western parts of the continents.

iii. Change in positioning of sun brings some difference in weather and seasons particularly in the regious falling between 60^0 and 70^0 latitudes in both the hemispheres. In Northen hemisphere where these higher latitudes find effect of Westerlies, snow melts and vegetation starts growing. Similarly, cold effect in winter brings dry weather with Polar winds.

Generally Western winds bring rain while Polar winds bring dry spell with them.

iv. Regions of monsoon winds have been created in India and world due to the shifting of air pressure belts and wind belts. Moreover due to this effect these winds blow completely opposite to each other in summer and winter.

Onset of Southwest Monsoon



2. Seasonal or Temporary winds : Seasonal winds are effected by the change in temperature and air pressure according to the change in season Monsoon winds are the finest example of these winds.

Origin of Indian Monsoon

The Term 'Monsoon' has been derived from the Arabic word 'mausim' – meaning 'Season'. Monsoon is a wind system in which there is compleat reversal of prevailing direction of winds after every six months, i.e. from Summer to Winter and Vice Versa.

Concepts about the origin of Monsoon

Monsoon is a complex meteorological phenomenon. Some of the important concepts about the origin of monsoon have been discussed as under :

The Thermal Concept or Classical theory was propounded of Halley in 1686. According to this concept, Monsoons are the extended land breeze and sea breeze on a large sale, produed by the differential heating of continents and ocean bodies. During the summers in northern hemisphere, When the sun rays are vertical over tropic of cancer, the huge landmas of Asia heats quickly and develops a strong low pressure centre near lake Baikal (Siberia) and Peshwara (Pakistan). Moreover the poleward shift of the Inter tropical Convergence Zone (ITCZ) to a position over Southern Asia reinforces the thermally induced low pressure centre in comparison to this, the pressure over the oceans towards the Indian and Pacific oceans is relatively high. Under these conditions, a sea to land pressure gradient develops. Consequently, the surface air flow is from the high pressure over the ocean towards the low pressure areas over the heated land. Contrary to this during the winter season in the northern hemisphere these develops a high pressure over near Baikal (Siberia) and Peshwar and Indian and Pacific oceans are comparatively warm haivng a low pressure. The winds blow from Land to Sea.

Dynamic Concept

The Dynamic Concept about the origin of Monsoon was put forward by Flohn in 1951. In his opinion, The Monsoon is the result of Seasonal Migration of Planetary Winds and pressure belts (fig.) The Inter-Tropical Convergence Zone At the time of Summer Solstice (21 June), when the sun rays are vertical over the tropic of cancer the North ITCZ is extended upto 30°N latitude, covering South and South-East Asia and thus equitorial westerlies are established over these Areas. The equitorial westerlies are established over these areas (fig.) The equatorial westerlies become South-West or Summer Monsoon. The NITCZ is associated with numerous atmospheric strams (Cyclones).

Recent Concepts

Tibetan Plateau and the circum Polar whirl. In 1973. The Monsoon Expedition

(Monex) was organized under the Joint Venture of the former Soviet. Moon and India. On the basis of investigation the meteorologists arrived at the conclusion that the Tibet Plateau plays a vital role in initiating the monsoon circulation over the Indian Subcontinent. Tibet Plateau is a high table land with dimensions 2000 x (600 – 1000) square Kilometer it has an average height of 4 Kilometer. Tibet Plateau affects the atmosphere in two ways (1) as a physical barrier, and (ii) as a high level heat source. At the begining of Juen the Sub tropical Jet Stream disappears completely over northrn India. (fig.). At this time the Jet Stream shifts to thenorth of Himalayas and Tibet and takes up a position at about 40°N. The plateau of Tibet accentuates the northward displacement of Jet Stream. Thus the abrupt onset of Summer Monsoon at the beginning of June is prompted by the hydro-dynamic effect of the Himalayas and not by the thermally induced low pressure centre over north West India in the middle of October the Plateau Proves to be the most important factor in causing the advance of the Jet Stream South of Himalayas or bifurcate it into twoparts.

EL Nino and Monsoon

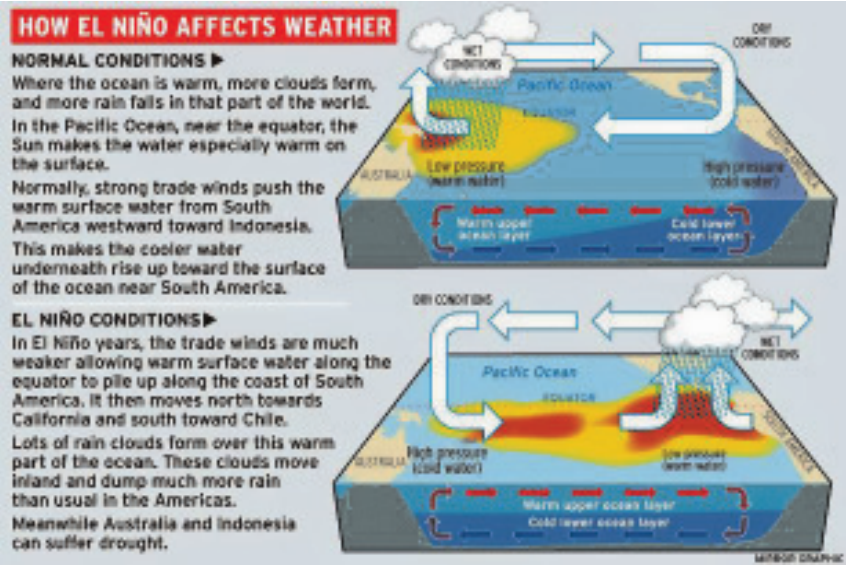
EL Nino meaning 'Child Christ' is a warm ocean current appearing along the Peru (South America) coast generally in December. It replaces the cold Peru or Humboldt current flowing along the Perm coast in normal years. Under Normal conditions, the Peru is Cold Water Current, While over the Western Pacific (Indonesia and Eatern Australia) the ocean current is warm and deep. (Fig.). The appearance of EL-Nino 'reversal' the condition' these develops warm conditions over the eastern Pacific (Peru Coast) and Cold conditions in Western Pacific. Whenever this usually warm ocean current (EL-Nino) is produced near the Peruvian Coast in South America, the amount of Precipitation in the coastal regions is usually high while the Australian and Indonesian coasts record drought conditions in brief, the occurrence of EL-Nino results into weak Monsoon causing droughts floods and failure of crops.

The Indian ocean has been warming at a rate faster than ever before (1.2°C during the Past Century). It is also the largest consistent contributor to the global ocean warming treds. The Western Indian Ocean, traditionally thought to have cooler sea surface temperatures than the central and eastern Idnian Ocean, is surprisingly showing an even stronger summer warming trend over the whole of the 20th Century then the central and eastern Indian Ocean.

El-Nino is abnormal warming of sea surface of south east Pacific ocean. during El-Nino event, Plankton does not flourish luxuriantly. Krill fish disappears. Penguins in Antarctica climate observe baby depression. Wild purple flower are found everywhere on Atacama sands. Thermocline either go deeper or changes its ends. Tropical diseses

increases manyfold. Landslides intrupt the system of life over piedmont plains of Andes or the western coast of South America.

South east Pacific ocean always remain a zone of confrontation between counter equitorial current and Humboldt cold ocean current, they tend to overpower each other. The constant upwelling of the cold water of Humboldt current generates cold sea surface and high air pressure. If west wind drift does not push sufficent cold water to it, counter equitorial current establishs its warm water over the larger areas. and raises sea surface temperature and induces El Nino conditions.



How El-Nino effects weather

A recent study focussed on the causes of its warming and found that it was mainly due to EL-Nino events. Which are getting longer and more frequent during recent decades, Possibly due to changing climate. These EL Nino events eaken the summer westerly winds over the Indian Ocean. Winds have the effect of cooling the sea surface. Strong winds cause evaporation and loss of latent heat from the ocean leading to cooling. When the winds are weakened the opposite happens - The ocean warms.

The study published recently in the 'Journal of Climate' was undertaken by Dr. Roxy Mathew Koll of the Indian institute of Tropical Meteorology, Pune and has found that the ocean atmospheric Phenomenon-The EL-Nino, and the influence on the walker circulation were responsible for periodic weakening of Monsoon Westerlies and led to abnormally high summer sea surface temperature in Western Indian Ocean. The study has found that 'The Frequency and magnitude of El-Ninos have also increased in the recent decades. Possibly due to global warming. This means a piling up of heat on the Indian Ocean.

Mostly this effect has been observed in Asian countries like India, Malayasia, China, Korea, Japan and Taiwan. Moreover, we can also see this effect in USA, Northern Australia and Western Africa.

These winds originate due to the difference between the temperature of land and water regions. Moreover, shifting of air pressure belts due to change in the position of sunand Earth also act as a major reason for the origin of these winds.

Research about these winds is going on at world level with advanced scientific techniques so that we can understand the nature of these winds accurately. Study about the higher atmospheric activities is also going on, specially about the role of Jet stream.

La Nina:

The sea surfce temperature of south east pacific ocean subsides by 3^0 to 5^0 Celsius. it leads to stronger Walker circulation. Robust, south east trade winds carry more moisture and all the places will be wetter than normal conditions on the eastern margins of the continents. Western margins will exibit excessive drought conditions. Pre advent of Monsoon, excessive rainfall over south east and Eastern Africa are frequently associated with La-Nina. It occures when counter equitorial current is weak and west wind drift pushes more water in Humboldt current. protracted La Nina conditions takes place on occassions. Mid 1998 to early 2001, the sea surface temperature of south east Pacific ocean remains excessively below normal. Last L Nina occures in 2010-11. it is expected, 2017 is having an extra ordinary La-Nina year.

3. Local winds : Local winds originate due to the difference between local relief and temperature and their effect is also local. These winds are limited upto particular region and local people give name of these winds. Name of these winds describe the affect on that particular region.

These winds can be further classified into two parts :

(i) Hot winds

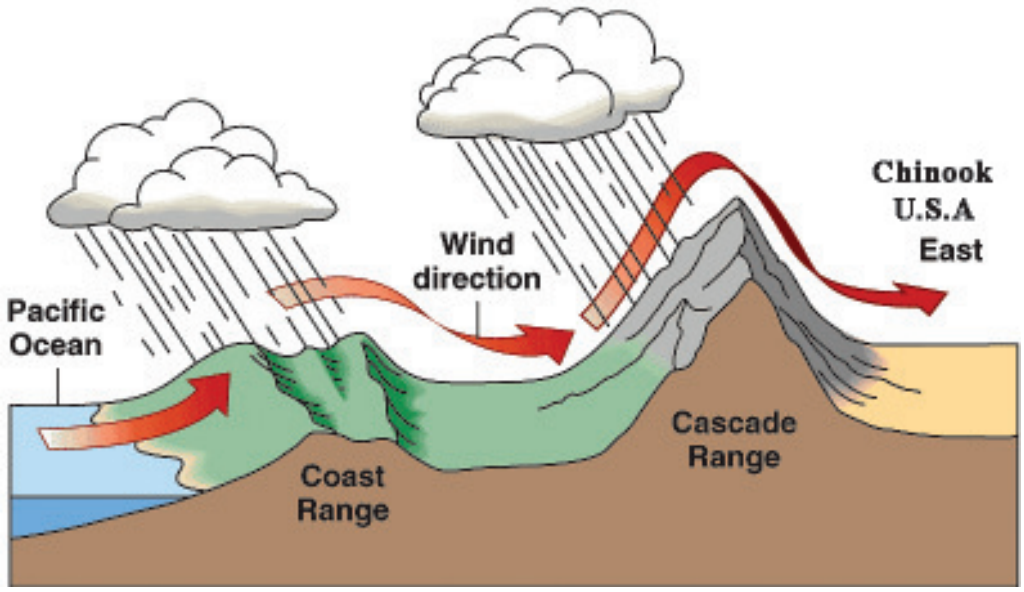
(ii) Cold winds

(i) Hot Winds : Hot winds originate by advection of hot air from warm source region and its movement toward adjacent region and moreover temperature of wind rises when it descends in mountainous region.

Foehn : Fohn or Foehn is a type of dry, warm, down slope wind that occurs in the northern slopes of Alps mountain for its heal and dryness is its dry adicbetic rate which

increases temperature even upto 10^0C per kolometer while decending from mountain tops. In spring season these winds increase the temperature because of which the ice melts and conducive enviornment is created for the cultivation of wheat and growth of fodder for animals. Increase is temperature and decrease in humidity brings soothing effect in weather.

Chinook : These are the hot and dry winds which descend toward Praire plains from Rocky mountains of North America, particularly in Colorado, Wyoning, British Colmbia and Montana states in spring season locally known as 'Chinook'. 'Chinook' means 'snow eater' for locals. Like Foehn winds these are also very helpful for local people. These winds create conducive environment for the cultivation of crops, fodder for animals and also give relief from cold. Canadian Punjabis have given them a new name, 'Shoonkan'.



Chinook Wind

Santa Ana : These are hot and dry down slope winds like Foehn and Chinook, they blow in southern parts of California (USA) from Santa Ana mountaineous regions to coastal plains. But these are harmful for orchards and other vegetations in plains and trees start dying because of dryness.

Loo : These are hot and dry winds which blow in parts of northern India i.e. Punjab, Harayana, UP and Bihar during the month of May and June. These are very harmful for human beings and every year large number of people die because of these winds.

Khamsin : These are hot and dry winds which blow in Egypt (Africa) from April to June and they carry dust particles with them. At times the blow off big dewellings.

Sirocco : Hot, dry and dusty winds which blow towards north from Sahara desert are knwon as 'Sirocco' winds. These winds cross the Medditranian sea and enter in Italy and Spain. These winds attain moisture while crossing the sea and bring rain laiden with dust. This rainfall is harmful for crops.

Harmattan : Harmattan winds are hot and dry and they blow from Sahara desert to Gulf of Guinea and carry dust particles with them. These winds decrease the humidity on the western coasts because of which local people have given the name 'doctors' to these winds.

World: Local Winds

(ii) Cold winds :

Mistral : Cold and dry winds blowing in spain and France during winter season are known as Mistral winds. These winds blow from Mediterranean plateaus to valleys of Rhone. These winds decrease the temperature abruptly which affects the crops and human life.

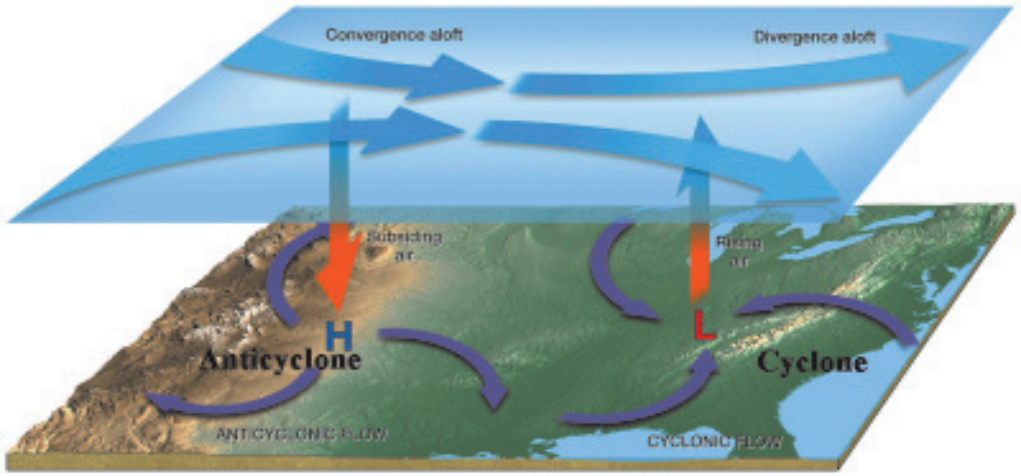
Berg : Cold and dry winds decending from the southern slopes of Alps mountain range are knwon as 'Berg'. These winds affect the eastern coasts of 'Adriatic Sea'(Italy).

Blizzard : Cold and dry snowy winds blowing in snow / ice covered polar regions are

known as Blizzard. As dust storms these winds also decrease the visibility. These winds blow in USA, Canada, Siberia and Antartica.

CYCLONES

Cyclone is a system of low pressure in which the barometric graident is steep. In a cyclone winds circulate, blowing inward in an anti-clock-wise in the Northern Hemisphere and in a clockwise direction in the Soutern Hemisphere. The Cyclones are mainly of two types : (1) The Temperate Cyclones also known as mid-latitude or extra tropical cyclone and (ii) the tropical cyclons known by different names in different countries of the world, like Hurricane in U.S.A. and Typhoons in China.



Anticyclone and Cyclone

(1) Temperature Cyclones (Mid latitude or Extra tropic Cyclones or Depressions)

The low pressure system of Temperate latitude is known as temperate cyclone, recently replaced by the term 'depressions'. In general, a depress is a region where the atmospheric pressure is low relative to that of its surroundings. The main characteristics of a temperate cyclone are as under :

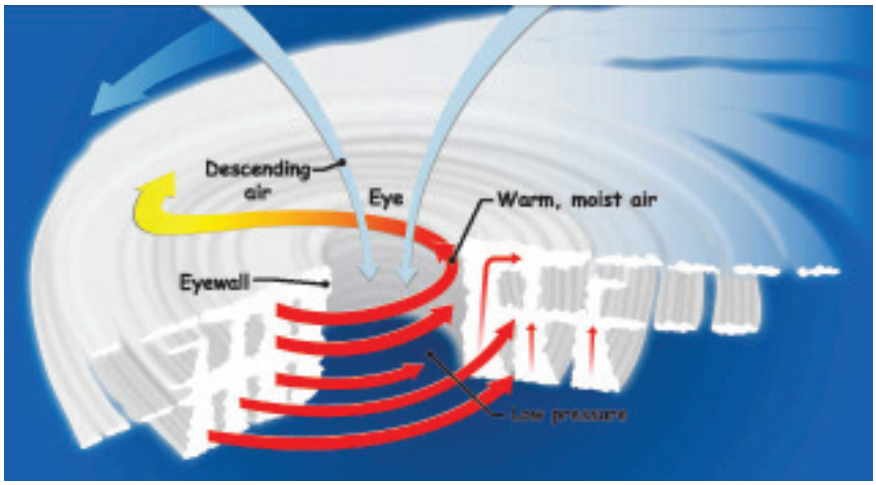
1. The isobars of a temperate cyclone are more or less oval or elongated in shape.

2. The isobars of a lowest pressure is nearest to the centre of depression.

3. In size (Diameter) it may be 150-3000 km (100-2000 Miles).

4. It may be practically stationary or moving at about800 to 1100 km (600 – 700 Miles) per day.

5. In the Northern Hemisphere, the winds of a depressoin (Cyclone) circulate round the centre in an anticlockwise direction, while in the Southern Hemisphere, the wind blow in a clockwise direction.



Graphic of inner part of the Cyclone

6. The temperate cyclone originates where warm tropical air meets cold polar air, the former ascending over the latter with the formation of frontal surfaces.

7. The depressions are characteristics with unsettled and variable weather.

8. Their general direction of movement is from west to eaast in themid-latitudes (westerlies) but specific paths are often curved and sometime erratic.

9. The Average speed of the temperate cyclone is about 30 to 50 km per hour or 800 to 1100 km per day. Speed is however, greater in Winters than in the summers.

10. The rainfall is light to moderate which occurs in the form of light showers. Fog and poor visibility are common in the precipitation areas.

11. A few hours after the front has passed, clean weather (Anticyclone) prevails.

Before the arrival of a temperate cyclone the high wispy cirrus clouds often in the form of mare's tail appear first over the Western Horizon As the front appraches, the clouds lower and thicken Progressively to Cirrostratus, altostratus and nimbostratus. The temperate cyclones rarely appear alone and they move in form of a family. Most

frequently, three or four such cyclone forms a series, and this is called a cyclone family.

Geographical Distribution of Temperate Cyclones :

The Major Areas and tracks of temperate cyclones have been shown in the map. In General they occur between 0° to 60° latitudes in both the Hemispheres However, in the Southern Hemisphere, the belt of maximum frequency of Cyclones is almost cotinuous around the world. The Great strom in U.K. 1987 'Great Strom' and Wilma in United States in 2005 were disastrous.

TROPICAL CYCLONES

Tropical Cyclones is a system of low pressure occuring in tropical latitude extend from the Tropic of Cancer 23½°N to the Tropic of Capricorn 23½° south, encompassing the equitorial belt of Doldrums the between 10°N and 10° South. They originate near the Western Flanks of the oceans, where warm tropical currents supply an abundance of Water Vapours. Tropical Cyclone is a powerful manifestation of earth's energy and moisture systems. The following weather conditions are necessary for the origin of a tropical cyclone :

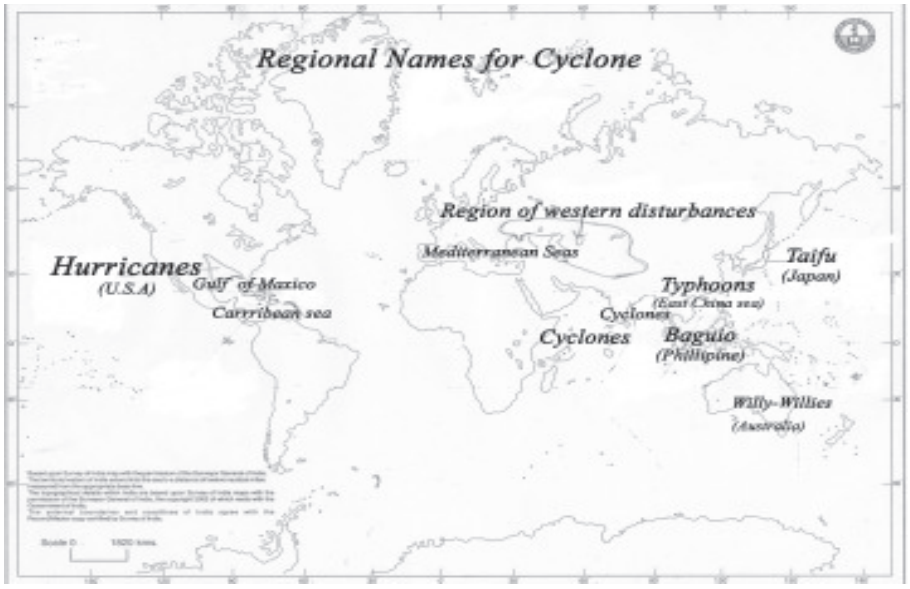
1. There should be continuous supply of abundant warm and moist air.

2. The sea temperature in lower latitude should be around 27°C.

3. They develops in a Inter Tropical Convergence Zone **(ITCZ).**

4. Existence of weak tropical disturbance is also required. The Pre-existing milk tropical disturbance, under favourable conditions, intensifies and develops into a Violent tropical cyclones.

5. There should be anticyclonic circulation at the height of 9 KM to 15 KM above the surface disturbance. The upper air anticyclonic circulation sucks the air from the ocean surface above, thus the upward movement of air is accelerated and low Pressure Centre at the surface is intensified.



The central part of the Cyclone are known by different names in different parts of the world. For example, in China Sea they are called as **Typhoons** (From the Arabic Word 'Toofan'. **Baguios**' in Philippines, **'Taifu'** in Japan, in the Carribean Sea and the Gulf of Maxico as **Hurricanes**, in the north West Australia as **'Willy-Willies'** and in the Bay of Bengal, Arabian Sea, Madagascar and Africa, as simply **cyclones.** Approximately 80 tropical cyclones occur annually worldwide. The Direction of winds in the tropical cyclones in anti clockwise in the Northern Hemisphere and Clockwise in the Southern Hemisphere. The main characteristics of tropical cyclones are as under :

1. In a tropical cyclone, the isobars are generally circular, and close to each others resulting into steep Pressure gradient.

2. The Whole Cyclone has a diameter of about 150 to 300 Km.

3. They originate in the tropical regionon the Western Margins of oceans, where the sea temperature exceed 27°C.

4. Most of them originates in the equitorial belt of calms – the doldrums, when this belt is at its farthest limit from the equator.

5. They are most frequent in late summers and autumn (August to October).

6. Violent Wind of Hurricane Speed (119 Km/h) Circulate around the centre of 'eye' of the strom – The eye of the Cyclone covers a restricted area, being often about 15

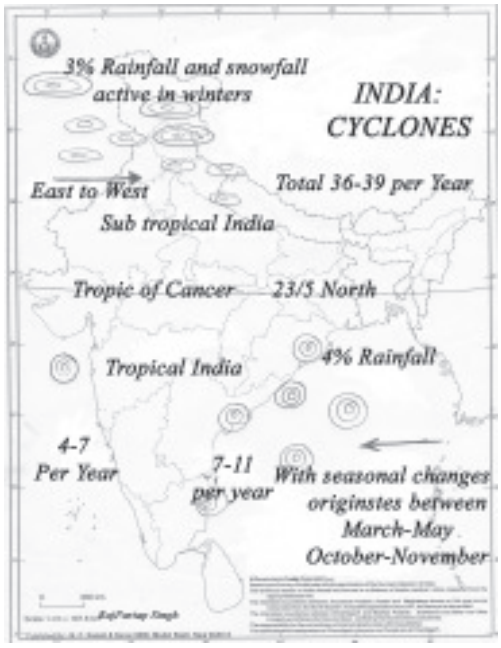
to 30 per in diameter in the eye of the Cyclone, the atmospheric pressure is excessively low, the air is sometimes calm, and the sky clear. Passage of the eye may take about half an hour, after which the strom strikes with renewed ferocity, but with winds in the opposite direction.

7. A tropical cyclone is accompanied by towering cumulonimbus clouds, torrential rainfall, violent winds, thunder and lightning.

8. The Majority of Cyclones decay when they come outer land or when they recurve northward over oceans.

The Tropical Cyclone cause immense domage to the coastal areas as they destroy buildings, roads, railways, bridges and shipyards. Moreover, trees are uprooted, crops damaed and Platations ruined. Thousand of lives have been lost in Bangladesh, India, Myanmar, Malaysia, Maxico, U.S.A. etc. because of Such Cyclone in the year 2014 Cyclone 'Hudhud' 'Nan, Nilofer and in 2015 'Ashobaa' and Komen have caused widespread damage in India (Map Given) In 2013 Mahasen Philin, Helen and Lehar Cyclonic storm 'Roanu' in the Bay of Bengal in may 2016 Andaman Islands and remaining parts of North Andaman Sea were important.

India:
Cyclones



TORNADOES

Tornado is a rapidly rotating column of air developed around a very intense low pressure centre. It is associated with dark funnel shaped cloud and with extremely violent winds (More than 400 Km/hour). The precise mechanism about the origin and

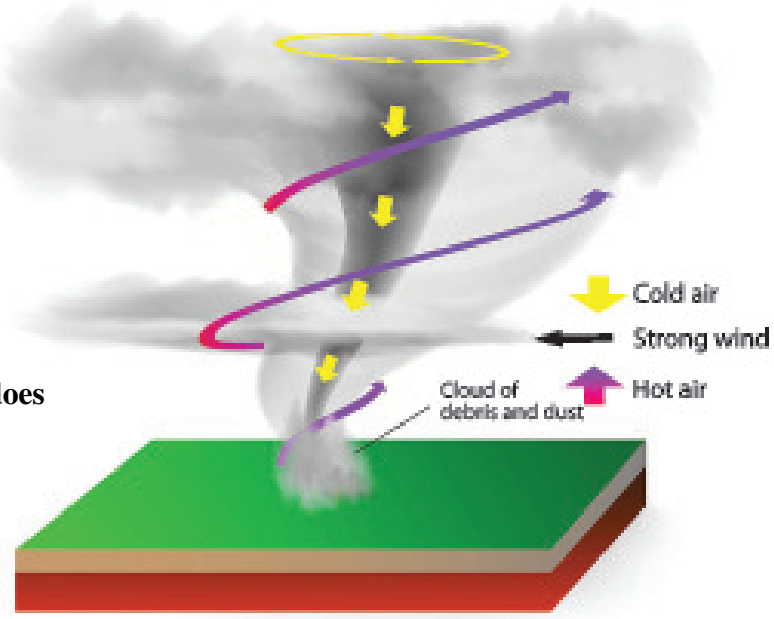
development of a tornade is not fully understood but the following atmospheric conditions appear to be necessary for Tornado development:

(1) A layer of warm moist air at low latitude.

(2) A layer of dry air at higher altitude with an intense cold front.

(3) Solar heating of the ground.

Tornados are generally regarded as having the greatest wind intensity of all the meterological hazards. The updraught of Tornado is associated with a cold front squall line and cumulonimbus clouds. The tornado appears as a dark funnel cloud hanging from the base of a dense cumulonimbus clouds. Tornadoes occurin many parts of the world but are most strongly associated with and most common in the united states – about 1000 are recorded there each year. Devastation from a tornado is often complete with in the narrow limit of its path. The precise mechanism about the origin and development of a tornado is not fully understood but the following atmospheric conditions appear to be necessary for Tornado development :



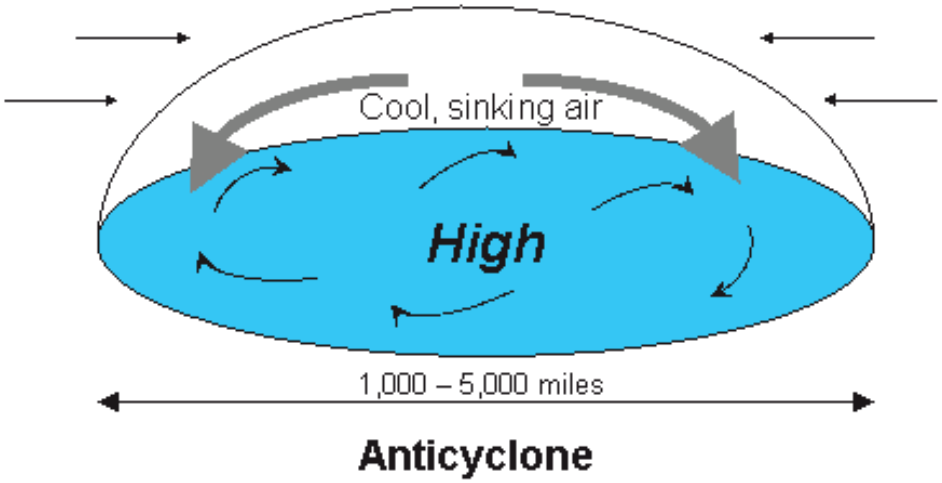
Graphic of Tornadoes

Anticyclone (The High)

The Concept of anticyclone was put forward by Sir francis Galton in 1861. A centre of high pressure is known as anticyclone. In other words, it is a region in which the atmospheric pressure is high compared with that of adjacent areas, and which shows

at least one closed isobar. Generally, there is a series of concentric closed isobars, approximately circular or oval in shape, the highest pressure being at the centre. Diameter of anticyclone range from a few hundred to a few thousand Kilometers.

The anticyclones of sub tropics are associated with the sub tropics highs. They are more stationary. In the Northern Hemisphere the genral and circulation is clockwise round the anticyclone and in the Southern Hemisphere, anticlockwise. The associated weather is settled and stable, generally warm, sunny and dry in Summer and Cold, frosty and clear (or foggy) in Winter. In the basis of their structure then may be classified into (1) The sub-tropical highs, (2) The Polar Continental Highs (3) High with in the Cyclone Series (4) The Polar Outbreak Highs blowing in an anti-clockwise spiral, but accompanied by violent down draughts.



Anticyclone

EXERCISE

1. Answer the following questions in one or two words :

(a) Give full name for ITCZ.

(b) What other name may be given to Perennial Winds ?

(c) The word 'Monsoon' belongs to which language ?

(d) Which latest concept is related to the Monsoon ?

(e) Where does Monsoon Outbreak happen ?

(f) What is local wind blowing in South-Western Punjab in summer, known as ?

(g) What name is given to Cyclones in Australia ?

(h) What is Punjabi name for Tornado ?

(i) Who gave concept of anti-cyclone ?

(j) What name is given to Fohen of Europe, in North America ?

2. Answer the following questions in one or two sentences :

(a) What do sailors name Western Winds at 40°, 50° and 60° latitudes ?

(b) Name various perennial winds.

(c) What changes take place in Northern Hemisphere under Farrel's law ?

(d) What is Santa Anna ?

(e) What is Blizzard ?

(f) What is difference between Hurricane and Baiguious ?

(g) How Hud-hud, Nilofar and Nanook are related ?

3. Answer the following in 60 to 80 words :

(a) Describe Summer and Winter seasons in light of anticyclones.

(b) What is EL-Nino, La Nina ? Explain.

(c) What is role of Tibet Plateau in process of Monsoon ?

(d) Explain 'Mango Showers'.

(e) Explain process of Shifting of pressure belts.

(f) What is Corriollis effect ? Howdoes it put affect on Earth, explain.

(g) What do you understand by 'Shookan' ? Write note.

4. Answer the following questions in 150 to 250 words :

(a) Classify Local Winds on the basis of tempeature.

(b) What are Perennial Winds ? Explain citinig its types.

(c) **Write notes on :**

(i) Corriollis Effect (ii) EL-Nino Effect

(d) Describe various principles related to origiin of Monsoons.

(e) What are Cyclones ? Give short detail of Tropical and Temprate Cyclones.

(f) **Write notes on :**

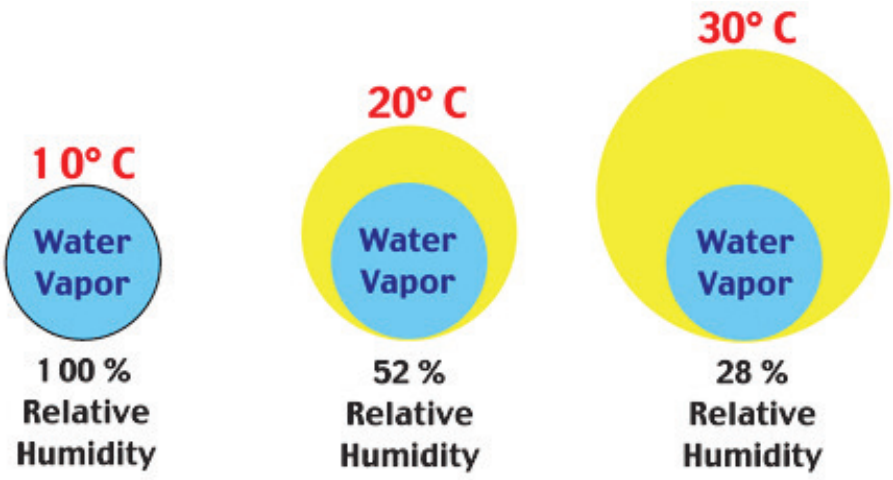
(i) Tornado (ii) Anticyclone.

Chapter - 8

Humidity and Precipitation

Water is present in air in gaseous state like other gases while it enters into atmosphere from various water sources in the form of vapours because of evaporation which takes place because of the heat of Sun.

Amount of water vapours in atmosphere varies with time and place. It is measured in comparison to volume on the scale from 0 to 4 percent but even small amount of variation is very important from the aspect of weather. Gaseous form of water present in air is known as humidity. Humidity is directly related with temperature and its amount decreases as we move from Equator to Poles and moreover it also decreases with increase of height.



Types of Humidities

From the aspect of weather science humidty is measured and represented in various ways. Details about these are given below:

1. Absolute humidity : Absolute humidity is the actual amount of water vapour present in a given volume of air. It is represented in gram per cubic meter unit. This method is not commonly used by weather scientists because absolute humidity changes with the change in volume due to expansion and shrinking of air although the humidity in air may not change. Amount of absolute humidity decreases as we move from Equator to Poles and oceans to continents. Absolute humidity gives us information about the precipitation on a particular place.

2. Specific Humidity : Mass of the vapour in a unit mass of moist air is known as specific humidity. It is usually expressed as grams of vapour per kilogram of air. Change in temperature and air pressure do not affect the specific humidity because of which it is widely considered by weather scientists. Specific humidity changes with the change in amount of water vapours. It is highest in Equatorial regions during summer i.e. near about 18 gram/kilogram and it is lowest in continental parts of Polar region during winters i.e. 0.2 gram/kilogram. It is one of the best methods for measuring humidity with help of which we can make an idea about the amount of water which Earth receives through precipitation.

Visibility Code

Scale Number	Description	Distance Visibility
0	Dense fog	25 metres
1	Thick fog	100 metres
2	fog	200 metres
3	Moderate fog	500 metres
4	Mist. Haze	1000 metres or 1 km.
5	Poor Visibility	2 km
6	Moderate Visibility	7 km
7	Good Visibility	10 km
8	Very good Visibility	30 km
9	Excellent Visibility	50 km

Note : Fog, Mist and Haze are forms of precipitation.
Visibility codes given above are used geographically, world over.

3. Relative Humidity : Ratio of amount of water vapours present in air at particular temperature and volume, and capacity of air to hold water vapours at same temperature is known as relative humidity. In other words we can say that the ratio between Absolute humidity and moisture holding capacity is known as Relative humidity. It is represented in percentage e.g. It temperature of air is 20^0C then its capacity to carry humidity shall be 8 grams per degree celsius at such stage, 100%

relative humidity means, air is completely saturated. It means that relative humidity is full to its capacity. This situation arises in following circumstances :–

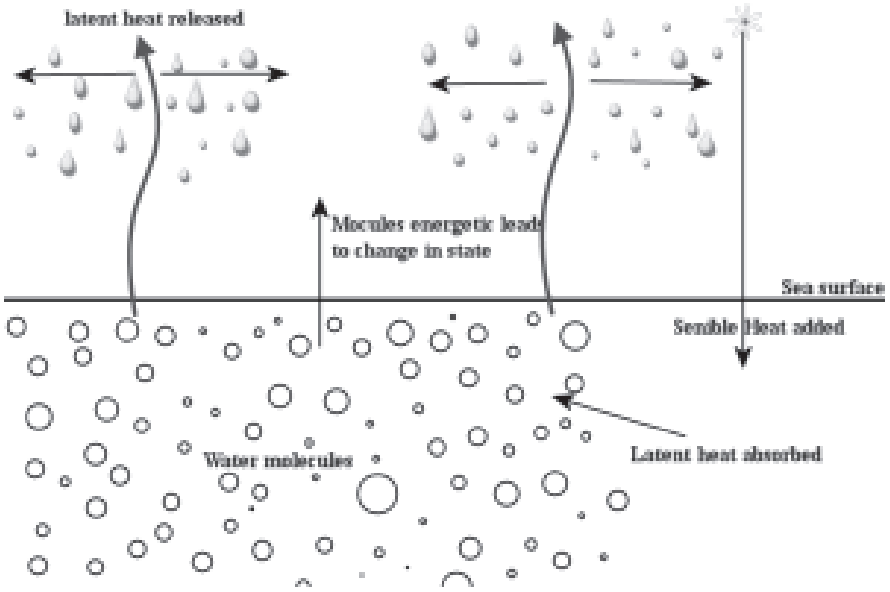
(i) When absoulte humidity increases due to high evaporation.

(ii) When moisture holding capacity of air decreases due to low temperature.

Relative humidity decreases when the temperature of air increases. Relative humidity is very important for scientists working on atmosphere because information about precipitation is possible through various forms of humidity. In human life relative humidity and comfort are related e.g. People donot like to live in regions having high relative humidity (i.e. more than 60 percent)

Rainfall as agent of Precipitation

Water from our mother earth enters into atmosphere through evaporation and in the form of water vapours. These vapours move from one place to other with the help of winds. Water vapours get converted into solid or liquid state by condensation and they fall on Earth. This process is known as condensation. Precipitation takes place in various forms at different places of world. Its most important form is 'Rainfall'.



The Process of Condensation

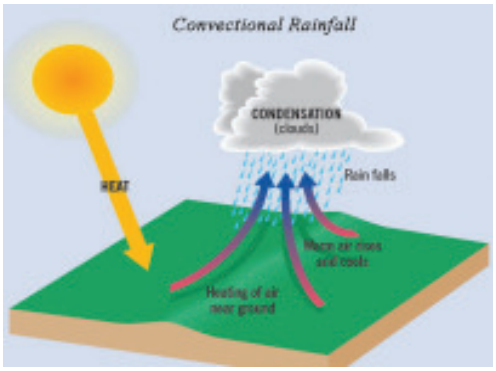
Technically when condensation takes place at temperature above zero degree celcius then water vapours convert into water drops. Their size varies upto 10 micrometer (size of human hair is 75 micrometer) A droplet of rain water is of more than 500

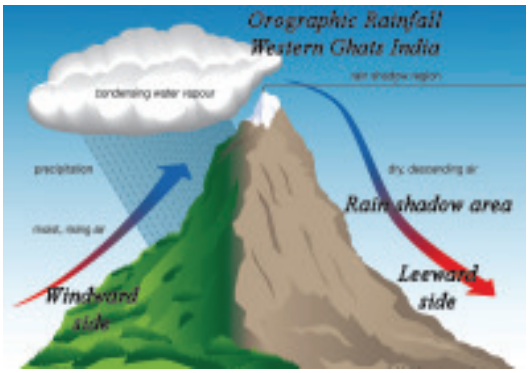
microne and clouds are formed by lakhs of such drops. Hot and humid air and humidity holding centers are required in large amounts to form condition for Rainfall. Water vapours get collected around these centers and clouds are formed when hot and humid air rises up and after cooling relative humidity comes to 100 percent. Formation of clouds does not necessarily mean that there will be rainfall because the size of drops of clouds is very small and their buoyancy in atmosphere does not allow them to fall as rain on Earth. Size of water drops suspended in air increases when they strike with each other. When their increasing size breaks the holding capacity of air, they fall as rain on Earth.

1 micrometer = 10,00,000th part of 1 meter

Types of Rainfall

Rainall is caused by clouds while formation of clouds is due to condensation and saturation. Rainfall may be divided into three types on the basis of upward movement of air :-





Convectional Rainfall **Orographic Rainfall**

1. Convectional Rainfall : Convectional rainfall is caused by convection, where the surface layer of atmosphere is heated by the heat of sun causing the moisture laden air to rise. As the air rises it cools down to form clouds by the process of condensation which results in rainfall. Rate of decrease in temperature which is known as adiabotic lapse rate is 10°C per 1000 meter, causing condensation which further helps in formation of nimbus clouds. This type of rainfall occurs daily at the lower latitudes. Generally day time heating creates convection and by the afternoon, convectional winds get saturated.

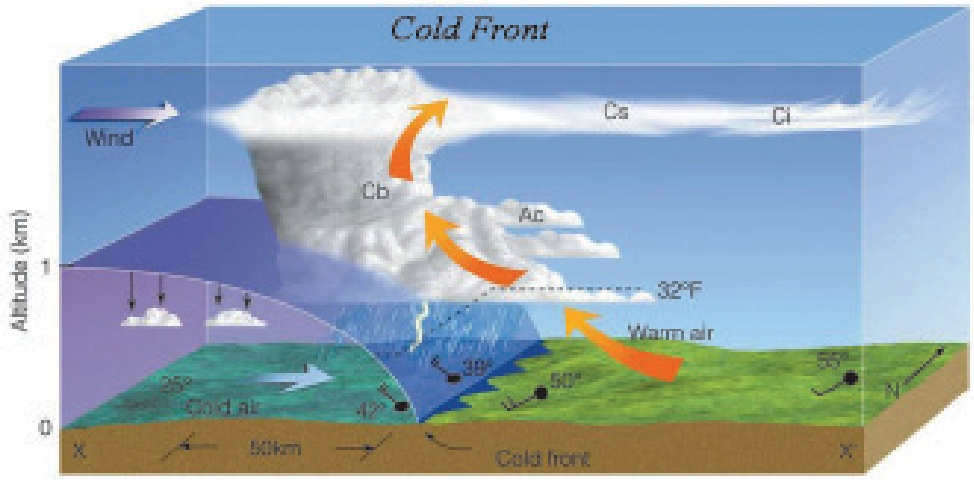
On the other hand at higher lattitudes this type of rainfall occurs during summer season.

This rainfall lasts upto short time but brings lightening and thundering with itself.

Because of conventional currents the size of clouds is large at height, which act as source of thundering and lightening.

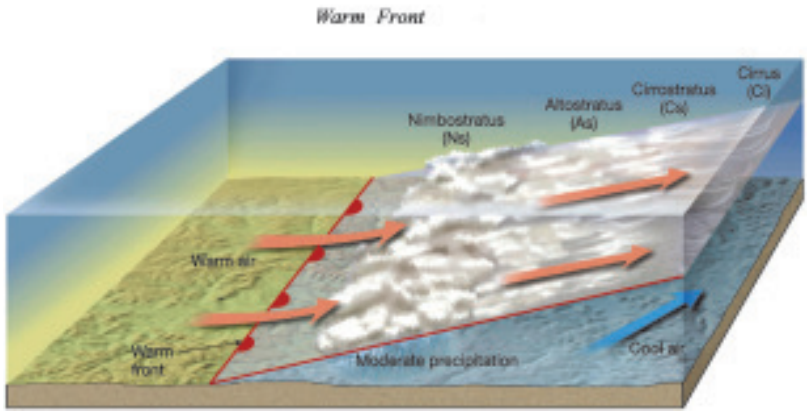
2. Orographic Rainfall : This word has been derived from Greek word 'OROS' which means from mountain. Orographic rain is produced when air is lifted as it moves over a mountain range. As the air rises and cools, orographic clouds form and serve as the source of precipitation. Mostly this type of rainfall is received by the windward side slopes of mountains which act as barrier in the movement of humid winds coming from sea. Low mountains situated near coasts and high mountains situated at inner parts of ocean Orographic rainfall. As the vapour holding capacity of hot air increases, relative humidity decreases because of which hot air moving down on the leeward slopes of mountains donot get rainfall. Most of the world's rainfall falls under the category of Orographic Rainfall. Difference between the rainfallreceived by eastern and western slopes of western ghats is very helpful in the concept of Orgraphic Rainfall.

3. Cyclonic Rainfall : When contrasting air masses enjoin, on abrupt zone or boundary is formed which is called a front. Two air masses may be hot or cold, dry and wet or might be of any other type. Such contrasting air masses' contact creates uncertainity in air because of which, hot and wet air rises up leaving below the cold and dry air.



Cold Front

This type of rainfall may further be divided into two types. Tropical regions receive cyclonic rainfall when humid air having different temperatures conjugate. Hot humid air starts rising resulting in formation of clouds which further leads to rainfall. In temperate regions, when hot and cold air masses make contact, an abrupt zone is formed. In this zone the hot air over rides the cold air resulting in the formation of cyclone. During Winters Punjab and North Western parts of India receive rainfall through cyclones arising from Gulf of Persia.



Warm Front

Distribution of Rainfall : Distribution of rainfall is very complex in the world. Rainfall on a particular place depends on lattitude, humidity, winds, relief, atmospheric conditions etc. Because of all these there are spatial and temporal variations in the division of rainfall. Average rainfall on earth is 80 centimeter but large variations are found in this.

Equatorial regions receive (1000 cm) rainfall continuously throughtout the year. On the other hand tropical Desert regions remain dry throughtout the year and they receive rainfall upto 10 cm only. In South American nation chile, Behia Faliksh region receives rian for 325 days each year while Erika region of Chile does not receive any rain continuously for years. Monsoon regions like India receive 80 percent of their annual rainfall during four months i.e. June to Septemeber.

Rainfall pattern of the world may be divided into six major regions :–

1. High rainfall Equatorial region : Region between 10^0 N and 10^0 S lattitudes is known as Intertropical convergence. This region receives vertical sun rays because of

which condensation of hot and humid air results in heavy rainfall continously throughout the year touching average of 150 to 200 cm annually

2. Trade wind region : Eastern parts of continents receive rainfall from the humid winds coming from sea because of the perennial winds blowing between 10^0 to 20^0 lattitudes in both the spheres. These winds become dry while reaching on the western parts of the continents because of this these parts donot receive any rainfall. That is why deserts are situated on the western parts of continents. Basically, Trade wind region receives rainfall during summer season.

3. Sub Tropical Scanty rainfall region : High pressure regions are located (situated) between 20^0 to 30^0 lattitudes in both the spheres. In these regions air moves down due to anti cyclones because of which favourable conditions are not created for rainfall and these regions remain dry.

4. Mediterraneon regions : Regions situated between 30^0 to 40^0 lattitudes in both the spheres receive rainfall in winters from westerlies and they remian dry during summer under the effect of (eastern) trade winds.

5. Mid Latitudnal high rainfall regions : Western parts of continents situated between 40^0 to 50^0 lattitudes in both the spheres receive heavy rainfall under the effect of westerlies blowing from sea to land however aAmount of rainfall decreases as winds proceed to eastern parts.

6. Low rainfall polar regions : Amount of rainfall decreases in the regions situated above 60^0 latitude in both the spheres because of low temperature and high air pressure. These regions receive average rainfall of 25 centimeters annually.

EXERCISE

1. Answer the following

(a) What name is given to 'Specific Humidity' in Punjabi?

(b) If a place faces high evaporation, what type of humidity shell increase?

(c) What is liquid form of Humidity?

(d) At what name 'Hail' is known as gaseous form prior to solidifying?

(e) What is cyclonic rainfall known in Punjabi?

2 Answer the followings in 60 to 80 words.

(a) What is humidity? Name various types of humidity.

(b) What is rainfall? name various types of rainfall?

(c) What is the difference between precipitation and rainfall? Explain..

(d) What is Saturated air ? Explain.

(e) What relation humidity, winid and temperature have ? Write short note.

3. Answer the following in 150 to 200 words :

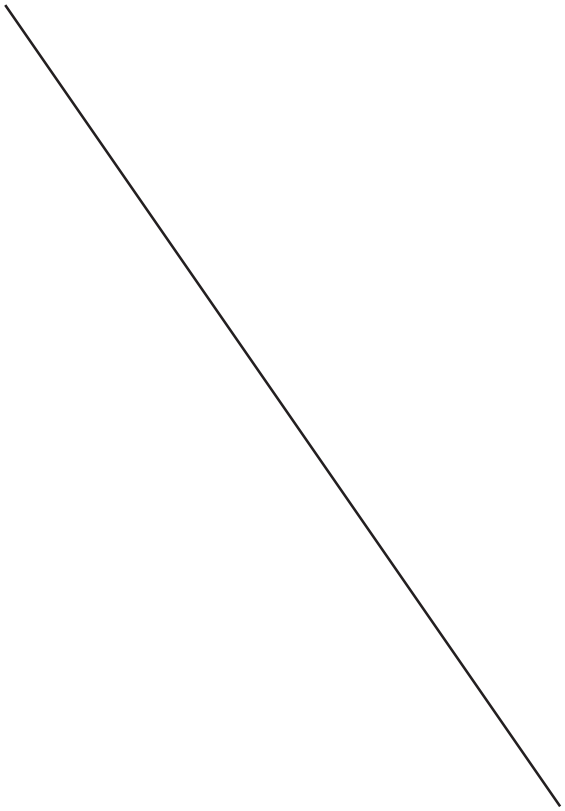
(a) Give detailed account of various types of humidity.

(b) Give detailed account of various types of rainfall.

(c) Explain distribution of rainfall, worldover.

UNIT - IV

HYDROSPHERE

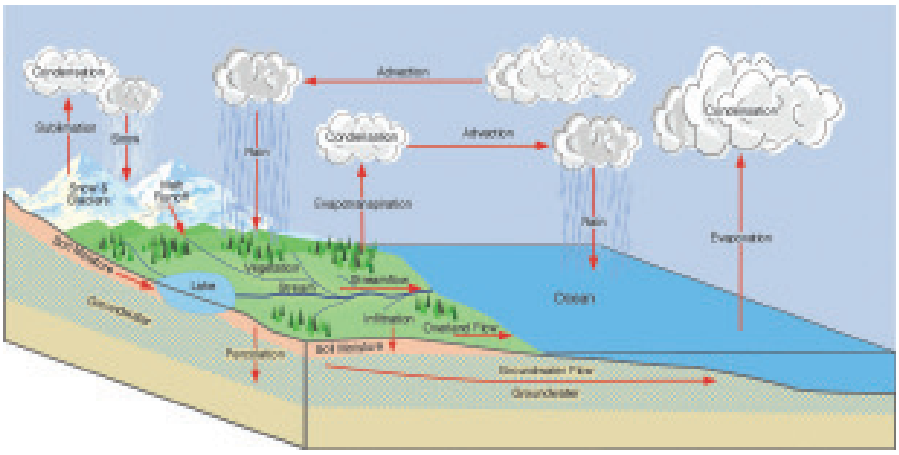


Chapter 9

OCEANS

Water is the basic need for life while Earth is known as blue planet because 2/3 part of earth is covered by this aspect i.e. water only which looks blue when noticed from Universe. All the water of Earth is part of hydrosphere and seas, lakes, rivers etc. include in it. Hydrosphere covers 70% part of Earth surface and is one of most important Spheres for various living organisms and vegetation.

Hydrosphere is continously moving like atmosphere. Movement is not clear in lakes and ponds but it could be easily noticed in rivers and seas. Of the hydrosphere, 97.2% of water on Earth is present in Oceans. Large part of lithosphere lies in Northern hemisphere. On the other hand 4/5 part of Southern hemisphere is covered by oceans and they cover 3/5 part of northern hemisphere.



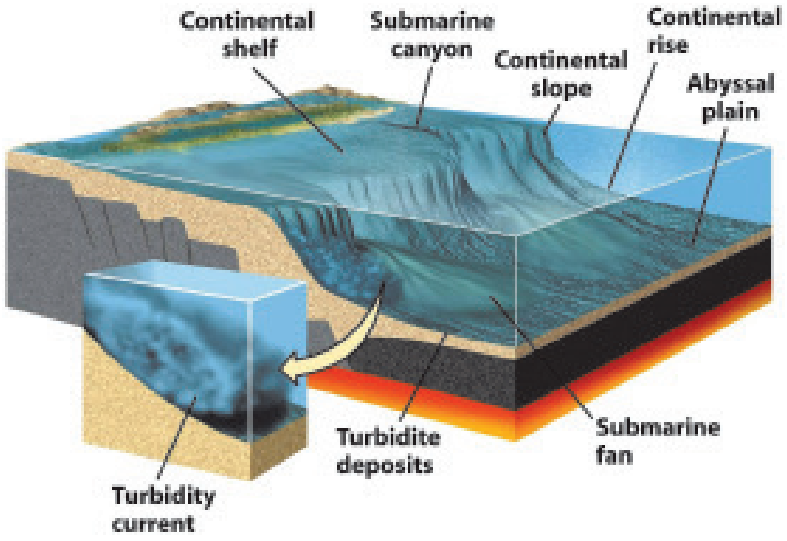
Hydrological cycle

Hydrological Cycle : Continuous exchange of water takes place between Hydrosphere, Atmosphere and Lithosphere. Water is a unique liquid which changes its form and place but never stops. It is because of evaporation, that water moves into air in the form of vapours and when density of these vapours increases, clouds are formed. These clouds shed water in the form of rainfall. Rain water moves into rivers and again starts its journey towards sea/oceans. During this process it passes through various stages. This unending process of water is known as water cycle.

Like land, ocean floors are also deep at some places and high at others. Mountains, Plateaus, Ridges, Canyons, Trenchs are situated at the surface of seas also. Collectively these land forms are known as Submarine Relief.

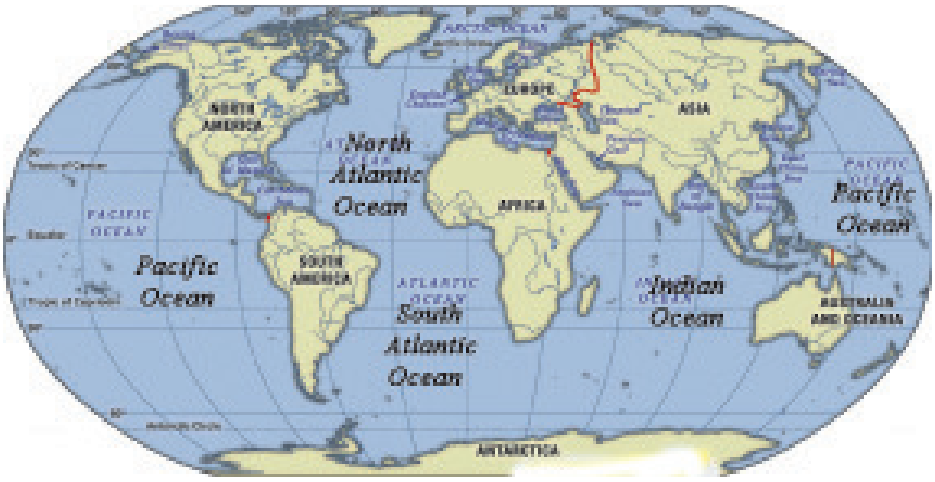
Ocean Basins may be divided into following four parts :

Continental Shelf : The part of sea adjoining the coast is known as Continental Shelf. In other words the parts of continents, looking like niche of land, which are submerged in sea are known as Continental Shelf. Rivers continously deposit soils, rocks, stones etc. on these shelves. These are not very deep therefore development process of various types of living organisms and vegetation takes place on the upper layer of water with the help of sunlight. The depth of continental shelf is not more than 200 meteres and its slope is angular, to 1 degree. The famous fishing regions of the world are situated on continental shelves. The breadth of continental shelf varies from some kilomemters to 1000 kilometers.



Marine physical features

Continental slope : Continental shelf ends abruptly and from that point continetal slope starts. Its slope is angular to 2 to 3 degree while its depth varies from 200 meter to 3000 meters. Continental slopes cover 8.5% part of Oceans. Their slope varies at different places, e.g. at Calicut coast slope angle varies from 5^0 to 15^0 while at Spain coast it is 30 degree and at St. Helena it is 40 degree. This part has less vegetation as compared to continental Shelf. At some places trenches are situated at slopes, which are known as submarine canyons. In Indian Ocean, submarine canyons are found at mouths of river Ganga and Indus.

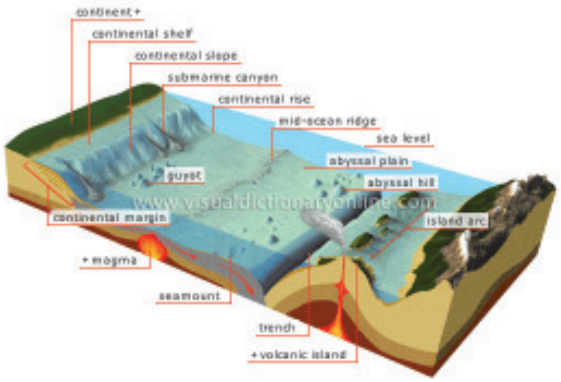


Major Oceans of the World

Continental Rise : Continental Rise which is next to continental slope, has very gentle slope which is angular at 0.5^0 to 1^0. These are not very high. As we go deeper it vanishes into leveled sea bed. At some places their breadth extends to more than 60 Kilometers.

Abyssal Plains : With the end of continental rise and where ever only continental slope exists, at the end of slope, 'Sea Plains' start which are known as 'Abyssal Plains'. These are levelled plains and their slope is less than 1 degree. Their depth varies from 2000 to 6000 meters. Red soil of volcanoes and remains of living organisms are found in these plains.

Submarine Ridges and Rises : Like lithosphere, mountain ranges are situated in the sea also. These extend upto thousands of kilometers and they cover 1/3 part of sea bed. These are also known as Mid-Oceanic Ridges. At some places these look like high mountains and at some places these are situated in the form of Plateau. These areas experience continous earthquakes and volcanic eruptions resulting in the formation of various physical features. Peaks formed by volcanic eruptions rise above the sea level to form Islands in the seas



Abyssal Plains

and oceans. Hawaii and Tahiti are their finest examples. Some times the upper parts of high peaks are flattened. These are known Guyots or Table Mounts.

The Ocean Deeps : The deepest part of the sea is known as Ocean deep. It is a type plain beneath the sea. These deep plains may be deep, long or levelled, all lie beneath the sea. The deepest deeps are found in Pacific Ocean on our mother Earth.

Marina is the deepest trench which is situated in South Western Part of Pacific Ocean. Its depth is 20 percent more than world's highest peak i.e. Mount Everest, that means if 'Mt. Everest' is placed into this trench, its highest point shall still remain 2 Kms. beneath the waters of pacific Ocean.

Six deep trenches are found in Indian Ocean. Among these, Java trench or Sonda Trench is 7,450 meter deep.

Floors of Oceans

According to International Hydrographic Organisation there are five major Oceans :

1. Pacific Ocean

2. Atlantic Ocean

3. Indian Ocean

4. Arctic Ocean

5. Antarctic Ocean

While we classify 'World Ocean' into four parts i.e. Pacific Ocean, Atlantic Oceans, Indian Ocean and Arctic Ocean.

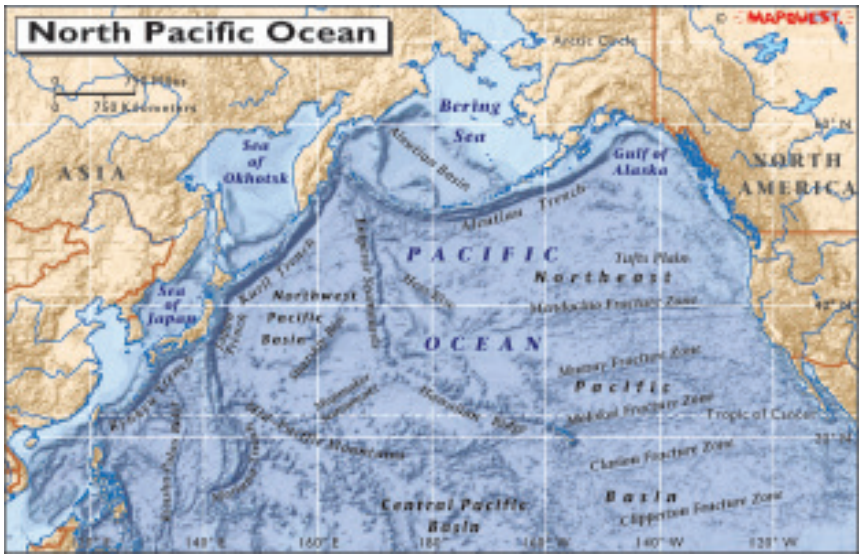
The floor of he Pacific Ocean, Shape and Size :

This is the largest ocean of the world. Its average depth is 4280 meters (14040 feet) or 2,333 fathoms. Its total area is 16,52,50,000 square kilometers which is 1/3 part of total area of Earth. Pacific Ocean covers 46% part of world Oceans. This Ocean is touched by five continents. At equator its extent is more than 16000 kilometers. Maximum typhoons and active volcanoes are found in this ocean.

It has triangular shape and Bearing Strait is situated in its north. Asia and Australia form its one part and other part is formed by North America and South America. Antartic

Ocean is situated towards its south. Size of Pacific Ocean is decreasing by 2-3 cms every year on the other hand the size of Atlantic Ocean is increasing.

The floor of the Pacific Ocean



Continental Slope : Continental Slope of Pacific Ocean is quite broad along Asia, Indonesia and Western Coast of Australia. Its breadth extends from 100 meters 150 meters. Many islands are situated along the continental slope of Pacific Ocean e.g. Islands of Japan, Phillipines, Indonesia and Newzealand. Its breadth becomes narrow along the western coast of America, where its average breadth is 100 meters.

Overall, more than 20,000 islands are situated in this Ocean. Islands situated in its north and continental slope are formed by volcanic eruption. Mauna Kea and Mauna Loa are the major peaks situated on these islands, height of these peaks, is 4213 and 4168 meters respectively. In north its depth extends from 5000 meters to 6000 meters. Various trenches are found in this ocean e.g. Aleutian, Kurile, Japan and Bonin. Most of the trenches are situated along the Islands. Celebes Sea, Coral Sea, East China Sea, Yellow Sea Tasman Sea etc. are situated towards its west coast. In the westen part Malacca Straight connects the Pacific and Indian Ocean.

Great Pacific - Garbage Patch : Every year, 90 billion kilograms of Plastic is produced in the world. Of this 10% plastic is disposed off into the Pacific Ocean in the form of waste. This waste is termed as the 'Great Pacific Garbage Patch'. It is deposited in those parts of sea where speed of winds is low and waves are weak. Its small part sinks down and rest of it floats. It is very dangergous for living organisms and vegetation of sea.

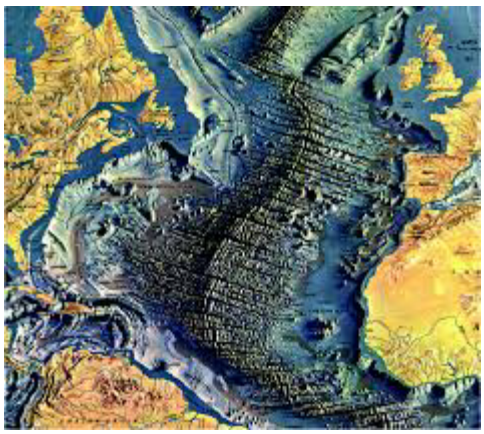
Floor of Atlantic Ocean, Shape and Size :

The shape of Atlantic Ocean resembles with English language Roman Script alphabet 's'. It covers 22% part of the Earth and its average area is 8,24,00,000 square kilometers. Its average depth is 3,339 meters (10,955 feet) or 1826 fathoms than that which is less Pacific Ocean. Its deeptest part is 'Milwanke-deep' (8380 meters) which is situated in the north of 'Puerto Rico'.

Its breadth is 1530 nautical miles (between Brazil and Sierra Leone) and in south it is 3450 nautical miles or 6400 kilometers. The eastern side of this ocean is connected with North and South America and its eastern side is connected with Africa and Europe.

Try to Know : North Atlantic touches with pair of which two developed nations ?

Continental Slope : It is quite wide at eastern and western coasts and is situated along the coasts of America and Europe. The slope is quite narrow between South America and Africa while major broad continental slopes of the world are around New Foundland and British Isles. Grand Bank and Dogger Bank are situated here which are the most popular places of world for fishing. The breadth of continental shelf extends from 250 to 400 Kilometers near the coasts of North Eastern America and North Western Europe.



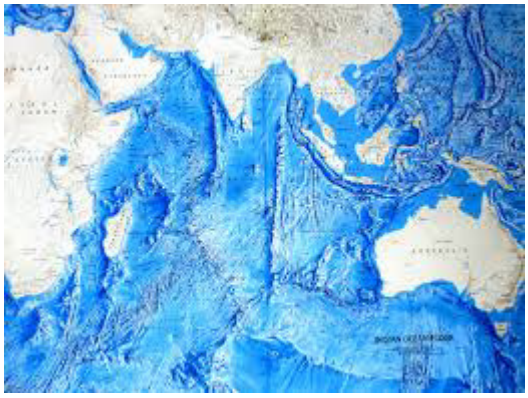
Floor of Atlantic Ocean

Mid Atlantic Ridge : Deep 'sea plains' are found in this ocean, which donot have equal depth. Their elevation towards central part to eastern and western coasts is quite gentle and a long mountain has been formed in the centre which is like a ridge. This is the speciality of Atlantic Ocean floor. This mountain extends from Greenland to Bouvet Islands and vertically divides this Ocean into two parts. Its average height is 14000 meters and it is 14000 kilometers long. Its large part is covered by water but some of its parts are visible above the sea in the form of islands. Some of these islands are Ascension Island, Tristan da, Cunha, Azares, St. Helena and Gough. These are all volcanic islands and their various small peaks attain the form of islands. The upper line of this mountain is quite wide at 55^0 North latitude, which is known as Telegraphic Plateau. This is also known as under water rise. Various seas and bays are situated on its coast. On the western coast of ocean 'Hudson Bay' and 'Basin Bay' are situated and on the eastern coast 'Northern Sea and Baltic Sea are situated.

This Ocean does not have large number of trenches. Around 19 trenches are 5500 meter deep at average and 2 trenches are 7000 meters deep in this Ocean. Many deep sea parts e.g. Labrador Basin, North Eastern Atlantic Ocean Basin, Argentina Basin and Agulhash Basin are part of Atlantic.

Floor of Indian Ocean, Shape and Size :

Although this ocean is smaller than Pacific and Atlantic Oceans yet it is more important for us. It is situated in the south of our contry and its name is also based on older name of our country. The total area of this ocean is 7,34,25,500 square kilometers and its average depth is 3960 meters. It is almost triangular in shape and is surronded by Iran, Pakistan, India, Bangladesh, in north and north east, by Australia in the east, by Antartica in the south and in west, by Africa.



Floor of Indian Ocean

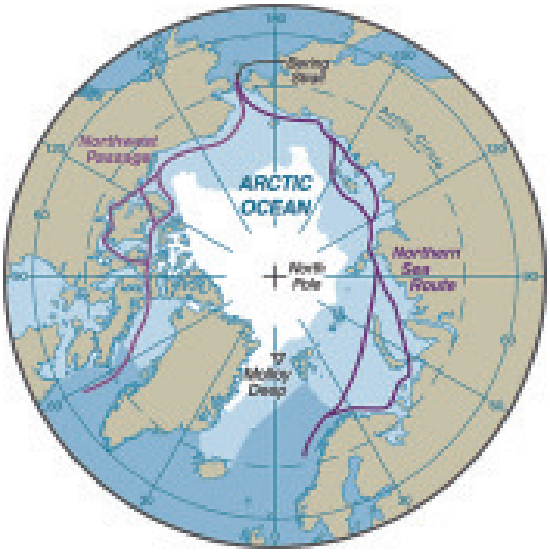
Continental Slope : Average width of its continental slope is 75 miles (120 km). It is 190 miles (1300 kms) wide near Mumbai, which is almost maximum. Tropic of cancer is the upper boundary of this Ocean and 90 percent part of this Ocean lies below the Equator i.e. in Southern hemisphere. Its bed is completly flat. Red sea and Persian Gulf are situated in its North, Arabian Sea in North West, Andeman Sea and Bay of Bengal are situated in its North east. Trenches are very rare in this Ocean. Sunde trench is situated in the south of Java. Which is 8152 meters deep. There are many under water mountains, situated on the bed of Indian Ocean. Longest mountain (Submarine Ridge) extends from cape Comorin to southwards (Towards Antartica). It is quite wide but it is not very high. It is wider than mid Atlantic Ridge. Its elevated (higher) parts are present in the form of islands e.g. Chages mountain in its north, St. Paul Ridge and New Amsterdem 'Medagaskar' and 'Sri Lanka' are the largest islands of Indian Ocean.

(i) Try to find out, Indian Ocean is connected with which sea through Suez Canal ?

(ii) Find out why the Andeman Nicobar Islands have shifted 1.25 meters towards South West and submerged in sea by 1 meter?

Floor of the Arctic Ocean, shape and Size :

Its size and depth is less as compared to other oceans. Actually it is circular and surrounds the North Pole. Its average size is 1,40,56,000 Sq. Kms. and its Coast line is 45390 kilometers. The Artic Ocean is surrounded by Eurasia, North America, Greenland and various islands. Various islands are found in this ocean namely, New Syberian islands near Canada, Navaea and Jalmaya are major islands while. Barents Sea, Beaufort Sea, Chukchi Sea, East Siberia Sea, Green land Sea, Kara Sea, White sea, Hudson Bay and Baffin Bay are also found in this ocean.



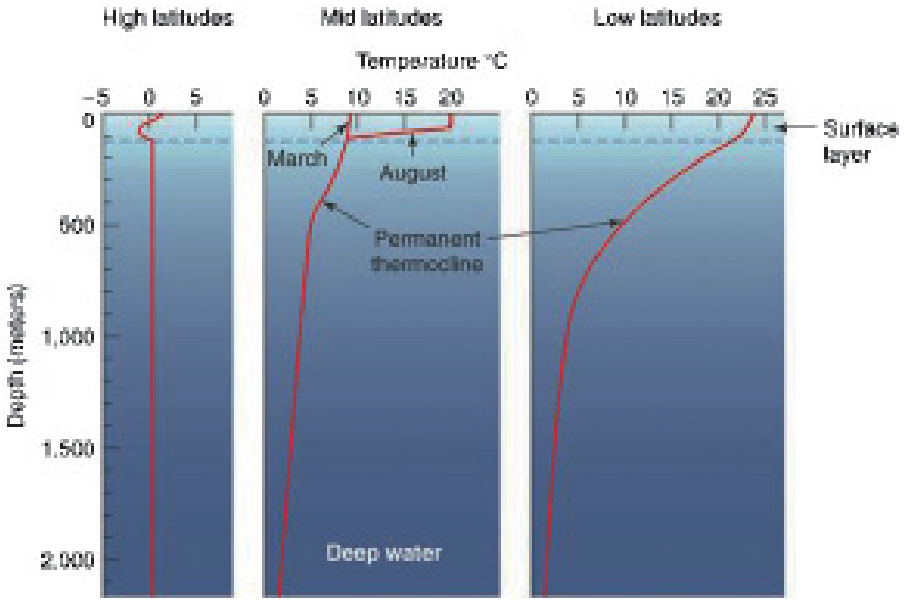
Floor of the Arctic Ocean

It is connected with Pacific Ocean by Baring Straight and connected with Atlantic Ocean with the help of Greenland Sea and Labredor Sea. Its long submarine Ridge is known as Lomnosone Ridge.

The layer of ice of this Ocean is melting continuously slow pace and there is a possibility that major changes to occur by 2040.

Temperature of Ocean Water

Temperature of land increases and decreases at faster pace as compared to that of sea or water while the temperature of sea waters is not same and constant at all the places. It is higher near the Equator and low near the Poles. The upper most layer of sea water is 500 meters thick (deep) and its temperature varies from 20^0 to 25^0 celcius. Thickness of second layer extends from 500 meters to 1000 meters and it is known as Thermocline. Because of its deepness, temperature starts decreasing and moreover the flow of cold waters in its lower part, the temperature decreases further. In simple words the temperature decreases with the increase in latitude and depth but does not reach at freezing point.



The Graphic of Theromocline

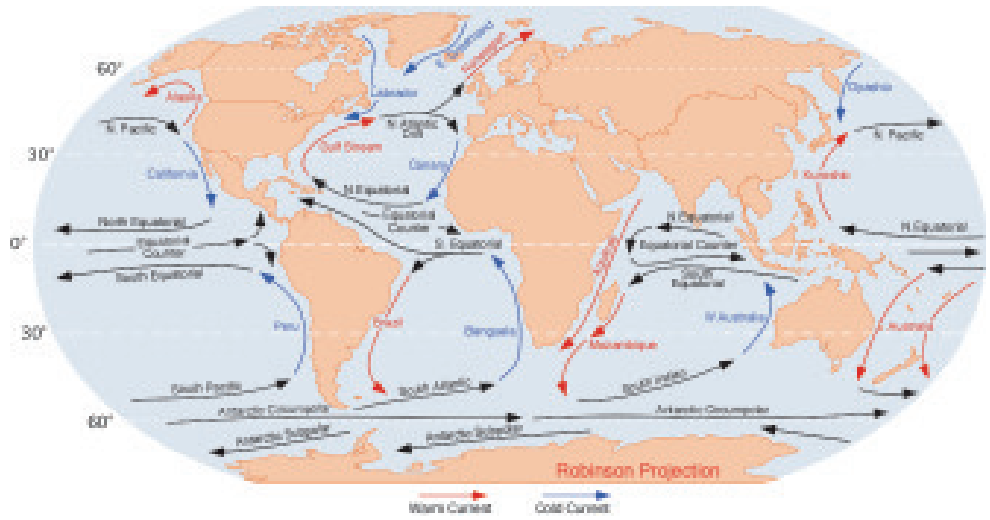
Factors Affecting Distribution of Temperature

1. Latitudinal extent of Sea : As we move from Equator to poles, temperature of sea water decreases. Temperature remains high at Equator and gets low towards poles, which affects temperature of sea water.

2. Albedo of the Ocean surface at varying times : Albedo of those water bodies is higher which have low mobility of water. Higher the Albedo, lower will be the temperature. Lighter and whiter bodies have higher Albedos than darker, black bodies.

> **Albedo :** It is the fraction of solar energy (Shortware rediation) reflects from the Earth back into space. Total Albedo of Earth is 35%.

3. Ocean Currents : Hot water currents increase the temperature and cold water currents decrease the temperature. Temperature of currents moving towards poles from Equator is high and on the other hand the temperature of currents moving towards Equator from poles is low.



World Ocean Currents

Hot water currents of Gulf Stream increase the temperature of western coast of Europe. Cold water currents of Labredor Sea decrease the temperature of North Eastern Coast of America. So, the temperature of currents affects the temperature of sea water.

4. Prevailing Winds : Oceanic waters become mobile with the movement of winds. This mobility results into mingling of cold and warm waters. Winds pressurise Sea waters to flow in the direction of their own flow. Hence, generally speaking waters start flowing from regions with lesser temperature to regions with higher temperature.

5. Effect of Adjacent land Masses : The temperature of sea increases in summer, which is surrounded by land masses and it decreses in winter. The temperature of ocean near Equator rises upto 26^0C in summer and in Red sea it rises utp 30^0C.

Try to find out :
Oceans in Northern hemisphere acquire more Solar energy as comared to oceans in Southern Hemisphere, Why ?

6. Salinity : If the sea water is more saline, its temperature will be higher because highly saline water contains more energy on the other hand the temperature of less saline water is low.

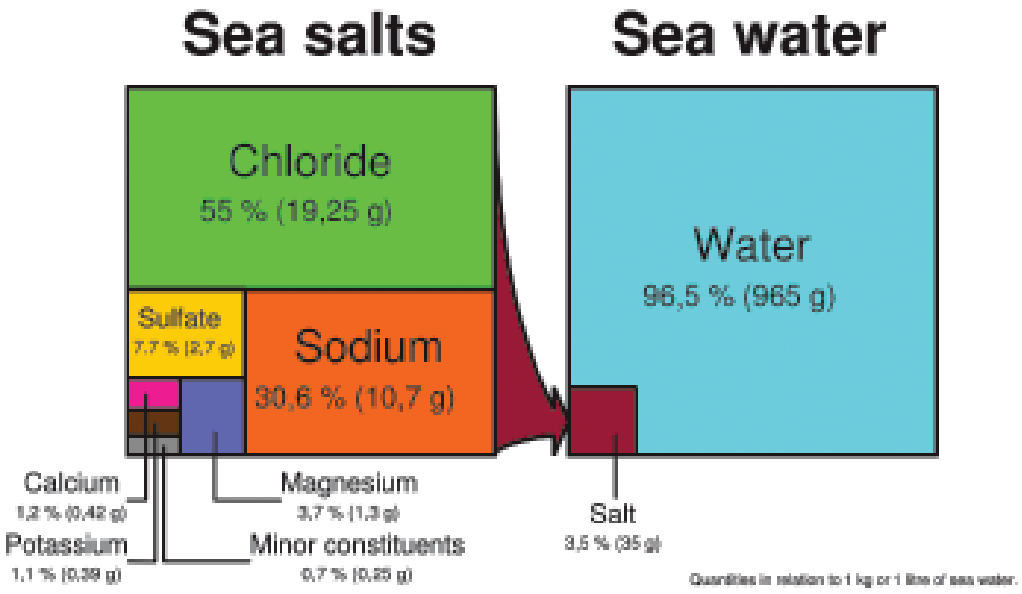
7. Ice flows and Ice bergs : These are made up of ice because of this they decrease the temperature of sea. Their affect is very common in polar regions.

Do you know ?

Some ice bergs from North polar and South polar regions start floating towards Equator in their respective summer seasons. These icebergs are known as ice flows also.

Salinity of the Ocean Waters

Sea water has brackish taste because of the dissolved salts in it. This water is not good for human consumption and it may be used only after distillation.



Composition of Sea Water

Do you know ?

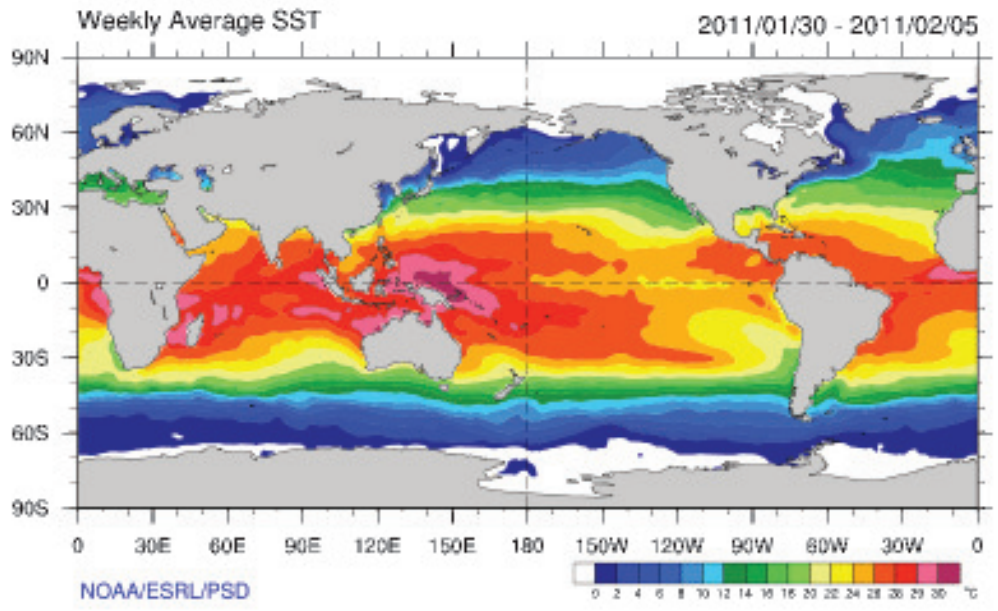
Salinometer is a device which is used to measure the salinity of sea water.

According to the scientist Dittmar, 47 different types of salts are present in sea. Some of the important elements are given below:

Constituents	Symbol	g/Kg in Sea water
Chlorine	Cl^-	18.47
Sodium	Na^+	10.47
Sulphate	$SO4^{-2}$	2.65
Magnesium	Mg^{2+}	1.28
Calcium	Ca^{2+}	0.41
Pottasium	K^+	0.38
Bicarbonate	HCO	0.14
Bromine	Br	0.06
Borate	BO_4 BO_3	0.02
Stugrium	Sr^{2+}	0.01

Various elements of these types are found in sea but Sodium (Na) and Chlorine (Cl) are the most important elements, they form sodium Chloride. Its common name is 'common salt' and 'table salt'. The average salinity of oceanic waters is 35%, which means that 1000 grams of water contains around 35 grams of salts. High salinity meter starts at 24.7% salinity measure. Salinity varies in different parts of oceans and seas. Regions, where evaporation is high, salinity is also high on the other hand where the amount of fresh water and rain water is more, salinity is less.

Salinity of sea water increases as we move from Tropic of Cancer and Tropic of Capricon to Equator. On the other hand it decreases toward poles. Rivers bring large amount of salt into sea because of the erosion and friction process which they perform in their valleys. Inspite of this, various types of living organisms and vegetation naturally increases the salinity of sea water. In a map showing salinity of oceanic waters, lines joining places with same note of salinity are known as Isohalines.



World Distribution of Salinity

The average oceanic salinity (per thousand) according to latitudual zones on the Earth is as under :

Latitudinal Zones		**Salinity %**
	Northern Hemisphere	
10^0N-15^0N		34-35
15^0N-40^0N		35-36
40^0N-50^0N		33-34
50^0N-70^0N		30-31
	Latitudinal Zones in Southern Hemisphere	
10^0-30^0S		35-36
30^0-50^0S		34-35
50^0-70^0S		33-34

Try to find out :

Salinity of Dead Sea is highest in the world, Why ?

Do you know :

If we spread all the slat of hydrosphere, on the Earth, the layer formed will be 150 meter thick, it shows that 1 kg water contains 35 grams of salt in it.

This measurment is generally made with the help of Part Per Thousand i.e. PPT which is represented as $\%_0$ (per thousand).

Factors affecting Salinity :

Following factors affect Salinity of Oceanic waters :

1. Evaporation : When water moves into atmosphere in the form of water vapours, that process is known as evaporation. It is directly related with temperature. Where the evaporation is high, salinity of sea water is also high.

Try to find out; Why the water at Tropic of Cancer and Tropic of Capricorn is highly saline?

2. Fresh Water : Fresh water affects the salinity to a great extent. Salinity of that sea water is low which receives high amount of river and rain water and on the other hand where the emergence of rain and river water is low, salinity will be high.

3. Ocean Currents : Hot water ocean currents, increase the temperature of water and cold water currents decrease the temperature. Because of this currents moving towards Poles from Equator bring highly saline water and on the other hand currents moving toward Equator from Poles bring water which have low salinity.

4. Winds : High speed winds result in the movement of water towards their flow, which affects the salinity of water.

Let us know :

It is because of human activities that one third Carbondioxide mixes up in sea water. Sea waters are becoming acidic because of atmospheric pollution and pollutents orignated by factories. All this is affecting the not only 'marine life but overall flora and fauna also.

Ocean Currents :

Sea water is a liquid which is not stable and free to move. This mobility of sea waters is divided into three parts :

1. Tides 2. Waves 3. Currents

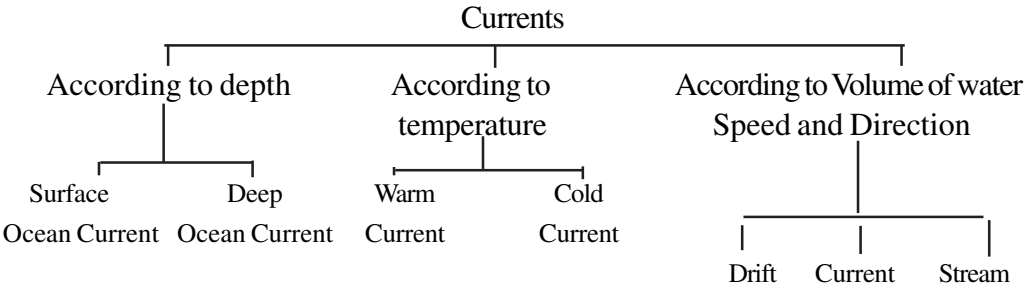
Currents are defined as those waves on the surface of sea water which move horizontally. Water moves from one place to another like a river, actually it moves in a specific direction. Name of current is based on their direction. A current is actually that water which flows in specific direction only. There are various types of currents in Oceans, which move and shift water from one place to another. These are affected by the size, depth and structure of sea. Water flowing as current remains stable at the both ends and moves faster than the river water in middle part and flow is much deeper and large also.

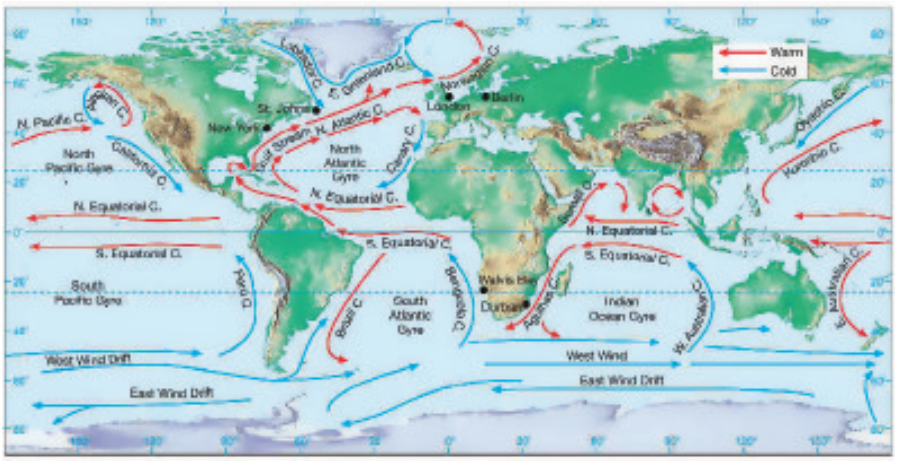
Ocean Currents : The length of currents extends upto 1000 Kms and they may be 200 Kms broad. Their speed is faster than that of rivers. In each current speed of water varies from 2 to 10 Km/Hr. They move towards a particular direction for long time and collectively form a big flow called 'Global Conveyor Belt', which affects the Global climate. e.g. The temperatures of Gulf stream and Humbolt current make their surroundings warm and cold respectively. Ports of eastern North America do not freeze in winter due to warm effect of Gulf Stream where as tempratures in Lima and Peru is lower than their surrounding areas. Although these are situated on tropical latitude but still their temperature is low.

Let us know :

Speed of Current is measured in Knots and 1Knot = 1.85 Km/Hr (1-15 miles/Hr)

Oceanographers have classified currents on the basis of various methods. These are given below :





World Ocean Currents

Types of Currents:

(a) **Periodic Currents :** Currents which change their speed and direction after particular fixed time are known as peridic currents.

(b) **Seasonal Currents :** Those currents which change their speed and direction with changing season.

(c) **Coastal Currents :** Those currents which move on the outer side of the sea coast.

(d) **Long shore Current :** Those currents move along the sea coast as these are produced when the waves strike of the coast, these flow close to coast and upto long distances.

(e) **Off shore Current :** These are produced at a distance from the coast.

(f) **Inshore Current :** This type of currents are produced near to the coast.

(g) **Drift :** Those currents which get broader under the affect of prevailing winds are known as drift. The velocity of the drift is less than 24 km a day. Namely, for example

(i) North Atlantic Drift

(ii) West Wind Drift

(h) **Streams :** These are large size currents, having large volume of water moving.

Types of Curents on the basis of Temperature :–

(a) **Hot Water Currents :** The currents which move from warm regions to cold regions are known as hot water currents.

(b) **Cold Water Currents :** Those currents which move from cold regions to hot regions are known as cold water currents.

Causes of origination of the Ocean Currents :

There are various reasons because of which ocean currents are formed; Roation of Earth, Gravitation, Heat of Sun, Temperature difference, Salinity, Density of water, Melting of Ice, Instant change in weather, Direction and size of coast etc.

Let us examine these reasons in detail :

(i) **Prevailing Winds :** These winds are permanent and always flow in one direction. With their friction they move sea water because of which currents are formed.

Trade winds blow towards west between 30^0 North and 30^0 South of Equator. Because of this currents move from east to west in the north and south of Equator i.e. in at Tropical region. Similarly, Western winds blow between 40^0 North to 65^0 North and 40^0 South to 60^0 South latitudes (Temperate region). They move from west to east because of this they are known as Western Winds. Currents moving from west to east are not known as western currents. They are known by the name of that direction in which they are moving. In Indian Ocean direction of Monsoon winds change with the change in Weather.

(ii) **Temperature :** Currents find their birth in variation of temperature of Oceanic waters. Currents move in North-South direction because of temperature difference between Equator and Polar regions. In other words we can say that when heavy and cold water of Polar regions settle down, hot water starts moving from Equator to Poles

for aquiring the empty space. Because of this hot water currents move from equator to poles causing birth of hot and cold water currents because of the difference in temperature.

(iii) **Density of water :** Density of saline water is more than the density of clean water. Highly saline water settles down because of its weight. To fill that space clean water moves toward the region, resulting in the formation of current. Salinity of Medittrainian sea is higher than that of Atlantic Ocean because of this a current moves from Atlantic Ocean to Medittrainian sea along side upper water.

(iv) **Evaporation :** Evaporation reduces the sea level as water evaporates in this process. As soon the water level decreases, flow of water from other regions begins towards decreased level region. This forms a 'current'.

(v) **Rotation :** Earth rotates on its own axis because of which 'centrifugal force' is produced. Under the affect of this force, flowing water opts a circular path, which is known as Gyre. The movement is clockwise in Northern Hemisphere and anticlockwise in Southern Hemisphere. Currents in 'N. Hemisphere' move towards right and in 'S.Hemisphere' currents move towards their left. Winds also turn on the basis of this 'Farrel's law'. In Atlantic Ocean, Western Winds produce a current called 'Gulf Stream'.

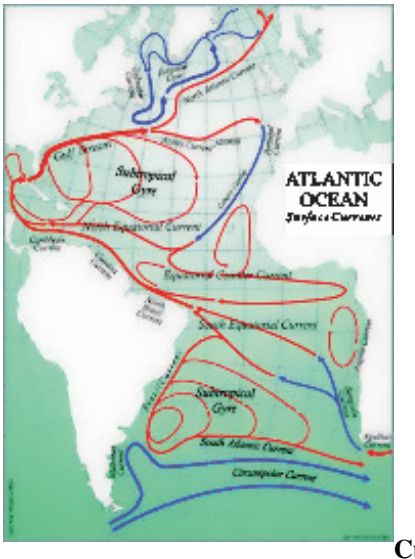
Do you know :

Gulf Stream is 50 miles wide and Its speed is 5 miles per hour.

Currents of Atlantic Ocean :

In the Equatorial region of Atlantic Ocean, Trade Winds give direction to important currents. In simple words, it is becasue of Trade Winds that water of Equatorial region starts flowing towards west, resulting in the formation of currents. These are hot water currents. Some of them move towards North from Equator and others move towards South.

An anti current starts flowing from west to east named as Equatorial Counter Current between North Equatorial Current and South Equatorial Current.



Currents of Atlantic Ocean

Currents of Northern Atlantic Ocean :

North Atlantic Ocean Equatorial Current : Flows from western coast of Africa to Central American Island along the equator due affect of Trade winds.

Antilles Warm Current : Antilles Current is actually south Atlantic Current which finds its origin under the effect of Trade winds in Southern Atlantic Ocean near the Equator at Western African Coast. Flowing west wards it reaches upto Cape-de-Sao-Rogue i.e. eastern end of Brazil. Here this current is divided into two parts. Southern part starts flowing southwards while its northern arm contributes its warm water to North Atlantic Equatorial Current.

Florida Current : This current moves along the South Eastern Coast of USA. This is a hot water current.

Hot Water Current of Gulf : From Cape Hateras to Grand Bank this current is known as Gulf stream. It is 45 Kilometer wide water channel and it moves at the speed of 6-7 km/hr. This hot water stream dEflects towards east due to the affect of western winds and rotation of Earth and after crossing Atlantic Ocean it is known as Hot water current of North Atlantic.

Norway's hot water Current : In eastern part of Atlantic Ocean, North Atlantic current is divided into two parts. The part which deflects towards north, enters into Arctic sea while moving along the coast of Norway. This is known as hot water current of Norway.

Canaries Cold Current : The other part of North Atlantic current deflects towards west and reaches upto canary Islands. Due to rotation of Earth and coastal obstacles/ hindrances, second branch of hot water current of North Atlantic deflects towards south. It moves along the eastern coast upto Spain and Azores in the form of new stream. This is known as cold water current of Canary. It moves further and conjugates with the hot Equatorial Waters. Thus North Atlantic Ocean currents complete their one circle flowing clockwise and ending up in equatorial waters at Sargasso Sea. The name of 'Sargasso Sea' is derived from the Oceanic Algae Or Sea weeds which is brown in colour and known as 'Sargassum'. The area of Sargasso Sea is taken 11000 square Kms.

Labredor Cold Current : This current moves towards New Foundland through Bay of Baffin. It moves along the eastern coast of Canada and conjugates with warm Gulf stream. This conjugation causes dense fog near New found land.

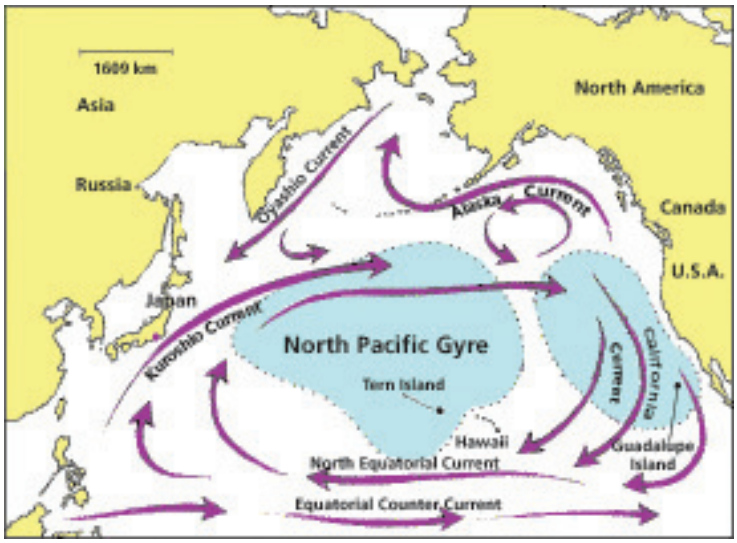
Southern Equatorial Current : As this current moves toward west, it gets divided into two parts at the coast of Brazil. One deflects towards north and other starts moving along the coast of Brazil. This is known as hot water current of Brazil.

Cold Water Current of Southern Atlantic Ocean : Hot water current of Brazil starts moving towards east due to affect of Western winds. When this current moves toward east, it is known as cold water current.

Benguela Cold Current : Due to the rotation of Earth, some part of current of southern Atlantic Ocean deflects towards north and when it strikes with the Western Coast of Africa, water starts flowing towards North. At that point it is known as Benguela Cold current. It conjugates with the Equatorial current and completes its cycle.

Currents of Pacific Ocean :

Currents of Pacific Ocean also move like the current of Atlantic Ocean.



Currents of Pacific Ocean

Northern Equatorial Current : Due to the affect of Trade winds these currents begin from the western coast of central America and reach upto Phillipines islands while moving from east to west.

Southern Equatorial Current : In south, Southern Equatorial Current moves towards west. Between these two currents an opposite current moves towards east. This is also a hot water current. From Phillipines islands, North Equatorial Current moves

towards north along the coast of Taiwan and Japan. At this point, this is known as Kuroshio Current.

North Pacific Current : Kuroshio current is divided into two parts while moving along the coast of Japan. One of its branch moves along the eastern coast and another branch moves along the western coast. Flowing along the coast of Japan, both of these currents start flowing towards North-East jointly, under the name of Warm Water Drift of Pacific Ocean.

Cold water Current of California : North Pacific Current is divided into two parts at the western coast of North America. Northern part flows anti clockwise along the coast of British Colombia and is known as 'Alaska Current'. This is a hot water current and due to this current water does not freeze at the coast of British Colombia and Alaska. Its second branch deflects towards south along the coast of California. This is also known as cold water current of California.

Oya Siwo Current : This is a cold water current which begins from Bearing strait and moves from north to south upto east of 'Kamchatka Peninsula'

Okhotsk Current or Cold Kurile Current : This current moves along the eastern coast of Sakhalin islands and conjugates with the Oya Siwo Current near Hakkaido island of Japan. Here Oya Siwo Current joins it and its water strats flowing beneath warm water of Oya Siwo because of which fog is formed at this point. Joining of hot and cold currents results into production of planktine, food for fish.

Southern Equatorial Current : This is a hot water current which moves along the coast of Central America in East to the eastern coast of Australia in west. It flows south wards along eastern coast of Australia and is known as warm current.

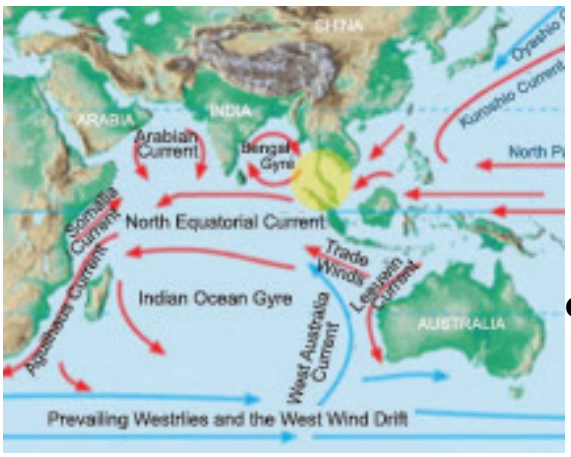
Southern Pacific Drift : Eastern Australia Currents move from west to east near Tasmania. Here, these are known as Southern Pacific Currents. This current deflects towards north at the south western coast of South America and moves further along the coast of Peru. This is also known as cold water current of Peru. In this way a cycle is completed. Because of this cold water current Chile and Peru receives very low rainfall at their coastal regions.

<u>Currents of Indian Ocean</u> :

Currents of Indian Ocean are highly affected by Monsoon winds. Direction of Monsoon winds changes in summer and winter season because of which direction of currents also change. In the north of Indian Ocean, more land mass is found and in southern

portion of Indian oeccan, more open sea is found. This snatches an opportunity from northern region to have a cycle of currents like that in other two oceans while Southern Indian Ocean enjoys same current cycle.

Currents of Northern Indian Ocean : In winters, northern equatorial current deflects southwards while moving from east to west. This is known as North Eastern Monsoon drift. This drift begins from Malacca strait enters into Arabian sea while moving along the coast of Bay of Bengal. It deflects southward near Bay of Aden and starts moving from west to east and completes its cycle by conjugating with Opposite Equatorial Current.



Currents of Indian Ocean

In summer, monsoon winds flow in south-east direction because of which some part of Southern Equatorial Current and Northern Equatorial Current start moving along the coast of Africa. This is also known as 'Current of Somali'

Do you know :

In ancient times Indian Ocean was known as Ratnakara, which means mine of Gems.

Try to find out :

In which months Monsoon wind flow South West and in which months they flow North-East ?

South Western Monsoon Drift : Currents of Somali creates a cycle around Indian sub continent due to the affect of South West Monsson Winds. These are known as South Western Monsoon Drift.

Various rivers flow to Indian Ocean, following are a few major out of them major : Zambezi, Indus, Narmada, Ganges, Brahamputra, Jubba and Irrawaddy.

Currents of southern Indian Ocean :

South Equatorial Current : South Equatorial Current moves from east to west as that of South Pecific Current.

While moving further it gets divided into two parts. One of its branch deflects towards the south of Madagaskar island and other moves along the coast of Mozambique. This is also known as hot water current of Mozembique. When this current moves along the eastern coast of Madagaskar it is known as Madagaskar hot water current.

Agulhas Current : This hot water current has been formed by the conjugation of hot water currents of Madagaskar and Mozambique.

West Wind Drift : Because of western winds, Agulhas current, deflects towards north at the southern end of Africa. While moving further it conjugates with cold Antartic current.

West Australian Current : It moves from west to east. It moves along the southern coast of Australia and its second branch deflects towards north from the western coast. The second part is known as cold water Current of Western Coast. While moving further it conjugates with the Southern Equatorial Current and completes the cycle of Southern Indian Ocean.

Effects of Currents

Ocean Currents leave intense effect in coastal regions, islands, economical activities, weather, agriculture etc. Let us study about this in detail :-

Hot water currents help in rising the temperature. Kuroshiwo current and Gulf stream modify the weather of Southern Japan and Eastern America respectively. Ports of Western Europe are used as trade points for whole of the year becasue hot water does allow water to freeze in any season. Cold water currents decrease the temperature coast of Labredour is freezingly covered by ice because of cold water current.

Currents also effect the amount of rainfall. Hot water currents increase the rainfall because they bring winds along with them, laden with water vapours. North America, Ireland, Britian and south India receive rainfall because of this process. On the other hand Atacama desert remains dry because cold water currents donot play any role in occurance of rainfall. Due to this various deserts are situated on the western coast of Australia, South America and Africa.

Try to find out :

Where is 'Atacama desert' situated ?

Conjugation of hot and cold water currents helps in increasing the development rate of 'Plankton', which is a diet of fish. This conjugation takes place of eastern coast of North America, where New Found land current and Labredour current enjoined making it a major fishing bank of world.

Superior quality fish are found in cold water currents. When these currents move towards regions with high temperature, they carry fish with them. This movement boosts the fishing trade. The direction of currents helps in saving fuel and time also while similar direction encourages speed of moving ships.

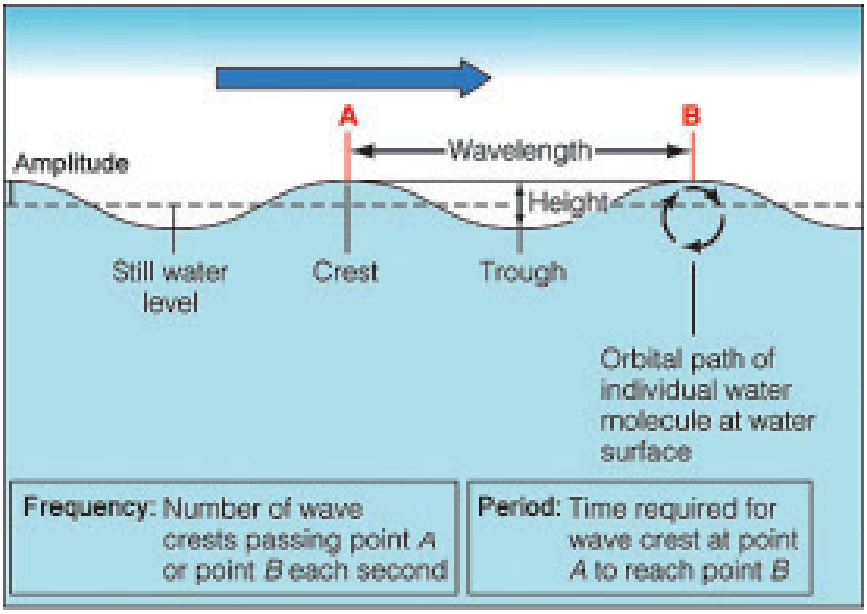
On the other hand conjugation of currents forms dense fog which creates problem for marine navigation. Sometimes ships are not able to move because of this fog. This whole situation effects the economic activities of respective areas.

Waves

Water of Oceans never stops. It moves in the form of waves in the direction of winds. Waves are the forward movement of ocean's water due to the oscillation of water particles by the frictional drag of wind over the water's surface. The peak of the wave is known as crest and lowest point is known as trough.

Waves donot move the water horizontally. We can prove this with an experiment. Fill a tub with water and make a disturbance in it with your hand, now put a cork in it. Notice it for some time, you will find out that cork moves up and down without changing its position. With the help of this experiment we can say that water doesnot move horizontally.

The wave length or horizontal size of wave is determined by the horizontal distance two crests or two troughs. The vertical size or height of wave is determined by the vertical distance between crest while direction and speed of waves is not same always and it depends upon the speed of winds. Wave period is a length of time it takes for a wave to pass a fixed point (crest to crest).



Sea Waves

We can find the speed of wind with the following method:

Try to find out :

What is th eeffect of waves on the depth of sea ?

$$\text{Wave Velocity} = \frac{\text{Wave length}}{\text{Wave Period}}$$

The effect of winds reduces over the waves and currents with increase of depth. Waves depend on the speed of winds. High speed winds increase the power and height of waves. Sometimes speed of wind reduces due to barries, this also effect the waves. When a wave breaks water moves with turbulent speed like a river towards coast which is known as swash/surge. Sometimes it moves sand, rock particles towards coast. The decending of this surge is known as back wash.

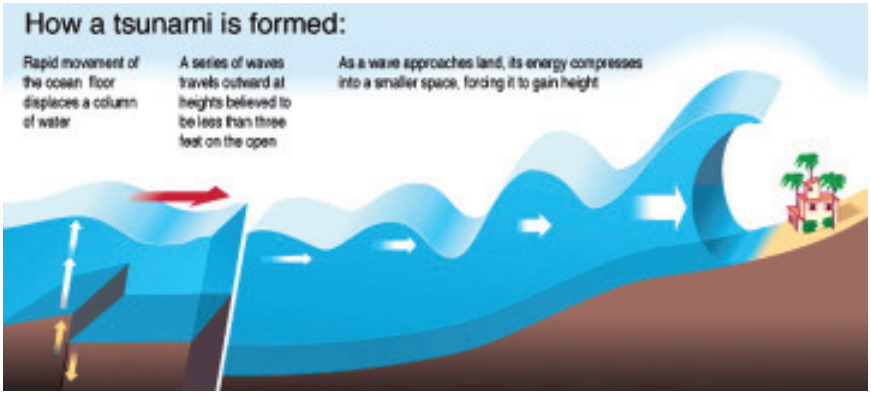
High speed waves which move for long time are known as swell. These are also known as capillary waves. Their wavelength is more than 100 meters. As waves approach land masses, the wave base begins to contact the sea floor. The friction slows the circular motion of wave's base. This is known as **breaker**. These type of waves when move towards shore these are known as **'surf'**.

'Erosion' is always high and fast at soft sea coasts which forms various types of land forms.

Tsunamis

These are also known as seismic sea waves or long wavelength sea waves. These are formed due to volcanic activity or Earthquakes in sea, Asteroid, Displacement on the surface of water because of break down of ice bergs etc. They may have wave length of 100 km and their speed may vary from 600 to 800 km/hr. Their height may grow more than 15 meters. (50 feet). In 2004 these waves resulted in the huge loss of life and property in south India. A large plate (hence large wavelength) of the earth's crust creates these waves by displacing water and the energy liberated is huge. Wave amplitudes are small (0.1 – 1 m) but the wavelength is large, typically 100 to 1,000 km. Oscillations of water particles are not just restricted to the water surface but are distributed in the entire depth. We cannot create such waves by a paddle. Because of the large volume of water involved, energy of tsunami waves is large even though the amplitudes are small. This is why it is difficult to observe the height of tsunami waves in the open sea but close to shore they become disastrous.

Collect more information about 'Tsunami'

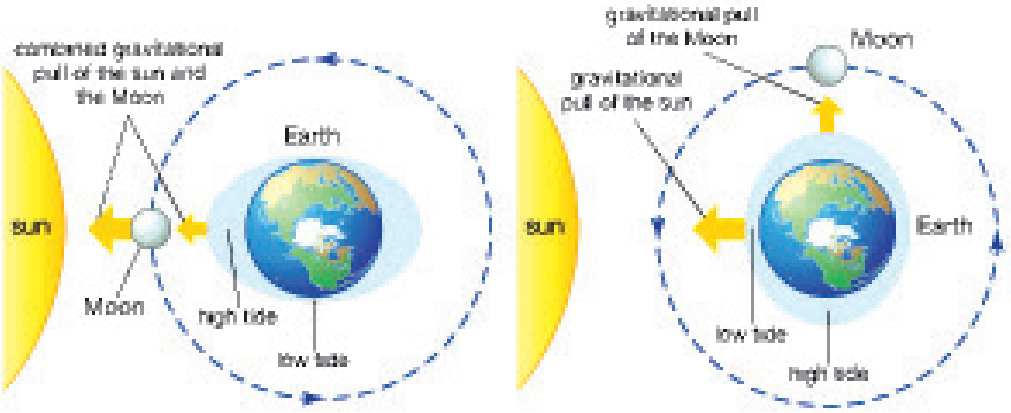


Tides

Tides refer to the periodic rise and fall of Oceanic water. This movement takes place because of gravitational pull of Sun, Moon and Earth. Height of tide depends on the position of Moon. Affect of gravitation is high because water particles are present in Sea in liquid form. Tides rise twice in a day with the gap of twelve hours approximately. To be more exact the difference may be put as 12 hours and 25 minutes. Basic reason behind this time difference is the difference of time taken by rotation of Earth and one revolvation of Moon. The Earth takes 24 hours to complete one rotation on its axis while moon takes 29 days and 12 hours to complete its one rotation around the Earth. Result of this time difference is that any place on Earth faces the same to moon not after each 24 hours but 24 hours and 50 minutes. Hence, tides occur after 12 hours and 25 minutes each. It is the gravity of Earth which gives birth to the tides along with effect of

rotation. When a tide rises on the portion of Earth facing moon, the opposite side of Earth also gives rise to tide due to rotational effect of Earth.

The average height of tide is 0.55 meters but sometimes it may vary from 2 to 3 meters. Sun also produces tides, these are known as Sun tides. Their height is less than lunar tides (Tides produced by Moon)



Formation of Tides From the Earth

Tides based on the location of Earth, Moon and Sun.

1. <u>Spring Tides</u> : These tides occur when the Sun and Moon are directly in line with Earth. These tides occur twice a month, at full Moon and new Moon.

2. <u>Neap Tides</u> : Spring tides and Neap tides occur with the difference of seven day. That means the days between full moon and new moon. Basically Sun, Earth and Moon are positioned so on the 7th and 21st day of lunar month that these callestial bodies form a right angle. The effect of these bodies is seen against each other which results into Neap tide as compared to normal tidal activity.

For once in a month moon draws nearest to the Earth during its revolvation which is known as 'Perigee'. While after two weeks it is situated farthest to the Earth known as 'Apogee'.

Importance of Tides :

Depth of water increases near the coastal area because of spring tides. Because of this big/heavy ships can easily move towards port. Kandla of Gujarat and Diamand Harbour of Bengal are its major examples. Tides act as barriers in the deposition of soil and helps in desiltation at mouth of rivers. Power is generated with the help of tides. Fishing boats also take help of tidal activity while entering the ports or getting out of it.

EXERCISE

1. Write the answer of the following questions in few words :

(a) What is the percentage of area covered by hydrosphere on Earth ?

(b) Why Earth is called blue planet ?

(c) Which unit is used for measuring depth of sea ?

(d) What is Plankton ?

(e) Write the name of any trench of Indian Ocean ?

(f) Name biggest ocean of the world.

(g) Agulhas Current flows in which ocean ?

(i) Indian Ocean (ii) Atlantic Ocean

(iii) Arctic Ocean (iv) Pacific Ocean

(h) Name deepest trench of Pacific Ocean.

(i) What is average depth of Indian Ocean ?

(j) With which continents Pacific ocean touches ?

(k) What is Tsunami ?

(l) Temperature decreases with increase in depth and latitude, comment.

(m) What is average temperature of oceans near Equator in summer ?

(n) Is Gulf Stream a hot water current ?

(o) What is Albedo?

(p) What is Salinity ?

(q) On which latitude, Salimity is maximum ?

10°N to 15°N

15°N to 40°N

60°S to 70°S

(r) Which unit is used to express salinity of oceanic waters ?

(i) per 10 grams.

(ii) per 1000 grams.

(iii) per 100 grams.

(s) Name factors effecting salinity of oceanic waters.

(t) What is difference between Salinity and Temperature ?

2. Answer the following in few sentences :

(a) Define Continental Slope

(b) What is difference between Guyots and Mounts ?

(c) What do you understand by Water Cycle

(d) Explain Difference between Abyssal plains and Continental Slope.

(e) What do you mean by Ocean Currents ?

(f) What are the reasons behind formation of Ocean Currents ? Explain any four reasons in detail.

(g) Explain any two hot water currents of Atlantic Ocean.

(h) What is the reason behind the presence of fog at New Foundland Coastal region ?

(i) What is the difference between Ocean currents and Tides ?

(j) Why does the temperature of sea changes with the variation in depth? Write about thermal layers also.

(k) What is the effect of currents on temperature ?

(l) Write in detail about factors affecting distribution of temperature of Oceanic Waters?

(m) What do you mean by Waves ?

(n) What are Tsunami Waves ?Write a note about the distruction they have caused at any place ?

(o) What is the length of waves ?

(p) What is the height of waves ?

(q) What is the relation between waves and winds ? Which formula is used to study the velocity of waves ?

(r) Define 'Surge'.

(s) When do the tides occur ?

(t) How many times do the tides occur in a day and what is their magnitude ? Explain.

(u) What is the average height of Tide ?

(v) What is the difference between Spring tides and Neap tides ?

3. Answer the following in detail :

(a) What is Ocean basin ? Explain in detail with examples.

(b) Write a note on Wetands of Punjab. Suggest ways to check their pollution.

(c) What is the effect of Monsoon winds on the currents of Indian Ocean ?

(d) Write in detail about the effects of Ocean Currents over their surroundings, with examples.

(e) Show the hot water and cold water currents on the world map. What is the effect of Currents on the surrounding area ?

(f) What is the procedure of tide formation and What is its importance ? Explain in detail.

CHAPTER - 10

GEOPOLITICAL IMPORTANCE OF LOCATION OF INDIAN OCEAN

The Concept of Geopolitics

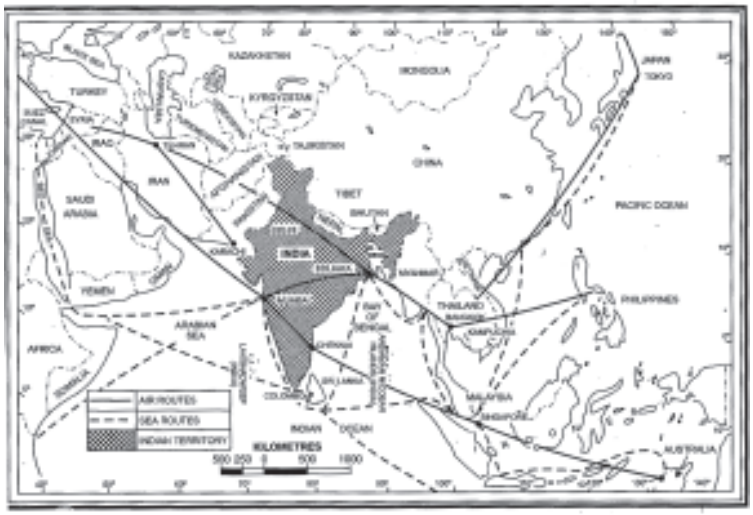
From the Academic point of view, Geopolitics is basically considered to be the "Method of political analysis, popular in the central Europe during the first half of the 20th century that emphasized the role played by Geography in international relations." From that stand point it was and still remains, a beneficial field of study.

As the student of Geography it is necessary to know locational value of of the entire Indian Ocean in order to understand the India's position in the international relations in context of world's most important route for the international maritime long-haul cargo, which remains vulnerable to piracy and highly unpredictable acts of maritime terrorism.

Geopolitics of Indian Ocean :

Indian Ocean is the third largest Ocean of the World with 78 Million (7 Crore, 80 Lakhs) square Kilometre and 20.4% total area of the world, after Pacific Ocean (46.4%), and Atlantic Ocean (22.9%). It lies adjacent to the continents of Asia, Africa, and Australia. It is closed towards the north but open to the south. The International Hydrographic Organisation recognised the coast of Antarctica as southern extreme of the Indian Ocean. Almost 40% of the coast line of the world extends in Indian Ocean.

The meridian of Cape Town, $18^0 82'$ East, forms the dividing line between the Indian Ocean and the Atlantic, whereas the meridian of the south east Cape of Tasmania, 147^0 East divides the Pacific and the Indian Ocean.



Map : Indian Ocean Region

Hisorically and strategically, the northern portion of the Indian Ocean is considered very important because it is accessible from the west and the east only through narrow straits. In the west, the narrow outlets are the Red Sea and the Persian Gulf, whereas in the east are the strait of Malacca and the Timore and Arafura seas. The Indian Ocean has its own unique features. Its waters, except at the southern extremity, are warm and calm with predictable wind velocity. The reversal of wind during the winter and summer Monsoon makes deep-sea navigation relatively simple by sailing with wind techniques and there are no treacherous currents. The 'Roaring Forties' Westerly's blowing along 40^0 South latitude help the movement of ships from the Cape of Good Hope to Australia's west coast.

The Indian Ocean consists of mariginal seas touching the littoral states. They are Malagassi Sea, Lakhshadweep Sea, Red Sea, Gulf of Aden, Persian Gulf, Gulf of Oman, Arabian Sea, Palk Strait, Suva Sea, Timor Sea Arafura Sea, Gulf of Carpentria and Tore strait, Exmouth Gulf, Great Australian Bight, Spencer Gulf and Bass Strait etc.

Indian Ocean is endowed with rich variety of natural resources some of which are briefly described as under:

Aggregates

Marine aggregates comprise of sand, gravel of shell deposits and are used primarily in construction industry. They are mainly found on the continental shelves.

Placers

Placer deposits are concentration of heavy, resilient, and chemically resistant minerals eroded from existing ore bodies by mechanical weathering. Such deposits include native Gold, Platinum tin, Titanium, Magnetite (iron), Zirconium, Monozite (thorium) and Gemstones.

Polymetallic Nodules

Polymetallic nodules are those which contain several metals, the important metals being Manganese, Copper, Nickle, Cobalt, etc. are found in abundance.

Manganese Nodules were first discovered on the 1872-76 scientific voyage of challenger but systematic exploration and detailed studies started only in late 1950s. The United Nations has granted permission to India to exploit the polymetallic Nodules over an area of 1,50,000 sq. km. in the Indian Ocean. Apart from this Phosphorite nodules, Phosphate, Barium sulphate, Copper, Cobalt, Iron ore, Bauxite, Sulphur are found on the Ocean floor Manganese nodules are scattered on the Ocean floor at depths ranging from 2m to 61 mt.

Oil and Gas

The continental shelf area of the Indian Ocean is rich in mineral oil. At present half of the world's total output of oil and gas comes from offhore wells and over 75 countries of the world are engaged in offshore drilling. The Kauchh Shelf, Gulf of Khambat and Mumbai High are rich sources of mineral oil. Krishna Godavari Basin off the coast of Andhra Pradesh has rich source of Natural Gas. Oil and Gas reserves of Persian Gulf are very important. It has the advantage of being sheltered from the open Ocean, is shallow, and relatively free of hazards. Kuwait, Saudi Arabia, Behrin, Qatar, UAE (United Arab Emirates), Iran & Iraq are the likely beneficiary States.

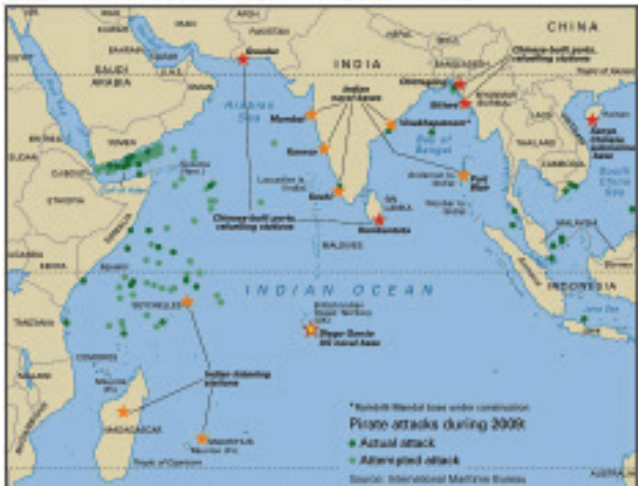
The Indian Ocean is once again becoming an arena for geostrategic rivialry and 'Great Base Race' around the region. At the same time there is the burgeoning concern over an army of non traditional security threats, especially energy security. The Indian Ocean region, rightely described as the **'Heart of the Third World',** is now the world's most important route for International maritime long haul Cargo, remains vulnerable to piracy and highly unpredictable potential acts of maritime terrorism.

Geopolitical Issues :

Geopolitics of Indian Ocean revolves around four core issues :

1. Climate change
2. Polarisation and Survival Equations
3. Natural Resource Development
4. Economic growth and Uninterrupted supply line

GREAT POWER COMPETITION IN THE INDIAN OCEAN



Issues

1. Piracy to commericial shipping throughout the Indian Ocean.

2. Development of vast resources, wealth in terms of Oil, natural Gas, Mineral deposits and Fisheries.

3. The Political and Economic implications of new deep water port construction throughout the Indian Ocean littoral.

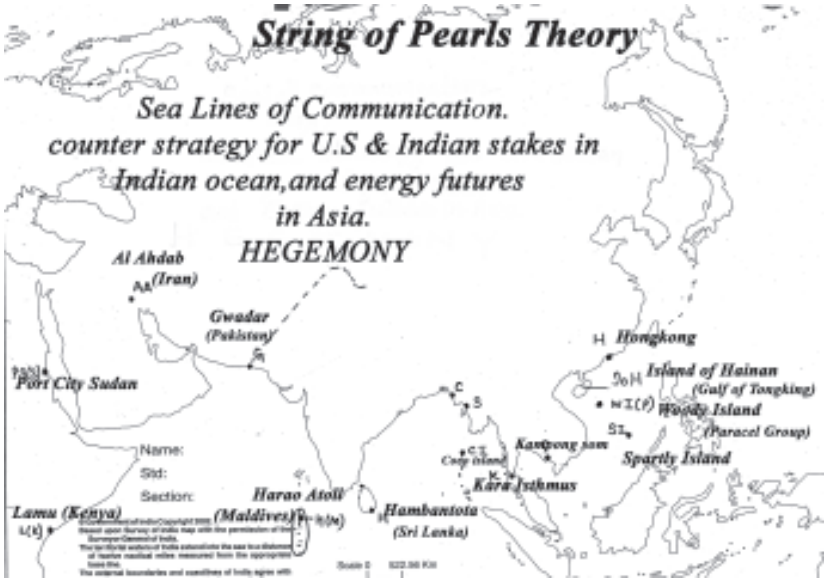
4. Projection of naval might in Indian Ocean by regional and extra regional players.

There are total 38+15+5 RIM countries of Indian Ocean. RIM Assoication consisting of 13 countries of Africa, 11 countries of Middle East, 5 of South Asia, 5 of South East Asia, 5 regions occupied by East Timor, France, Australia, Great Britain etc., there are seven choke points or the portals of International Trade Routes in the Indian Ocean these are :-

1. Mozambique Channel
2. Bab-El-Mandeb
3. Suez Canal
4. Strait of Hormuz
5. Malacca Strait
6. Sunda Strait
7. Lombok Strait

CHINA'S STRING OF PEARLS STREATEGY

String of Pearls is a Chinese attempt to safeguard oil shipping lanes. It is



manifestation of China's rising geopolitical influence through efforts to increase access to ports and airfields, modernisation of defence lines by spacial diplomatic relationships, it is an extension in China's reach from South China Sea to Suez Canal across strait of Malacca, Indian Ocean, Strait of Hormz, Persian Gulf, and Red Sea, Chinese string of pearls passes through several choke points and is an endevour for its quest for Energy Future in Asia.

India has choked Malacca strait to cut down chinese sea lanes to Pakistan. String of pearls is a geopolitical strategy to replenish the supply lines anywhere across the Indian Ocean and to subdue the 'arbitrary behaviour of India' China propagates, "we seek harmonious ocean and no hegemony, There will be no Military expansion, muscle stretching and Vindictive competition with other nations".

Pearls :-

1. Hongkong (The spacial administrative region)
2. Island of Hainan (Gulf of Tongking)
3. Woody Island (Paracel Group of Islands)
4. Spartly Island (claimed by six nations)
   (China, Vietnam, Taiwan, Malaysia, Philippines, and Brunei)
5. Kampong Som
6. Kra Isthmus - Thailand
7. Coco Island of Myanamar
8. Sittwe Coastal City of Myanamar
9. Chittagong of Bangladesh
10. Hambantota of Srilanka
11. Harao Atoll of Maldives
12. Gwadar of Baluchistan (Pakistan)
13. Al-Ahdab of Iraq
14. Lamu of Kenya
15. North Port City of Sudan

China wishes a multipolar world and a unipolar Asia. USA wishes a unipolar world and multipolar Asia. India wishes a multipolar world and multipolar Asia.

India's Response

In 2007, Indian Navy published the **"Indian Maritme Doctrine"**, a document outlining prospective Indian Nawal strategies. It describes ambitions for an active Indian Naval presence from strait of Hormuz to the strait of Malacca. Furthermore, the doctrine makes explicit mention of the need to police International shipping lanes and control choke points of Indian Ocean trade in perticular. In the last two decads India has stealthily straddled its interests in the Indian Ocean RIM, which includes the Island of Mauritius, Maldives, Seychelles and Madagascar and the RIM States of South Africa, Tanzania and Mozambique by very deft moves in foreign policy.

Indian Navy possesses a sophisticated hyorographic cadre with eight well equipped survey ships, numerous survey craft, a large world class electronic chart production facility in Dehradun and a hydrographic school at Goa.

Like China, India is heavily dependent on foreign oil producers for its energy needs. About 89% of India's Oil arrives by ship, and the bruning of oil provides for approximately 33% of Indias energy needs. The protection of the major sea lines of communication is therefore recognised as an economic imperative. India has historically focused heavily on antipiracy and counter-terrorism efforts across the Indian Ocean.

Chabahar project

India, Afghanistan and Iran signed the trilateral trade treaty for developing the Chabahar port. The strategic location of the port will allow India to access Central Asia through Afghanistan, more importantly skipping Pakistan, and the Persian Gulf as it is the only Iranian port with access to the Indian Ocean.

United Nations Convention on the Laws of the Sea (UNCLOS 1982)

These are also called law of the sea convention is the international agreement that resulted from the third United Nations conference on the laws of the sea which took place between 1973 and 1982. The law of the sea convention defines the rights and responsibilities of nations with respect to their use of the world's Oceans, establishing guidelines for businesses, the environment, and management of Marine natural resources, UNCLOS came into force in 1994. As on August 2013, 165 countries and the European union have joined the convention.

The convention introduced a number of provisions. The most significan issues covered were setting limits, navigation, archipelagic status and transit regimes,

Exclusive Economic Zone (EEZ), Continental Shelf jurisdiction regimes, proteciton of the marine environment, scientific research and settlement of disputes. The convention set the limit of various areas :–

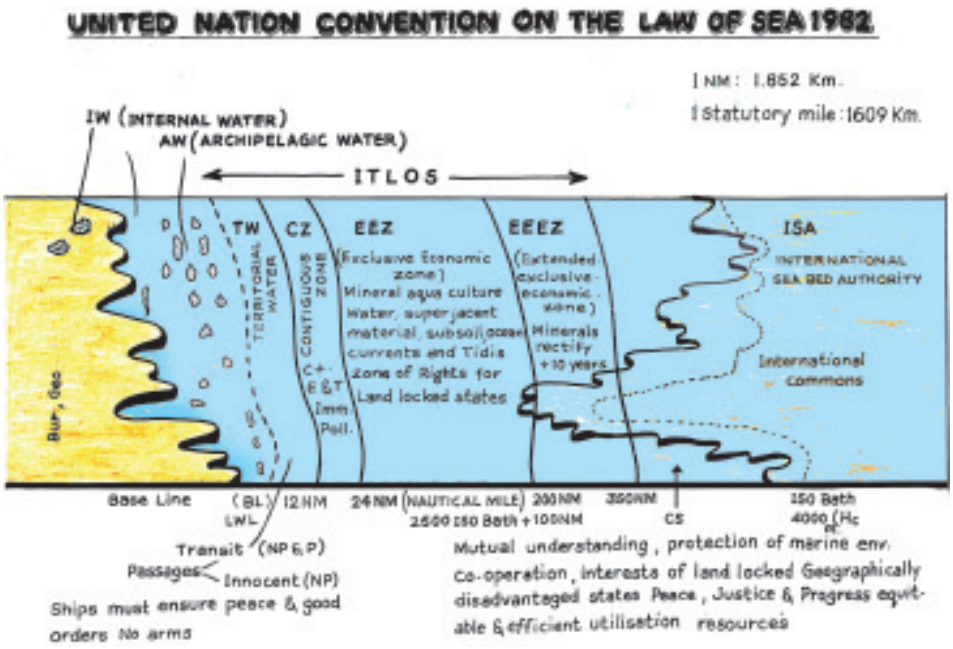
(1) **Base line -** Low water line or the straight line where fringing reefs or highly indented coast line points are joined altogether.

2) **Internal waters** – Covers all water and water ways on the land ward side of the base line. The coastal state is free to set laws, regulate use, and use any resource. Foreign vessels have no right of passage with an internal waters.

3) **Territorial waters –** Out of 12 nautical miles (22 kilometers ; 14 miles) from the baseline, the coastal state is free to set laws, regulate use, and use any resource, vessles were given the right of innocent passage' through any territorial waters, with strategic straits allowing the passage of military craft as transit passage.

4) **Archipelagic waters** – The convention set the definition of archripelagic water in part IV, which also defines how the state can draw its territorial borders. A base line is drawn between the outer most points of the outer most island. All waters inside this baseline are designated Archipelagic waters. The state has full sovereingnity over these waters.

5) Contiguous Zone – Beyond the 12-nautical mile (22 km) limit, there is a further 12 nautical mile from the territorial sea baseline limit, the contiguous zone, in which a State can continue to enforce laws in four specific areas; custom, taxation,



immigration and pollution, if the infringement started within the state territory or territorial waters, or if this infringment is about to occur with in the State's territory or territorial waters.

6) **Exclusive Economic Zone EEZ** – This zone extend from the edge of the territorial sea out of 200 nautical miles (370 kilometer ; 230 miles) from the baseline, with in this area, the coastal nation has sole exploitation rights over all natural resources.

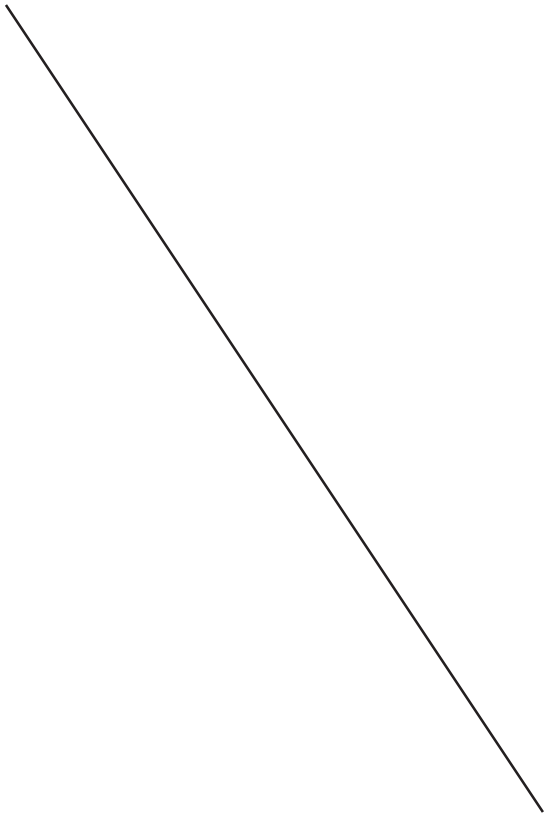
7) **Continental Shelf –** The continental shelf is defined as natural prolongation of the land territory to the land territory to the continental margin's outer edge or 200 nautical miles (370 km) from the coastal state's base line, whichever, is greater. A continental shelf may exceed 200 nautical miles until the natural prolongation ends.

8) **International Tribunal on the Law of the Sea (ITLOS) –** This tribunal covers sumarization of rules and regulation fisheries and disputes related to marine environment.

9) **International Seabed Authority (ISA) –** It is intergovenmental body established to organise and control all mineral related activities in the international sea bed beyond the limits of national jurisdictions.

UNIT-V

PRACTICAL GEOGRAPHY & MAP WORK



MAPS

We use globe to understand the acutal structure of Earth which represents our planet in right manner but in very small size as compared to its original size. It represents the size, shape, direction, distance and relation between the continents, oceans and other forms found on our Earth. But we cannot use and carry it everywhere. There are certain difficulties related with its use e.g. large size globe is also not able to provide vast information and more over its formation is also quite tough.

Globe

Map provides the solution of above mentioned problems. Map is a visual representation of an area or selected features of Earth, typically on a flat surface with the help of traditional symbols on the scale which is reduced as compared to actual scale because various types of natural and man made features are located on Earth and their collective representation is not possible on a single map. An attempt in relation to above mentioned situation will make a map purposeless and unintelligible.

Inspite of this, in present era maps are not only used by army and students of geography. These are also used by Governments, Planners, Industrial, Commerce, Trade Sector etc. Different Types of Maps are desgined on the basis of needs of varoius users.

1. On the basis of scale : The scale on the map is shown in same ratio propotionate to the actual distance on the Earth. Meaning thereby, a map is just reduced form of Earth or a part of it, which finds its reduction at same propotionate ratio. The relation of scale of some map also relates with the purpose and information of a map. It is purposefully that maps are prepared on bigger or smaller scale.

(a) **Land Maps :** Such maps are used for Revenue records by land revenue officials and local government departments. These maps are prepared on large scale such as 1cm : 20 m or 1 cm : 40 m. Very small features such as extents of playgrounds situation of wells, trees and houses etc. are shown in such maps, origin of land use maps is found in France, where Cadesters were prepared in French language means revenue record registers were prepared in french language. These are used by the government for collection of taxes and revenue.

(b) **Physical Map :** Physical maps are prepared for detail conformation about land form, natural traits, light vegetation, drainage pattern and other proffessional needs, on

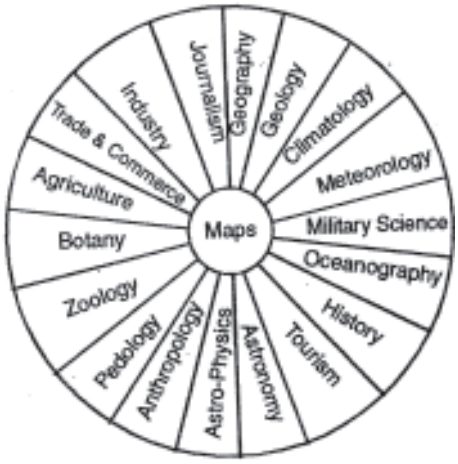
the basis of extensive surveys. Generally these maps are prepared to show 1 inch: 1 mile to 1 inch : 4 mile scales. Apart from geographers such maps are very useful for armed forces and land planners.

(c) **Wall maps :** Such maps are prepared on small scale to show whole of the world, some continents or climate, vegetation, soils, minerals, agriculture, transportation etc. of the world. These maps are used as teaching aids for students in class or labs. Although such maps are prepared on small scale yet related information is printed in large font.

(d) **Atlas Maps :** Various maps formed in the form of a book in an order is known as Atlas. As wall maps, these maps are also preapred on small scale and they represent various features of various countries and continents. These are meant for individual use. School Atlases are prepared for the use of students. These include detailed maps of various regions of countries and maps representing main feaures of continents are included in these Atlases. Inspite of this, Atlases based on particular subject are also prepared e.g. Population Atlas, Agriculture Atlas, Census Atlas etc. provide information about related topic.

2. On the basis of purpose : These are divided according to the information provided in them. Especially natural and cultural maps are categorised as follows:

(1) Natural Maps : Natural maps show various features related to natural aspects such as :



Types of Maps on the Basis of Purpose

(i) **Relief Maps :** Relief Maps show various land forms according to their classification on a map. Heights of relief, depth, slopes and drainage are commonly shown in such maps.

(ii) **Geological Maps :** These are prepared according to the structure of the Rocks on the basis of their classification.

(iii) **Soil Maps :** These represent the features of various type of soils and areas where they are found. These maps are very helpful for agriculture sector in particular.

(iv) **Climatic Maps :** These maps represent rainfall, temperature, winds and atmospheric pressure according to the season.

(v) **Vegetation Maps :** These maps represent the division of Forests, Grass plains, Shrubs etc. Natural vegetation and plantation is also depicted in such maps.

(2) Cultural Maps : Such maps present various geographic, cultural aspects, such as :

(i) **Political Maps :** These show political boundaries of different political regions e.g. country, state, district etc. These are helpful in planning and administrative purposes.

(ii) **Historical Maps :** These provide information about the historical feature.

(iii) **Strategic Maps :** These help armies in strategic purpose and during war. Information provided by these maps is more accurate and detailed as compare to the commonly used maps.

(iv) **Social Map :** These provide information about the language, religion, tradition etc. about the people of a country or whole world or any part of it.

(v) **Classified Maps :** In such maps regional classification of any particular characterstic, which has not been covered above, is shown. Such characterstics may be about any natural or human trait e.g. population, agriculture, industries, rainfall, temperature etc.

Importance of Maps : Map is an imporant tool for geographers. It helps in understanding the complicaitons of our large size Earth in an easy way. Obiviously single person cannot collect all the information of world himself only. Information about the unseen and distant parts of world presented in the form of pictures, appeal to mind and help to understand the complicated features. Other than of students of Geography, maps are used by various people in different sectors. Like an international tourist who is not able to speak the language of a particular country in which he is touring, can use a map for his/her destinations. In present global era, international trade has been increased alot and takes place through sea and airways. Navigation charts play an important role in the movement of ships.

During war inspite of armed strength of armed forces depends on strategy of war and information about the areas of enemies, barriers and danger. In such situation importance of relief maps is very clear to us. Large countries like India depend upon

natural resources, adequate use of these for administrative and planning purposes, maps provide information about the situation and condition of these resources. Maps are used upto great extent by large bussiness houses, who run their trade in different countries of world.

Scales of Maps

Drawing actual shape of Earth on paper is known as map. It is always smaller than the actual size of Earth or a part of it. In other words original distances are represented on maps according to a fixed ratio. The ratio of distance shown on the map and the actual distance on earth is known as scale. e.g. on an map if distance between two points is 1 cm and distance between those two places on earth is 5 kms, then the scale of map will be 1 cm equal to 5 kms.

We can easily understand the scale of map through air travel or observation. The view, we get while sitting in an plane, flying thousands feet high from surface, is a form of map.

Representation of Scales :

Basically scales of maps are represented in three ways:

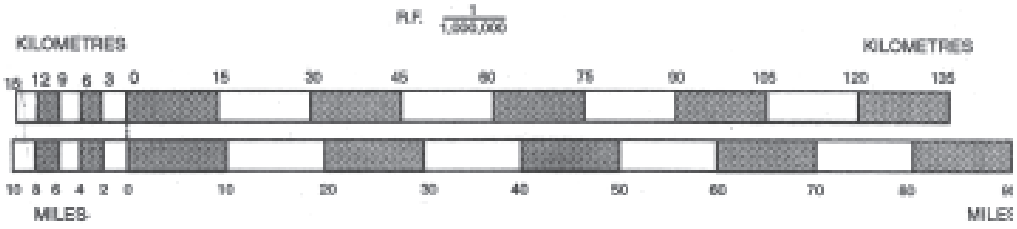
1) Statement of Scale

2) Representative Fraction (R.F.)

3) Linear Scale

Let us study these ways in detail.

1. **Statement of Scale :** In this method a statement is given about the scale of the map e.g. 1 inch shows 2 miles. This statement can make even a lay man understand that an inch of distance on map is showing 2 miles of actual distance on Earth. This form of expressing scale is perhaps the simplest form but various units of showing distance are used world over. Therefore, any statement may not have any meaning for those people who do not use the unit of distance as shown in a statement. Secondly the importance of statement vanishes if we enlarge or reduce a map because change in scale gives birth to various problems in measuremet of distances.



Plain Scale

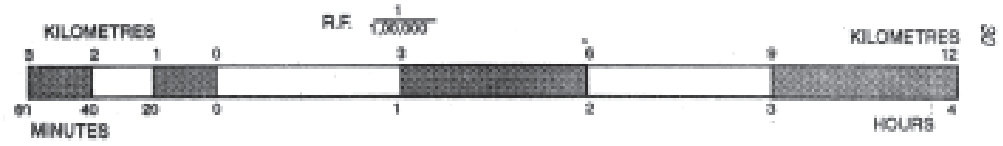
2. **Representative Fraction (R/F) :** In this method scale is shown in at fraction in which numenator is always one while denominator is claculated according to scale. The distance on map is shown in a particular ratio to the actual distance on Earth. The distance on map is one unit (Numenator) while actual distance is denominator units. e.g. If R.F. is shown as 1/1,00,000 Then it means that 1 cm on map shows 1,00,000 cms on Earth or 1 inch on map shows 1,00,000 inches on Earth on the actual distance. Similarly, R.F. may be applied on any unit of distance.

The greatest benefit of this method of showing scale is that an observor of map can use any unit of distance of his choice while studying it. That is why R.F. method is also known as Numerical Fraction Method and even International Method.

For various maps prepared in India R.F. method of showing scale was deemed particularly beneficial in 1957 when India adopted to metric system of measurement. Prior to 1957 the distance shown in Indian maps was in inches, feets, yards furlong & miles. R.F. method made it possible to study that system in metric form.

Despite various positive characterstics of R.F. method of showing scale, biggest weakness is that it is quite difficult for layman to understand it. Secondly, reduction and enlargement of map brings in various other problems of measuring distances.

3. Linear Scale : A straight line measuring about 15 cm or 6 inches, divided in various parts shows the scale in linear method. It is quite easy to show distances on scale representing actual distances. The sub part of linear scale at the left is further divided into sub parts which shows smaller units of distance more accurately. This method excludes the drawbacks of previous two methods. With the help of this method the scale remians acurate whether we increase or decrease the size of map. But this requires more time and better technique.

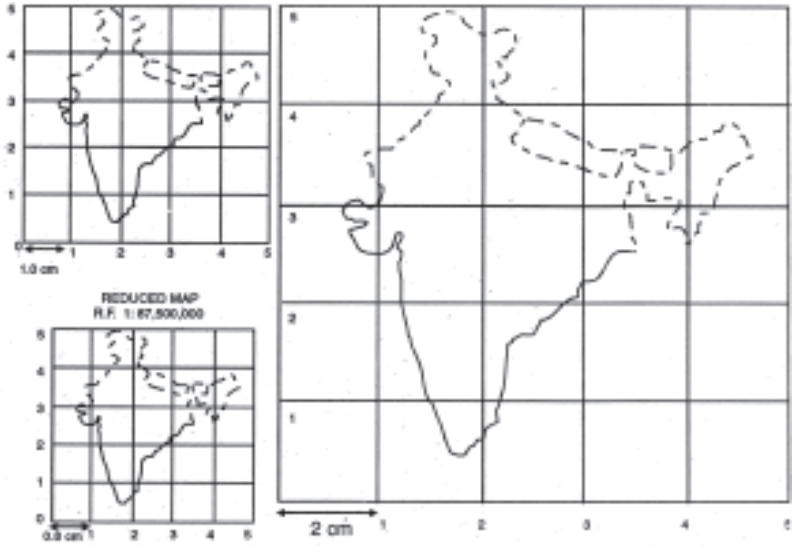


Linear Scale

<u>Use of scale in Maps</u>: Each map is incomplete without scale. To represent the relief on map accurately it is necessary that the distances between different places on Earth should be shown after reducing according to a fixed ratio. With the help of these shapes, sizes, distances, and directions of various places shown on map, look according to the real situation. This is possible only with a scale. Map drawn without scale would be a picture or sketch.

Enlargement and Reduction of a map : While using maps, usually such situations arise when we need to increase the size of maps, specially when we have to add new or extra information in a present map.

For Example : Large scale maps are required for urban planning. These provide large space in which detailed information and even the smallest points can be shown. Therefore, at times map is quite big but we have to reduce it according to size of paper and need so that major features may be concentrated upon.



Enlargement and Reduction of Maps

Bookish maps or Atlases are necessarily reduced form of basic maps as information on these is to be shown in very small type size. Nowadays it is easier to reduce such maps photographically. Although it is still technically tough job to prepare maps on different scales and then enjoining them to be shown on one scale.

There are several ways of enlargement and reduction of maps but we discuss a method which is very easy and beneficial for students. This method is known as 'Grid of Squares' method. In this method, first of all, a map which is to be reduced on enlarge is to be covered with the grid of squares of convienient size, say each of 0.5 cm. The squares must be marked with very light pencil and should cover whole of the map in a big rectangular or square shape. Each square be given a numeral identity. Second step is to reduce or enlarge the grid of squares at new place according to following formula.

$$\text{Size of new square} = \frac{\text{R.F. of new map} \times \text{Size of the square of base map}}{\text{R.F. of base map}}$$

On calculating the size of new square, prepare a new grid which is of same shape and size as the grid on base map is. Give same numeral identification to the squares in new grid. Now cartograph the map in each square on the basis of basement square. For better results we may prepare sub-sections of the squares with slanting lines.

Teachers may ask the students to practise reduction and enlargement of two maps each from the Atlas.

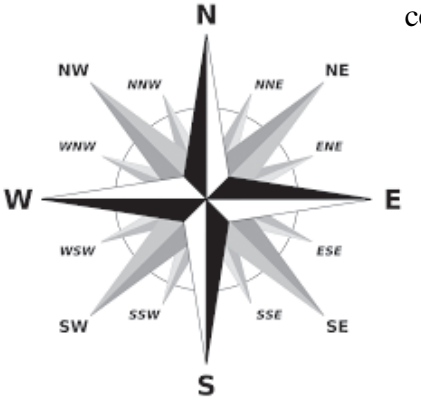
Use of instrument known as propotional dividers may be beneficial to prepare new map.

Directions

Directions are very important. Knowledge about directions is necessary for making maps and also for reading them, specially for the army during the war.

Mainly we get information about directions from the rotation of Earth. As we all know that sun rises in East and sets in West. Hence North and South directions are diagonally at right angles to East West line. Principally any line on the Earth which touches Northern most part of Axis, points towards North. Same way anyline touching southern most part of axis points towards South.

So, out of four directions East, West, North, South, if we know about one direction then we can find out others also. In ancient times travellers and sailors were able to find their routes without compass in sea, forests and deserts.

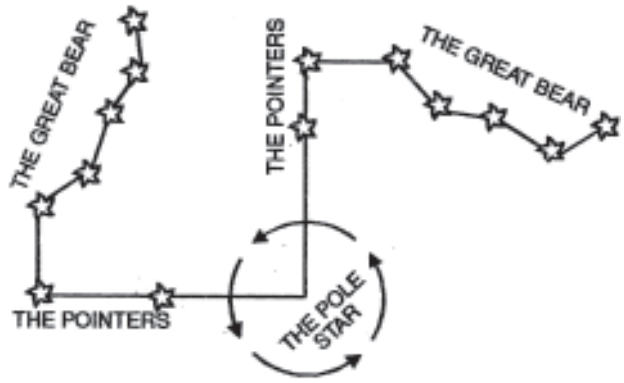


Directions

Methods to find out North Direction : In map and field 'North' direction is easiest to locate because we know that longitudes are the semi circles which join the North and South poles. In maps these are shown as vertical lines and they point towards North in a map. So the upper part of the map depicts North and lower part depicts South. Its right hand side is East and left side is West.

These are several ways which have been used to find out 'North' direction in the open areas in India.

1. <u>Pole Star</u> : This is the only star which is present above the North Pole of Earth. It does not change its position as other stars and seems to be still. With the help of two groups of stars. We can locate the pole star.

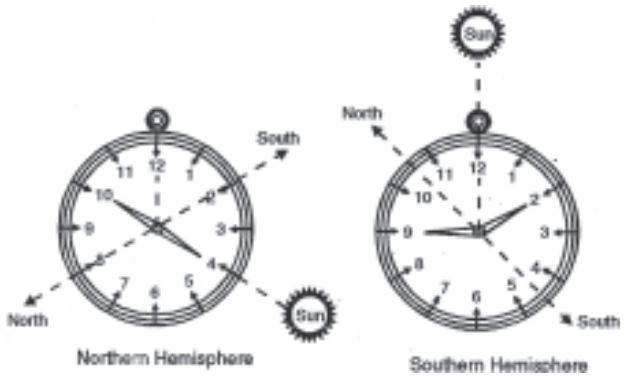


Determining North with the help of Pole Star

First group comprises seven stars, which is also known as 'SaptaRishi' The bright star present at the distance of $4^{1/2}$ times the distance between the first two stars (Pointers) of this group.

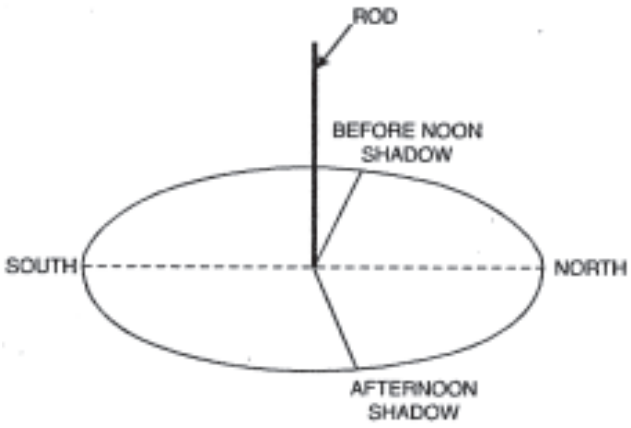
Second group is present in the opposite direction of 'SaptaRishi' and it look likes Alphabet 'W' and have five stars. It's also known as 'Kaemeopia'. This method is not useful during day and cloudy nights.

2. <u>With the help of Watch</u> : In this method clock is placed on a levelled surface and the arm representing hours is pointed towards Sun. For this purpose we can use a pin, its shadow tells us about the direction of Sun. Now half the angle formed by its hour hands position pointing towards 12, shall indicates toward South direction and if we extend it backwards then that line shall point towards North.



Determining North with the help of Watch

3. With the help of a stick : Place a stick upright into the Earth on a sunny day before noon. Sunlight must fall on that place for whole day without any obstacle. Taking shadow of the stick as radius and stick as centre draw/mark a circle. Suppose this circle meets the shadow at point 'A' Shadow will decrease till noon and start increasing in afternoon. Again the shadow will touch the circle oat another point mark it as 'B'. Centre of the circle and these two points make an angle. Bysection of this angle into half shall points toward north.



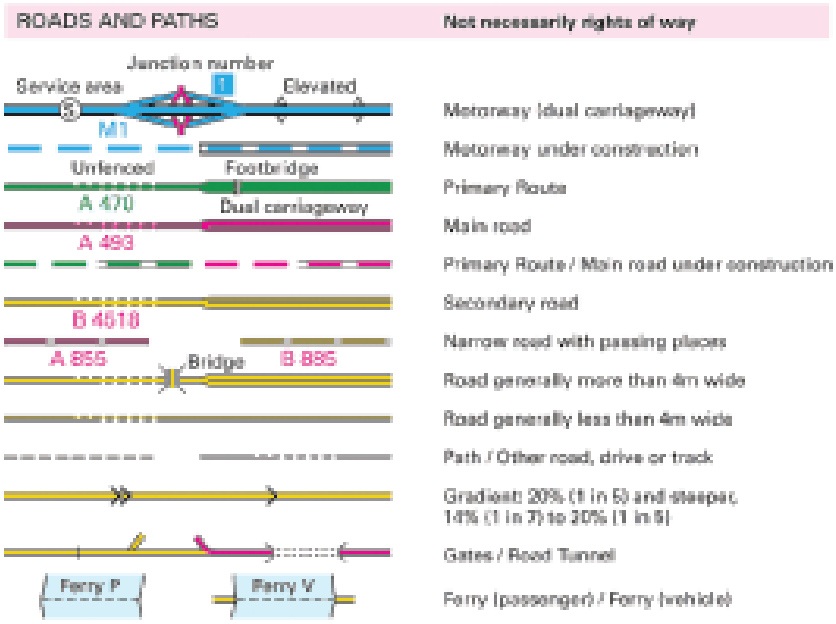
Determining North with the help of Rod

<u>Orientation of Local Map in the field</u> : The correct use and the method of obtaining or gaining maximum information from a map depends upon the coordination of map with field and actual places situated on Earth. We should be efficient in finding directions so that we would be able to find North direction while moving in real world.

Second step is to equate the north shown on the map and actual North of the Earth. This activity shall help us in understanding the information correctly, shown in local map.

Third stage is to select that important features in the local map which we can locate originally also. Such features may be a bridge, a road, railway line, canal, any factory, high power line, a ridge etc. We can easily locate our location if we find more than one features on a local map and in original as well we can draw an angular direction from theh original feature on the map. Use of scale can make us aware of original distance also.

MAP SYMBOLS



Representing Earth or its any part on paper is known as a map. Symbols are important part of any map. Various natural and human characteristics that are found on land or relief, are shown by some indentical set of symbols on a map. Such symbols are known as traditional or cultural symbols. Knoweldge of these symbols is an identity of a good map curator because reading and understanding the information provided in map is an art. History has also proved that those countries achieved which expertise in making and using the maps and kept themselves well informed about the forces, relief and resources of other nations, got sucess also. Various types of symbols are used in different types of maps:

1. Symbols used in Atlases : No one can understand the importance of Atlas as a students can. Atlas is a book of maps which is a combination of maps of continents, Oceans, Countries and specially the natural political regions of India.

Natural maps : Colours play an important role in these maps. Each colour represents particular height and depth. To understand these features, index is provided with each map. For heights we use greens, yellow, orange, brown, red and white colours. On the other hand blue colour is used for depth. It varies from light blue to dark blue, as the depth increases the darkness of blue colour also increases.

In political maps colours are used to differentiate any region from another. For example, varous states (provinces) of a country are represented by different colours in the map of a country. On the other hand different nations are represented by different colours and in a World map. single or same colour is used for all the states of a country. Similarly in the map of state different colours are used for different districts.

India: Political

We should take care of certain aspects while selecting the colours for maps because the effectiveness of map decreases if we use the colour of same tone in a map, showing places near to each other. Similarly, if the number of regions is large then we can repeat same colour but it should not be used physically near to previous one. Use of colours in political map is an art which depends on a asthetic sense of map maker.

The line separating one region from another is known as boundary or border. These are classified on the basis of their importance. Border between two countries, two states, two districts and two tehsils (sub-divisions) can be shown in a map. All these boundaries have their own importance therefore different symbols are used for their representation.

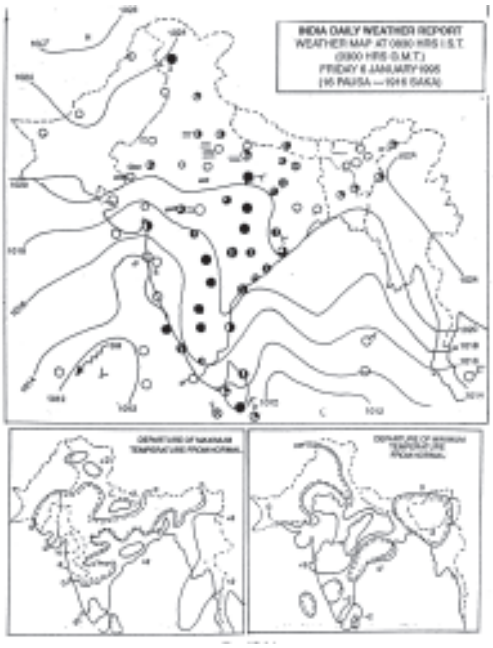
Use of different 'stensils' is also related with importance of a place, E.g. In map of India, different stensils are used for writing the name of our country, Neighbouring countries, Names of States, Names of Capitals and Cities. So that the map user can easily understand the difference between all these.

2. Use of symbols in Relief maps : Commonly used large scale relief maps are very important for 'geographers' and 'armies' as well because all other maps are prepared on the basis of these maps. These maps provide inormation about Relief, Vegetation, Water bodies, Population, Agriculture and Transportation Because of such features these are very popular and important. Use of traditional and cultureal symbols is highest common in these maps that is why two lines on indexes are found on such maps.

There are hundreds of traditional and cultural symbols which may be learnt on the basis of use and experience. For the facility of students teachers can share the information about the symbols from a regional map of Punjab and the regions represented by these symbols.

Commonly used symbols have been shown on a map. It is really important to understand the role of colours in these symbols.

3. Use of symbols in Weather maps : Conditions of a place during a particular time related with temperature, atmosphere, winds, humidity, clouds and rain are known as weather of that place. Representation of all these conditions on a map is known as weather map. Indian weather department is stationed in New Delhi. This department collects information from various weather stations located in India. On the basis of this information this department makes maps twice a day and publishes them. This information is very helpful for armies, pilots, fishermen, navigators, farmers and other people also. Various symbols are used to represent the aspects of weather.



Temperature : Temperature is shown on map with the help of isotherms which are imaginary lines drawn on a map connecting the regions having similar temperature. For marking these isotherms, mean average temprature is set at sea level which minimises the variation on the basis of increase in height.

One of the two smaller maps given below the main map gives information about the difference between the hightest temperature and normal temperature and other map gives information about the difference between the normal and lowest temperature. Average temperature of last 30-35 years of a particular place is known as normal temperature.

Weather Map

Air pressure : Like temperature imaginary lines are also used to represent the Air pressure known as isobars. Isobars are used to represent to air pressure of particular place on a map. Air pressure is measured in 'millibars'. A value is written with air pressure lines. This value represents the air pressure of a place from where to pass.

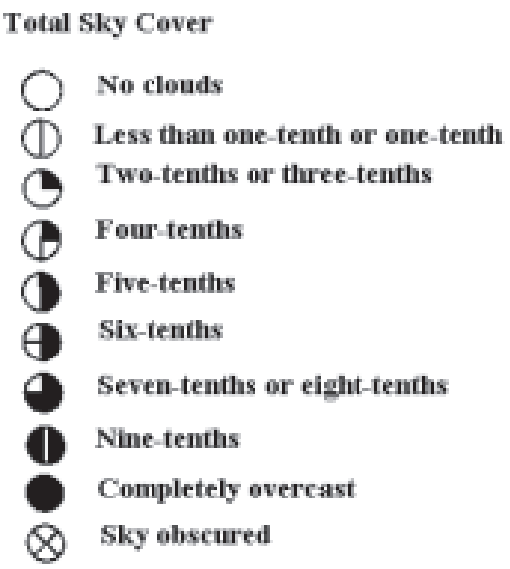
e.g. 1012 mb

1014 mb

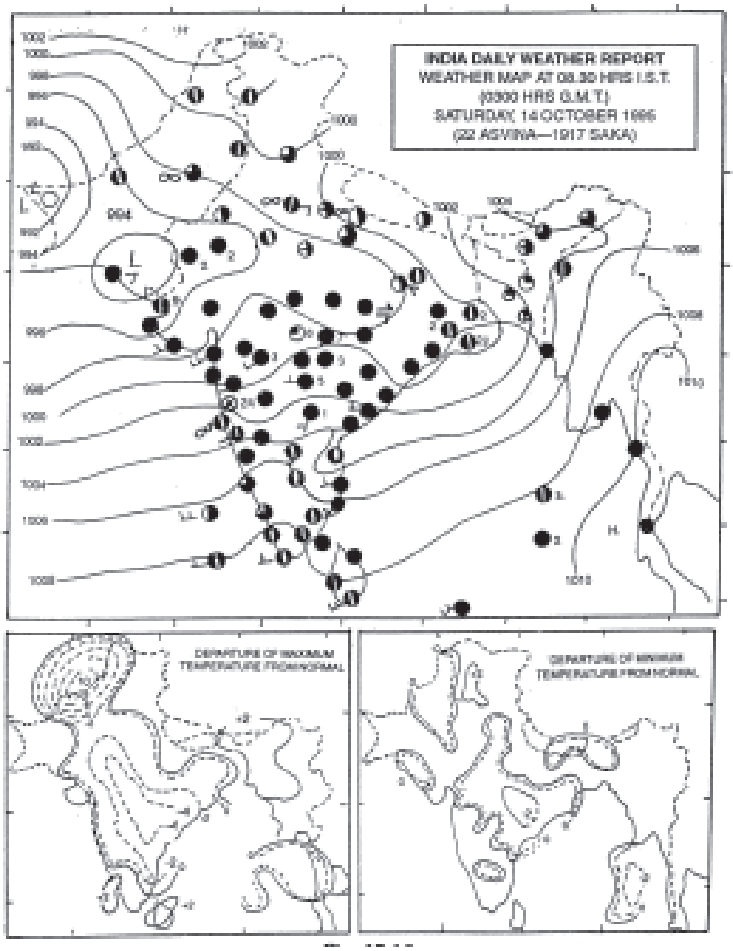
Air pressure lines are drawn with the difference of two millibars. Their shape depends on the air pressure of a particular place, they might be circular or 'U' shaped. Difference between two air pressure lines represent the pressure variation at a place.

Clouds : To collect information about the situation of cloudy sky is divided into four imaginary parts and clouds are divided into eight. On the basis of this side 'O' represents clear sky and '8' represents 'over cast'.

With the same process intermediate conditions are measured. Sky is represented by circles on a map and these are darkened according to the presence of clouds.



Winds : Winds always blow from high pressure to low pressure regions. On a map winds are represented by lines, which is connected with the circles showing the condition of clouds. Speed and direction of winds are two important aspects. Windvane or windcock is used to find the direction of winds. This instrument is actually a liver which moves freely on a pivot having signs showing four or eight directions around it. Importance of this moving instrument lies in its shape as its narrower side faces toward the direction, wind is blowing from and broader side turns to the direction, wind is blowing to.



Weather Map

Anemometer is used to measure the speed of wind. It consist of four hemispherical cups, each mounted at equal angles to each other on a vertical shaft. It moves with the blowing effect of wind while an instrument fitted beneath it turns its rotational speed into speed of wind which is measured on kilometer per hour scale.

Speed of wind is shown in weather maps with the help of big and small lines marked in the direction of wind itself.

e.g.

5 Knot	15 Knot	25 Knot
10 Knot	20 Knot	30 Knot
40 Knot	45 Knot	50 Knot

Knot stands for Nautical mile per hour. 1 Nautical mile : 1852 meters on land. An oceanic mile is slightly bigger than the mile on land.

Other Weather aspects :

Animometer

1) Hail : Precipitation in the form of spherical or irregular pellets of ice larger than 2 mm and their weight may vary upto 2 pounds.

2) Snowfall : Snowfall is te precipitation in the form of flakes of cystalline water ice that falls from clouds. These are very soft.

3) Rain : It is the major form of precipitation in which water droplets fall.

4) Drizzle : In this the size of water droplets is smaller than 2mm (,)

5) Snow Rain : It is the combination of snowfall and Rain.

6) Fog : Fog is collection of water droplets suspended in the air near the Earth's surface. It decreases the visibility forms of fog on the basis of visibility

fog = Ground frost --- Light Ground frost

7) Frost : When condensation takes place at the temprature lower than 0^0c, water vapours turn into snow particles.

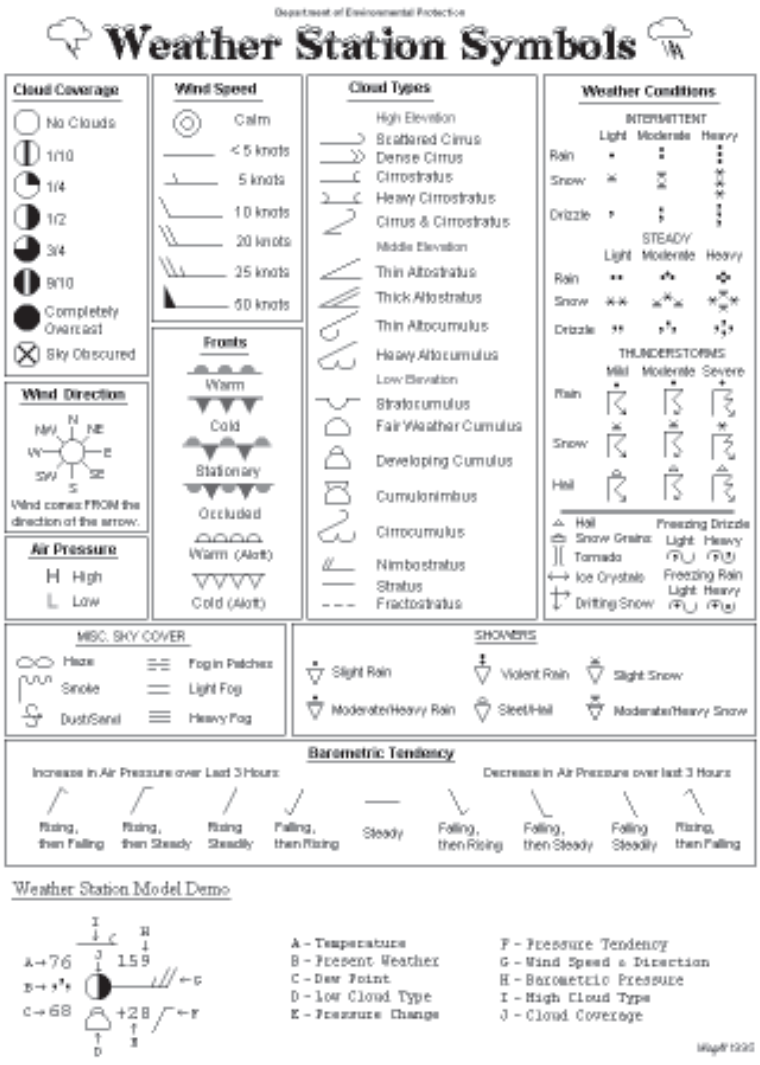
8) Dew : Dew is water in form of droplets that freezes on trees, plants and other exposed objects due to condensation of vapours present in air. This process takes place due to fall in temperature during night.

9) Storm : As wind blows, it takes dust particles with it, known as storm.

10) Lightening & Thunder :

Sea Conditions :

In weather maps of India situation of waves of Arabian sea, Bay of Bengal and Indian Ocean are shown. Initials of English have been used to show the condition of waves according to the scale of calm to high and dangerous waves



Weather Station Model Demo

A - Temperature
B - Present Weather
C - Dew Point
D - Low Cloud Type
E - Pressure Change
F - Pressure Tendency
G - Wind Speed & Direction
H - Barometric Pressure
I - High Cloud Type
J - Cloud Coverage

e.g.

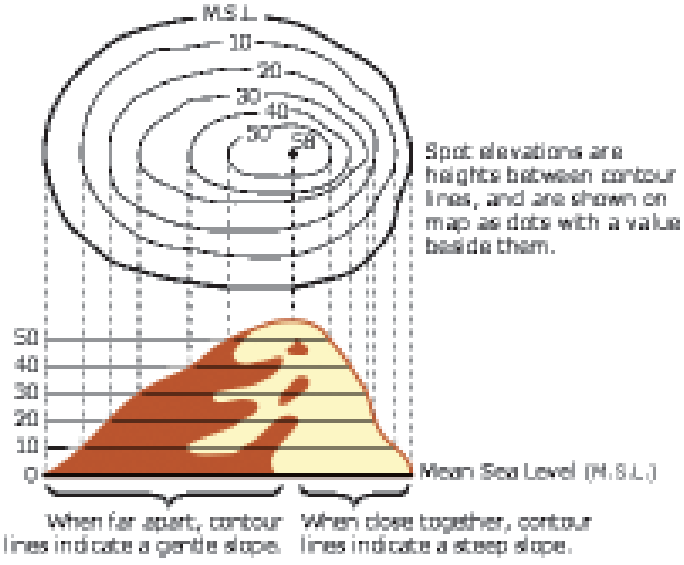
cm	calm	RO	Rough	Ph	Phenomenal
sm	smooth	V.R.	Very Rough		
sl	slight	Hi	High		
Mod	Moderate	V.H.	Very High		

Methods of showing Relief on Maps

Surface of our Earth is not leveled Mountains, Plateaus and Plains are situated on it and these three important parts are also not similar. Collectively these low and high regions of earth are known as relief. Maps which represent these different aspects of land surface are known as relief maps.

Table of Standard Slopes

Angle of Slope	Gradient	Description	Remarks
Less than 1°	1/60	Gentle	Steel railway gradient
1° to 3°	1/60 to 1/20	Moderate	Cyclists Walk
3° to 6°	1/20 to 1/20	Stiff	Horse driven vehicles proceed at a walk
6° to 12°	1/10 to 1/5	Steep	Cars find gradient difficult have to change gear.
12° to 20°	1/5 to 1/3	Very Steep	Horses descend obliquely, on slopes greater than 15° and horse drawn vehicles cannot ascend
20° to 30°	1/3 to 1/2	Very Steep	Limit for Cars
Over 30°	Over 1/2	Precipitous	Man can ascend using his fet and hands



To represent/show the relief on maps various methods have been used e.g. Hachures, Hill shading, Relief colours Bench Mark, Spot height and Contour Lines. Among all these contour lines are used mostly.

Contour Lines: Contour lines are the imaginary lines which are used to connect the areas situated at the similar height from the sea level. This is the best method of understand the details of Relief and variation between slopes of particular region.

In Ancient times survey method was used to measure the height and collect information about different places. On the basis of collected data and information. Relief maps were prepared. These days, information is collected about every region with the help of aeroplanes and sattelites by using Aerial photography and remote sensing techniques. With the help of this information Relief Maps are prepared by using 'Photogrammetry' which is an advance technology.

Commonly contour lines are drawn according to the relief at the gap of 20,50 or 100 meters. The gap depends on the slope of that region. Low slope is represented by more gap and for steep gradient gap between lines is reduced.

Characterstics of Contour Lines

1) Height of all the regions is same at one contour line.

2) Shape of contour lines depend on the height and slope of particular region.

3) They extend from one end to another circular shape. They never start or end abruptly.

4) Contour lines drawn at small gaps show steep slope and lines drawn at large gap represent slow slope.

5) Commonly contour Lines do not intersect except in the case of cliff or waterfall.

Drawing-Contour Lines :

Enjoining places with same height by drawing contour lines on a given map is called drawing a contour map or interpothen of contours. While drawing contours, following points are to be kept in mind.

1) Meaningful contours maps may be drawn if height of maximum places is provided in a map.

2) Note the highest and lowest point on the map.

3) Note the difference between the hightest and lowest point because on the basis of this we have to decide the range of contours lines.

4) The interval of contour lines should be at some whole number such as 10,20,30,50

or 100 meters.

5) Value of contour lines be specified keeping in mind range and interval

6)List of all contour with lead height be drawn and then the value in asending order be drawn, reaching to the contour with maximum height.

7) To find out exact position of contour between two heights, connect two heights with a line and divide it into two equal parts.

Drawing of a cross section or profile from Contours:

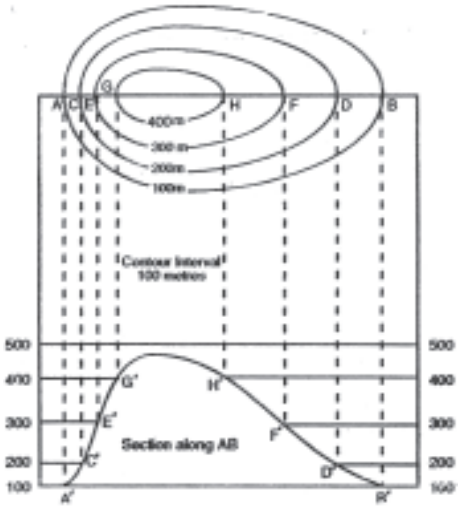
Vertical front view of a relief feature is called a cross section profile from contours. This is same as an apple is cut in two with the help of a knife and its both parts from cut line shall be taken as cross section profile.

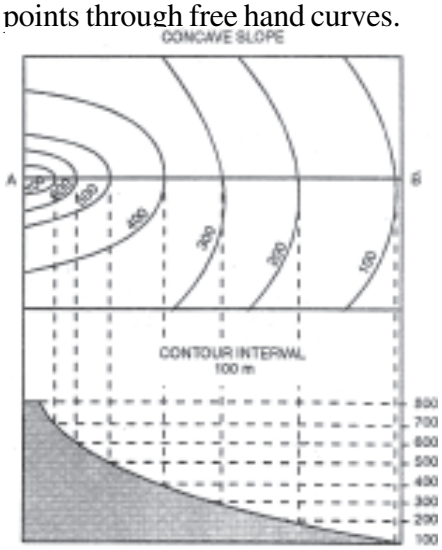
Drawing of cross section is necessary to understand the landforms shown on map. It helps in identifying height, depth and slope in a cross section.

Following methods are used to prepare a cross section ;

(a) **Right angle method :** This is a simple method. As shown in example, a right angled line is to be drawn which pases through all the contours. This A'-B' line intersects al the contours at points A,C,E,G,I,J,H,F,D&B respectively. Draw another line A"-B" parellel to A'-B' at some distance. Draw two right angled lines enjoining A'-B' with A"-B". Extend these A'-B' and A"-B" lines more than lowest rated contour extents as shown in the figure highest valued contour here in the given figure is of 500 meters and shown between I & J points but still height between these two points may be lower than 500 meters but certainly more than 400 meters.

Now draw per pendiculars from A,C,E,G,I,J,H,F,D&B down wards, towards N,O,P,Q,R,S,T,U,W respectively. Enjoin these points through free hand curves.





Point to be noted here is that horizental scale in such a cross section is maintained while vertical scale is extended 5 times to 10 times so that relief may be represented in clear way.

The cross section shown above in showing a hill in worth-south direction while we may prepare such cross section from east-west.

Identification of simple Relief Features from a Contour Map.

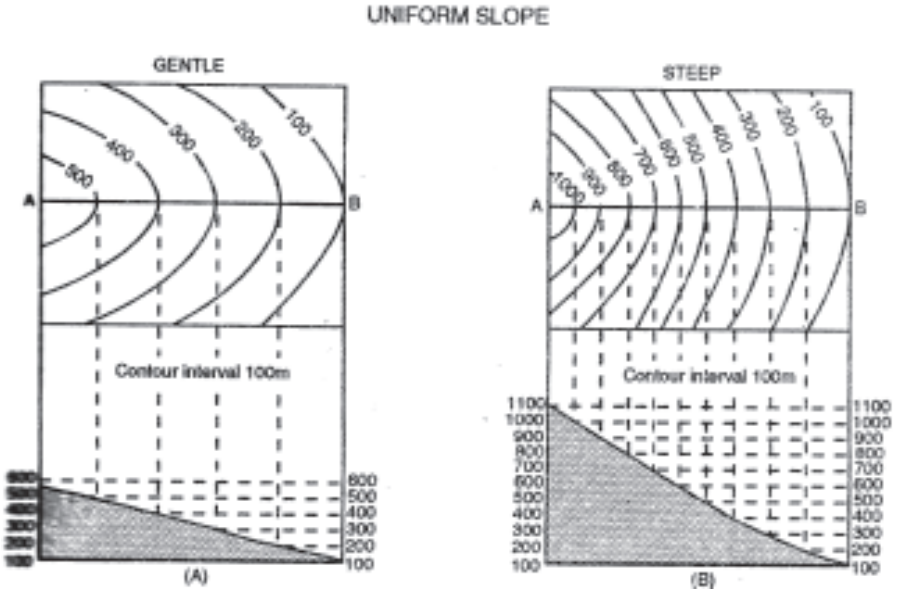
With the help of contours we can identify almost every type of land form found on our mother earth. Detail about some of the important land forms is given below:

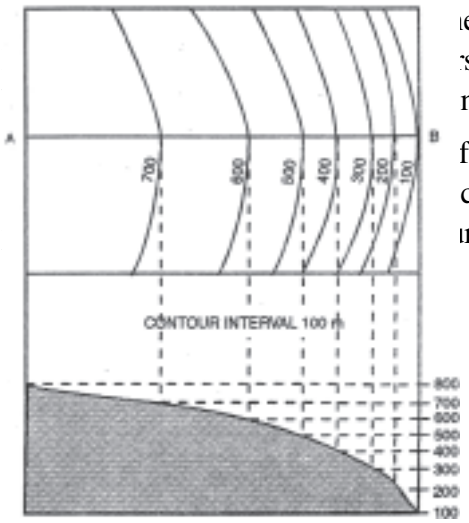
1) Slope : An angle formed horizentally with plane relief is called slope. Information about slopes is very important for the study of land forms. Commonly we can divide slopes into different types.

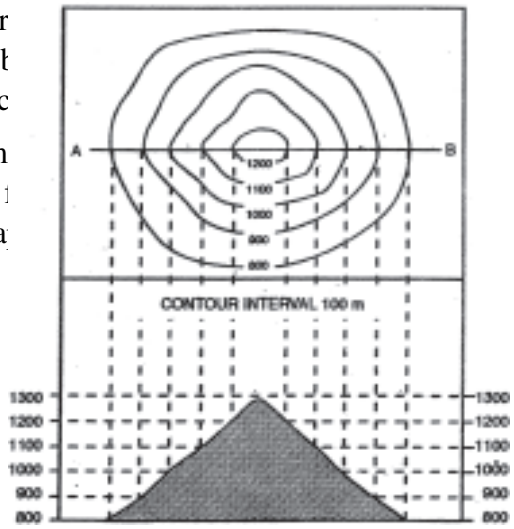
a) **Gentle Slope:** When the contours are situated at large distance in a region of a map and variation in height because of distance is less than 1/10 to 6^0. This type of slope is known as Normal slope.

b) **Steep Slope:** Abrupt change in the height of relief is represented by contours drawn near to each other. It is different from 1/10 and 6^0.

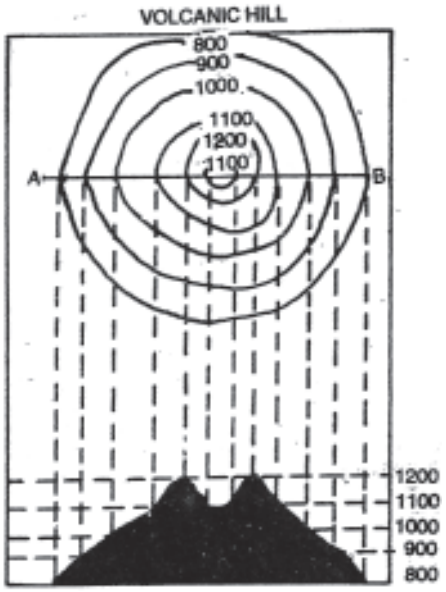
c) **Concave slope :** When a lower part of region has normal slope and upper part has steep slope. Contours of lower part has been drawn at large gap and In upper part these are draw close to each other.



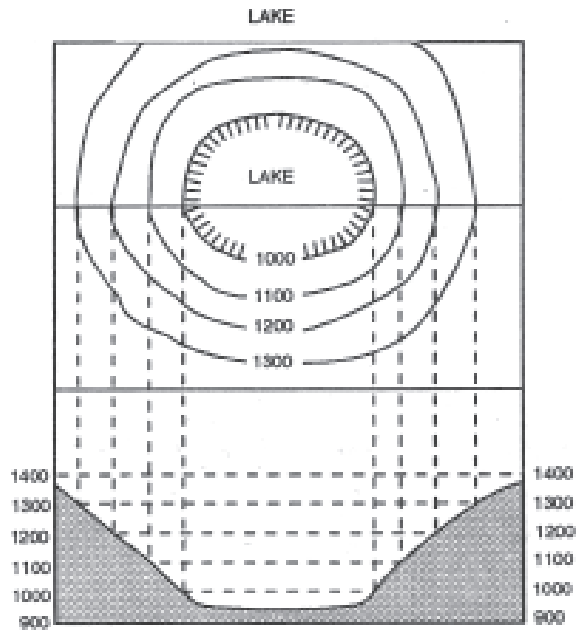




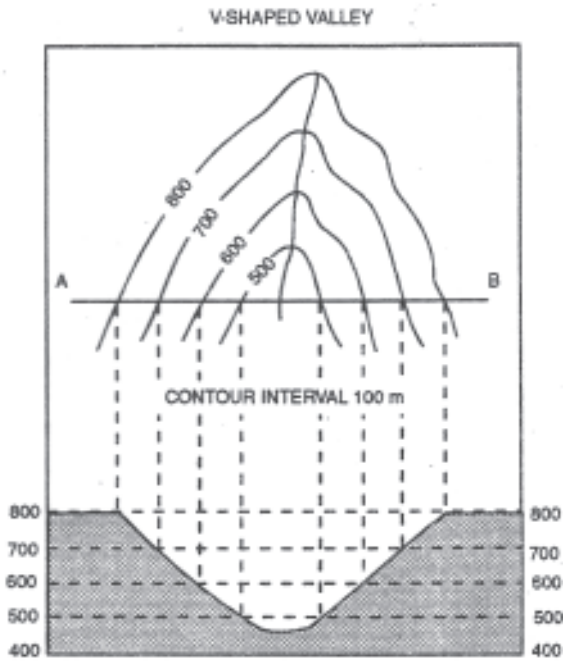
3. Volcanic Mountain Peak : The contour map of volcamic Mountain to similar to that of conical mountain in the context that contour lines are marked at regular intervals. As the volcanic eruptions create a dent at the top of mountain, called as crater, central contour shows its value less than that of its adjoining contour value. It means that contour value is lesser at interior most point which rises as we go outer and then starts decreasing as we proceed further.



4. Lake : Contour map of a water body known as lake or what ever, is similar to that of a conical mountain volcanic mountain but value of contours goes on decreasing as we proceed towards central point or interiors.



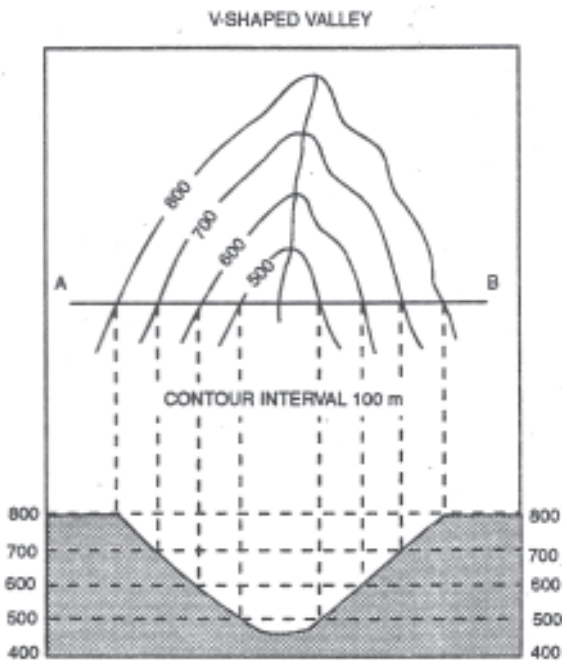
5. Valley : Valley is a low region situated between two mountains formed by the erosion process of Glacier or River.



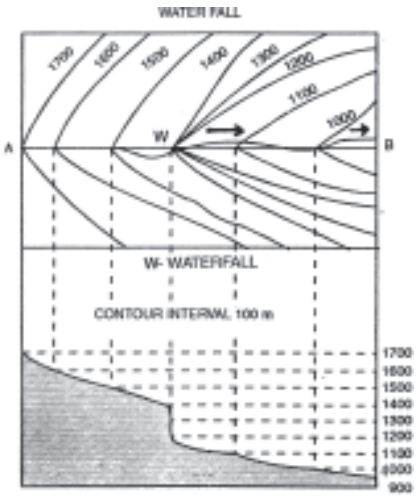
(a) **'U' Shape Valley :** In high mountaincous regions valleys are formed by the erosion process of Glaciers. The valley are formed by the erosion process of Glaciers. The

Valley are wide with steep slopes and they look like Alphabet 'U'.

b) **'V' Shape Valley :** 'V' shape valleys are formed in mountaineous regions due to erosion process of rivers. Contour maps of such valleys show increasing value of outer contours and at regular intervals.



c) **Gorge :** Gorges are formed in high mountains, having hard rocks. Erosion is higher due to vertical flow of rivers which results in the formation of deep and narrow valleys. These valleys have steep sides.

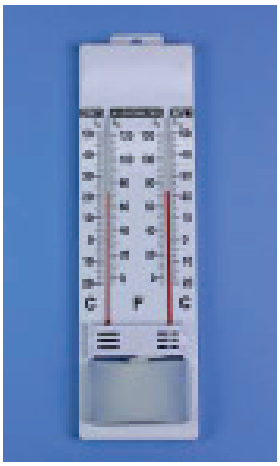


6. Waterfall : When a river falls from a very steep height in any mountaineous region, the form is called water fall. Cronsection or contour map of water falls shows intersecting contours on a map.

7. Cliff : In coastal areas, the slope of mountainous region adjoining the sea looks steep due to erosional process of waves. Contour maps of cliff region also intersect and hence these maps show intersecting contour lines.

Observation and Recording of various weather elements with the help of following instruments :

After the study of weather, weather elements and weather maps. It is realy important for th estudents of geography to attain knowledge about the instruments used for the study of weather. Following are the instruments that are used for the study of weather:



1) Six's Maximum and Minimum Thermometer :

Temperature of wind is one of the most important aspects in the study of weather. Commonly to measure the temperature a narrow tube of glass is used which have alchohal or mercury in it. A scale is printed on tube which is divided into 0^0 to 100^0c. This scale shows boiling to freezing points temprature of water In India, degree celsius/centigrade scale is used. In some countries Fahrenheit scale is also used. In fahrenheit scale, boiling point is 212^0 and freezing point is 32^0.

These two scales may be converted in one another according to the following methods :-

C = 5/9 (F – 32) or F = 9/5 (C + 32)

Figures & statistics of daily temperature are required for weather maps. For this we use a special thermometer and we donot have to check it again and again. After setting it once when we check it after 24 hours then we will get information about the maximum and minimum temperature of last day. This thermometer has narrow 'U' shape tube and have bubls on its both ends.

The bulb on left side is completely filled with Alchohal while bulb on right side is partially filled with Alchohal and 'U' shaped tube is filled with mercury. Two iron pins (Pieces of thin wire having size about 1 cm) are placed above mercury on both sides. These pins move on their place due to the up and down movement of mercury.

Movement of mercury has been controlled by the left bulb completly filled with alchol. As the temperature rises, the Alchohal expands which results in the downward movement of mercury in the left tube and upward movement in right side tube because of this iron pin moves upward in the right side tube. On the other hand vis cosity/ density of alcohal is less than the iron pin in the left tube because of which mercury moves down without making any change in the position of iron pin in right tube represents the highest temperature.

As the temperature starts decreasing, the alcohal in the bulb of left tube starts shrinbing and because of this mercury starts retreating . To be more specific, mercury retreats in right funnel while rising in left funnel.

If temprature goes on decreasing, the iron wire gets rising in left funnel with the help of rising mercury. This process continues till temprature does not reach at lowest ebb. Finally lower end of iron wire shows minimum temperature.

It is mentionable here that temprature scale decreases as we go higher in left funnel whereas the scale increases upwards in right funnel. This helps in narrating minimum and maximum temprature through the thermometer. To set the thermometer we have to set ieces of iron wire daily with the help of magnet. Iron wires need to touch the mercury in both the funnels. For this purpose small magnet is used. This activity should not be carried out at highest or lowest temperature, evening time is best for this processing so that on next morning we can record the lowest temperature of night and in the evening we can record the highest temperature of the day recorded in the afternoon.

With the help of these figures we can find out daily mean temperature, daily mean temprature difference. Monthly mean temperature, Annual temperature difference and daily normal temperature.

Aneroid Barometer : Air pressure is an important aspect of air. Like all physical items, air also contains weight. Air pressure of a particular place changes within a short span of time and it also varies from place to place. Information of every second of Air pressure is necessary for the intimation about rain, winds, strom, clear weather etc. This information is important for pilots and fishers Aneroid barometer has been used to measure the air pressure. Airforces Navy and Mountaineers use this to measure the pressure and also to find out the height from the sea level. Liquids are not used in this device/it is a small round metal box in which vaccum is created.

With the increase in air pressure the cap of box moves down and it rises with the

decrease in pressure. Although the change in air pressure brings a little change in the cap but it has been multiplied with the help of levers. These levers are connected with a needle, so that the change in pressure can be recorded on the scale of dial made on the box and it can be measure in centimeter, Inches and Millibars. Inspite of these units sometimes words like storm, rain, clear, dry etc. are also printed on scale so that a person who is not aware about the details of air pressure, can also acquire information about air pressure.

It is also important to mention that to record the change in air pressure on timely basis a red colour needle is fixed on the glass cap of the device. Needle fixed above is set in the direction air pressure needle is with the change in air pressure, pressure needle changes its position and change may be noted accordingly.

Wind Vane : Wind is another aspect of weather, as we know that winds move from high pressure to low pressure areas. Direction and speed of winds is very important in the study of weather. A simple instrument has been used to find out the direction of winds and it can be easily made. A light weight metal piece has been used in it and it might be in the shape of 'arrow' or 'cock'. It's one end is narrow and other is wide.

This metal piece is connected with a iron rod in such a way that it can easily rotate. When wind blows the narrow part of metal piece point towards that direction from which wind is blowing towards this device.

Four iron connected diagnally to one another and pointing towards four directions namely North, South, East and West are fixed beneath this instrument.

Commonly these devices are installed 10 meters higher than land so that it may face moving wind freely. These are installed at wide open places and above the enclosed building.

It is really important to mention a fact for the information of students that name given to the winds are related with their direction. E.g. winds coming towards Punjab from east a (Purab) are known as 'Pura' and winds coming from west (Passham) are knwon as 'Pasho or Pashwa'. Similarly there are southern and mountaineous winds.

Animometer : After direction of winds, other aspect is speed of winds. Speed of winds is measured with the help of Animometer. There are various Animometers with Slight differences but Robinson Cup Animometer is used the most. It is made of three or four metalled hemispherical cups installed at the horizontal spokes resting upon vertical spindle. These cups start rotating with even hardly blowing wind and with the help of axle and gear attached beneath. Speed of wind meter per second is noted.

Wet and Dry Bulb Thermometer : As we know wind always have gaseous part of water in it. Amount of vapours varry with time and place. Presence of vapours in wind is directly velated with temperature. Gaseous form of water in atmosphere is known as'Humidity'. There are three main measurements of humidity : Absolute, Relative and Specific.Among these three relative humidity is the most used because the prior information about sacturation of air plays a vital role in the prediction of rain and relative humidity describes it better than other two types of humidity.

The ratio of water vapours present in air at particular temperature and capability of air to carry humidity is known as absolute humidity. This is measured and represented in percentage.

Dry and wet bulb thermometer is used to measure the absolute humidity. This thermomemeter has two casual thermometers installed on a wooden board in upright position. the bulb of one of the thermometer is wraped in cloth and another end of that cloth is dipped in water in such a way that bulb of this thermometer remain wet. This thermometer is known as wet bulb thermometer. The second thermometer is not covered covered by any cloth and is left open. This is known as dry bulb thermometer. Both the thermometers record different temperature & because temprature of wet bulb is lesser than that of dry bulb because of coolness created by moisture & evaporation.

The difference between the temperature of these two thermometers is directly related with the moisture present in air, meaning thereby, if moisture is higher, eraporation shall be more and it shall create more cooling effect resulting into greater difference of temprature between two thermometers.

It means that the temperature recorded by wet bulb thermometer is always low as compared to the dry bulb thermometer. A special table (chart) is used to check the atmospheric humidity, which is provided on the purchase of this device. Its sample is

given below.

E.g. If the temp. of dry bulb thermometer of a place is 90^0 F and the temperature of wet bulb thermometer is 82^0F and their difference is 8^0F. Now to calculate the absolute humidity, we refer to the chart in which temprature of dry bulb thermometer being 90^0F and difference between two thermometers being 8^0F, humidity shall be 71%.

Commonly absolute humidity has been recorded at 8:30 in the morning and 5:30 in the evening. This device should not be exposed to direct sunlight. For this weather scientists use a special wooden box which protect this device from direct sunlight but wind passes through it freely. This device is installed away from buildings and trees in an open place at the height of 1 meter from the ground. This device is also used for other weather devices also, such as Stewenson screen.

Rain Gauge : Falling of water vapours from air/sky in the form of drizzle, rian, sleet, snow, graupel and ail is known as precipitation. It has been measued in centimeters or inches. When we say that a particular place has received 10 millimeter rainfall then it means that if the water donot move below the surface and it is not converted into vapours due to evaporation and Run off process donot take place then a 10 millimeter high layer of water will be collected at that place.

To measure the rain fall a simple device is used which has two metal cylinders and a funnel. Bigger cylinder has a funnel by same size and its narrower side opens in the cylinder which accumulates rain water.

Funnel is kept 10 centimeter below the big cylinder so that water droplets donot fall out because of any kind of movement.

Smaller cyclinder is actually a measurement jar with milimeters, centimeters and inches marked on it. Measurement jar and the funnel have areas with specific ratio. This measurement jar is narrow cylinderical jar so that it may measure even slightest of rain water.

In weather maps of India figures of rainfall are included on the basis of total rainfall during last 24 hours at a particular place. Basically these are recorded at 8 O'clock in the morning.

This device should be used at an open place away from buildings and trees, where rainfall can be recorded freely. It should be kept 1 feet high from the ground so that water droplets after striking the ground donot enter into funnel. It should be placed away from children and animals at a safe place so that we can protect it from falling.

Stevonson Screen

Drawing of Isotherms, Isobars and Isohyets :

There is only one method to draw Isotherms, Isobars and Isohyets or any other kind of isopleth lines on maps.

First of all figures about maximum places are required for given map. Larger the number of figures, result has better representation. Second step is to identify the places which have maximum and minimum value of isopleths so that variation value may be finalised. Third and last step is to draw isopleths which is to be begun from lowest value to upper value grades. The isopleth with highest value is to be drawn in the end.

For the facility of students can practice with the figures of local place or other states with the help of their teachers. Prepare isobar and isohyte maps also.

Activity :

Prepare a Weather Station at your school with the help of your teacher. Install Rain gauge, Thermoeters, Wind Vane, Animometer, Stevers on Screen in it. Register change in weather characteristics.

EXERCISE

1. Answer in short :

(a) Define a map.

(b) Classify maps on basis of scale.

(c) Why a scale is must in a map ?

(d) Classify maps on basis of purpose.

(e) Explain enlargement and reductionof map.

(f) Why knowledge of directions is necessary for students of Geogaphy ?

(g) What are Map Symbols ? What is their use ?

(h) What symbols are used to show various aspects related to Weather.

(i) Which instruments are used to record Air Pressure, Speed of Winds and Temperature ?

(j) What are Contours ?

2. Answer in detail :

(a) Classify maps on bases of use and purpose. Explain thoroughly.

(b) How many ways are there to find 'North' ? Which one you like the most and Why ?

(c) What are Contour Profiles ?

(d) **Prepare Contour profiles of the following :**

(i) Steep Slope	(v) Lake
(ii) Convex Slopes	(vi) U-Shaped Valley
(iii) Concave Slope	(vii) V-Shaped Valley
(iv) Conical Valley	(viii) Water fall

(e) Prepare a Weather Map of India for January, using Weather Symbols.