Government of TamilNadu

Department of Employment and Training

Course : SSC EXAM

Subject : GEOGRAPHY

Topic : GEOGRAPHY

Commissioner,
Department of Employment and Training.

INTRODUCTION

Geography

Geography is a field of science devoted to the study of the lands, features, inhabitants, and phenomena of the Earth and planets.

GEOMORPHOLOGY: EXTERNAL and INTERNAL FORCES – LAYERS OF EARTH, CONTINENTAL MOVEMENTS THEORIES, EARTHQUAKES and FORCES of CHANGE

Earth is mainly made up of Iron, followed by Oxygen.

There are many explanations for the movement of Continents and evolution of geography.

LAYERS of EARTH

Most of the information about interior of earth is obtained *indirectly* as samples from deep inside cannot be collected. Earthquakes, gravitation, magnetic field, and meteors include some of the *indirect sources*. Volcanic eruptions, hot springs, rocks, deep drillings, deep mines etc are *direct sources* of internal information.

Just like an onion, the earth is made up of several concentric layers with one inside another.

I. Crust

The uppermost layer over the earth's surface is called the crust. It is the thinnest of all the layers, just like an egg shell. It is about 35 km on the continental masses and only 5 km on the ocean floors. It is lighter than the layer beneath it and generally density of material goes on increasing as we go down. Thus core (**NiFe** – Nickle+Ferrous) is heaviest.

Oxygen is the largest constituent of the Crust. It is present in form of oxides of various elements. Silicon is second largest substance. Upper layer of crust – very thin – is made up of sedimentary rocks, while most of the crust is composed of crystalline igneous and metamorphic rocks which are generally acidic in nature.

Half of crust is made from ***Feldspar*** which is a mineral made of Silicon, Oxygen and other elements.

- **Continental Crust** – The main mineral constituents of the 'continental crust' aresilica and alumina. It is thus called '**sial'** (si-silica and al-alumina). It is lighter than the oceanic crust.
- **Oceanic Crust** – The 'oceanic crust' mainly consists of silica and magnesium; it

is therefore called '**sima'** (si-silica and ma-magnesium)

Oceanic Crust vs Continental Crust –

 Oceanic crust is thinner as compared to the continental crust. The mean thickness of oceanic crust is 5 km whereas that of the continental is around 30 km.

 Oceanic crust is made up of heavier rocks having density of 3 g/cm3. This type of rock found in the oceanic crust is Basalt. The mean density of material in oceanic crust is 2.7 g/cm3.

II. **Mantle**

Second Layer is mantle. By volume it is the largest layer. It has higher density than that of the crust.

Aesthenosphere – *The mantle contains a weaker zone called Asthenosphe*re. *It is from this that the molten rock materials find their way to the surface.* Asthenosphere is a plastic layer type which has high temperature and upon which lithosphere floats. The material in the upper mantle portion is called magma. The slow movement of Asthenosphere also disturbs the layer of lithosphere also and leads to 'folding' and 'faulting' (termed as tectonic activities).

III. **Core**

Third Layer is core, the innermost layer is the core with a radius of about 3500 km. It is mainly made up of nickel and iron and is called '*nife'* (ni – nickel and fe – ferrous i.e. iron). The central core has very high temperature and pressure. *Due to this, it remains in solid state.*

Discontinuities – There are also some sharp discontinuities that demarcate the core from mantle and mantle from crust –

 Mohorovick's Discontinuity – Sharp boundary between crust and Mantle

 Guttenberg Discontinuity – The discontinuity between outer core and lower mantle is called Guttenberg discontinuity.

Lithosphere

Lithosphere is the solid crust or the hard top layer of the earth (covers both Oceans and Land surface). It is made up of rocks and minerals and covered by a thin layer of soil. It is an irregular surface with various landforms such as mountains, plateaus, plains, valleys, etc. Landforms are found over the continents and also on the ocean floors.

PLATES

A tectonic plate (also called lithospheric plate) is a massive, irregularly-shaped slab of solid rock, generally composed of both continental and oceanic lithosphere. Plates move horizontally over the asthenosphere as rigid units. Now it is known that Lithospehere is further subdivided into various minor and 7 major plates. There are three types of plates –

- Continental Plates – these are comparatively lighter
- Oceanic Plates – these are comparatively heavier
- Partly continental partly oceanic plates

Pacific plate is largely an oceanic plate whereas the *Eurasian plate may be called a continental plate.*

Plate Movement

These plates move around very slowly – *just a few millimetres each year*. (*Rates of Plate Movement – The strips of normal and reverse magnetic field that parallel the mid-oceanic ridges help scientists determine the rates of plate movement*.)

I. **Continental Drift Theory** – It was given by Wegener who claimed that continents were part of a single mass and later drifted apart. According to Wegener, all the continents formed a single continental mass and mega ocean surrounded the same. The super continent was named **PANGAEA**, which meant all earth. The mega-ocean was called **PANTHALASSA**, meaning all water. He suggested that the movement responsible for the drifting of the continents was caused by *pole-fleeing* force and *tidal* force. The polar-fleeing force relates to the rotation of the earth. It argued that the continents are "plowed" through the sea. Evidence in support of the Continental Drift –

- The Matching of Continents (Jig-Saw-Fit)
- Rocks of Same Age across the Oceans
- Distribution of similar fossils
- Tillite – It is the sedimentary rock formed out of deposits of glaciers. The Gondawana system of sediments from India is known to have its counter parts in six different landmasses of the Southern Hemisphere.
- Placer Deposits – The occurrence of rich placer deposits of gold in the Ghana coast and the absolute absence of source rock (placer deposits) in the region and instead presence of such rocks in Brazil also points

to the fact that Brazil and Ghana were part of one land.

The biggest limitation of Continental Drift Theory was that the basis it provided for the force which moves the continents/plates was not held to be true by many later studies. Considerable research was done after this theory, and it was found that many of the postulates were true and some were replaced by other discoveries.

Some argued that the movement or the moving force is the convectional currents in the mantle due to radioactive elements causing thermal differences in the mantle portion.

Mapping was also done on ocean floor, with the help of Sonar etc, which found that ocean floor is not plain and there is a varying relief with mountains, trenches etc and some of these features were much younger than many features on continents. This pointed to the fact that some other force might have been responsible for the creation of these rocks, figures etc.

II. **Sea Floor Spreading** – In the wake of new discoveries post-drift theory **Hess** (1961) proposed his hypothesis, known as the 'Sea Floor Spreading'. After the theory of Sea Floor spreading, it has been found that Earth surface is not rigid and solid as it appears and as it was proposed by Wegner. Instead, the upper crust floats on Magma and hence can move. Thus, movement of plates is because of the movement of the molten magma inside the earth. The molten magma inside the earth moves in a circular manner. The movement of these plates causes changes on the surface of the earth. The earth movements are divided on the basis of the forces which cause them. Hess argued that constant eruptions at the crest of oceanic ridges cause the rupture of the oceanic crust and the new lava wedges into it, pushing the oceanic crust on either side. The ocean floor, thus spreads. The younger age of the oceanic crust as well as the fact that the spreading of one ocean does not cause the shrinking of the other, made Hess think about the consumption of the oceanic crust. He further maintained that the ocean floor that gets pushed due to volcanic eruptions at the

crest, sinks down at the oceanic trenches and gets consumed.

III. **Plate Tectonics Theory** – This theory was given in 1960s in wake of new information like sea floor spreading. A tectonic plate (also called lithospheric plate) is a massive, irregularly-shaped slab of solid rock, generally composed of both continental and oceanic lithosphere (as against assumption of Wegner, who assumed continental and oceanic mass as different categories). The theory of plate tectonics proposes that the earth's lithosphere is divided into seven major and some minor plates. Young Fold Mountain ridges, trenches, and/or faults surround these major plates. These plates have been constantly moving over the globe throughout the history of the earth. It is not the continent that moves as believed by Wegener. Moreover, it may be noted that all the plates, without exception, have moved in the geological past, and shall continue to move in the future as well. Wegener had thought of all the continents to have initially existed as a super continent in the form of Pangaea. However, later discoveries reveal that the continental masses, resting on the plates, have been wandering all through the geological period, and Pangaea was a result of converging of different continental masses that were parts of one or the other plates and hence, was one of the phases of plate movements. Three type of plate boundaries are proposed – convergent, divergent and transforming.

Boundary Interactions of **Plates**

I. **Divergent Boundaries** or **Constructive Boundaries** – Where new crust is generated as the plates pull away from each other (as in case of Seafloor Spreading). The sites where the plates move away from each other are called spreading sites, due to this at bottom of oceans, new sea floor is added as a result of sea floor spreading.

Two drifting oceanic plates give rise to **Mid Oceanic Ridges**. The best-known example of divergent boundaries is the Mid-Atlantic Ridge. At this, the American Plate(s) is/are separated from the Eurasian and African Plates.

II. **Convergent Boundaries** or **Destructive Boundaries** – Where the crust is destroyed as one plate dived under another. Also called Destruction Zone. When oceanic crust moves towards continental crust, but being heavier/denser sinks and is destroyed and sea **Trenches** and **Island Ridges** are formed (with volcanos). The location where sinking of a plate occurs (heavier oceanic plates underride the lighter continental plates) is called a **Subduction Zone**. (*subduction zones are regions of maximum earthquakes in the world, Circum Pacific Belt lies on such a zone*) There are three ways in which convergence can occur. These are: (i) between an oceanic and continental plate (*as shown in figure below*); (ii) between two oceanic plates; and (iii) between two continental plates – Continent Convergence.

A Wadati–Benioff zone is a deep active seismic area in a subduction zone.

III. **Transform Boundaries** or **Conservative Boundaries** – Where the crust is neither produced nor destroyed as the plates slide horizontally past each other. Transform faults are the planes of separation generally perpendicular to the mid oceanic ridges.

Movement of the Indian Plate

The Indian plate includes Peninsular India and the **Australian continental** portions. The subduction zone along the Himalayas forms the northern plate boundary in the form of continent— continent convergence.

In the east, it extends through Rakinyoma Mountains of Myanmar towards the island arc along the Java Trench. The eastern margin is a spreading site lying to the east of Australia in the form of an oceanic ridge in SW Pacific.

The boundary between India and the Antarctic plate is also marked by oceanic ridge (divergent boundary) running in roughly W-E direction and merging into the spreading site, a little south of New Zealand. *India was a large island situated off the Australian coast, in a vast ocean*. The Tethys Sea separated it from the Asian continent till about 225 million years ago. *India is supposed to have started her northward journey about 200 million years ago at the time when Pangaea broke*. India collided with Asia about 40-50

million years ago causing rapid uplift of the Himalayas.

During the movement of the Indian plate towards the Asiatic plate, a major event that occurred was the outpouring of lava and formation of the Deccan Traps. This started somewhere around 60 million years ago and continued for a long period of time. Note that the subcontinent was still close to the equator. From 40 million years ago and thereafter, the event of formation of the Himalayas took place. Scientists believe that the process is still continuing and the height of the Himalayas is rising even to this date.

GEOMORPHIC FORCES

The forces which act in the interior of the earth are called as **Endogenic forces** and the forces that work on the surface of the earth are called as **Exogenic forces**. *Endogenic forces sometimes produce sudden movements and at the other times produce slow movements. Sudden movements like earthquakes and volcanoes* cause mass destruction over the surface of the earth.

I. **Endogenic forces**

Two main endogeneic processes are – Volcanism and Diastrophism.

Distrophism – Diastrophism refers to deformation of the Earth's crust, and more especially to folding and faulting. It is classified as Epeirogenic and Orogenic based on direction of movement viz – horizontal/tangential or vertical.

a. Epeirogeny or Epirogenic Forces *is a vertical movement.* ***Upwarping*** and ***Downwarping*** are two epirogenic processes other being Isostacy (during Isostacy all the landmass etc either lifts together or sinks together and remain in hydrological equilibrium).

b. Orogeny or Orogenic Forces – *Orogeny is a horizontal/tangential earth movement, on the other hand, Folding, Faulting, and continental drift constitute orogenic movements.*

 Folding – it is the bending of the rock strata due to compression tangential forces. Strata crumbles into folds with highs/crests/upfolds called anticline and lows/trough/downfolds called synclines forming as a result.

 Fault – It is a fracture of large magnitude in crustal surface. Displacement occurs

parallel to the plane of break. A fault is the ultimate result of vast regional tensions. The fault plane makes an angle with the horizontal termed as 'dip'. While angle made with the vertical is called 'hade'. Horst or Block Mountain is the uplifted landmass between two adjacent faults.

II. **Exogenetic forces**

All the exogenic geomorphic processes are covered under a general term, **denudation**. The word 'denude' means to strip off or to uncover. **Weathering**, **mass wasting/movements**, **erosion** and **transportation** are included in denudation. The effects of most of the exogenic geomorphic processes are small and slow and may be imperceptible in a short time span.

a. Weathering – Weathering is defined as mechanical disintegration and chemical decomposition of rocks through the actions of various elements of weather and climate. Weathering processes are conditioned by many complex geological, climatic, topographic and vegetative factors. *Climate is of particular importance*. Not only weathering processes differ from climate to climate, but also the depth of the weathering mantle. There are three major groups of weathering processes: (i) ***chemical*** (A group of weathering processes viz; solution, carbonation, hydration, oxidation and reduction act on the rocks to decompose, dissolve or reduce them to a fine elastic state through chemical reactions by oxygen, surface and/or soil water and other acids.); (ii) ***physical*** or mechanical (Physical or mechanical weathering processes depend on some applied forces. The applied forces could be: (i) gravitational forces such as overburden pressure, load and shearing stress; (ii) expansion forces due to temperature changes, crystal growth or animal activity; (iii) water pressures due to ice formation flow etc.); (iii) ***biological*** weathering (Due to activities of animals, insects, plants and humans) processes.

Significance of weathering – Weathering processes are responsible for breaking down the rocks into smaller fragments and preparing the way for formation of not only regolith and soils, but also erosion and mass movements. *Biomes and biodiversity is basically a result of forests*

(vegetation) and forests depend upon the depth of weathering mantles. Erosion cannot be significant if the rocks are not weathered.

Weathering vs **Erosion –** Weathering involves two processes that often work in concert to decompose rocks. Both processes occur in place. *No movement is involved in weathering*. Chemical weathering involves a chemical change in at least some of the minerals within a rock. Mechanical weathering involves physically breaking rocks into fragments without changing the chemical make-up of the minerals within it. It's important to keep in mind that weathering is a surface or near-surface process. As soon as a rock particle (loosened by one of the two weathering processes) moves, we call it erosion or mass wasting. So it involves *moving particles from one place to another. The most important force of erosion is gravity. The most important agent of erosion is water.*

b. Erosion and **Deposition** – *Erosion involves acquisition and transportation of rock debris or soil*. When massive rocks break into smaller fragments through weathering and any other process, erosional geomorphic agents like running *water, groundwater, glaciers, wind and waves* remove and transport it to other places depending upon the dynamics of each of these agents.

By erosion, relief degrades, i.e., the landscape is worn down. That means, *though weathering aids erosion it is not a pre-condition for erosion to take place*.

Weathering, mass-wasting and erosion are degradational processes. It is erosion that is largely responsible for continuous changes that the earth's surface is undergoing. *After weathering processes have had their actions on the earth materials making up the surface of the earth, the geomorphic agents like running water, ground water, wind, glaciers, waves perform erosion.*

Work of rivers – A river while flowing may give rise to many types of landforms, they fall under above categories –

- Erosion Land forms like– Valleys (Gorges, canyon etc)
- Depositional Landforms like – Alluvial deposits, Deltas, Flood plains etc.

Work of sea waves – The erosion and deposition of the sea waves gives rise to coastal landforms. Sea waves continuously strike at the rocks. Cracks develop. Over time they become larger and wider. Thus, hollow like caves are formed on the rocks. They are called Sea Caves. As these cavities become bigger and bigger only the roof of the caves remain, thus forming Sea Arches. Further, erosion breaks the roof and only walls are left. These wall like features are called Stacks.

The steep rocky coast rising almost vertically above sea water is called Sea Cliff. The sea waves deposit sediments along the shores forming Beaches.

Work of ice – Glaciers are "rivers" of ice which too erode the landscape by bulldozing soil and stones to expose the solid rock below. Glaciers carve out deep hollows. As the ice melts they get filled up with water and become beautiful lakes in the mountains.

Maximum development of Glaciers occurs in *Karakoram Range in Kashmir*. Siachin Glacier has the distinction of being the largest single glacier outside poles. (Karakoram Highway – a link between China and Pakistan is very close to this glacier, it increases its strategic value). *Himalayan Glaciers are biggest glaciers outside poles.* The material carried by the glacier such as rocks big and small, sand and silt gets deposited. These deposits form **Glacial Moraines**. Thus, a moraine is any glacially formed accumulation of unconsolidated glacial debris (soil and rock) which can occur in currently glaciated and formerly glaciated regions, such as those areas acted upon by a past glacial maximum. *Moraines may be composed of debris ranging in size from silt-sized glacial flour to large boulders.* Moraines may be on the glacier's surface or deposited as piles or sheets of debris where the glacier has melted. They can be of several type – *Lateral Moraines, Medieval moraine, Terminal Moraine*. Material deposited at either side is called lateral moraine. One forming at the melting front of the glacier is called terminal moraine.

Cirques are the most common of landforms in glaciated mountains. The cirques quite often are found at the heads of glacial valleys. They are deep, long and wide troughs or basins with very steep

concave to vertically dropping high walls at its head as well as sides.

Glacial Valleys/Troughs, Depositional Landforms, Horns and *Serrated Ridges* are the other examples of the works of ice erosion.

Work of wind – An active agent of erosion and deposition in the deserts is wind. In deserts you can see rocks in the shape of a mushroom, commonly called ***Mushroom Rocks***. *Winds erode the lower section of the rock more than the upper part.* Therefore, such rocks have narrower base and wider top. When the wind blows, it lifts and transports sand from one place to another. When it stops blowing the sand falls and gets deposited in low hill – like structures. These are called **Sand Dunes**. When the grains of sand are very fine and light, the wind can carry it over very long distances. When such sand is deposited in large areas, it is called **Loess**. Large deposits of Loess is found in China.

c. Mass Movements – These movements transfer the mass of rock debris down the *slopes under the direct influence of gravity*. It can be very slow (**Creep** is one type under this category which can occur on moderately steep, soil covered slopes. Movement of materials is extremely slow and imperceptible except through extended observation), rapid (These movements are mostly prevalent in humid climatic regions and occur over gentle to steep slopes. Movement of water-saturated clayey or silty earth materials down low-angle terraces or hillsides is known as *'earthflow'*. Another type is *'Mudflow'*. A third type is the *debris avalanche*, which is more characteristic of humid regions with or without vegetation cover and occurs in narrow tracks on steep slopes. This debris avalanche can be much faster than the mudflow. Debris avalanche is similar to snow avalanche) or sudden (as in case of landslides).

EARTHQUAKE

Most of the earthquakes and Tsunamis occur in an area called '*Pacific Ring of Fire'*.

In an Earthquake, the place in the crust where the movement starts is called the **Focus**. The place on the surface above the focus is called the **Epicentre**.

Origin and **Cause –** All natural earthquakes (*there can be other non-natural like due to Reservoirs for dams, mines collapse etc*) take place in the lithosphere(upto 200km

and it consists of Crust and Upper most layer of mantle) and are mainly caused by activities in the

I. Tectonic plates – associated with faulting

II. Volcano eruption.

When plates/structure exert pressure on each other, at one point this becomes critical and plates move releasing energy which takes shape of an earthquake. This energy release takes the form of seismic waves.

Shallow Earthquakes – Whose *epicenter lies near surface) are more dangerous.*

Types of **Earthquake Waves –** Earthquake waves are basically of two types — Body waves and Surface waves.

Waves

Body Waves

Primary waves (Fastest)

Secodary or Sheer Waves (Only Solids)

Surface Waves

Rayleigh Waves

Long Waves (Maximum destruction)

I. **Body Waves –** These are *generated due to the release of energy at the focus and move in all directions* travelling through the body of the earth. Hence, the name body waves. There are two types of body waves. They are called **P** and **S-waves**.

P-Waves – They move faster and are the first to arrive at the surface. These are also called 'primary waves'. The P-waves are similar to sound waves and compress the material in the same direction as they travel. They travel through all media i.e. gaseous, liquid and solid materials. From studying the speed of these waves it is inferred that earth has an inner solid core made up of extremely compact material.

S-Waves – They arrive at the surface with some time lag. These are called secondary waves. An important fact about S-waves is that they *can travel only through solid materials.* So they are also called ***Sheer waves***, as they are able to make changes in the material due to sheer stress only – which is *only possible in solids*. *This characteristic of the S-waves is quite important. It has helped scientists to understand the structure of the interior of the earth*. The direction of vibrations of S-waves is perpendicular to the wave direction in the vertical plane. Hence, they create troughs and crests in the material through which they pass.

II. **Surface Waves** – The body waves interact with the surface rocks and generate new set of waves called surface waves. These waves move along the surface. The surface waves are the last to report on seismograph. These waves are most destructive. They cause displacement of rocks, and hence, the collapse of structures occurs. They are mainly – **Rayleigh Waves** and **Long Waves** (R and L Waves respectively). *Long waves are the ones that cause maximum destruction to the buildings*.

The velocity of waves changes as they travel through materials with different densities*. The denser the material, the higher is the velocity*.

Their order *of appearance is – PSLR on seismograph* **Shadow Zone of an Earthquake** – Earthquake waves get recorded in seismographs located at far off locations. However, there exist some specific areas where the waves are not reported on seismograph. Such a zone is called the 'shadow zone'. This is mainly due to the inability of earthquake waves to penetrate some areas. For example – S waves cannot travel through molten core and the study of different events reveals that for each earthquake, there exists an altogether different shadow zone.

Seismic Gaps – Earthquakes usually occur in a pattern where every major quake is preceded by minor shocks (which may occur a few seconds or even a few years before) called ***foreshocks*** and followed by another shocks (which may occur a few seconds or even a few years before) called ***aftershocks***.

Measurement of an Earthquake – Earthquake is measured either on the basis of the destruction caused or the amount of the energy released.

Mercalli Scale is used for measuring destruction caused.

Richter Scale – Destruction may depend upon various factors – say Delhi vs Sahara desert – another scale Richter Scale is used. It is a logarithmic scale and two consecutive integer values represent 10 fold energy release than previous.

Earthquake Liquifaction – It refers to compaction and rolling over of soft alluvial deposits because of seismic Waves.

Distribution of Earthquake Regions around the World 29

I. **Circum Pacific Belt** – It is located along the edges of the Pacific Ocean, most of the volcanoes in this belt are located on the high young folded mountains such as Rockies, the Andes etc. Most of the deadly earthquakes also originate in this region. Reason is subduction and it has maximum earthquake occurrence in the World. All types of quakes viz – Shallow, Intermediate type and Deep type occur here.

II. **Trans Eurasian Mountain** – These are caused by Convergence or Collision. This belt has Shallow and Intermediate type only.

III. **Mid Oceanic Ridges** – Here only shallow type earthquakes occur.

RIS – Reservoir Induced Seismicity – 1967 Koyana Earthquake in India and 2008 Sichuan earthquake in China are such examples.

VOLCANIC LANDFORMS

Intrusive Forms – The lava that is released during volcanic eruptions on cooling develops into igneous rocks. The cooling may take place either on reaching the surface or also while the lava is still in the crustal portion. Depending on the location of the cooling of the lava, igneous rocks are classified as **volcanic rocks** (cooling at the surface) and **plutonic rocks** (cooling in the crust). The lava that cools within the crustal portions assumes different forms. These forms are called intrusive forms. *Lacoliths*, *Phacoliths*, *Batholiths*, *Dykes* etc are some of the intrusive forms. Which one of the following is a 'direct source of information about the interior of the earth'?

a) Earthquake waves

b) Gravitational force

c) VOLCANOES

d) Earth magnetism

Which one of the following is the type of plate boundary of the Indian plate along the Himalayan mountains?

a) Ocean-continent convergence

b) Divergent boundary

c) Transform boundary

d) CONTINENT-CONTINENT CONVERGENCE

EXTERNAL PHYSIOGRAPHY of EARTH

The oldest landmass, (the Peninsula part), was a part of the Gondwana land. (It is the southern part of the ancient super continent Pangea). The Peninsula is formed essentially by a great complex of very ancient gneisses and granites, which constitutes a major part of it. Since the Cambrian period, the Peninsula has been standing like a rigid block with the exception of some of its western coast which is submerged beneath the sea and some other parts changed due to tectonic activity without affecting the original basement. As a part of the Indo-Australian Plate, it has been subjected to various vertical movements and block faulting. The rift valleys of the Narmada, the Tapi and the Mahanadi and the Satpura block mountains are some examples of it.

The Gondwana land included India, Australia, South Africa, South America and Antarctica as one single land mass.

The convectional currents split the crust into a number of pieces, thus leading to the drifting of the Indo-Australian plate after being separated from the Gondwana land, towards north. The northward drift resulted in the collision of the plate with the much larger Eurasian Plate. Due to this collision, the sedimentary rocks which were accumulated in the geosyncline known as the Tethys were folded to form the mountain system of western Asia and Himalaya.

Himalayan uplift out of the Tethys sea and subsidence of the northern flank of the peninsular plateau resulted in the formation of a large basin. In due course of time this depression, gradually got filled with deposition of sediments by the rivers flowing from the mountains in the north and the peninsular plateau in the south. A flat land of extensive alluvial deposits led to the formation of the northern plains of India. From the view point of geology, Himalayan mountains form an unstable zone. The northern plains are formed of alluvial deposits. The peninsular plateau is composed of igneous and metamorphic rocks with gently rising hills and wide valleys.

MOUNTAINS

Strike of a mountain is the compass direction of the line of intersection of an inclined stratum with an imaginary horizontal plane. E.g. – Strike Valley.

Dip of a mountain refers to the maximum angle of slope of a tilted stratum, measured directly downward from the horizontal plane.Dip is always perpendicular to Strike.

Mountains are basically of two types –

I. Block Mountains – These are created when large areas are broken and displaced vertically. The uplifted blocks are termed as horstsand the lowered blocks are called graben. The Rhine valley and the Vosgesmountain in Europe are examples of such mountain systems. Satpura mountain in India is an example of Block Mountain.

II. Fold Mountains – Fold Mountains are mountains formed mainly by the effects of folding on layers within the upper part of the Earth's crust. In the time before either plate tectonic theory developed, or the internal architecture of thrust belts became well understood, the term was used for most mountain belts, such as the Himalayas, *Alps*, *Andes*.

Young Mountains Features –

- Rivers are youthful and the valleys are deep and their flow is fast.
- Landslide and volcanic activities are common
- Mountains are high as their erosion has still not taken much and/or they are still growing like Himalyas
- Slope is steep

MOUNTAIN SYSTEM of INDIA

THE HIMALAYAN MOUNTAINS

Himalayas are not only the physical barrier, they are also a climatic, drainage and cultural divide.

The mountains are supposed to emerge out of '**The Tethy's Sea**'. The altitudinal variations are greater in the eastern half than those in the western half. The Himalaya consists of three parallel ranges in its longitudinal extent. A number of valleys lie between these ranges.

Himalaya as Young Mountains –

- Presence of Fossils in Shiwalik similar to Tibetan Plateau
- Frequent Occurrence of Earthquakes indicates that they have still to reach isostatic equilibrium.
- Himalayan Rivers are still in their youthful age with characteristic V gorges, steep water falls etc

The Himalayas along with some other peninsular mountains are young, weak and flexible in their geological structure unlike the rigid and stable Peninsular Block. These mountains are *tectonic in origin, dissected by fast-flowing rivers* which are in their youthful stage. Various *landforms like gorges, V-shaped valleys, rapids, waterfalls*, etc. are indicative of this stage.

Broad ranges of Himalayas –

I. **Northern Most Range** is known as the **Great** or **Inner Himalayas** or the **'Himadri'**.

It is the most continuous range consisting of the loftiest peaks with an average height of 6,000 meters. It *contains all the prominent Himalayan peaks*. Great Himalayas are asymmetrical in nature. The ranges are mainly *composed of highly compressed and altered rocks*. The core of some part of Himalayas is *composed of granite with outer cover as sedimentary*. Its *southern slope (towards India) is steep* and northern slope (towards Tibet) is gentle. The altitude varies between 3,700 and 4,500 meters and the average width is of 50 Km and most of the tallest peaks lie here.

II. **Mid Himalayas** or **Lessser Himalyas** – Valley of Kashmir lies in these. These are less hostile and *most of the hill resorts like Kullu, Manali, Shimla, Nainital etc are located here*.

III. **Shiwalik** is the southernmost range and is *least in Average height. Also called Outermost Himalayas.* They were almost continuous and blocked the courses of rivers which in past led to formation of *lakes* which after drying led to formation of *plains* called *Duns in the West and called Duars in the east*.

On the basis of relief, alignment of ranges and other geomorphological features, the Himalayas can be divided into the following sub-divisions:

Kashmir or Northwestern Himalayas Mountain Ranges – It comprise a series of ranges such as the Karakoram, Ladakh, Zaskar and Pir Panjal **Glaciars** – Important glaciers of South Asia such as the Baltoro and Siachen are also found in this region.

 Karewa Formation – The Kashmir Himalayas are also famous for Karewa formations, which are useful for the cultivation of Zafran, a local variety of saffron. (Karewas are the thick deposits of glacial clay and other materials embedded with moraines. In Kashmiri language, they refer to lake deposits found in the flat topped terraces of the Kashmir valley and on the Pir Panjals. These deposits consist of clays, sands and silts.) The Kashmir and northwestern Himalayas are well-known for their scenic beauty and picturesque landscape. Some famous places of pilgrimage such as Vaishno Devi, Amarnath Cave, Charar -e-Sharif, etc. are also located here.

II. **Himachal and Uttaranchal Himalayas** – The two distinguishing features of this region from the point of view of physiography are the 'Shiwalik' and 'Dun formations'.

River Basins – This part lies approximately between the Ravi in the west and the Kali (a tributary of Ghaghara) in the east. It is drained by two major river systems of India, i.e. the Indus and the Ganga. Tributaries of the Indus include the river Ravi, the Beas and the Satluj, and the tributaries of Ganga flowing through this region include the Yamuna and the Ghaghara.

 Shiwalik – The lowest altitude portion of Himalyas

 Doons –Doons are the plain areas in the river valleys formed due to alluvial deposits by the rivers. Some important duns located in this region are the *Chandigarh-Kalka dun, Nalagarh dun, Dehra Dun*, Harike dun and the Kota dun, etc. Dehra Dun is the largest of all the duns with an approximate length of 35-45 km and a width of 22-25 km.

 Nomads – In the Great Himalayan range, the valleys are mostly inhabited by the Bhotia's. These are nomadic groups who migrate to 'Bugyals' (the summer glasslands in the higher reaches) during summer months and return to the valleys during winters.

 The famous '*Valley of flowers'* is also situated in this region.

III. Darjiling and Sikkim Himalayas – They are flanked by Nepal Himalayas in the west and Bhutan Himalayas in the east. It is relatively small but is a most significant part of the Himalayas.

Known for its fast-flowing rivers such as Teesta.

 High Mountain Peaks – It is a region of high mountain peaks like Kanchenjunga (Kanchengiri), and deep valleys.

 Tribes – The higher reaches of this region are inhabited by Lepcha tribes while the southern part, particularly the Darjiling Himalayas, has a mixed population of Nepalis, Bengalis and tribals from Central India.

 Tea Plantations – The British, taking advantage of the physical conditions such *as moderate slope, thick soil cover with high organic content, well distributed rainfall throughout the year and mild winters, introduced tea plantations in this regio*n.

 Duars – *Duars are 'flood plains' and 'foot hills' of eastern Himalayas in North East India around Bhutan. They are plains in foothills of eastern Himalayas. Duar in Nepali means Gateway and this region form gateway to Bhutan from India. The term duar is also interchangeably used with Terai or Doon in India.*

IV. **Arunachal Himalayas** – The general direction of the mountain range is from southwest to northeast. Some of the important mountain peaks of the region are Kangtu and NamchaBarwa. These ranges are dissected by fast-flowing rivers from the north to the south, forming deep gorges. Bhramaputra flows through a deep gorge after crossing

Namcha Barwa *(It is the highest peak of Arunachal and Eastern Himalyas)*. Some of the important rivers are the Kameng, the Subansiri, the Dihang, the Dibang and the Lohit. These are perennial with the high rate of fall, thus, having the highest hydro-electric power potential in the country.

 Tribes – An important aspect of the Arunachal Himalayas is the numerous ethnic tribal community inhabiting in these areas. Some of the prominent ones are the Monpa, Daffla, Abor, Mishmi, Nishi

and the Nagas. Most of these communities practice Jhumming. It is also known as shifting or slash and burn cultivation.

 Biodiversity – This region is rich in biodiversity which has been preserved by the indigenous communities. *Due to rugged topography, the inter-valley transportation linkages are nominal.* Hence, most of the interactions are carried through the duar region along the Arunachal-Assam border.

V. **Eastern Hills and Mountains** – These are part of the Himalayan mountain system having their *general alignment from the north to the south direction.* They are known by different local names. In the north, they are known as ***Patkai Bum*** *(famous for being the boundary between India and Myanmar),* Naga hills, the Manipur hills and in the south as Mizo or Lushai hills. These are low hills, inhabited by numerous tribal groups practicing Jhum cultivation. Most of these ranges are separated from each other by numerous small rivers. The Barak *is an important river in Manipur and Mizoram*.

Most of the rivers in Nagaland form the tributary of the Brahmaputra. The range lies between Tista river and Brahamputra river. While two rivers of Mizoram and Manipur are the tributaries of the Barak River, which in turn is the tributary of Meghna; the rivers in the eastern part of Manipur are the tributaries of Chindwin, which in turn is a tributary of the Irrawady of Myanmar.

Loktak – *The* physiography of Manipur is unique by the presence of a large lake known as 'Loktak' lake at the *centre, surrounded by mountains from all sides*. Mizoram which is also known as the 'Molassis basin'which is made up of soft unconsolidated deposits.

Himalaya and Indian Climate

 They prevent Cold wave during winters that otherwise would blow from Tibet plateau

 They play important role in causing monsoon rains in India

 Rivers originating in Himalaya has led to huge alluvial deposits which have been cradle of human civilization in India.

PENINSULAR and OTHER MOUNTAINS and HILLS

The Aravali Hills lie on the western and northwestern margins of the peninsular plateau. These are highly eroded hills and are found as broken hills. They are oldest fold mountains in India. They extend from Gujarat to Delhi in a southwest-northeast direction. They are the one which block the Bay of Bengal from reaching western region and render it as a rainshadow area. Its highest peak is Gurushikhar in Mount Abu.

Satpura Range lies between Narmada and Tapti rivers. It is a classic example of the relict mountains which are highly denuded and form discontinuous ranges.

PLATEU

Plateu is an elevated flat land. It is a flat-topped table land standing above the surrounding area. *Plateaus are very useful because they are rich in mineral deposits.* As a result, many of the mining areas in the world are located in the plateau areas. African plateau is famous for gold and diamond mining. In India huge reserves of iron, coal and manganese are found in the **Chhotanagpur plateau**. The reason that Deccan Plateau is rich in minerals is that it is formed by the **Basaltic rocks** (lava eruptions or extrusive igneous rocks) which are rich in minerals. Primary mineral ores found in this region are ***mica*** *and* ***iron ore*** *in the Chhota Nagpur region*, and ***diamonds***, ***gold*** *and other metals in the Golconda region*.

The lava plateaus are rich in *black soil* that is fertile and good for cultivation. Many plateaus have scenic spots and are of great attraction to tourists.

Relief of peninsular plateau is highly uneven.

Major Plateu in India are – Peninsular plateau, Chotanagpur plateau and The North-Eastern Plateau or Meghalaya Plateau.

THE PENINSULAR PLATEAU

The Peninsula is formed essentially by a great complex of very ancient **gneisses** and **granites**, which constitutes a major part of it. As a part of the Indo-Australian Plate, it has been subjected to various *vertical movements and block faulting* since Cambarian period. The Peninsular plateau has undergone recurrent phases of upliftment and submergence accompanied by crustal faulting and

fractures. However, it has *not been affected much by tectonic forces*. (The *Bhima fault* needs special mention, because of its recurrent seismic activities). These spatial variations have brought in elements of diversity in the relief of the Peninsular plateau. The plateau has broad and shallow valleys and rounded hills. The river valleys here are shallow with low gradients.

Composition – The Peninsular plateau is a tableland composed of the *old crystalline, igneous and metamorphic rocks* mostly the *Archaen Gneisses* and *Schists*

Formation – It was formed due to the *breaking and drifting of the Gondwana land* and thus, making it a part of the oldest landmass.

Slope – The general elevation of the plateau is from the west to the east, which is also proved by the pattern of the flow of rivers.

Rift Valleys – The rift valleys (*rifts form after faulting of land, this indicates that the peninsular block had been subjected to various geological movements*) of the Narmada, the Tapi and the Mahanadi and the Satpura block mountains are some examples of it.

Black Soil – The western and northwestern part of the plateau has an emphatic presence of black soil.

Mountains and **Hillocks** – The Peninsula mostly consists of relict and residual mountains like the Aravali hills, the Nallamala hills, the Javadi hills, the Veliconda hills, the Palkonda range and the Mahendragiri hills, etc.

Complex Relief – This Peninsular plateau has undergone recurrent phases of upliftment and submergence accompanied by crustal *faulting* and *fractures*. (The Bhima fault needs special mention, because of its recurrent seismic activities). These spatial variations have brought in elements of diversity in the relief of the Peninsular plateau. The northwestern part of the plateau has a complex relief of ravines and gorges. The ravines of Chambal, Bhind and Morena are some of the well-known examples.

This plateau consists of two broad divisions, namely, the Central Highlands and the Deccan Plateau.

I. Central High Land

The part of the Peninsular plateau lying to the north of the Narmada river covering a major area of the Malwa plateau is known as the Central Highlands.

Metamorphised Area – This region has undergone metamorphic processes in its geological history, which can be corroborated by the presence of metamorphic rocks such as marble, slate, gneiss, etc.

Hills and **Mountains** – The *Vindhyan* range is bounded by the Central Highlands on the south and the *Aravalis* on the northwest. The further westward extension gradually merges with the sandy and rocky desert of Rajasthan. An eastern extension of the Central Highland is formed by the *Rajmahal* hills, to *the south of which lies a large reserve of mineral resources in the Chotanagpur plateau.*

Slope – The flow of the rivers draining this region, namely the Chambal, the Sind, the Betwa and Ken is from southwest to northeast, thus indicating the slope.

Rivers – Chambal, Ken, Betwa flow towards North and form Tributaries of Ganga. While Narmada and Tapti drain towards West in Arabian Sea. Banas is the only significant tributary of the river Chambal that originates from the Aravalli in the west.

The Central Highlands are wider in the west but narrower in the east.

Boundaries – The eastward extensions of this plateau are locally known as the Bundelkhand and Baghelkhand. The Chotanagpur plateau marks the further eastward extension, drained by the Damoder river.

Note – *Narmada Valley is the dividing line of Central highland and Deccan Plateau*

II. The Deccan Plateau

The Deccan Plateau is a triangular landmass that lies to the south of the river Narmada.

Hills and **Mountains** -The Satpura range flanks its broad base in the north while the Mahadev, the Kaimur hills and the Maikal range form its eastern extensions. ‘Anaimudi’

(2,695 m), the highest peak of Peninsular plateau is located on the Anaimalai hills of the Western Ghats

Deccan Trap – One of the distinct features of the peninsular plateau is the black soil

area known as Deccan Trap. This is of volcanic origin hence the rocks are igneous. It was formed by the outpouring of basalt lava. *Actually these rocks have denuded over time and are responsible for the formation of black soil*. 'Trap' in Swedish means – a 'Step' or 'Stair'.

Ghats – The Western Ghats and the Eastern Ghats mark the western and the eastern edges of the Deccan Plateau respectively.

a. **Western Ghats** or **Shayadri**

The Western (also known as 'Sahyadri') Ghats are higher than the Eastern Ghats.

Names – Western Ghats are locally known by different namessuch as Sahyadri in Maharashtra, Nilgiri hills in Karnataka andTamil Nadu and Anaimalai hills and Cardamom hills in Kerala.

Continous – While the Western Ghats are almost continuous, the Eastern Ghats are broken and uneven.

Rain – The Western Ghats cause orographic rain by facing the rain bearing moist winds to rise along the western slopes of the Ghats.

Height – The height of the Western Ghats progressively increases from north to south. Their average elevation is 900–1600 metres as against 600 metres of the Eastern Ghats.

Rivers – Most of the Peninsular Rivers have their origin in the Western Ghats.

b. Eastern Ghats

Irregular and **Discontinous** – The Eastern Ghats stretch from the Mahanadi Valley to the Nigiris in the south. The Eastern Ghats are discontinuous and irregular and dissected by rivers draining into the Bay of Bengal.

Low in **Height** – Compared to Western Ghats they are low

Eroded by **Rivers** – Eastern Ghats comprising the discontinuous and low hills are highly eroded by the rivers such as the Mahanadi, the Godavari, the Krishna, the Kaveri, etc.

The Eastern and the Western Ghats meet each other at the Nilgiri hills.

CHOTANAGPUR PLATEAU

THE NORTH-EASTERN PLATEAU or MEGHALAYA PLATEAU

In fact it is an extension of the main Peninsular plateau. It is believed that due to the force exerted by the northeastward movement of the Indian plate at the time

of the Himalayan origin, a huge fault was created between the Rajmahal hills and the Meghalaya plateau. Later, this depression got filled up by the deposition activity of the numerous rivers. Today, the Meghalaya plateau stand detached from the main Peninsular Block.

The Meghalaya plateau is further sub-divided into three – The Garo Hills; The Khasi Hills; The Jaintia Hills, named after the tribal groups inhabiting this region.

Similar to the Chotanagpur plateau, the Meghalaya plateau is also rich in mineral resources like coal, iron ore, sillimanite, limestone and uranium. This area receives maximum rainfall from the south west monsoon. As a result, the Meghalaya plateau has a highly eroded surface. Cherrapunji displays a bare rocky surface devoid of any permanent vegetation cover.

PLAINS

They are, generally, not more than 200 metres above mean sea level. Some plains are *extremely level.* Others may be slightly rolling and undulating. Most of the plains *are formed by rivers and their tributaries*. The rivers flow down the slopes of mountains and erode them. They carry forward the eroded material. Then *they deposit their load consisting of stones, sand and silt along their courses and in their* valleys. It is from these deposits that plains are formed.

Generally, *plains are very fertile.* Construction of transport network is easy. Thus, these plains are very thickly-populated regions of the world. Some of the largest plains made by the rivers are found in Asia and North America. For example, in Asia, these plains are formed by the Ganga and the Brahmaputra in India and the Yangtze in China.

PLAINS in INDIA

I. **Doabs –** The Indus and its tributaries– the Jhelum, the Chenab, the Ravi, the Beas and the Satluj originate in the Himalaya. This section of the plain is dominated by the doabs. (Do - Means two, and Ab - means water)

II. **Northern Plains – The Ganga Plain –** The northern plains are the granaries of the country. They provide the base for early civilisations. The plateau is a storehouse of minerals, which has played a crucial role in the industrialisation of the country. It extends between Ghaggar and Teesta rivers. It is spread over the states

of North India, Haryana, Delhi, U.P., Bihar, partly Jharkhand and West Bengal to its East, particularly in Assam lies the Brahmaputra plain. The northern plains are generally described as flat land with no variations in its relief. It is not true. These vast plains also have diverse relief features.

The states of Haryana and Delhi form a water divide between the Indus and the Ganga river systems.

Regions of Northern Plains – *From the north to the south, these can be divided into three major zones* – the Bhabar, the Tarai and the alluvial plains. *The alluvial plains can be further divided into the* Khadar and the Bhangar. So, there are four regions –

a. **Bhabhar** – It is a narrow belt ranging between 8-10 km *parallel to the Shiwalik foothills* at the break-up of the slope. As a result of this, the streams and rivers coming from the mountains deposit heavy materials of rocks and boulders, and at times, *disappear in this zone*. It forms the Northern boundry of alluvial plains. As the region is made of assorted *sediments like pebbles which have high porosity* and hence river streams sink in this region. That's why, *except for rainy season, this area is dry.* The area is *not suitable for agriculture* and *only big deep rooted trees thrive here*.

b. **Tarai** – South of bhabhar belt, the streams and rivers re-emerge and create a wet, swampy and marshy region known as terai. This was a *thickly forested region* full of wildlife. The region is wetter towards east for higher rainfall in the region. The forests have been *cleared to create agricultural land* and to settle migrants from Pakistan after partition. *This has a luxurious growth of natural vegetation and houses a varied wild life and hence most important from ecological perspective*. However, *Terai soil unlike Alluvial soil is rich in Nitrogen, but is poor in Phosphate*.

c. **Alluvial Plains** – They are further divided into new or younger alluvial plains and older alluvial plains. Alluvial soil however lacks the process of Humification and as a result lack Nitrogen. Therefore there is considerable use of Nitrogenous fertilizers in the northern plains.

 Bhangar – The largest part of the northern plain is formed of *older alluvium*.

They lie above the flood plains of the rivers and present a terrace like feature. This part is known as bhangar. The soil in this region contains calcareous (CaCO3 rich) deposits locally known as kankar.

 Khadar – The newer, younger deposits of the flood plains are called khadar. They are renewed almost every year and so are fertile, thus, ideal for intensive agriculture. *Khader are formed in flood plains, in Punjab these are called **Bets**. While khaddar carries fossil remains of the species which still roam around, bhangar carry remains of older species also which no longer exist today. The khader plains are flooded every year and have less kanker.*

Apart *from* the above, there are also other types of plains –

 Reh or **Kallar** – These are barren, drier and saline parts in UP and Haryana. These have increased due to increased irrigation.

 Bhur – Elevated piece of land situated along bank of Ganga in upper Ganga-Yamuna doab formed by the sand accumulated by winds in hot dry season.

III. **Northern Plains – Brahmputra plains** – The Brahmaputra plains are known for their riverine islands and sand bars. Most of these areas are *subjected to periodic floods* and *shifting river courses forming braided streams*. The mouths of these mighty rivers also form some of the largest deltas of the world, for example, the famous Sunderbans delta. Otherwise, this is a featureless plain with a general elevation of 50-150 m above the mean sea level.

IV. **Cosatal Plains –** The Peninsular plateau is flanked by stretch of narrow coastal strips, running along the Arabian Sea on the west and the Bay of Bengal on the east.

a. Western Coastal Planes – The western coast, sandwiched between the Western Ghats and the Arabian Sea, is a narrow plain. It has following features –

 Coastal Division – The northern part of the coast is called the **Konkan** (Mumbai – Goa), the central stretch is called the **Kannad Plain**, while the southern stretch is referred to as the **Malabar Coast**.

 The Malabar coast has got certain distinguishing features in the form of **'Kayals'** or backwaters (backwater is a

stretch of water that has become bypassed by the main flow of a stream, although still joined to it. It has a very low rate of flow), which are used for fishing, inland navigation and also due to its special attraction for tourists.

 Submerged and **Narrow Planes** – The western coastal plains are an example of submerged coastal plain. It is believed that the city of Dwaraka which was once a part of the Indian mainland situated along the west coast is submerged under water. There are other proofs like presence of submerged forests etc. *Because of this 'submergence' it is a narrow belt*.

 The western coastal plains are narrow in the middle and get broader towards north and south.

 Natural Harbours – Because of the submerged side the continental shelf is also narrower, the narrow strip of plane and shelf*provides natural conditions for the development of ports and harbours*. Kandla, Mazagaon, JLN port NavhaSheva, Marmagao, Mangalore, Cochin, etc. are some of the important natural ports located along the west coast.

b. **Eastern Coastal Planes** – While Western Plains are formed due to submergence, they are mainly formed by alluvial deposits.

 Coastal Division – The plains along the Bay of Bengal are wide and level. In the northern part, it is referred to as the **Northern Circar**. While the southern part is known as the **Coromandel Coast**.

 Emergent Coast – As compared to the western coastal plain, the eastern coastal plain is broader and is an example of an emergent coast. Because of its emergent nature, it has less number of ports and harbours. The continental shelf extends up to 500 km into the sea, which makes it difficult for the development of good ports and harbours.

 Deltas – There are well developed deltas here as coastal planes are wider with low gradient, formed by the rivers flowing eastward in to the Bay of Bengal. These include the deltas of the Mahanadi, the Godavari, the Krishna and the Kaveri.

Significance of Coastal Palins –

 Many crops like Rice and Coconut are grown here

 More than 98% of the sea trade is done through ports on these plains

 Sedimentary rocks in these plains carry mineral oils

 Kerala coast also carries Monazite deposits – Thorium ore

ROCKS, MINERALS and MINING

ROCKS

Rocks are made up of ***minerals***. Minerals are chemical substances found in nature may be either as elements and compounds. There are three major types of rocks: igneous rocks, sedimentary rocks and metamorphic rocks.

I. **Igneous Rocks –** When the molten magma cools, it becomes solid. Rocks thus formed are called igneous rocks. They are also called ***primary rocks*** as other rocks are said to be derived of them. These are usually massive, having layers, hard, compact, free of fossils. Igneous rocks are classified based on texture. Texture depends upon size and arrangement of grains or other physical conditions of the materials. If molten material is cooled slowly at great depths, mineral grains may be very large. Sudden cooling (at the surface) results in small and smooth grains. There are two types of igneous rocks: intrusive rocks and extrusive rocks.

 Extrusive Rocks – Lava (When *Magma comes on surface*) is one such rock and it is actually fiery red molten Magma (*lava which is inside surface*) coming out from the interior of the earth on its surface. When this molten lava comes on the earth's surface, it rapidly cools down and becomes solid. Rocks formed in such a way on the crust are called extrusive igneous rocks. *Igneous rock occurs in form of various bodies such as Batholiths (which are large masses of solid rock bodies inside earth), Lacoliths, Dykes etc.* They have a very fine grained structure and hence a shiny surface. For example, Basalt. The Deccan plateau is made up of basalt rocks. Upon erosion, the basaltic rocks have been converted into black soil called – Regur.

 Intrusive Rocks – Sometimes the molten magma cools down deep inside the earth's crust. Solid rocks so formed are called intrusive igneous rocks. Since they cool down slowly they form large grains. Granite is an example of such a rock. Grinding stones used to prepare paste/powder of spices and grains are made of granite. Tors and Domes are *characteristics of Granite landscape. It is the most abundant of earth's crust. Number of economic minerals extracted from it are also more than sedimentary*

rock. Platinum, diamond, gold, copper, zinc, silver, manganese, lead etc are found in such rocks.

Other igneous rocks are – quartz and feldspar

II. **Sedimentary Rocks –** Rocks roll down, crack, and hit each other and are broken down into small fragments. These smaller particles are called sediments. These sediments are transported and deposited by wind, water, etc. Water is the most predominant carrier and hence most of the sedimentary rocks are formed under water. These loose sediments are compressed and hardened to form layers of rocks. These types of rocks are called sedimentary rocks. For example, sandstone is made from grains of sand. Sedimentary rocks contain fossils also. Hence, sedimentary rocks can also be made up of organic matter. Coal and limestone (made up of shells of sea organisms) are such examples. Alluvial deposits in the Indo-Gangetic plain is of sedimentary nature. They form almost 75% of the covered area of crust yet make up only 5% of total rocks. They typically occur in layers. *Carbonaceous rocks which produce 'coal' and 'oil' belong to category of rocks called sedimentary.*

III. **Metamorphic Rocks –** Igneous and sedimentary rocks can change into metamorphic rocks under great heat and pressure. For example, clay changes into slate and limestone into marble. Granite is converted into Gneiss; Shale into Schist; Sandstone into Quartzite; Coal turns into Anthracite. Actually all rocks form a cycle called ***Rock Cycle***, Molten magma into Igneous rocks, Igneous into Sedimentary, Igneous and Sedimentary into Metamorphic and metamorphic again under heat turns into molten Magma and the cycle repeats.

CAVE STRUCTURES

Stalactite – A stalactite is a type of secondary mineral that hangs from the ceiling of limestone caves. It is a type of dripstone. Stalactites hang as icicles of different diameters.

Stalagmite – Stalagmites on the other hand rise up from the floor of the caves. In fact, stalagmites form due to dripping water from the surface or through the thin pipe, of the stalactite, immediately below it. Both of them form due to the dripping

of mineralized solutions and the deposition of calcium carbonate.

Column – If these formations grow together, the result is known as a column.

ROCKS in INDIA

India has a diverse geology. Different regions in India contain rocks of all types belonging to different geologic periods. Some of the rocks are badly deformed and transmuted while others are recently deposited alluvium.

Deccan Trap – Firstly, the Deccan Trap covers almost all of Maharashtra, a part of Gujarat, Karnataka, Madhya Pradesh and Andhra Pradesh marginally. It is believed that the Deccan Trap was formed as *result of sub-aerial volcanic activity* associated with the continental deviation in this part of the Earth during the *Mesozoic era*. That is why the rocks found in this region are generally igneous type.

The Precambrian rocks of India have been classified into two systems, namely the *Dharwar* system and the *Archaean* system.

 The rocks of the **Dharwar system** are mainly sedimentary in origin, and occur in narrow elongated synclines resting on the gneisses found in Bellary district, Mysore and the Aravalis of Rajputana.

 A considerable area of peninsular India, the Indian Shield, consists of **Archean** gneisses and schists which are the oldest rocks found in India.

MINERALS

Rocks are made up of different minerals. *Minerals are naturally occurring homogeneous substances* which have certain physical properties and definite chemical composition. Minerals usually occur in a form called – ***ore***. Minerals are metallic or non-metallic. Metallic are further classified as ferrous or non-ferrous. Non-metallic minerals are either organic in origin such as fossil fuels also known as mineral fuels which are derived from the buried animal and plant life such as coal and petroleum. Other type of non-metallic minerals are inorganic in origin such as mica, limestone and graphite, etc.

Formation of Minerals – In *igne*ous and metamorphic rocks minerals may occur in the cracks, crevices, faults or joints. The smaller occurrences are called veins and

the larger are called lodes. *Diamond* occurs in such veins and lodes.

Vein – It is a distinct sheet like body of crystallized minerals within a rock. Veins form when mineral constituents carried by an aqueous solution within the rock mass are deposited through precipitation. The hydraulic flow involved is usually due to hydrothermal circulation.

In most cases, *they are formed when minerals in liquid/molten and gaseous forms are forced upward through cavities towards the earth's surface.* They cool and solidify as they rise. Major metallic minerals like tin, copper, zinc and lead etc. are obtained from veins and lodes.

Placer Deposits – Certain minerals may occur as alluvial deposits in sands of valley floors and the base of hills. These deposits are called 'Placer Deposits' and generally contain minerals, w*hich are not corroded by water*. Gold, silver, tin and platinum are most important among such minerals.

Another mode of formation involves the decomposition of surface rocks, and the removal of soluble constituents, leaving a *residual mass of weathered material* containing ores. Bauxite is formed this way.

MINERALS AROUND THE WORLD

I. Asia

China and India have large iron ore deposits. The continent produces more than half of the world's tin. China, Malaysia and Indonesia are among the world's leading tin producers.

China also leads in production of lead, antimony and tungsten.

II. Europe

Europe is the leading producer of *iron-ore* in the world. The countries with large deposits of iron ore are Russia, Ukraine, Sweden and France.

Minerals deposits of copper, lead, zinc, manganese and nickel are found in Eastern Europe and European Russia.

Germany produces Lignite

III. North America

The mineral deposits in North America are located in three zones:

- the Canadian region north of the Great Lakes,
- the Appalachian region and
- the mountain ranges of the west.

Iron ore, nickel, gold, uranium and copper are mined in the Canadian Shield Region, coal in the Appalachians region. Western Cordilleras have vast deposits of copper, lead, zinc, gold and silver.

Canada produces Asbestos

US produces Coal and Copper

IV. South America

Brazil is the largest producer of high grade iron-ore in the world.

Chile and Peru are leading producers of copper.

Brazil and Bolivia are among the world's largest producers of tin.

South America also has large deposits of gold, silver, zinc, chromium, manganese, bauxite, mica, platinum, asbestos and diamond.

Mineral oil is found in Venezuela, Argentina, Chile, Peru and Columbia.

V. Africa

Africa is rich in mineral resources. It is the world's largest producer of diamonds, gold and platinum. South Africa, Zimbabwe and Zaire produce a large portion of the world's gold. The other minerals found in Africa are copper, iron ore, chromium, uranium, cobalt and bauxite. Oil is found in Nigeria, Libya and Angola.

VI. Australia

Australia is the largest producer of bauxite in the world. It is a leading producer of gold, diamond, iron ore, tin and nickel. It is also rich in copper, lead, zinc and manganese. Kalgoorlie and Coolgardie areas of Western Australia have the largest deposits of gold.

MINERALS in INDIA

Extraction of Minerals in India is guided by New Mineral Policy of 1994 which has following broad objectives –

I. To explore minerals on and offshore

II. To exploit them with the national and strategic interest in mind

III. To also keep in mind the environmental impact of such exploration and extractions

IV. To promote foreign trade in minerals

V. To promote research in minerals

Our country is well-placed in respect of ferrous minerals both in reserves and production. However, India is poorly

endowed with non-ferrous metallic minerals, like copper, except bauxite.

Mineral Belts in India

Most of the metallic minerals in India occur in the peninsular plateau region in the old crystalline rocks. Over 97 per cent of coal reserves occur in the valleys of Damodar, Sone, Mahanadi and Godavari.

Areas of high rainfall lack in soluble minerals like Limestone, Gypsum and Salt.

Northern Plains are poor in minerals because thick layers of alluvium are deposited on the original surface.

Minerals are generally concentrated in three broad belts in India.

I. **The North-Eastern Plateau Region** – This belt covers Chotanagpur (Jharkhand), Orissa Plateau, West Bengal and parts of Chhattisgarh. It has variety of minerals viz. iron ore coal, manganese, bauxite, mica.

Chota Nagpur Plateau is called 'the Mineral heart' of India.

II. **The South-Western Plateau Region** – This belt extends over Karnataka, Goa and contiguous Tamil Nadu uplands and Kerala. This belt is rich in ferrous metals and bauxite. It also contains high grade iron ore, manganese and limestone. This belt packs in coal deposits except Neyveli lignite. *This belt does not have as diversified mineral deposits as the north-eastern belt.* Kerala has deposits of monazite and thorium, bauxite clay. Goa has iron ore deposits.

III. **The North-Western Region** – This belt extends along Aravali in Rajasthan and part of Gujarat and minerals are associated with Dharwar system of rocks. Copper, zinc have been major minerals. Rajasthan is rich in building stones i.e. sandstone, granite, marble. Gypsum and Fuller's earth deposits are also extensive. Dolomite and limestone provide raw materials for cement industry. Gujarat is known for its petroleum deposits.

Major Mineral and their locations in India

I. **Iron** – *India is rich in good quality iron ores*. Magnetite is the finest iron ore with a very high content of iron up to 70 per cent. It has excellent magnetic qualities, especially valuable in the electrical industry. Hematite ore is the most important industrial iron ore in terms of the quantity used, but has a slightly lower iron content than magnetite. (50-60 per cent).The mineral is found mainly in Jharkhand, Orissa, Chhattisgarh, Madhya

Pradesh, Goa, Maharashtra and Karnataka. The major iron ore belts in India are –

a. Orissa-Jharkhand Belt

In Orissa high grade hematite ore is found in Badampahar mines in the Mayurbhanj and Kendujhar districts. In the adjoining Singbhum district of Jharkhand haematite iron ore is mined in Gua and Noamundi.

b. Durg-Bastar-Chandrapur Belt

It lies in Chhattisgarh and Maharashtra. Very high grade hematites are found in the famous Bailadila range of hills in the Bastar district of Chattisgarh. The range of hills comprise of 14 deposits of super high grade hematite iron ore. It has the best physical properties needed for steel making. *Iron ore from these mines is exported to Japan and South Korea via Vishakapatnam port.*

c. Bellary-Chitradurga-Chikmaglur-Tumkur Belt

It is in Karnataka has large reserves of iron ore. The Kudermukh mines located in the Western Ghats of Karnataka are a 100 per cent export unit. Kudremukh deposits are known to be one of the largest in the world. The ore is transported as slurry through a pipeline to a port near Mangalore.

II. **Manganese** – Manganese is *mainly used in the manufacturing of steel and ferro-manganese alloy.* Its sources lie near Iron ore mines in India. Nearly 10 kg of manganese is required to manufacture one tonne of steel. It is also used in manufacturing bleaching powder, insecticides and paints.India's manganese deposits lie in Maharashtra, Madhya Pradesh, Chhattisgarh, Orissa, Karnataka and Andhra Pradesh.

III. **Bauxite** – Though, several ores contain aluminium, it is from bauxite, a clay-like substance that alumina and later aluminium is obtained. Bauxite deposits are formed by the decomposition of a wide variety of *rocks rich in aluminium silicates.* Orissa is the largest bauxite producing state in India with 45 per cent of the country's total production in 2000-01. Panchpatmali deposits in Koraput district are the most important bauxite deposits in the state.

Major bauxite producing areas are Jharkhand, Orissa, Chhattisgarh, Madhya Pradesh, Gujarat, Maharashtra and Tamil Nadu.

IV. **Mica** – Mica is a mineral made up of a series of plates or leaves. It splits easily into thin sheets. These sheets can be so thin that a thousand can be layered into a mica sheet of a few centimeters high. Mica can be clear, black, green, red yellow or brown. Due to its excellent di-electric strength, low power loss factor, insulating properties and resistance to high voltage, mica is one of the most indispensable minerals used in electric and electronic industries. Mica deposits are found in the northern edge of the Chota Nagpur plateau. Koderma Gaya – Hazaribagh belt of Jharkhand is the leading producer. In Rajasthan, the major mica producing area is around Ajmer. Nellore mica belt of Andhra Pradesh is also an important producer in the country.

Mica deposits mainly occur in Jharkhand, Bihar, AndhraPradesh and Rajasthan. India is the largest producer and exporter of mica in the world.

V. **Copper** – It is mainly produced in Rajasthan, MadhyaPradesh, Jharkhand, Karnataka and Andhra Pradesh. India is critically deficient in the reserve and production of copper. The Balaghat mines in Madhya Pradesh produce 52 per cent of India's copper. The Singbhum district of Jharkhand is also a leading producer of copper. The Khetri mines in Rajasthan are also famous.

VI. **Limestone** – Major limestone producing states in India are Bihar, Jharkhand, Orissa, Madhya Pradesh, Chhattisgarh, Rajasthan, Gujarat and Tamil Nadu.

VII. **Gold** – Kolar in Karnataka has deposits of gold in India. These mines are among the deepest in the world which makes mining of this ore a very expensive process.

VIII. **Salt** – It is obtained from seas, lakes and rocks. India is one of the world's leading producers and exporters of salt.

IX. **Natural gas** – Natural gas is found with petroleum deposits and is released when crude oil is brought to the surface. It can be used as a domestic and industrial fuel. Russia, Norway, UK and the Netherlands are the major producers of natural gas. In

India Jaisalmer, Krishna Godavari delta, Tripura and some areas off shore in Mumbai have natural gas resources.

X. **Coal** – Coal is found in a variety of forms depending on the degrees of compression.

a. **Peat** – Decaying plants in swamps produce peat which has a low carbon and high moisture contents and low heating capacity.

b. **Lignite** - Lignite is a low grade brown coal, which is soft with high moisture content. The principal lignite reserves are in Neyveli in Tamil Nadu and are used for generation of electricity.

c. **Bituminous** -Coal that has been buried deep and subjected to increased temperatures is bituminous coal. It is the most popular coal in commercial use. Metallurgical coal is high grade bituminouscoalwhich has a special value for smelting iron in blast furnaces.

d. **Anthracite** - Anthraciteis the highest quality hard coal.

In India coal occurs in rock series of two main geological ages, namely Gondwana, a little over 200 million years in age and in tertiary deposits which are only about 55 million years old, *Gondwana rocks have 90% of Indian coal reserves*. The major resources of Gondwana coal, which are metallurgical coal, are located in Damodar valley (West Bengal-Jharkhand). Jharia, Raniganj, Bokaro are important coalfields. The Godavari, Mahanadi, Son and Wardha valleys also contain coal deposits. Tertiary coals occur in the north eastern states of Meghalaya, Assam, Arunachal Pradesh and Nagaland.

Problems in coal mining –

a. There is no competition – Coal India is sole monopoly and investments are not in accordance with the changing circumstances. As a result, power plants in India are facing shortage.

b. Deep Mines – around 2/3rd of the deposits are deep seated which make them uneconomical to extract despite investment

c. High Ash Content – Indian coal is of poor quality and this is the reason that sometimes despite availability, coal is imported from countries like Indonesia

MINING

It can be of 3 types –

I. **Open Cast Mining** – Cheapest and easiest way in which overburden is removed to extract the minerals or to get

the raw materials. Limestone is often quarried in such a manner

II. **Underground Mining** – When ore lies deep inside.

III. **Alluvial Mining** – When minerals occur in alluvial deposits they are usually recovered by ***Placer Mining Method***. This is done by mixing the alluvium with a great deal of water and tilting or rotating the gravels until the lighter particles are washed off and leaving behind the heavier ores – e.g. gold, tin chromium, platinum etc. It is easy mining as compared with others.

Which one of the following minerals is formed by decomposition of rocks, leaving a residual mass of weathered material?
(a) coal (b)'BAUXITE'(c) gold (d) zinc

Which one of the following minerals is contained in the Monazite sand?
(a) oil (b) uranium (c) 'THORIUM' (d) coal

GENERAL PHYSIOGRAPHY– INDIA and WORLD

INDIA

- India has an area of about 3.28 million sq. km. The north-south extent from Kashmir to
- Kanyakumari is about 3,200 km. And the east-west extent from Arunachal Pradesh to Kuchchh is about 2,900 km.
- From south to north, India extends between 8°4'N and 37°6'N latitudes – 3,219 km
- From west to east, India extends between 68°7'E and 97°25'E longitudes - 2,933 km

PHYSIOGRAPHIC DIVISIONS of INDIA

The physical features of India can be grouped under the following physiographic divisions

I. The Himalayan Mountains

II. The Northern Plains

III. The Peninsular Plateau

IV. The Indian Desert

V. The Coastal Plains

VI. The Islands

IST – Indian Standard Time

There is a general understanding among the countries of the world to select the standard

meridian in multiples of 7°30' of longitude. That is why 82°30' E has been selected as the standard meridian' of India. Indian Standard Time is ahead of Greenwich Mean Time by 5 hours

and 30 minutes.

CLIMATE of INDIA

From the values of latitude, it is understood that the southern part of the country lies within the tropics and the northern part lies in the sub-tropical zone or the warm temperate zone.

LAYERS of EARTH

Most of the information about interior of earth is obtained indirectly as samples from deep inside cannot be collected. Earthquakes, gravitation, magnetic field, and meteors include some of the indirect sources. Volcanic eruptions, hot springs, rocks, deep drillings, deep mines etc are direct sources of internal information.

Just like an onion, the earth is made up of several concentric layers with one inside another.

I. Crust

The uppermost layer over the earth's surface is called the crust. It is the thinnest of all the layers, just like an egg shell. It is about 35 km on the continental masses and only 5km on the ocean floors. It is lighter than the layer beneath it and generally density of material goes on increasing as we go down. Thus core (NiFe – Nickle+Ferrous) is heaviest.

Oxygen is the largest constituent of the Crust. It is present in form of oxides of various elements. Silicon is second largest substance. Upper layer of crust – very thin – is made up of sedimentary rocks, while most of the crust is composed of crystalline igneous and metamorphic rocks which are generally acidic in nature.

Half of crust is made from Feldspar which is a mineral made of Silicon, Oxygen and other elements.

- Continental Crust – The main mineral constituents of the 'continental crust' aresilica and

alumina. It is thus called 'sial' (si-silica and al-alumina). It is lighter than the oceanic crust.

- Oceanic Crust – The 'oceanic crust' mainly consists of silica and magnesium; it is therefore called 'sima' (si-silica and ma-magnesium) Mantle Second Layer is mantle. By volume it is the largest layer. It has higher density than that of the crust.

Aesthenosphere – The mantle contains a weaker zone called Asthenosphere. It is from this that the molten rock materials find their way to the surface. Asthenosphere is a plastic layer type which has high temperature and upon which lithosphere floats. The material in the upper mantle portion is called magma. The slow movement of Asthenosphere also disturbs the layer of lithosphere also and leads to 'folding' and 'faulting' (termed as tectonic activities).

III. Core

Third Layer is core, the innermost layer is the core with a radius of about 3500 km. It is mainly made up of nickel and iron and is called 'nife' (ni – nickel and fe – ferrous i.e. iron).

The central core has very high temperature and pressure. Due to this, it remains in solid state.

EARTHQUAKE

Most of the earthquakes and Tsunamis occur in an area called 'Pacific Ring of Fire'.

In an Earthquake, the place in the crust where the movement starts is called the Focus. The place on the surface above the focus is called the Epicentre.

Origin and Cause – All natural earthquakes (there can be other non-natural like due to Reservoirs for dams, mines collapse etc) take place in the lithosphere(upto 200km and it consists of Crust and Upper most layer of mantle) and are mainly caused by activities in the

I. Tectonic plates – associated with faulting

II. Volcano eruption.

When plates/structure exert pressure on each other, at one point this becomes critical and plates move releasing energy

which takes shape of an earthquake. This energy release takes the form of seismic waves.

Shallow Earthquakes – Whose epicentre lies near surface) are more dangerous.

Types of Earthquake Waves – Earthquake waves are basically of two types — Body waves and Surface waves.

MOUNTAIN SYSTEM of INDIA

THE HIMALAYAN MOUNTAINS

Himalayas are not only the physical barrier, they are also a climatic, drainage and cultural divide.

The mountains are supposed to emerge out of 'The Tethy's Sea'. The altitudinal variations are greater in the eastern half than those in the western half. The Himalaya consists of three parallel ranges in its longitudinal extent. A number of valleys lie between these ranges.

Himalaya as Young Mountains –

- Presence of Fossils in Shiwalik similar to Tibetan Plateau
- Frequent Occurrence of Earthquakes indicates that they have still to reach isostatic equilibrium.
- Himalayan Rivers are still in their youthful age with characteristic V gorges, steep water falls etc The Himalayas along with some other peninsular mountains are young, weak and flexible in their geological structure unlike the rigid and stable Peninsular Block. These mountains are tectonic in origin, dissected by fast-flowing rivers which are in their youthful stage. Various landforms like gorges, V-shaped valleys, rapids, waterfalls, etc. are indicative of this stage.

Broad ranges of Himalayas –

I. Northern Most Range is known as the Great or Inner Himalayas or the 'Himadri'. It is the most continuous range consisting of the loftiest peaks with an average height of 6,000 meters. It contains all the prominent Himalayan peaks. Great Himalayas are asymmetrical in nature. The ranges are mainly composed of highly compressed and altered rocks. The core of some part

of imalayas is composed of granite with outer cover as sedimentary. Its southern slope (towards India) is steep and northern slope (towards Tibet) is gentle. The altitude varies between 3,700 and 4,500 meters and the average width is of 50 Km and most of the tallest peaks lie here.

II. Mid Himalayas or Lesser Himalyas – Valley of Kashmir lies in these. These are less hostile and most of the hill resorts like Kullu, Manali, Shimla, Nainital etc are located here.

Shiwalik is the southernmost range and is least in Average height. Also called Outermost Himalayas. They were almost continuous and blocked the courses of rivers which in past led to formation of lakes which after drying led to formation of plains called Duns in the West and called Duars in the east.

PLATEU

Plateu is an elevated flat land. It is a flat-topped table land standing above the surrounding area.

Plateaus are very useful because they are rich in mineral deposits. As a result, many of the mining areas in the world are located in the plateau areas. African plateau is famous for gold and diamond mining. In India huge reserves of iron, coal and manganese are found in the Chhotanagpur plateau. The reason that Deccan Plateau is rich in minerals is that it is formed by the Basaltic rocks (lava eruptions or extrusive igneous rocks) which are rich in minerals. Primary mineral ores found in this region are mica and iron ore in the Chhota Nagpur region, and diamonds, gold and other metals in the Golconda region.

The lava plateaus are rich in black soil that is fertile and good for cultivation. Many plateaus have scenic spots and are of great attraction to tourists.

Relief of peninsular plateau is highly uneven.

Major Plateu in India are – Peninsular plateau, Chotanagpur plateau and The North-Eastern Plateau or Meghalaya Plateau.

Ghats – The Western Ghats and the Eastern Ghats mark the western and the

eastern edges of the Deccan Plateau respectively.

a. Western Ghats or Shayadri

The Western (also known as 'Sahyadri') Ghats are higher than the Eastern Ghats.

Names – Western Ghats are locally known by different names such as Sahyadri in Maharashtra, Nilgiri hills in Karnataka and TamilNadu and Anaimalai hills and Cardamom hills in Kerala.

Continuous – While the Western Ghats are almost continuous, the Eastern Ghats are broken and uneven.

Rain – The Western Ghats cause orographic rain by facing the rain bearing moist winds to rise along the western slopes of the Ghats.

Height – The height of the Western Ghats progressively increases from north to south. Their average elevation is 900–1600 metres as against 600 metres of the Eastern Ghats.

Rivers – Most of the Peninsular Rivers have their origin in the Western Ghats.

b. Eastern Ghats

Irregular and Discontinuous – The Eastern Ghats stretch from the Mahanadi Valley to the Nigiris in the south. The Eastern Ghats are discontinuous and irregular and dissected by rivers draining into the Bay of Bengal.

Low in Height – Compared to Western Ghats they are low Eroded by Rivers – Eastern Ghats comprising the discontinuous and low hills are highly eroded by the rivers such as the Mahanadi, the Godavari, the Krishna, the Kaveri, etc.

The Eastern and the Western Ghats meet each other at the Nilgiri hills.

PLAINS in INDIA

I. Doabs – The Indus and its tributaries– the Jhelum, the Chenab, the Ravi, the Beas and the Satluj originate in the Himalaya. This section of the plain is dominated by the doabs. (Do - Means two, and Ab - means water)

II. Northern Plains – The Ganga Plain – The northern plains are the granaries of the country. They provide the base for early civilisations. The plateau is a storehouse of minerals, which has played a crucial role in

the industrialisation of the country. It extends between Ghaggar and Teesta rivers. It is spread over the states of North India, Haryana, Delhi, U.P., Bihar, partly Jharkhand and West Bengal to its East, particularly in Assam lies the Brahmaputra plain. The northern plains are generally described as flat land with no variations in its relief. It is not true. These vast plains also have diverse relief features.

ROCKS

Rocks are made up of minerals. Minerals are chemical substances found in nature may be either as elements and compounds. There are three major types of rocks: igneous rocks, sedimentary rocks and metamorphic rocks.

I. Igneous Rocks – When the molten magma cools, it becomes solid. Rocks thus formed are called igneous rocks. They are also called primary rocks as other rocks are said to be derived of them. These are usually massive, having layers, hard, compact, free of fossils.

Igneous rocks are classified based on texture. Texture depends upon size and arrangement of grains or other physical conditions of the materials. If molten material is cooled slowly at great depths, mineral grains may be very large. Sudden cooling (at the surface) results in small and smooth grains. There are two types of igneous rocks: intrusive rocks and extrusive rocks.

 Extrusive Rocks – Lava (When Magma comes on surface) is one such rock and it is actually fiery red molten Magma (lava which is inside surface) coming out from the interior of the earth on its surface. When this molten lava comes on the earth's surface, it rapidly cools down and becomes solid. Rocks formed in such a way on the crust are called extrusive igneous rocks. Igneous rock occurs in form of various bodies such as Batholiths (which are large masses of solid rock bodies inside earth), Lacoliths, Dykes etc. They have a very fine grained structure and hence a shiny surface. For example, Basalt. The Deccan plateau is made up of basalt rocks. Upon erosion, the basaltic rocks have been converted into black soil called – Regur.

 Intrusive Rocks – Sometimes the molten magma cools down deep inside the earth's crust. Solid rocks so formed are called

intrusive igneous rocks. Since they cool down slowly they form large grains. Granite is an example of such a rock.

Grinding stones used to prepare paste/powder of spices and grains are made of granite. Tors and Domes are characteristics of Granite landscape. It is the most abundant of earth's crust. Number of economic minerals extracted from it is also more than sedimentary rock. Platinum, diamond, gold, copper, zinc, silver, manganese, lead etc are found in such rocks.

Other igneous rocks are – quartz and feldspar

II. Sedimentary Rocks – Rocks roll down, crack, and hit each other and are broken down into small fragments. These smaller particles are called sediments. These sediments are transported and deposited by wind, water, etc. Water is the most predominant carrier and hence most of the sedimentary rocks are formed under water. These loose sediments are compressed and hardened to form layers of rocks. These types of rocks are called sedimentary rocks. For example, sandstone is made from grains of sand.

Sedimentary rocks contain fossils also. Hence, sedimentary rocks can also be made up of organic matter. Coal and limestone (made up of shells of sea organisms) are such examples. Alluvial deposits in the Indo-Gangetic plain is of sedimentary nature. They form almost 75% of the covered area of crust yet make up only 5% of total rocks. They typically occur in layers. Carbonaceous rocks which produce 'coal' and 'oil' belong to category of rocks called sedimentary.

III. Metamorphic Rocks – Igneous and sedimentary rocks can change into metamorphic rocks under great heat and pressure. For example, clay changes into slate and limestone into marble. Granite is converted into Gneiss; Shale into Schist; Sandstone into Quartzite; Coal turns into Anthracite. Actually all rocks form a cycle called Rock Cycle, Molten magma into Igneous rocks, Igneous into Sedimentary, Igneous and Sedimentary into Metamorphic and metamorphic again under heat turns into molten Magma and the cycle repeats.

ROCKS in INDIA

India has a diverse geology. Different regions in India contain rocks of all types belonging to different geologic periods. Some of the rocks are badly deformed and transmuted while others are recently deposited alluvium.

MINERALS in INDIA

Extraction of Minerals in India is guided by New Mineral Policy of 1994 which has following

Broad objectives –

I. To explore minerals on and offshore

II. To exploit them with the national and strategic interest in mind

III. To also keep in mind the environmental impact of such exploration and extractions

IV. To promote foreign trade in minerals

V. To promote research in minerals Our country is well-placed in respect of ferrous minerals both in reserves and production.

However, India is poorly endowed with non-ferrous metallic minerals, like copper, except

bauxite.

Mineral Belts in India

Most of the metallic minerals in India occur in the peninsular plateau region in the old crystalline rocks. Over 97 per cent of coal reserves occur in the valleys of Damodar, Sone, Mahanadi and Godavari.

Areas of high rainfall lack in soluble minerals like Limestone, Gypsum and Salt.

Northern Plains are poor in minerals because thick layers of alluvium are deposited on the original surface.

Minerals are generally concentrated in three broad belts in India.

I. The North-Eastern Plateau Region – This belt covers Chotanagpur (Jharkhand),

Orissa Plateau,West Bengal and parts of Chhattisgarh. It has variety of minerals viz. iron ore coal, manganese, bauxite, mica.

Chota Nagpur Plateau is called ‘the Mineral heart’ of India.

II. The South-Western Plateau Region – This belt extends over Karnataka, Goa and contiguous Tamil Nadu uplands and Kerala. This belt is rich in ferrous metals and bauxite. It also contains high grade iron ore, manganese and limestone. This belt packs in coal deposits except Neyveli lignite. This belt does not have as

diversified mineral deposits as the north-eastern belt. Kerala has deposits of monazite and thorium, bauxite clay. Goa has iron ore deposits.

III. The North-Western Region – This belt extends along Aravali in Rajasthan and part of Gujarat and minerals are associated with Dharwar system of rocks.

Copper, zinc have been major minerals. Rajasthan is rich in building stones i.e. sandstone, granite, marble. Gypsum and Fuller's earth deposits are also extensive. Dolomite and limestone provide raw materials for cement industry.

Gujarat is known for its petroleum deposits.

Major Mineral and their locations in India

I. Iron – India is rich in good quality iron ores. Magnetite is the finest iron ore with a very high content of iron up to 70 per cent. It has excellent magnetic qualities, especially valuable in the electrical industry. Hematite ore is the most important industrial iron ore in terms of the quantity used, but has a slightly lower iron content than magnetite. (50-60 per cent).The mineral is found mainly in Jharkhand, Orissa, Chhattisgarh, Madhya Pradesh, Goa, Maharashtra and Karnataka. The major iron ore belts in India are –

a. Orissa-Jharkhand Belt

In Orissa high grade hematite ore is found in Badampahar mines in the Mayurbhanj and Kendujhar districts. In the adjoining Singbhum district of Jharkhand haematite iron ore is mined in Gua and Noamundi.

b. Durg-Bastar-Chandrapur Belt

It lies in Chhattisgarh and Maharashtra. Very high grade hematites are found in the famous Bailadila range of hills in the Bester district of Chattisgarh. The range of hills comprise of 14 deposits of super high grade hematite iron ore. It has the best physical properties needed for steel making. Iron ore from these mines is exported to Japan and South Korea via Vishakapatnam port.

c. Bellary-Chitradurga-Chikmaglur-Tumkur Belt

It is in Karnataka has large reserves of iron ore. The Kudermukh mines located in the Western Ghats of Karnataka are a 100 per cent export unit. Kudremukh deposits are

known to be one of the largest in the world. The ore is transported as slurry through a pipeline to a port near Mangalore.

II. Manganese – Manganese is mainly used in the manufacturing of steel and ferro-manganese alloy. Its sources lie near Iron ore mines in India. Nearly 10 kg of manganese

is required to manufacture one tonne of steel. It is also used in manufacturing bleaching powder, insecticides and paints. India's manganese deposits lie in Maharashtra, Madhya Pradesh, Chhattisgarh, Orissa, Karnataka and Andhra Pradesh.

III. Bauxite – Though, several ores contain aluminium, it is from bauxite, a clay-like substance that alumina and later aluminium is obtained. Bauxite deposits are formed by the decomposition of a wide variety of rocks rich in aluminium silicates. Orissa is the largest bauxite producing state in India with 45 per cent of the country's total production in 2000-01. Panchpatmali deposits in Koraput district are the most important bauxite deposits in the state.

Major bauxite producing areas are harkhand, Orissa, Chhattisgarh, Madhya Pradesh, Gujarat, Maharashtra and Tamil Nadu.

IV. Mica – Mica is a mineral made up of a series of plates or leaves. It splits easily into thin sheets. These sheets can be so thin that a thousand can be layered into a mica sheet of a few centimetres high. Mica can be clear, black, green, red yellow or brown. Due to its excellent di-electric strength, low power loss factor, insulating properties and resistance to high voltage, mica is one of the most indispensable minerals used in electric and electronic industries. Mica deposits are found in the northern edge of the Chota Nagpur plateau. Koderma Gaya – Hazaribagh belt of Jharkhand is the leading producer. In Rajasthan, the major mica producing area is around Ajmer. Nellore mica belt of Andhra Pradesh is also an important producer in the country.

Mica deposits mainly occur in Jharkhand, Bihar, AndhraPradesh and Rajasthan. India is the largest producer and exporter of mica in the world.

RIVERS and WATER RESOURCES of INDIA

All major rivers of India originate from one of the three main watersheds –

I. The Himalaya and the Karakoram ranges

II. Vindhya and Satpura range in central India (The rivers Narmada and Tapi flow through these ranges.)

III. Sahyadri or Western Ghats in western India

Classification – Rivers are broadly divided into Himalayan and Peninsular rivers.

I. The Himalayan Rivers

Their major features are –

 They perform intensive erosion activity in their upper courses and

 Carry huge loads of silt and sand. The Kosi brings huge quantity of sediments from its upper reaches and deposits it in the plains. The course gets blocked, and consequently, the river changes its course. (This is the reason that Himalayan rivers change their course sometimes)

The Himalayan Rivers have long courses from their source to the sea.

 These rivers pass through the giant gorges carved out by the erosion activity carried on simultaneously with the uplift of the Himalayas.

 Besides deep gorges, these rivers also form V-shaped valleys, rapids and waterfalls in their mountainous course

 While entering the plains, they form depositional features like flat valleys, ox-bow lakes, flood plains, braided channels, and deltas near the river mouth.

 In the Himalayan reaches, the course of these rivers is highly tortuous, but over the plains they display a strong meandering tendency and shift their courses frequently.

 In the middle and the lower courses. The streams within a drainage basin form certain patterns, depending on the slope of land, underlying rock structure as well as the climatic conditions of the area.

II. Peninsular Rivers

Their major features are –

 The Peninsular drainage system is older than the Himalayan one. This is evident from the broad, largely-graded shallow valleys, and the maturity of the rivers.

 The Western Ghats running close to the western coast act as the water divide between the major Peninsular rivers, discharging their water in the Bay of Bengal and as small rivulets joining the Arabian Sea.

 Peninsular rivers are seasonal, as their flow is dependent on rainfall. During the dry season, even the large rivers have reduced flow of water in their channels.

 Peninsular rivers are characterized by fixed course, absence of meanders and nonperennial flow of water.

 The Peninsular Rivers have shorter and shallower courses as compared to their Himalayan counterparts.

 The drainage basins of the peninsular rivers are comparatively small in size.

 Most of the rivers of peninsular India originate in the Western Ghats and flow towards the Bay of Bengal.

 However, some of them originate in the central highlands and flow towards the west. (they are Narmada and Tapti)

River Systems in India – A river Along with its tributaries is called a river System. Following are the major river systems –

I. Northern River Systems

a. The Indus River System – The river Indus rises in Tibet, near Lake Mansarowar. Flowing west, it enters India in the Ladakh district of Jammu and Kashmir. It forms a picturesque gorge in this part. Several tributaries, the Zaskar, the Nubra, the Shyok and the Hunza, join it in the Kashmir region. The Indus plain has a very gentle slope. With a total length of 2900 km, the Indus is one of the longest rivers.

According to the regulations of the Indus Water Treaty (1960), India can use only 20 percent of the total water carried by Indus river system. This water is used for irrigation in the Punjab, Haryana and the southern and western parts of Rajasthan.

Tributaries of Indus –

 The Jhelum, an important tributary of the Indus, rises from a spring at Verinag situated at the foot of the PirPanjal in the south-eastern part of the valley of Kashmir. It flows through Srinagar and the Wular lake before entering Pakistan through a deep narrow gorge.

 The Chenab is the largest tributary of the Indus. It is formed by two streams, the

Chandra and the Bhaga, which join at Tandi near Keylong in Himachal Pradesh.

Hence, it is also known as Chandrabhaga.

 The Ravi is another important tributary of the Indus. It rises west of the Rohtang pass in the Kullu hills of Himachal Pradesh and flows through the Chamba valley of the state.

b. The Ganga River System – The headwaters of the Ganga, called the 'Bhagirathi' is fed by the Gangotri Glacier and joined by the Alaknanda at Devaprayag in Uttarakhand. At

Haridwar the Ganga emerges from the mountains on to the plains.

Tributaries of Ganga – The Ganga is joined by many tributaries from the Himalayas, a few of them being major rivers such as the Himalayan Tributaries or Left Bank Tributaries – The Ghaghara, the Gandak and the Kosi are main tributaries. (Yamuna is an Himalayan tributary, but a Right bank tributary).

The Ghaghara, the Gandak and the Kosi rise in the Nepal Himalaya. They are the rivers, which flood parts of the northern plains every year, causing widespread damage to life

and property but enriching the soil for the extensive agricultural lands.

Peninsular Tributaries or Right Bank Tributaries – The main tributaries, which come from the peninsular uplands, are the Yamuna (a Himalayan River), Tons and the Son.

These rise from semi arid areas, have shorter courses and do not carry much water in them. The Son is a largest south bank tributary of the Ganga, originating in the Amarkantak plateau. The river Yamuna rises from the Yamunotri Glacier in the Himalayas. It flows parallel to the Ganga and as a right bank tributary, meets the Ganga at Allahabad. It is joined by the Chambal, the Sind, the Betwa and the Ken on its 'right bank' which originates from the Peninsular plateau Enlarged with the waters from its right and left bank tributaries, the Ganga flows eastwards till Farakka in West Bengal. This is the northernmost point of the Ganga delta.

The river bifurcates here; the Bhagirathi-Hooghly (a distributor) flows southwards through the deltaic plains to the Bay of

Bengal. The mainstream, flows southwards into Bangladesh and is joined by the Brahmaputra. Further down stream, it is known as the Meghna. This mighty river, with waters from the Ganga, and the Brahmaputra, flows into the Bay of Bengal. The delta formed by these rivers is known as the Sunderban delta.

Meandering of Ganga – It is due to low gradient – Ambala is located on the water divide between the Indus and the Ganga river systems. The plains from Ambala to the

Sunderban stretch over nearly 1800 km, but the fall in its slope is hardly 300 meters. In other words, there is a fall of just one meter for every 6 km. Therefore, the river develops large meanders. This is also the reason that some other rivers like Kosi shift their path frequently as gradient is very low and hence flood a large area.

c. The Brahmaputra River System – The Brahmaputra rises in Tibet east of Mansarowarlake very close to the sources of the Indus and the Satluj. It is slightly longer than the Indus, and most of its course lies outside India. It flows eastwards parallel to the Himalayas.

The Peninsular River Systems

The main water divide in Peninsular India is formed by the Western Ghats, which runs from north to south close to the western coast.

East Flowing Peninsular Rivers – Most of the major rivers of the Peninsula such as the Mahanadi, the Godavari, the Krishna and the Kaveri flow eastwards and drain into the Bay of Bengal. Eastern flowing rivers make deltas at their mouths. There are numerous small streams flowing west of the Western Ghats. The Narmada and the Tapi are the only long rivers, which flow west and make estuaries.

a. The Godavari Basin – The Godavari is the largest Peninsular river. It rises from the slopes of the Western Ghats in the Nasik district of Maharashtra. Its length is about 1500 km. It drains into the Bay of Bengal. Its drainage basin is also the largest among the peninsular rivers. The basin covers parts of Maharashtra (about 50 per cent of the basin area lies in Maharashtra), Madhya Pradesh, Orissa and Andhra Pradesh. The Godavari is joined by a number of tributaries such as the Purna, the Wardha, the Pranhita, the

Manjra, the Wainganga and the Penganga. The last three tributaries are very large.

Because of its length and the area it covers, it is also known as the 'Dakshin Ganga'.

b. The Mahanadi Basin – The Mahanadi rises in the highlands of Chhattisgarh. It flows through Orissa to reach the Bay of Bengal. The length of the river is about 860 km. Its drainage basin is shared by Maharashtra, Chhattisgarh, Jharkhand, and Orissa.

c. The Krishna Basin – Rising from a spring near Mahabaleshwar, the Krishna flows for about 1400 km and reaches the Bay of Bengal. The Tungabhadra, the Koyana, the Ghatprabha, the Musi and the Bhima are some of its tributaries. Its drainage basin is shared by Maharasthra, Karnataka and Andhra Pradesh.

d. The Kaveri Basin – The Kaveri rises in the Brahmagri range of the Western Ghats and it reaches the Bay of Bengal in south of Cuddalore, in Tamil Nadu. Total length of the river is about 760 km. Its main tributaries are Amravati, Bhavani, Hemavati and Kabini. Its basin drains parts of Karnataka, Kerala and Tamil Nadu. It forks into two streams and then rejoins again forming island like structure in Tamil Nadu at three places – Sivasamudram, Srirangapattanam, Srirangam. Kaveri is the most harnessed river of India.

West Flowing Peninsular Rivers – Major rivers are Narmada and Tapti. The reason why they flow westward is that – there is a fault plain parallel to Vindhyas formed during geological upheavals formed by bending and sagging of the Northern part of Peninsula during formation of Himalayas. Other main west flowing rivers are Sabarmati, Mahi, Bharathpuzha and Periyar.

a. The Narmada Basin – The Narmada rises in the Amarkantak hills in Madhya Pradesh. All the tributaries of the Narmada are very short and most of these join the main stream at right angles. (i.e. a Trellis Pattern). The Narmada basin covers parts of Madhya Pradesh and Gujarat. It flows in a rift valley, flowing west between the Satpura and Vindhya ranges. The Tapti River and Mahi River also flow through rift valleys, but between different ranges. It forms an estuary and there are a number

of islands in its estuary out of which Aliabet is largest.

b. The Tapti Basin – The Tapti rises in the Satpura ranges, in the Betul district of Madhya Pradesh. It also flows in a rift valley parallel to the Narmada but it is much shorter in length. Its basin covers parts of Madhya Pradesh, Gujarat and Maharashtra. The coastal plains between Western Ghats and the Arabian sea are very narrow. (The eastern Coastal plains are much broader.) Hence, the coastal rivers are short. These two rivers don't form Delta because of two reasons –

- They flow through hard rocks and hence are not able to form tributaries.
- They flow in narrow valleys where tributaries are not formed.
- Unlike East flowing rivers which flow through a low gradient and hence have slower speed, conditions are apt for delta formation. On the western Ghats gradient is higher.

Other west flowing rivers are – Sharawati in Karnataka, Sabarmati and Mahi are the two famous rivers of Gujarat, Mandovi and Juari are from Goa, Periyar in Kerala.

ATMOSPHERIC LAYERS

The proportion of gases changes in the higher layers of the atmosphere in such a way that oxygen will be almost in negligible quantity at the height of 120 km. Similarly, carbon dioxide and water vapour are found only up to 90 km from the surface of the earth. Various Layers are –

I. Troposphere – This layer is the most important layer of the atmosphere. Its average height is 13 km. The air we breathe exists here. Almost all the weather phenomena like rainfall, fog and hailstorm occur in this layer.

An intermediary layer is called Tropopause, the lower latitude has higher convectional currents, therefore height of tropopause also varies and it also varies according to seasons. It is more near equator. Near equator as insulation is high, convection currents are strong.

II. Stratosphere – Above the troposphere lies the stratosphere. It extends up to a height of 50 km. This layer is almost free from clouds and associated weather phenomenon, making conditions most ideal for flying airplanes. This is mainly

because of isothermal conditions that exist in this sphere and hence there are least temperature variation and there is also relatively absence of the clouds. There is also relative absence of strong convectional currents.

One important feature of stratosphere is that it contains a layer of 'ozone' gas. Ozone is mainly produced in mid latitudes and tropical latitudes. In the lower layers ozone is relatively very less. But it increases at a level of around 32 km, a layer known as ozone belt is there. The absorbed UV radiation is responsible for the heating effect of the ozone layer. This layer absorbs ultra-violet radiation and shields life on the earth from intense, harmful form of energy.

Troposphere and **Stratosphere** are clearly separated. The air of the two spheres don't mix easily and it may take several months.

III. Mesosphere – This is the third layer of the atmosphere. It lies above the stratosphere. It extends up to the height of 80 km. Meteorites burn up in this layer on entering from the space. Mesopahere is the coldest (-90 or -95 degree Celsius).

IV. Thermosphere – In thermosphere temperature rises very rapidly with increasing height.

IONOSPHERE is a part of this layer. This layer helps in radio transmission. In fact, radio waves transmitted from the earth are reflected back to the earth by this layer.

Exosphere – The upper most layer of the atmosphere is known as exosphere. This layer has very thin air. Light gases like helium and hydrogen float into the space from here.

VI. Magnetosphere – Above 500 km, the motion of ions is strongly constrained by the presence of the earth's magnetic field. This region is called magnetosphere, it is compressed by the solar wind on the sunlight side of earth and stretched outward in a long tail on its night side. The colourful aurora display often seen in polar latitudes are associated with the generation by solar energy outbursts of high energy particles in magnetosphere, which are subsequently injected into the lower ionosphere.

CLIMATE in INDIA

The climate of India is described as the 'monsoon' type. In Asia, this type of climate is found mainly in the south and the southeast.

India is not affected by any major current.

In general, coastal areas experience less contrasts in temperature conditions. Seasonal contrasts are more in the interior of the country.

There is decrease in rainfall generally from east to west in the Northern Plains.

Most parts of the country receive rainfall from June to September. But some parts like the Tamil Nadu get rain in Oct-Nov.

India lies in the region of north easterly winds. These winds originate from the subtropical high-

pressure belt of the northern hemisphere. They blow south, get deflected to the right due to the Coriolis force, and move on towards the equatorial low-pressure area. Generally, these winds carry very little moisture as they originate and blow over land. Therefore, they bring little or no rain. Hence, India should have been an arid land, but, it is not so.

THE MONSOONS

Monsoons are like a Heat Engine, which collects, concentrates, stores the sun's energy of South Indian Ocean and transports it to the great Northern plains and release it over the parched landscape.

The monsoons are experienced in the tropical area roughly between 20° N and 20° S. To understand the mechanism of the monsoons, the following facts are important –

I. The differential heating and cooling of land and water

It creates low pressure on the landmass of India while the seas around experience comparatively high pressure. This strengthens the 'The Monsoon Trough'(i.e. he low pressure system created due to heating of Indian subcontinent also known as ITCZ) and the whole system acts as a magnet and attracts moisture laden winds. Over the north, the process of condensation results into releasing of latent heat thereby sustaining high temperature in northern region and hence low pressure region. I.e. conditions of monsoon trough perpetuate themselves II. The shift of the position of 'Inter Tropical

Convergence Zone (ITCZ)' (Also called 'monsoon trough' or 'Doldrums') as Sun moves Northwards. The Inter Tropical Convergence Zone (ITCZ) or Thermal Equator is a broad trough of low pressure in equatorial latitudes (it always remains on the north of the equator due to effect of landmass). This is where the northeast and the southeast trade winds converge and this is a low pressure zone. This convergence zone lies more or less parallel to the equator but moves north or south with the apparent movement of the sun. At the time of monsoons, it shifts towards north (towards India) and hence attracts moisture laden winds. According to meteorologists, Monsoon is the result of the shift of the ITCZ under the influence of the vertical sun towards Tropic of Cancer. The ITCZ being the zone of lowest pressure in the tropical region, is the target destination for the Trade winds of both the hemispheres. Consequentially, with ITCZ at the Tropic of cancer (over Indian peninsula), the South East Trade winds of the Southern Hemisphere have to cross the equator to reach the ITCZ. However, due to Coriolis Effect, these South East trade winds are deflected eastwards in the Northern Hemisphere transforming into South West trades. These pick up the moisture while travelling from sea to land and cause orographic rain once they hit the highlands of the Indian Peninsula. This results in the South-West Monsoon.

ONSET of the MONSOON

The Monsoon, unlike the trade winds, are not steady winds but are pulsating in nature, affected by different atmospheric conditions encountered by it, on its way over the warm tropical seas.

The duration of the monsoon is between 100- 120 days from early June to mid-September.

Burst of monsoon – Around the time of its arrival, the normal rainfall increases suddenly and continues constantly for several days. This is known as the 'burst' of the monsoon, and can be distinguished from the pre-monsoon showers.

Pre-Monsoon Showers or Mango Showers – Mango showers are the pre-monsoon showers in the Indian states of Karnataka, Kerala, Konkan and Goa that help in the ripening of mangoes.

Also known as April rains or Summer showers, they are a result of thunderstorms over the Bay of Bengal. These summer rains normally come in the second half of the month of April. The showers prevent the mangoes from dropping prematurely from trees and are crucial for the mango cultivators of South India.

WITHDRAWAL or THE RETREAT of THE MONSOON

By the end of September, the southwest monsoon becomes weak as the low pressure trough of the Ganga plain starts moving southward in response to the southward march of the sun.

It is a more gradual process. The withdrawal of the monsoon begins in north western states of India by early September. By mid-October, it withdraws completely from the northern half of the peninsula. The withdrawal from the southern half of the peninsula is fairly rapid. By early December, the monsoon has withdrawn from the rest of the country.

October Heat – The retreating southwest monsoon season is marked by clear skies and rise in temperature. The land is still moist. Owing to the conditions of high temperature and humidity, the weather becomes rather oppressive. This is commonly known as the 'October heat'.

TAMILNADU and SOUTHWEST MONSOONS

Tamil Nadu coast remains dry during this season. There are two factors responsible for it –

 The Tamil Nadu coast is situated parallel to the Bay of Bengal branch of southwest monsoon.

 It lies in the rain shadow area of the Arabian Sea branch of the south-west monsoon.

Tamil Nadu on the other hand gets rain from the retreating monsoon or the North East

Monsoon as it picks moisture from Bay of Bengal.

TYPES OF VEGETATION IN INDIA

Usually precipitation is the biggest factor in deciding the vegetation. However, towards Himalayas temperature also plays an important role. Influence of topography

and soil is also important and is seen in case of Mangrove forests.

Forest Cover – In terms of forest cover, Northern plains are least covered. In terms of percentage forest cover of India is just 19% out of which also only 12% are dense forests and remaining are sparse and degraded forests. Major forest belt lies in the Himalayan region which – from Kashmir to Assam – constitute around 25% of the forest cover of India.

The following major types of vegetation may be identified in our country-

I. Tropical Evergreen Forests

II. Tropical Deciduous Forests

III. Tropical Thorn Forests and Scrubs

IV. Montane Forests

V. Mangrove Forests

Biosphere Reserves – 17 biosphere reserves have been set up in the country to protect flora and fauna. Four out of these, the Sunderbans in the West Bengal, Nanda Devi in Uttarakhand, the Gulf of Mannar in Tamil Nadu and the Nilgiris (Kerala, Karnataka and Tamil Nadu) have been included in the world network of Biosphere reserves

 National Parks –More than 100 National Parks, 490 Wildlife sanctuaries and Zoological gardens are set up to take care of Natural heritage.

ECOLOGY, CONSERVATION, ECOLOGICAL BALANCE AND SUSTAINABILITY

Some basic terms and concepts –

 Habitat – A habitat in the ecological sense is the totality of the physical and chemical factors that constitute the general environment.

 Ecosystem – A system consisting of biotic and a biotic components is known as ecosystem. From a structural point of view, all ecosystems consist of a biotic and biotic factors. Ecosystems are of two major types: terrestrial and aquatic. Terrestrial ecosystem can be further be classified into ‘biomes’.

 Biomes – A biome is a plant and animal community that covers a large geographical area. The boundaries of different biomes on land are determined mainly by climate. Therefore, a biome can be defined as the total assemblage of

plant and animal species interacting within specific conditions. There are five major biomes – forest, desert, grassland, aquatic, tundra. Factors that affect a biome are – Annual variation in temperature, mineral availability, rainfall etc. Of all the biomes, tundra is the most continuous as it occurs almost unbroken along the pole ward margins of the Northern Continent. It is also the most fragile as it lacks diversity.

 Eco-Tone – It refers to a transition zone between two biomes. It generally has higher species diversity as compared to any neighbouring biomes.

 Eco-region – An ecoregion (ecological region), sometimes called a bioregion, is an ecologically and geographically defined area that is smaller than an ecozone and larger than an ecosystem.

Ecoregions cover relatively large areas of land or water, and contain characteristic, geographically distinct assemblages of natural communities and species. The biodiversity of flora, fauna and ecosystems that characterize an ecoregion tends to be distinct from that of other ecoregions. In theory, biodiversity or conservation ecoregions are relatively large areas of land or water where the probability of encounter of different species and communities at any given point remain relatively constant, within an acceptable range of variation (largely undefined at this point).

The greatest damage inflicted on Indian forests was during the colonial period due to the expansion of the railways, agriculture, commercial and scientific forestry and mining activities. Even after Independence, agricultural expansion continues to be one of the major causes of depletion of forest resources. Many species became extinct from India, for example -Cheetah became extinct from India in 50s.

Some of our environmental activists say that the promotion of a few favored species, in many parts of India, has been carried through the ironically-termed ‘enrichment plantation’, in which a single commercially valuable species was extensively planted and other species eliminated. For instance, teak monoculture has damaged the natural

forest in South India and Chir Pine plantations in the Himalayas have replaced the Himalayan oak and Rhododendron forests.

Situation in India –

 Over half of India's natural forests are gone

 One-third of its wetlands drained out,

 70 per cent of its surface water bodies polluted,

 40 per cent of its mangroves wiped out,

 With continued hunting and trade of wild animals and commercially valuable plants, thousands of plant and animal species are heading towards extinction.

Species on the basis of their vulnerability (from most vulnerable to less vulnerable) –

I. Endangered Species (Most Vulnerable) – These are species which are in danger of extinction.

The survival of such species is difficult if the negative factors that have led to a decline in their population continue to operate. The examples of such species are black buck, crocodile, Indian wild ass, Indian rhino, lion tailed macaque, sangai (brow antler deer in Manipur), etc.

II. Vulnerable Species – These are species whose population has declined to levels from where it is likely to move into the endangered category in the near future if the negative factors continue to operate. The examples of such species are blue sheep, Asiatic elephant, Gangetic dolphin, etc.

III. Rare Species (Less Vulnerable) – Species with small population may move into the endangered or vulnerable category if the negative factors affecting them continue to operate. The examples of such species are the Himalayan brown bear, wild Asiatic buffalo, desert fox and hornbill, etc.

MEASURES to CONSERVE FLORA and FAUNA

National Parks, Reserved Forests and Protected Forests – Wild life reserves in India are classified in these categories.

I. Wild Life Sanctuaries – They are relatively open to human activity and human interaction is not completely barred. In a sanctuary, hunting without

permission is barred and grazing of cattle is regulated.

II. National Park – A natural area designated to protect the ecological integrity of one or more ecosystems for present and future generations. They enjoy highest degree of protection and human activity is totally banned. The National parks of India are **IUCN** category II protected areas. India's first national park was established in 1936 as Hailey National Park, now known as Jim Corbett National Park. Today there are more than 100 National parks.

III. Reserved Forests – More than half of the total forest land has been declared reserved forests. Reserved forests are regarded as the most valuable as far as the conservation of forest and wildlife resources are concerned. As of present, reserved forests and protected forests differ in one important way: Rights to all activities like hunting, grazing, etc in reserved forests are banned unless specific orders are issued otherwise.

In reserved forests, rights to activities like hunting and grazing are sometimes given to communities living on the fringes of the forest, who sustain their livelihood partially or wholly from forest resources or products. Thus, typically reserved forests enjoy a higher degree of protection with respect to protected forests. However, it is possible that certain protected forests may enjoy more protection with respect to certain reserved forests.

IV. Biosphere Reserves in India – They are internationally recognized, nominated bynational governments and remain under sovereign jurisdiction of the states where they are located and are a part of UN 'Man and Biosphere' program. Biosphere reserves serve in some ways as 'living laboratories' for testing out and demonstrating integrated management of land, water and biodiversity. Collectively, biosphere reserves form a world network: the World Network of Biosphere Reserves (WNBR). Within this network, exchanges of information, experience and personnel are facilitated. There are over 500 biosphere reserves in over 100 countries. In India there are 7 as a part of this chain (out of its total 17 biosphere reserves). Functions of Biosphere Reserves are threefold –

 A conservation function – to contribute to the conservation of landscapes, ecosystems, species and genetic variation;

 A development function – to foster economic and human development which is socio-culturally and ecologically sustainable;

 A logistic function – to provide support for research, monitoring, education and information exchange related to local, national and global issues of conservation and development.

In India there are 17 Biosphere reserves, out of which 7 biosphere reserves are part of World Network of Biosphere Reserves. Efforts are on to include the rest also in this list.

Core areas of these biospheres are protected under Wildlife Protection Act 1972 and Indian Forest Act 1927.

The Nilgiri Biosphere Reserve (NBR), the first of the 17 biosphere reserves of India, was established in September 1986.

Some other Biosphere reserves are –

 Nokrek Meghalaya

 Agasthyamalai Kerala, Tamil Nadu

 Manas Assam

 Seshachalam Hills Andhra Pradesh

 Pachmarhi Biosphere Reserve Madhya Pradesh

 Sunderbans Bengal

 Gulf of MannarTamilnadu

 Simlipal Orissa

 AchanakamarAmarkantak Madhya Pradesh

 DihangDibang Arunachal Pradesh

 DibruSaikhova Assam

 Agasthyamalai Kerala

V. Protected Forests – Almost one-third of the total forest area is protected forest, as declared by the Forest Department. This forest land are protected from any further depletion. Protected forests are of two kinds -demarcated protected forests and undemarcated protected forests, based on whether the limits of the forest have been specified by a formal notification.