1

UNDERSTANDING GEOGRAPHY

Unit Structure:

1.0. OBJECTIVES:

Module 1 is on Understanding of Geography will help the student:

- Will help them to understand through various definitions how different scholars have perceived geography.
- To realize the scope and importance of the Physical and Human Geography.
- To study various branches of physical, human and interface geography.
- To understand the spatial distribution of physical and human phenomenon on the earth's surface.
- To study various aspects of earth's interior.
- To know about earthquake and its waves.
- To understand how and where the land and water is distributed on the earth's surface in the world.

1.1. INTRODUCTION:

Geography is a fundamental science that helps us to understand our physical environment with its elements and

components forming a complex structure of the earth which is the only habitable planet in the solar system. Geographers study the factors responsible for spatial distribution and variation of people, places with their locations. Physical geographers explain the phenomenon of evolution of landforms, tectonic movements, weather and climate, ocean characteristics and properties, flora and fauna. Human geographers explain the interrelationship between man and his physical environment. Interface geographers study various physical and human aspects in the form of their interaction and interrelation. The study of the earth system with specific approaches by geographers has therefore developed specialized branches of geography.

1.2. DEFINING GEOGRAPHY:

Geography is related to the distribution of various features natural or man-made on the surface of the earth. A Greek scholar Eratosthenes was the first to coin the term Geography derived from the two Greek words i.e. 'Geo' means 'earth' and 'graphe' means description. Geography is thus a description of earth's surface and the entire phenomenon appearing on it. However different scholars have defined geography as per their view point. Some of these are as follows:

i) According to Richard Hartshorne 'Geography is a discipline that seeks to describe and interpret the variable character from place to place of the earth as the world of man'.

ii) According to Bowman 'Geography tells what is where, why and what it is made of'.

iii) Vidal de la Blache defines Geography as the science of places.

iv) As per Griffith Taylor opinion 'Geography is the correlative science'.

v) According to David Harvey 'Geography is concerned with the description and explanation of the areal differentiation of the earth's surface'.

Check your progress:
Q.1) How is geography viewed by different geographers?

1.3. NATURE AND SCOPE OF GEOGRAPHY:

Geography is one of the important subjects of understanding the spatial science of the earth in relation with the components of physical and human aspects. Physical Geography as a science studies the earth's surface and its characteristics representing spatial relationships and varying regional patterns. It thus includes:

- The land surface and its features (Lithosphere)
- The water surface and its characteristics (Hydrosphere)
- Gaseous envelop surrounding the earth (Atmosphere)
- Living organisms in the environment (Biosphere)

Scope of Geography: Maps form an important aspect of explaining the spatial phenomenon of the earth. Geographical Information System (GIS) is an advanced Computer Software programme useful in almost all disciplines in the economy of the world. Geography covers many of the physical and human branches in General knowledge and is one of the compulsory paper in any competitive examination like MPSC, UPSC. Nearly 50-60% graduates, prefer Geography as special subject for these exams because Geography it deals with physical and human phenomenon of day to day to life and so relatively easy to understand and score marks in these competitive examinations. Besides, Geography is one of the popular subjects at B.Ed. Colleges. Geography students can get better opportunities in Tourism, town planning, teaching etc. Geography as a subject therefore offers wide and diverse employment opportunities in their career.

Human geography studies the patterns of human activities in an environment. It includes human, political, cultural, economic aspects of social sciences. Human geography studies various activities in relation to its physical components and involves quantitative and qualitative data for analysis. Human geography is studied with the help of thematic maps giving location and other attributes of the phenomena under study. For example distribution and pattern of rural and urban settlements transport and communication lines etc. in any area.

Check your progress:

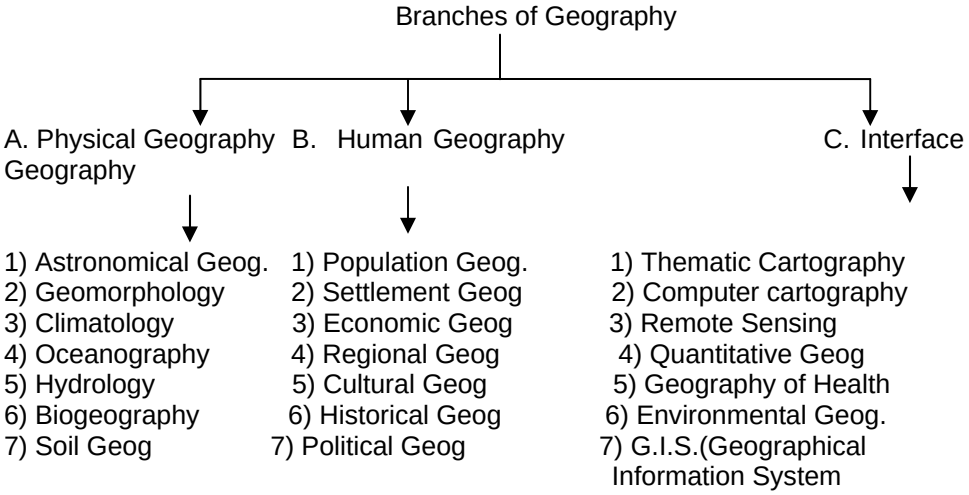
Q.2) Explain in brief the nature and scope of geography?

Physical geography undertakes the study of the earth with its four major components viz:

a) Lithosphere,
b) Hydrosphere,
c) Atmosphere, and
d) Biosphere.

All these four components with their varying spatial and temporal aspects have produced different characteristics features on the earth. This is well identified / observed by spatial distribution of different phenomenon on the surface of the earth. For example distribution of relief features natural vegetation, birds and animals, human population etc. However all these phenomenon are unevenly distributed on the earth surface.

1.4. BRANCHES OF GEOGRAPHY



A. Physical Geography: Following are the branches of physical geography.

1) Astronomical Geography: is the part of mathematical geography that treats the earth in its relation to the other celestial bodies in the solar system. Astronomical geography thus studies the earth as a planet with its shape, size, imaginary lines of latitude and longitude, time zones, and the earth's diurnal and annual motions (yearly calendar and seasons).

2) Geomorphology: According to Bloom 'Geomorphology is a systematic description and analysis of landscapes and the processes that change them'.

3) Climatology: According to Miller 'Climatology is the aggregate study and analysis of climatic conditions with long term keen observations'. Climatology is thus a e science

which deals with the atmosphere various changes that take place in the atmosphere due to temperature, humidity and atmospheric pressure and so the formation of various climatic zones on the earth and their influence on the natural environment.

4) Oceanography: According to J. Proudman Oceanography studies the fundamental principle of dynamics and thermodynamics in relation to the physical and biological properties of the sea water. It is related to the study of oceans i.e. temperature, salinity of the ocean water, relief of the ocean floor, movements of the ocean water, tides, ocean currents etc.

5) Hydrology: It is a study of earth's surface and subsurface water bodies found in the form of oceans, rivers, glaciers, lakes and seas, underground water, water vapour in the atmosphere.

6) Biogeography: It is a study of factors responsible for evolution and spatial uneven distribution of various species (plants and animals / flora and fauna) found on the earth.

7) Soil Geography: It helps to understand the formation, its nature (structure and texture), types and distribution on the earth. Soil is the most important component of the earth that determines the growth and distribution of natural vegetation and thus the species associated with it.

B. Human Geography: Following are the branches of Human Geography:

1) Population Geography: is a branch of geography that studies factors responsible for various patterns of spatial distribution and location of population on the earth's surface. It studies various demographic aspects of human population explaining growth of population, structure and occupation of population and other socio-socio cultural aspects.

2) Settlement Geography: Settlement geography explains the evolution and growth of rural and urban settlements in relation to their site and situation; their structure and pattern, nature of functions.

3) Economic Geography: This branch explains us about spatial distribution and concentration of different types of economic activities influenced by physical factors and practiced by man

based on their locational attributes. Accordingly they can be classified as:

i) **Primary activities**: e.g. Food gathering and hunting, agriculture, fishing, mining and quarrying.

ii) Secondary activities: e.g. Manufacturing and construction activity.

iii) Tertiary activities: e.g. Trade, Transport and Communication.

iv) Quaternary activities: e.g. activities related to specialist service providers such as banking and insurance, administrative and educational, defense and security, legal and medical.

It is noticed that large population engaged in primary activities are concentrated in underdeveloped countries while in developed countries they are concentrated more in secondary and tertiary activities, quaternary services.

4) Regional Geography: is a branch of geography that takes into account the homogeneous physical characteristics of an area to designate it as a region. Thus various regions are formed by taking into consideration its climate, relief, drainage, natural vegetation and population that determines unique characteristics for forming a particular region. For example Monsoon region based on climate, Himalayan mountainous region based on relief, coastal region based on coastal location, river plain of Indus and Ganga river basin, savanna region based on grassland, Amazon region based on forest, demographic regions based on population characteristics for example density of population etc.

5) Cultural Geography: studies various traditional customs and traits of a community which is reflected in their life-style, dressing pattern, food- habits, religious rituals and ceremonies, fairs and festivals, arts and architecture, language, and the type of occupation practiced by them and the nature of governance over the space. For example in terms of festivals it can be said that Christmas of Christian community, Diwali of Hindus, Id of Muslims, Buddha Jayanti of Buddhists, Mahavir jayanti of Jains etc. In case of architecture Moghul architecture of Moghuls, Gothic architecture of Britishers, Dravidian architectural style of south Indian, Hoysala architectural style of Indo-aryan, Stupas and Pagodas architecture of Buddhist etc. This spatial distribution and variation of different cultures are studied as cultural regions in this branch of geography which have evolved over a period of time due to different experiences, need and interactions. The culture of man has thus changed with changing time and technology that can be identified as a nomadic primitive man practicing hunting and food-gathering, to a cultivator developing permanent rural settlements;

manufacturer, trader, transporter that developed urban settlements. All this has influenced to some extent the traditional culture of each society.

6) Historical Geography: is a branch of geography that takes into account the geographical and human factors and processes responsible for the happening of different historical acts and events in the space over a period of time.

7) Political Geography: is a branch of geography that studies the organization of political system in a country. It mainly deals with its jurisdiction (boundaries and frontiers) and nature of relationship with neighboring and other countries in the world. The functioning of the political system determines the stability/ instability of the government and its power within and outside the country in the world.

C. Interface Geography: Following are the branches of Interface Geography:

1) Thematic Cartography: is a science of preparing maps and diagrams involving field survey with specific themes representing the spatial distribution of the phenomenon under study; for example spatial distribution of population density in the world, distribution of rainfall etc.

2) Computer Cartography: Thematic maps and graphs prepared by adopting quantitative and qualitative data analysis using specialized software's in a computer are called as computer cartography. Computer cartography has provided ease by saving time, cost and energy while producing different spatial dimension of maps / diagrams.

3) Remote Sensing: Remote sensing may be defined a collection of data bout an object from a distance. For example aircraft provides with aerial photographs, space satellites provide with satellite imagery. These have specific uses such as information about weather phenomenon, security purpose, identified the areas affected with flood/ drought/ earthquake, landslide, landuse, study of natural resource etc.

4) Quantitative Geography: The application of mathematical and statistical concepts and methods to the study of geography. Quantitative Geography is thus an empirical study of spatial phenomenon found on the earth surface that helps in determining certain scientific principles and laws.

5) Geography of Health: Health geography is the application of geographical information with spatial perspectives and methods to the study of health, disease, and health care of any area.

6) Environmental Geography: Is a branch of geography that studies how physical and human environment are interacting with each other to produce different landuse and its effect on the nature environment and on living species.

7) Geographical Information System (G.I.S.): G.I.S. is defined as a system that facilitates storage and intelligent use of data about land and water resources and human activities. An essential feature of G.I.S. is the use of sophisticated computer hardware and software to collect, store, operate and process the geographic data. G.I.S. technology today is highly utilized in the field of integrated development planning such as, water resource management, water-shed management, environmental monitoring and assessment, landscape conservation, telecommunication and network analysis, defence and military planning operations.

Check your progress:

Q.3) Discuss various branches of Physical Geography
Q.4) Discuss various branches of Human Geography
Q.5) Discuss various branches of Interface Geography

1.5. SPATIAL DISTRIBUTION OF PHENOMENON

All things or objects are not evenly distributed on the surface of the earth. They are concentrated in some areas and absent in the other areas for e.g. sand-dunes are found in hot deserts, sand beaches near sea-coast, coal is sedimentary rocks, higher educational institutions and medical services in urban areas glaciers/snow in areas in minus degree temperatures, agriculture and forest in area with favourable physical factors, mining in mineralized zones etc.

Geographers study the pattern of distribution of a particular phenomenon under study for e.g. population, where population is

concentrated and why? This geographical approach is also termed as Spatial Analysis. Spatial means related to space.

Geographers use maps for representing various features found on the earth. This pattern of distribution helps geographers to understand the areas of concentration and dispersion. It is a geographer who finds the reasons for this uneven distribution of various natural and man- made resources on the earth surface.

Maps help to understand the distribution of various phenomenons at a glance.

The ability to analyse information given in the map provides spatial analysis of the phenomena represented by the expertise of the Geographer.

World map
Population
Distribution

Our earth was formed about 4600 million years ago. Almost all natural living features like plants, animals, birds, fish, and insects appeared on the earth much before the emergence of man. Radius of the Earth is 6371 Kms.

Man appeared on the earth just about 2 million years ago. Man has well developed thinking and reasoning ability. Hence he developed science and technology and modified natural landscape. Natural features modified by the man are known as Cultural features. All the features found on the earth are therefore classified as:

(i) Natural features e.g. Mountains, rivers, trees, animals, plains, oceans etc. and
(ii) Cultural/man-made features. e.g. production of primary goods, rural and urban settlements, transport and communication, manufacturing industries, trading houses, administration and security etc.

<u>DIAGRAM</u>
Natural features

<u>DIAGRAM</u>

Cultural or Man-made features

1.6. IMPORTANCE OF PHYSICAL GEOGRAPHY:

Physical geography is that branch of natural science which deals with the study of processes and patterns in the natural environment like the atmosphere, hydrosphere, biosphere, and geosphere that shapes the Earth's surface, the animals and plants that inhabit it, and the spatial patterns they exhibit. The study of Physical geography is well done with the help of field survey and field visits for understanding various natural features .

1.7. INTERIOR OF THE EARTH:

INTERIOR OF THE EARTH: The changes that occur over the earth's surface are related with the deep existing internal forces operating from within the earth. The interior parts of the earth can be divided into 3-4 zones as: a) crust b) mantle and c) Core. It is important to study the structure of the earth's interior as explained below:

a) Crust: This is the outermost layer of the earth. Various landform features like mountains, plateau and plains, rivers, lakes, sea, oceans and human settlements are found on the crust. It is the most significant zone of the solid earth with an average thickness of 17 kilometer. The base of the crust is sharply defined where it contacts the mantle. This surface of separation between the crust and mantle is called '*Moho' (*Mohorovicic discontinuity). The crust varies greatly in thickness which is as small as 5 km. thick in some places beneath the ocean and up to 70 km. depth under the mountain ranges. It is composed of silicon (27.7 %), aluminum (8.1%), Iron (5%), Calcium (3.6%) and other elements.

The layer of SIMA is found below the layer of SIAL. The density of this layer is about 3.09/cm^3. The silicates of magnesium, calcium and iron are found in SIMA. SIMA (SI – Silica + MA – Magnesium). The bottoms of ocean are composed of denser material termed as SIMA.

Magma is found in this layer which comes out on the earth's surface as lava during volcanic eruption.

a) The rocks of this layer are subdivided into:

i) Basaltic rocks underlying the ocean basins containing much of iron and magnesium, and

ii) Granite rock: The rock that make the continents which are rich in silicon and aluminum and are lighter in colour and density.

Boundary between the crust and next layer Mantle is termed as Moho discontinuity or Mohorovicic discontinuity.

b) Mantle: The mantle is a thick layer which lies below the crust of the earth and extends up to a depth of 2900 km. and above the core. Temperature and density increase with increase in depth in this layer. The average density is 5.6 g cm^3. It is mainly of solid olivine rocks made up of silicates of magnesium and iron. Silicate minerals rich in iron and magnesium are found in this zone. Boundary between Mantle and core is termed as Gutenberg discontinuity.

c) Core: is the centre of the earth beyond a depth of 2900 km and reaches up to 6371 km with a spherical zone and a radius of 3475 km. It is assumed that the core is subdivided into two parts. Outer core and Inner core. The outer core extends from mantle up to the depth of 5100 km. and the inner core extends from 5100 km. to 6371 km. i.e. centre of the earth. Due to extreme pressure the inner core is assumed to be in the solid state. Temperature of the core is very high. As we move from surface of the earth towards it's centre, there is a rise in temperature i.e. 1^0c per 32 metres of depth. The temperature of the core is between 2200^0 Celsius and 2750^0C with atmospheric pressure as high as three to four million times found at sea level and a density of 13.5 g cm^3. It is named as Barysphere and also *Nife.* The central part is a liquid core consisting of small proportion of nickel, ferrous (80%) and other elements. The earth has a magnetic field. We are able to find out north direction due to the earth's magnetic field. This is possible due to the presence of iron-rich core. The core of the earth is composed of Nickel and Ferrous material. Hence it is termed as NiFe. (Ni = Nickel and Fe=Ferrous)

Interior of the Earth

Cross-Section of the earth

Temperature increases with depth.

From the diagram it is clear that the temperature at the centre will be more than 5000^0C. Metals such as iron, aluminium, copper and even tungstone have lower melting points than 5000^0C. Hence we assume that the core is in liquid state.

Check your progress:
Q.6) Explain with the help of suitable diagram various sections of the earth's interior.

1.8. EARTHQUAKE WAVES:

Earthquake waves provide useful information about interior of the earth. Different types of waves are generated at the time of earthquake i.e. 'P' Waves, 'S' Waves, 'L' Waves etc. These waves have different wave motions, and so have different properties. e.g. 'P' waves are able to pass through liquid material but 'S' waves are absorbed in the liquid material. These are;

P-Wave or Primary/ Longitudinal wave: These waves travel in straight line and their speed is maximum i.e. up to 12 km. per second. These waves can travel through solid as well as liquid part of the interior of the earth.

S-Wave / Secondary Wave or Transverse Wave. They move with 60 % velocity of the 'P' waves. Theses waves are slower than the P-Waves due to their zigzag wave motion. These can travel through solid part but are absorbed in the liquid part of the earth.

L-Waves :

Also known as Surface Waves or Love Waves (Love is the name of the scientist who discovered these waves). These waves cannot travel to a long distance and are restricted to the surrounding surface region where earthquake occurs. These are the most destructive waves.

These earthquake waves are recorded all over the world through the instrument called seismograph. Scientists used this data/ information and on the basis of this data they visualised internal structure of the earth.

Check your progress:

Q.7) Explain different types of earthquake waves.

1.8. DISTRIBUTION OF LAND AND WATER:

1) The distribution of landmasses and water-bodies on the surface of the Earth is not uniform. The landmasses or continents occupy 29 percent, while water-bodies or oceans cover 71 percent surface area of the earth. The surface area of the Earth is 510 million km^2 which has land surface of 149 million km^2 and water surface with 361 million km^2.

Distribution of land and water on the earth

2) The distribution of land and water in the northern hemisphere is nearly equal but it is highly uneven in the southern hemisphere. Of the total earth surface in the northern hemisphere 61 % is land and 39 % is water, while in southern hemisphere it is 19 % land and 81 % water surface. The proportion of water in the southern hemisphere is nearly 15 times more than the amount of land in the southern hemisphere is given in table 1.

I. Land masses / continents	Area in million sq.km. approximately
1. North America	24
2. South and Central America	18
3. Europe	10
4. Africa	30
5. Asia (including C.I.S. Common wealth of Independent States)	44
6. Australia	7.8
7. Antarctica	13
II. Water bodies /Oceans	
1. Pacific Ocean	165
2. Atlantic	82
3. Indian	73
4. Arctic	14

3) Water-bodies or oceans/seas are found at the antipodal locations of landmasses or continents.

Antipodal Locations	

4) Land area is almost continuous in the temperate belt (23 ½ ^{0}N. to 66 ½^{0}N.) of the northern hemisphere.

5) Water bodies or oceans form complete circle in the southern hemisphere 55^0 south latitude
i.e. between the southern continents and the continent of Antarctica.

6) Continents or land masses become narrow in the southern hemisphere.

7) East-West trade and transport routes are more important in the northern hemisphere while north – south routes are more important in the southern hemisphere.

Major transport routes in the northern hemispheres like Trans-Siberian railway, North Pacific routes, Trans-continental American railways, North Atlantic route form complete of Transport network around globe.

8) The landmass of Antarctica has three extended areas one towards Australia second towards South Africa and third towards south America.

10) About 90% of the world population is concentrated in the northern hemisphere and hence transport and communication network has developed more in the northern hemisphere.

11) Due to extensive landmasses in the northern hemisphere the interior parts of the continents like Asia experience extreme variation in summer and winter temperatures.

The range of temperature (i.e. difference between maximum and minimum temperature) increases as we move away from the sea-coastal areas towards inside of the continents. This phenomenon is termed as continentality.

of temperature is less in these areas.

Check your progress:

Q. 8) Account for the distribution and location of landmasses and water-bodies on the
earth's surface.

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_____
_____

1.9. CONCLUSION

This module has thus explained the meaning, nature, scope, importance and various branches with respect to physical, human and interface geography. Various processes, features, facts, locations and their distribution on the earth's surface and

subsurface are well explained with **supporting maps and diagrams.**

1.10.QUESTIONS

1) Define and explain the nature and scope of Geography.
2) Describe various branches of geography.
3) With the help of suitable diagram explain the interior of the earth.
4) Give an account of distribution of land and water on the earth's surface.

2

Rocks and Minerals

Unit Structure:

2.0. Objectives:

- To understand different types of rocks and minerals and their importance in human life.
- To study different types of folds and faults and their impact on determining the landform features.
- To understand the factors responsible for weathering and its types.
- To understand the mass movement of weathered materials by different agents and the resultant landforms.

2.1. Introduction:

The hard solid surface of the earth is called as lithosphere. ‘Lithos’ means rocks. Rock material may be soft or hard constituting mud, clay, sand or stones and boulders. Rocks contain different types of minerals and elements that play an important role in the cycling movement of different geo-bio-chemical cycles enabling ecosystem to function. These ecosystems thus supply different food elements to living species of the earth making it a habitable (living) planet. The settlements, building structures, different types of economic activities, transport

and communication, defense services etc. are developed only because of the presence and utilization of these rocks and minerals in various forms.

2.2. Rocks and Minerals:

Rocks and Minerals are found on the earth's surface, and in the crust of the earth below the earth's surface.

- **Rocks:** According to the geographer or geologists the term rock is applied to any naturally occurring agglomeration of minerals particles can be termed as rock. It can be soft materials as clay, mud or sand as well as hard, massive boulders of stone.

- **Mineral**s are the chemical compounds of different elements.
  for e.g. Silica ($Si O_2$).

Some minerals contain only one element e.g. sulphur and carbon (diamond).

Some minerals are crystalline because the atoms forming the crystals are arranged in a definite manner e.g. quartz.

Some minerals are non-crystalline as the atoms forming these minerals are not arranged in definite manner.

Rocks are formed due to the combination of minerals. Some rocks may contain only one mineral but many rocks are composed of different minerals.

Rocks are known by different names which are related to the combination of minerals.

Some common minerals are found everywhere on the earth and hence are termed as ‘Rock forming minerals’, while some minerals are scarce and are found only at particular location. These minerals are costly and are termed as Economic minerals.

Metals are extracted from some minerals which are known as ‘Ore’ of that metal e.g. Bauxite is an ore of Aluminum.

a) The Rock forming minerals:

Most of the rocks found on the earth are composed of following major minerals.
(1) Feldspar (2) Quartz (3) Pyroxenes (4) Amphiboles (5) Mica (6) Olivine

b) Economic minerals: Some of the important economic minerals and their uses are as follows.

i) Apatite: It is red, brown or yellow phosphorous and Fluorine is obtained from it.

ii) Barite: It is white or brown. It is used in glass, rubber, chemical and other industries.

iii) Dolomite: It is white. It is used in cement and iron and steel industries.

iv) Gypsum: It is soft, white. Used for the preparation of objects of art, idols etc.

v) Pyrite: It is yellow. Sulphuric acid is obtained from it.

vi) Talc: It is white or brown. It is used in making paints, rubber, crockery, paper, plastic, insecticides.

C) Ores: An economic mineral from which metal is extracted is termed as **an ore**. Some of the metals extracted from ore are as follows:

Ore	Metal
Bauxite	Aluminum
Cinnabar	Mercury
Galena	Lead
Haematite	Iron
Magnetite	Iron

Check your Progress:

Q.1. Define mineral.

Q.2**.** What is an ore?

Q. 3. State any four uses of rocks.

Q.4. How is mineral different from the rock?

Q. 5. Which type of rock is associated with crude oil?

- **Rock Cycle:**

Rocks are classified according to their mode of formation. Rocks which are formed due to solidification of molten lava/magma are termed as the Igneous Rocks. These rocks are disintegrated due to various agencies and processes on the earth's surface.

The weathered pieces of rocks are carried pieces of rocks are carried by different agencies of erosion like river, glacier, wind, sea waves etc. Which are deposited in sea, lake or desert. These weathered pieces of rocks are cemented together to form sedimentary rocks.

Sedimentary rocks change their structure due to crustal movements and heat and pressure inside the earth. The changed rock is known as the metamorphic rock.

Metamorphic rocks go deep towards interior part of the earth due to crustal movements and melt and become part of magam-molten material inside earth. When magma comes out on the earth's surface it is termed as lava. Thus the rock cycle continues.

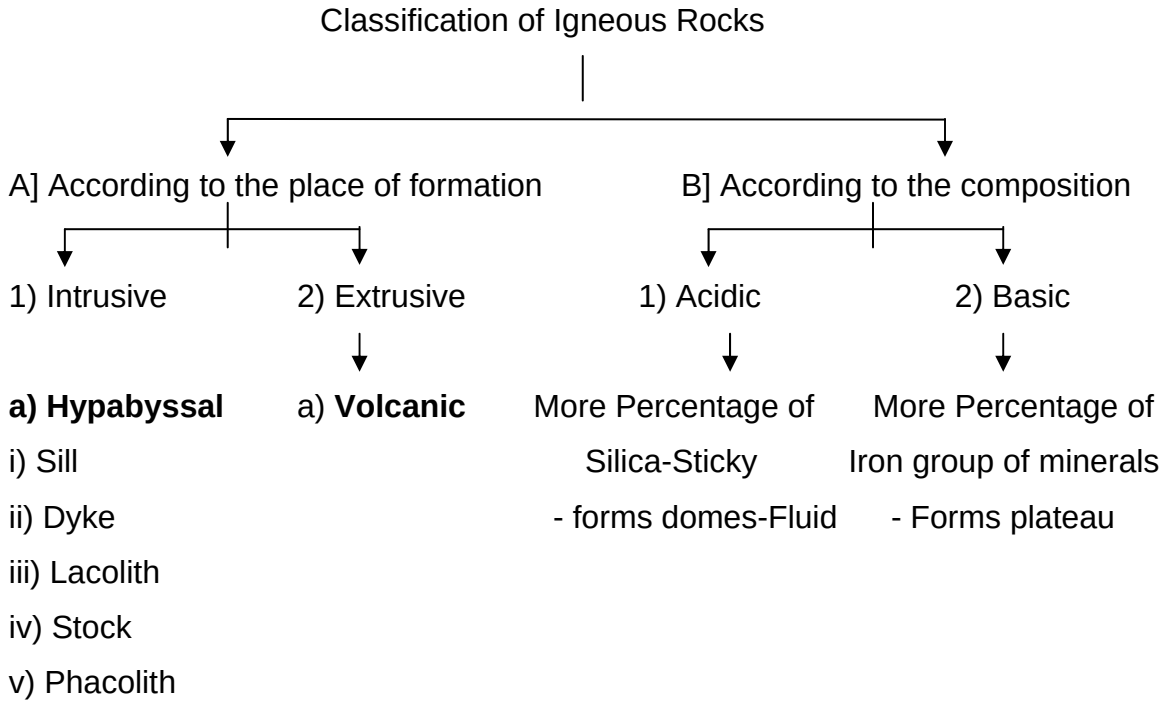
A) Igneous Rocks:

'Magma' is the molten material found below the crust. When magma comes out on the earth's, surface, it is termed as 'Lava'.

The rocks which are formed due to solidification of 'lava' or 'magma' are termed as Igneous Rocks. (derived from the Latin word 'ignis' means fire) Igneous rocks are formed first in the Rock cycle and hence these rocks are also termed as primary rocks. Igneous rocks are formed due to solidification of magma and hence these rocks are also termed as 'Magmatic rocks' Igneous rocks are classified according to the :

A) Place of formation

B) Composition



a) Hypabyssal

i) Sill

ii) Dyke

iii) Lacolith

iv) Stock

v) Phacolith

b) Plutonic

i) Batholith

1) **Classification of the Igneous rocks according to their place of formation:**

The igneous rocks which are formed on the earth's surface are termed as 'Volcanic' or 'Extrusive' rocks. The cooling process of lava is more rapid on the earth's surface and hence different minerals in lava do not get opportunity to come together. So we do not find large size crystals in the volcanic or extrusive rocks. These are termed as 'find grained' rocks.

On the other hand cooling process of magma below earth's surface is very slow hence different minerals in magma get sufficient time to come together so we get large size crystals in the intrusive igneous rocks. These rocks are also known as 'course grain' rock.

- **Intrusive igneous** rocks are known by different shapes formed by the solidification of magma into the cracks of the existing rocks. These are:

a) Stock : Thick vertical formation like huge pillar.
b) Dyke : Vertical wall like formation.
c) Lacolith : Dome shaped formation.
d) Sill : Horizontal sheet like formation
e) Lapolith : Saucer type formation.
f) Phacolith : Wave like formation.

All these types of intrusive rocks are formed below earth's surface but not at very great depth. These are called as Hypabasal rock.

The rocks which are formed at great depth e.g. Batholith are known as Plutonic rock. These are coarse grained rocks.

2) **<u>Classification of the igneous rocks according to the composition.</u>**

Igneous rocks are classified according to their composition i.e. the type of magma/ lava. If lava/ magma contain more proportion of silica it is termed as Acidic. Acidic lava being stickier (viscose) is not spread over large area, it forms

domes. The igneous rocks formed due to solidification of acidic lava have light colours.

On the other hand if the lava contains more percentage of iron group of minerals it is termed as basic lava. It is more fluid and so it spreads over large area and forms plateau e.g. The Deccan Plateau. The igneous rocks formed due to solidification of basic lava are dark in colour.

Check your progress:

Q.1. What are igneous rocks? How are they formed? Give examples.
Q.2. Give a classification of igneous rocks.
Q.3. Draw a neat diagram to represent intrusive igneous rocks

B. Sedimentary Rocks:

Sedimentary rocks are also termed as ‘secondary rocks’ because these are formed after the formation of primary rocks (i.e. igneous rocks). Igneous and other types of rocks are weathered and eroded by the denudation processes and agents of erosion such as river, glacier, wind, etc.) The particles of these rocks are transported and deposited in parallel layers, one upon the other. Over a period of time, these layers become compact and cemented together due to the

.

Proportion of igneous and sedimentary rocks

Weight of the overlying layers and gradual process of cementation develops hard, stratified layers termed as sedimentary rocks. Of all the rocks that are found in the Earth’s crust up to the depth of 16 kms from the surface; about 95% are non-sedimentary rocks.

However, on the surface of the Earth, about 80 per cent rocks are sedimentary. These rocks are also known as stratified or layered rocks.

Bedding plane

The plane of separation between two layers of the sedimentary rocks is termed as the Bedding plane. Sedimentary rock can break easily along the bedding plane.

Characteristics of the Sedimentary Rocks:

These rocks are termed as layered or stratified rocks as they display many layers in them.

Fossils of plants and animals are found in these rocks. As the process of formation of sedimentary rock is long and slow (i.e. heat or excessive pressure is not required), the imprints of the dead organisms remain on the rock. Such remains are termed as fossils. These fossils help us to identify the age or geological period of the organisms through the process of carbon dating.

Mostly sedimentary rocks are porous.

About 80% of the rocks on the surface of the Earth are sedimentary rocks.

Sedimentary rocks contain fossil fuels such as coal, crude oil etc.

Generally, these rocks are not crystalline as these are formed due to compaction of the weathered material.

The sedimentary rocks are formed in extensive horizontal layers. Therefore they form extensive horizontal landforms.

Classification of Sedimentary Rocks: Sedimentary rocks can be classified according to their components (composition) or according to the place of formation.

1) **Classification of sedimentary rocks according to the composition:** Sedimentary rocks have different chemical composition, colour and size of particles.

a) **Clastic rocks and their types**: These sedimentary rocks are composed of rock fragments. Clastic rocks are classified according to the size of particles or grains of the sedimentary rocks.

❖ **Types of clastic sedimentary rocks**

- **Clayey or argillaceous rocks:** These rocks are composed of very fine sediments, e.g. shale, mudstone, etc.
- **Sandy or arenaceous rocks:** These rocks are composed of sand particles, e.g. sandstone.
- **Conglomerate:** The sedimentary rock composed of large rounded pebbles is known as conglomerate.
- **Breccia:** This sedimentary rock is com-posed of large angular fragments of rocks.

b**) Non-clastic rocks and their types:** These sedimentary rocks are composed of the remains of plants and animals.

❖ **Types of Non-clastic Rocks:**

- **Carbonaceous rocks:** The sedimentary rocks formed of the remains of plants are known as carbonaceous rocks. This is because these rocks contain carbon, e.g. lignite, coal, etc.

Formation of coal

- **Calcareous rocks:** The rocks formed of the remains of animals are known as calcareous rocks. Calcium Carbonate ($CaCO_3$) is the main component of calcareous rocks. When fish and other aquatic animals die their bodies are decomposed. The two main components- (i) Bones and (ii) Flesh – are separately decomposed. Bones contain calcium. The bones get disintegrated into powder. This powder, which is deposited at the bottom of the ocean, gradually becomes compact to form layers of limestone.

Formation of limestone:

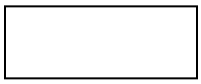
Limestone and dolomite are examples of calcareous sedimentary rocks.

Formation of crude oil

2) Classification of Sedimentary Rocks According to the Place of Formation

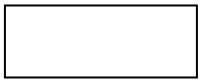
The process of sedimentation can take place at different locations. Therefore sedimentary rocks are also classified according to the place of formation.

Marine sedimentary rocks – These are formed on the seabed.



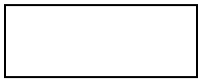
Marine sedimentary rocks

i) **Lacustrine sedimentary rocks –** When the sedimentary rocks are formed in a lake, they are termed as the Lacustrine sedimentary rocks.



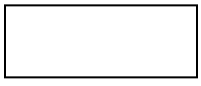
Lacustrine sedimentary rocks:

ii) **Riverine or Fluviatile sedimentary rocks -** Alluvium, i.e. the disintegrated particles of rock with decomposed organic matter, is deposited either on river bed or on flood plains during floods. These layers of alluvium become compact to form the riverine sedimentary rocks. The plains of North India, the Nile Delta of Egypt, the Mississippi Delta, etc. are well known for such sedimentary rocks.



Riverine sedimentary rocks

iii) **Aeolian sedimentary rocks –** These rocks are formed in the arid and semi-arid areas (i.e. desert areas) where the action of wind is strong. These winds carry loose particles of the rocks and deposit them elsewhere. Aeolian (related to wind) rocks are formed due to compaction of these particles.



Aeolian sedimentary rocks

iv) **Glacial sedimentary rocks:** The weathered / eroded material carried down by the glacier is termed as moraine. When glaciers melt, the material brought by the glaciers is deposited on the bed or in the surrounding region, which becomes compact to form glacial sedimentary rocks. Many places in North America and North Europe are known for such rocks.

Check your progress:

Q.1. What are sedimentary rocks. Give examples.

Q.2. Which agents of erosion are responsible for the formation of sedimentary rocks?

Q.3. Name three types of sedimentary rocks according to their place of formation.

C. Metamorphic Rocks:

The primary igneous rock or secondary sedimentary rock are changed in their appearance or change in their mineral composition and texture due to intense heat from below and pressure from above. This process of change due to intense heat and pressure in original rock structure and composition is called as metamorphism. The word ‘Metamorphism’ means change of form.

The process of metamorphism brings change in the form of rocks in two ways:

a) **Physical metamorphism** causing changes in textural composition of rocks, and

b) **Chemical composition** that changes chemical composition of rocks. med.

v) **Agents of Metamorphism:** Three agents contribute to the process of metamorphism:

i) Heat: is the fundamental agent that brings changes in the parent rock to form metamorphic rocks. Intense heat that is received during the process when hot and molten magma from the core tries to come out (vulcanicity) through the crustal rocks beneath the earth surface changes entirely the composition of minerals in the rock.

ii) Compression: The endogenetic forces cause convergent horizontal movement causing folding in rock beds. As a result pressure from compressive forces and consequent folding is responsible for changing the form and composition of original rock. This feature is mainly observed during mountain building process.

iii) Solution: During vulcanicity the chemically active hot gases and water act as solution while moving out from the core through the crustal rocks beneath the earth that changes the chemical composition of the rock.

vi) **Types of metamorphism:** is based on their process that is characterized by the nature of the agent and the place and area involved in metamorphism.

a) On the basis of the nature of agents:

- **Thermal metamorphism (due to intense heat):** In this case, the structure of rocks is changed due to heat caused by magma, hot gases, geothermal energy, etc. Clay which changes into shale is the best example of thermal metamorphism.
- **Dynamic metamorphism: (due to intense pressure):** High pressure due to crustal movements generates great heat and pressure. This causes dynamic metamorphism.

- **Hydro-metamorphism (due to hydro-static pressure):** Hydro-static pressure is caused by a column of water. In the upper crust of the Earth, there are enough fractures, cracks, and porosity that the fluid within these voids is under hydrostatic pressure.
- **Hydro-thermal pressure (due to pressure of water and heat):** Rocks that are altered at high temperatures and moderate pressures by hydrothermal fluids are hydrothermally metamorphosed. This is common in basaltic rocks that generally lack hydrous minerals. Rich ore deposits are often formed as a result of hydrothermal metamorphism.

❖ Effect of high pressure and high temperature:

The interior of the Earth is very hot. Due to crustal movements such as mountain building, rocks are subjected to high temperature and high pressure. As a result the structure of rocks is altered, e.g. limestone is converted into marble.

❖ Effects of basic change in the structure of rocks

Rocks are disintegrated due to chemical and mechanical actions. These disintegrated pieces of rock are again assembled to form hard rock, i.e. metamorphic rock.

b) On the basis of place or area:

- **Contact metamorphism (localized in area):** The rocks which come in contact with the hot molten magma are metamorphosed and are converted into metamorphic rocks.

Contact metamorphism

- **Regional metamorphism (large area is involved):** The layers of sedimentary rocks covering large areas below the surface are crumbled

and compressed due to the pressure developed by crustal movements. Metamorphic rocks formed by regional metamorphism are found in the Himalayas, the Alps etc.

vii) Formation of metamorphic rocks

Examples of the metamorphic rocks are given below:

Type	Original rock	Metamorphic rock
Igneous rocks	Basalt →	Schist
	Granite →	Gneiss
Sedimentary rocks	Limestone →	Marble
	Sandstone →	Quartzite
	Shale →	Slate

Check Your Progress:

Q.1. What are metamorphic rocks? Give examples.

Q. 2. Explain the process and agents of metamorphism.

Q.3. Write a note on types of metamorphism.

2.3. FOLDS AND FAULTS- TYPES

1. Introduction: It is a well known fact that our earth is dynamic nature and undergoes constant changes caused by internal forces that are sometimes sudden and some are very slow requiring hundreds of years to view any significant changes in the earth.

'Endogenic' forces are the internal forces that produce sudden movements in earth that are easily felt by man during his existence. For example volcanic eruption and tremors produced by earthquakes.

This dynamism in earth through Endogenetic and Exogenetic forces are explained as under:

a) **Endogenic (Internal): These are diastrophic forces classified as:**

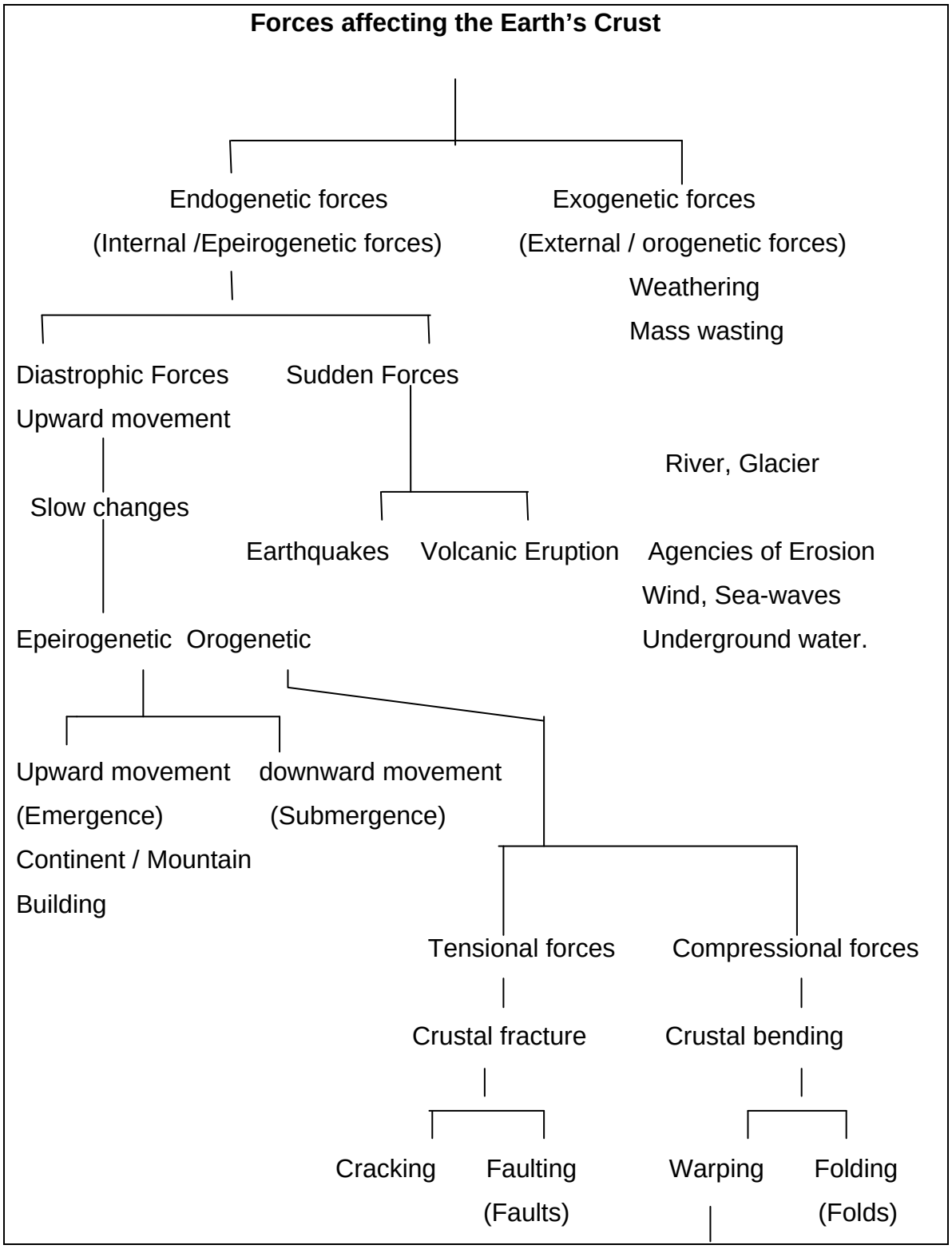
i) Epeirogenetic) Forces: The force coming from beneath the earth is called as endogenetic force. These can be experienced into two types:

- Sudden movement in the form of volcanic eruption or earthquake.
- Slow development that may be horizontal (compressional and tensional) and vertical (upward – uplift or downward-subsidence).

As the submergence or emergence of the region affects very large areas, these are also termed as the continent-building forces.

ii) Orogenic (Tensional and compressional) Forces: 'Oros' means mountain and genesis means to form. Hence, these forces are termed as Orogenic or mountain forming forces. Orogenic forces consist of fold and faults. Fault is caused by tensional forces while fold is caused due to Compressional forces of the Earth. Faults block mountains or rift valleys are formed due to the horizontal tensional forces.

a) **Exogenic (external) Forces:** The force coming from outside the earth is called as exogenic force. They consist of all forces that are actively engaged in leveling the relief of Earth. They are doing all kind of erosional transportational and depositional work. Exogenic forces on the Earth are water (sea, river and underground), wind, glaciers and cosmic forces.



(Source: Physical Geography – Savindra Singh, Allahabad.)

Check Your Progress:

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1. Differentiate between "vertical movement" and "horizontal movement".

2. Mention exogenetic forces.

3. State Endogenetic forces.

- **FOLDS:**

Folds on the Earth's surface are wave-like bends formed due to tangential compressive force caused by the internal deep force from within the earth to form folds. These forces acting on crustal rocks give rise to a series of bends called as folds. The upfolds are called as Anticlines and the downfolds as Synclines.

FIGURE: 2.

Anticlines and Synclines

The sides of a fold are termed as 'limbs'. Folding mostly occurs at the margins of the continental plates. Fold Mountains are developed due to a series of parallel folds, e.g. the Alps or the Himalayas. Different types of folds can be observed. These are;

a) Types of Folds:

The horizontal compressional forces acting towards each other are sometimes equal but are unequal in most of the cases. This inequality of the forces gives rise to various types of folds. These are:

i) **Symmetrical folds:** These are simple folds in which both the limbs of the fold incline uniformly. This is because the forces exerted on both the sides of the limbs are equal.

FIGURE: 2.

Symmetrical fold

ii) **Asymmetrical folds:** Asymmetrical folds are produced due to exertion of unequal force on both the sides of the limbs.

FIGURE: 2

Asymmetrical fold

iii) **Monoclinal / Vertical folds:** In this case, one of the limbs is moderately inclined and the other limb has a steeply inclined slope at right angle indicating application of greater force in that direction so as to develop monoclonal or vertical folds.

iv) **Isoclinal folds:** Here compressive forces are so strong that both the limbs of the fold become parallel to each other but are not horizontal.

FIGURE: 2.

Isoclinal fold

v) **Recumbent folds:** Here compressive forces are so strong that both the limbs of the fold become parallel as well as horizontal.

FIGURE: 2

Recumbent fold

vi) **Overturned folds:** In this case, as the force on one side is extreme, the fold breaks and the upper part slides over the lower part. Thus one limb of the fold is thrust upon another fold due to intense compressive forces. Limbs her are seldom horizontal.

FIGURE: 2.

I. **Faults:** A fracture in the crustal rock where the rocks get displaced along a plane is called as a fault. In other words displacement of crustal rocks caused tensional movement due to internal force develops a fracture is called as a fault.

Horizontal tensional forces often develop cracks in the rock strata. These cracks are called joints. The crustal blocks move upward or in downward direction that develop faults. Faults also developed in the horizontal direction.

FIGURE: 2.

a) **Types of Faults Related to Gravitational Force. These are:**

i) **Normal faults:** Here the rock strata move in the downward direction due to the gravitational force. Hence, such faults are also termed as gravity faults'. For example 'Rift' or 'Graben' Valley is formed due to the normal fault. Rivers Tapti, Purna and Narmada of central part of India flow through the rift valleys. Rift valleys generally have steep sides or steep banks. Other examples of rift valley are:

- Rhine rift valley in Europe;
- Jordan River valley from Syria through Red Sea basin to Zambezi valley is the longest rift valley with 6440 km.
- Dead Sea in Asia
- Narmada, Tapti rift valleys in India.

ii) **Reverse / thrust faults:** Here the rock strata are forced in the upward direction due to the horizontal compressional forces. Hence, the rock strata move up against the force of gravity. Here the vertical stress is minimum and horizontal stress is maximum. Therefore it is termed as reverse fault. Block mountains or horsts are formed due to reverse fault

FIGURE: 2.

Normal fault Reverse fault

FIGURE 2:

Block Mountain

Faults also develop due to the horizontal displacement of the rock blocks. This is termed as the ‘lateral’ or ‘strike-slip faults’.

FIGURE: 2.

Rift valley

Block mountains or horsts: Block Mountains/'horsts' are formed due to faulting and so they are also associated with rift valleys. Block Mountains normally have steep sides and flat tops that are developed due to faulting process. For example:

- The Black Forest Mountain of Germany.
- The Vosges in France.
- The salt range in Pakistan.
- The Flinders Mountains in Australia.

Check Your Progress:

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1. What do you mean by "folding"?
2. Mention different types of folds.
3. What do you understand by the term "Faulting"?

2.4. Conclusions:

The present chapter has helped us to understand various processes responsible for the formation of different types of rocks, their location; structure; and physical and chemical composition. These various processes involved in formation and change of parent rock thus provide us with different types of rocks and minerals. Different types of human settlements and his activities are dependent upon the availability of these rocks and minerals.

2.5. Questions.

Q.1. Explain any three differences between rocks and minerals.

Q.2.How is igneous rock formed?

Q.3.With the help of a neat diagram explain rock cycle.

Q.4. Give major characteristics of the igneous rocks?

Q.5. Give broad classifications of igneous rocks on the basis of their place of formation? Give

two examples for each.

Q.6.Give a classifications of igneous rocks according to their composition?

Q.7.What are the four important characteristics of sedimentary rocks?

Q.8. Give a classifications of sedimentary rocks?

Q.9.How is metamorphic rock formed? Give four examples of metamorphic rocks.

Q.10. Explain with the help of suitable diagram the formation of crude oil.

Q.11. Explain the different types of folds with the help of suitable diagrams.

Q.12 Describe the major types of faults with suitable diagrams.

Q.13 Discuss the different types of forces affecting the earth's crust.

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5

WORK OF WIND AND WORK OF SEA-WAVES

Unit Structure:

5.0. OBJECTIVES:

- To study the importance of wind and their types.
- To study the work of wind as an agent erosion and associated landforms.
- To study the work of wind as an agent deposition and associated landforms.
- To study the importance of sea waves and their types.
- To study the work of sea waves as an agent erosion and associated landforms.
- To study the work of sea waves as an agent deposition and associated landforms.

5.1. INTRODUCTION:

Winds play an important role in the changing the weather of an area that influences various human activities in the world. Winds are also responsible in shaping the landforms through different types of aeolian processes. Winds also act as agents for dispersal of plant seeds to produce various species in different areas. They act as natural cleansing agent by removing and dispersing the air pollution produced in an area. At times they are furious and may lead of spread of wild fires in the forest; destroy the standing crop,

bring down the trees and weak structures etc. The work of wind and the features associated with it are explained below:

5.2. WORK OF WIND (AEOLIAN LANDFORMS):

Wind is an important agent of erosion in deserts. Its work involves erosion of dry, loose, and unprotected geomaterials and their transportation and deposition. It is the most active agent of erosion in arid and semi-arid regions of tropical and temperate regions.

5.3. EROSIONAL AND DEPOSITIONAL LANDFORMS OF WIND:

- There are three processes responsible for erosional and depositional work carried by wind. These are:

  i) **Deflection :** The process of removing, lifting and blowing away dry and loose particles of sand and dust by winds.

  ii) **Abrasion :** It breaks up rocks by sandblasting by wind when they hit sand particles against standing rocks.

  iii) **Attrition :** In this process the sand particles, while they are moving colide against each other and are converted into finer particles.

- **Features produced by Wind Erosion :**
  Some of the features produced by wind erosion are as follows:

  i) **Zeugen:** It is also known as mushroom rocks in Death Valley California. This is an upstanding rock in desert, caped with a harder stratum and undercut by wind at base. It is indicative of differential erosion. The base is being softer, more easily eroded rock. They are more common in arid area such as eastern province of Saudi Arabia. Zeugen may be as high as 30 meters. Ultimately they are undercut and gradually worn away.

DIAGRAM

ii) **Yardangs :** Yardangs are formed by wind erosion when bands of hard and soft rocks lie parallel to the prevailing winds in a desert region. Such rocks are turned into ridge and furrow landscape by wind and abrasion. The belt of hard rock standup as rocky ribs up to 15 meters in height yardages are very in the central Asian deserts and in the Atacama desert.

DIAGRAM

iii) **Inselberg :** In some desert areas erosion by wind has removed all the original surface except for isolated pieces which stand up as round topped masses of rocks called Inselbergs. Inselbergs are common in Australian Desert, Kalahari Desert in Africa, Northwest Nigeria and parts of Algeria.

DIAGRAM

- **Features produced by wind deposition :** When very powerful wind blows across the desert, carry large amounts of desert dust and sand particles from one desert to another desert or in surrounding areas. When wind velocity decrease such material is immediately deposited, resulting in formation of some depositional features by wind.

  i) **Sand Dunes :** There are two types of sand dunes 1) Barkhan or crescent shaped dunes and 2) Self dunes.

  ii) **Barkhan or crescent shaped sand dunes :**
  Barkhan is a crescent shaped dune, lies at right angles to the prevailing wind. A barkhan usually develops from the accumulation of sand caused by a small obstruction like a rock or some vegetation. As the mound of sand grows bigger and bigger its two edges are slowly carried forward down-wind and a typical crescent shape slowly develops. The windward face of barkhan is gently sloping but the lee-ward is steep and slightly concave. A barkhan moves slowly forward as sand particles are carried up the windward face and slip down the lee-ward side. The height of barkhan ranges from a few meters to 30 meters.

  iii) **Seief Dunes:** Seief dune is generally long and straight dune, which is parallel to the prevailing wind. The corridors between the dunes are swept clear of sand by this wind. The dunes are lengthened by the prevailing wind. Seief dunes

are generally several hundred meters high and many kilometers long. Many seief dunes occur in that desert of Rajasthan and desert in Western Australia.

iv) Loess: Every year wind blows fine particles out of the deserts. Some particles are blown into sea and some are deposited on land. Fine particles deposited on the land outside desert are called Loess. There are extensive deposits of loess in North China. Loess in China are formed by dust blown out by wind from Gobi Desert Loess deposits in China has been intensively eroded by rivers and produced 'badland' landscape.

Check your Progress:

Q. 1. Explain the importance of winds.
Q.2. Which processes are responsible for the work carried by wind?
Q.3. Explain the erosional landforms developed by wind action.
Q.4. Explain the depositional landforms developed by wind action.

5.4. INTRODUCTION TO SEA WAVES:

Sea waves are defined as undulation of seawater characterized by well developed crests and troughs. The generation of sea waves is probably because of the mechanism of release of some of sort of energy caused by atmospheric circulation of winds that is responsible for movement of fluids of two contrasting densities (air and sea water) along the interfaces of two masses of fluids of varying densities. Sea waves the most powerful agent responsible for the formation of various landforms. Sea waves play an important role in the coastal ecosystems function. Today they are playing an important role in contemporary tourism of surfing sports to earn large revenue in few naturally bestowed countries. Ocean water currents help to move eroded debris and deposit it as slit, sand and gravels along the coast. However, the coastline is undergoing changes over a period of time due to the action of sea waves, tides and ocean currents.

5.5. WORK OF SEA WAVES:

Various processes are involved in the work of sea waves that produce different types of erosional and depositional landforms in the coastal areas. Sea waves operate in the following ways to transform the coastal landscape:

i) Corrosion: Sea waves armed with rock debris of different sizes and shapes charge against the base of the cliff and wear them back by corrosion. Ocean currents and tides

complete the work by sweep in the eroded materials into the sea.

ii) **Attrition:** The constantly moving sea waves that transport beach materials such as boulders, pebbles, sand etc. These waves also hurl these fragments against each other, until they are broken by attrition into very small pieces.

iii) **Hydrolic Action:** Dashing sea waves against a cliff face causes air in cracks and crevices to become suddenly compressed. When the wave retreats, the air expands with violent explosion. Again and again such action enlarges the cracks and crevices and fragments are broken down.

5.6. EROSIONAL AND DEPOSITIONAL LANDFORMS OF SEA WAVES:

- **Coastal Landforms of by Sea Wave Erosion :**

i) **Capes and Bays :** On exposed coasts, the continued action of waves on rocks of various resistance causes the coast lines to be eroded irrigularly. This is particularly pronounced where hard rocks e.g. granite basalt occurs in alternative bands with softer rocks e.g. sand and clay. The soft rocks are worn back into inlets, bays and harder rocks persists headlands capes etc.

DIAGRAM

ii) **Sea-cliff:** A steep rocky coast rising almost vertically above sea-level is called as sea-cliff.

DIAGRAM

iii) **Wave-cut Platform :** Generally any very steep rock facing adjoining the coast forms cliff. The rate of recession however, will depend on its geological structure, i.e. the stratification and jointing of the rocks and their resistance to wave attack. If the bed deep seaward, large block of rock will be dislodged and fall into sea. The cliff will rise in series of stapes. On the other hand, if the beds dip landwards, the cliff will be more resistant to wave erosion. At the base of the cliff the sea cuts a notch which gradually undermines the cliff as the cliff recedes landwards and eroded base is left behind called wave-cut platform.

iii) **Caves, Arches and Stacks and Stump :** These minor erosional features are produced by wave action during the

process of cliff formation. Prolonged wave attack on the base of the cliff excavates holes. When two caves approach one another from either side of the headland and unite, until, they form an arch.

DIAGRAM

Further erosion by waves will ultimately lead to the total collapse of the arch. The seaward portion of the headland will remain as a pillar of rock known as a stack. In course of time these stubborn stack will gradually be removed. The vertical rock pillars are eroded leaving behind only the stump, which are only just visible above the sea level, particularly at low tides.

- **Coastal Landforms of Sea Wave Deposition :**

i) Beach : The most important depositional feature of the work of deposition by sea waves is beach. The main action of constructive waves is to deposit mud, sand and pebbles. When these materials deposited along a coast, form a gently sloping platform called a beach. Beaches usually lie between high and low water levels, but storm waves along some coast throw pebbles and stones well beyond the normal level reached by waves at high tide. The material deposited in this way produces a ridge called a storm beach.

DIAGRAM

ii) Spit: Spit is a narrow, low ridge of sand or pebbles joined to the land at one end and its other end is terminating in the sea. Sometimes, a spit develops at a headland and projects across a bay. Its waves swing into the bay obliquely, the end of the spit becomes curved or like a hook.

DIAGRAM

iii) Bar: Bar is very similar to spit. The bar which extends right across a is very common type of bar. It starts as a spit growing out from a headland, stretches across the bay to next headland. Such bar is called a bay-bar.

iv) Lagoon: A shallow body of seawater separated from Open Ocean by a spit or by Barrier Island or reef.

- **Check Your Progress:**

Q. 1. Explain the importance of sea-waves.
Q.2. How is sea wave generated?
Q.3. Which processes are responsible for the work carried by sea waves?
Q.4. Explain the erosional landforms developed by sea waves.
Q.5. Explain the depositional landforms developed by sea waves.

5.7. CONCLUSION:

It is thus important to note that winds and sea waves as geomorphic agents play a significant role in shaping and producing different landforms in the arid and semi-arid regions in case of winds and sea –waves along the coastal areas in the world. Different landform features developed by erosional and depositional process by wind and sea waves in respective areas provide a scenic beauty to the landscape to promote tourism activity and thus a source of income to the local community and the country. Besides their role in the promoting the functioning of ecosystems in different ecological area provides with necessary food nutrients at diffident tropic levels in the food pyramid.

5.8. QUESTIONS:

1. With the help of suitable diagrams explain the erosional landforms developed by wind action.
2. Explain the depositional landforms developed by wind action. Draw suitable diagrams.
3. Drawing suitable diagrams explain the erosional landforms developed by sea waves.
4. With the help of suitable diagrams explain the depositional landforms developed by sea waves

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6

COMPOSITION AND STRUCTURE OF THE ATMOSPHERE AND DISTRIBUTION OF TEMPERATURE

Unit Structure:

6.0. Objectives:

Atmosphere is one of the most important components of our earth.

- To study the composition of earth's atmosphere
- To study the structure of earth's atmosphere
- To study the factors controlling the distribution of temperature.
- To understand the variation in spatial distribution of temperature on the surface of the earth.
- To know the significance of atmosphere and temperature for living kingdom.

6.1. Introduction

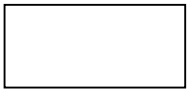
The earth's atmosphere is composed of gaseous, suspended particles and water molecules. In the initial period after the formation of the earth the processes of chemical and biological reactions on the earth formed the gaseous envelop encircling the earth called as atmosphere. The differences in the cooling and heating of the elements in the atmosphere due to incoming solar energy and outgoing heat radiated from the earth helps to differentiate between atmospheric layers.

6.2. Composition and Structure of the Atmosphere

6.2.1. Composition of the Atmosphere:

The gaseous envelope which surrounds the Earth is termed as the 'atmosphere'. Most of the atmosphere is confined to a thin shield around the earth, with the pressure and density of air decreasing rapidly with altitude and gradually merging into the emptiness of space. Fifty percent of the mass of the atmosphere is within 5.5 kilometers of sea level; 90 percent is within about 16 kilometers of sea level, and 99.9 percent is below 49 kilometers. The atmosphere contains many gases. The atmosphere also contains water vapour and aerosols (small microscopic particles). Most of them are concentrated near the Earth's surface. This is due to the gravitational pull of the Earth and as the density of air is maximum. As we move up above the surface of the earth, the density of air decreases.

Layers of air are squeezed into smaller space near the Earth.



Density of atmosphere

From the diagram it is clear that 50 percent of the atmosphere lies below the height of 5.6 km. and about 90 per cent below 16 kilometers. Only about 0.00003 percent of all the gases found in the atmosphere are beyond 100 kilometers.

Table 6.1. Composition of air in the earth's atmosphere

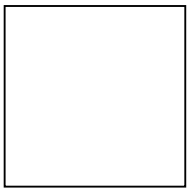
Component	Symbol	Volume of dry air in %
Nitrogen	N_2	78.08 %
Oxygen	O_2	20.94 %
Argon	Ar	0.93
Carbon dioxide	CO_2	0.03
Neon	Ne	0.0018
Helium	He	0.0005
Ozone	O_3	0.00006
Hydrogen	H_2	0.00005
Krypton	Kr	Trace element
Xenon	X_2	Trace element
Methane	CH_4	Trace element

Nitrogen and oxygen together make up about 99 percent of the volume of atmospheric gases. Some of the minor gases such as CO_2 and O_3 play an important role in the atmosphere. CO_2 absorbs heat radiated by the earth surface during night and so is responsible for warming the globe. O_3 gases protect the earth by absorbing the incoming harmful ultraviolet (UV) rays of the sun. This composition of the atmospheric gases remains the same up to a height of about 80 km. Therefore, the lower parts of the atmosphere up to 80 km are termed as the Homosphere. Composition of the atmosphere varies after 80 km of height. Hence, it is termed as Heterosphere.

The lower parts of the atmosphere up to 10-15 km contain water vapour. It is derived from the evaporation and evapo-transpiration from water bodies, soil cover and vegetation respectively. The amount of vapour is determined by the

temperature conditions near the surface of the earth. As temperatures are higher near the equator and decreases towards the poles, the amount of vapour therefore is more near the equator and become less as we move towards the poles. In terms of vertical distribution of vapour content more than 90 % of the total atmospheric vapour is held up to an altitude of 5 kilometer. Condensation of water vapor in the atmosphere is responsible for different types of weather phenomena.

The atmosphere also composes of microscopic elements such as dust and salt particles, etc. They are termed as aerosols. The hygroscopic salt particles absorb water and act as condensation nuclei in the formation of clouds. They also scatter solar radiation. The sky appears blue due to the scattering of violet rays of the incoming solar radiation.



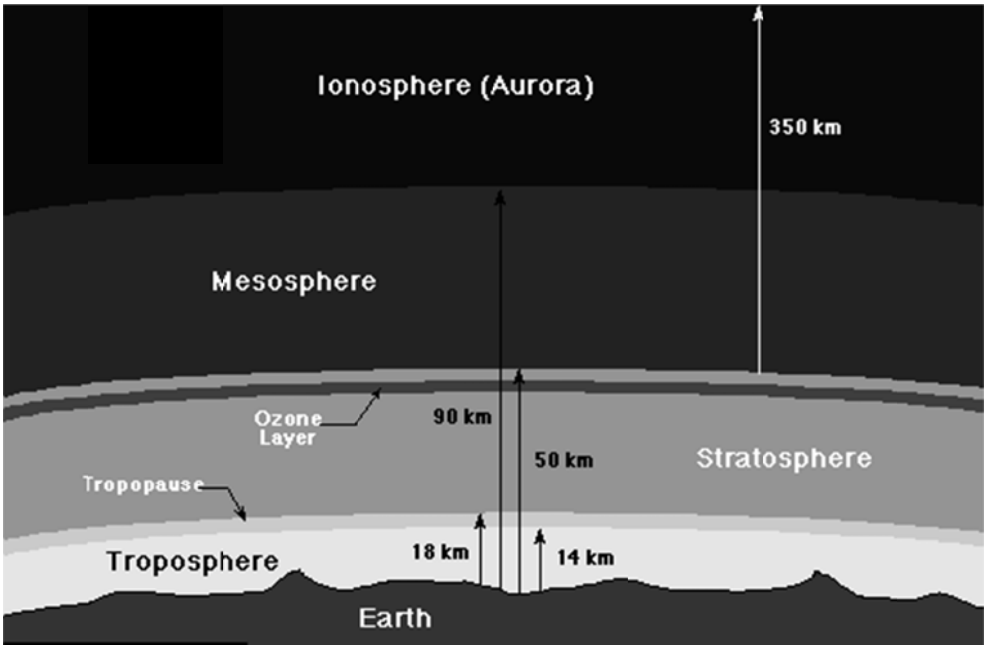
Composition of atmosphere

6.2.2. **Structure of the Atmosphere:** On the basis of the characteristics of temperature and air pressure the structure of the atmosphere is divided into four layers upwards from the surface of the earth. These are:

i) Troposphere: Troposphere' means 'a region of intense mixing of atmospheric components' where weather conditions are formed. Human activities are directly related to the weather conditions of this layer. It contains 75 percent of the atmospheric gases, water vapour and aerosols. Hence this lowest layer of the atmosphere is very useful to man. It is important to note that temperature decreases with increasing height at the rate of **6.5^0Centigrade per 1000 meter** (1 kilometer). This rate of decrease of temperature is called as **Normal Lapse rate.**

However it should be noted that there is seasonal variation in the height of the troposphere and changes from equator towards the poles. The average height of the troposphere is about 16 kilometer over the equator and 6 kilometer over the poles. The upper limit of the troposphere is called tropopause. The boundary between Troposphere and Stratosphere (the next layer) is known as **Tropopause**. It is an inversion layer (i.e. temperature does not decrease with increase in altitude in this layer). Tropopause acts as a lid for Troposphere. Therefore, troposphere becomes a self-contained layer of the atmosphere. Strong vertical convectional air currents are found near the Equator. Therefore the height of the Tropopause is about 16 km at the Equator, but it is only 8 km near the poles.

Exosphere



ii) Stratosphere: Stratosphere extends from Tropopause up to the height of 50 km. There is an absence of storm or changing weather conditions and water vapour. Temperature remains constant at the lower part of the stratosphere, but it increases with increase in height. The lower part of the stratosphere is used by jet aircrafts. The ozone layer is mainly found in the lower portion of the stratosphere from

approximately 20 to 30 kilometers above earth. Its thickness varies seasonally and geographically. Ozone layer in this region absorbs the harmful ultra-violet rays of the sun from reaching the earth. The composition of the stratosphere also changes with the latitude i.e. it begins with 9 km above the poles, 10 or 11 km in the middle latitudes, and 16 km at the equator, and extends outward up to 32 km. It is a zone of dry, thin air, cold and clear, with a horizontal temperature gradient. In Polar Regions the temperature is - 40°C to - 46°C, but near the equator it ranges from - 62°C to below - 74°C; in the middle latitudes it remains steady at about - 55°C. No weather occurs in the stratosphere. Air temperature slowly increases with height in the stratosphere.

6.2.3. Role of the ozone layer: Concentration of ozone ($O_{3)}$ is found in this zone between 25-50 km. Ozone is made up of three atoms of oxygen (O_3) – ordinary oxygen molecule is made up of only two atoms (O_2). Oxygen molecule is broken into two atoms by UV radiation. Therefore the unstable atom combines with the other molecule of oxygen ($O+O_2 = O_3$). Thus, O_3 or ozone is formed. O_3 molecule may also split into O_2 molecule and the unstable oxygen atom by the UV radiation. This constant conversion of ozone to oxygen and oxygen to ozone utilizes much of the UV radiation. Thus the amount of UV radiation reaching the Earth's surface is considerably reduced. (Excessive quantity of UV radiation reaching Earth's surface may create problems such as blindness, skin cancer and can even damage vegetation).

iii) Mesosphere: Mesosphere lies above stratosphere and below the thermosphere. It extends from about 50 to 85 km from the earth's surface. Temperature in the mesosphere decreases with height. The coldest temperatures in the Earth's atmosphere i.e. about -90° C is found near the top of the mesosphere. Mesopause is a boundary that lies between mesosphere and thermosphere.

Various types of waves and tides in the atmosphere influence the mesosphere.

These waves and tides carry energy from the troposphere and the stratosphere

upward into the mesosphere, driving most of its global circulation.

iv) Thermosphere: Above the mesosphere, in the thermosphere and beyond, gas particles collide so infrequently that the gases become somewhat separated based on the types of chemical elements they contain. The thermosphere lies between the mesosphere and the exosphere. It extends from about 90 km to between 500 and 1,000 km geographically above the earth surface. Temperatures increase sharply in the lower thermosphere i.e. from 200 to 300 km height. The density of air is very low in thermosphere. Solar activity strongly influences temperature in the thermosphere. The aurora (the Southern and Northern Lights) primarily occurs in the thermosphere. Charged particles (electrons, protons, and other ions) from space collide with atoms and molecules in the thermosphere at high latitudes, exciting them into higher energy states. Those atoms and molecules shed this excess energy by emitting photons of light, which we see as colorful auroral displays. Thermopause is a boundary that lies between the thermosphere and the exosphere. The Earth's thermosphere also includes the region of the atmosphere called the ionosphere. The ionosphere is a region of the atmosphere that is filled with charged particles. The high temperatures in the thermosphere can cause molecules to ionize. The ionosphere represents less than 0.1% of the total mass of the Earth's atmosphere but is extremely important because upper atmosphere is ionized by solar radiation where the Sun's energy is strong at this level which breaks apart molecules. Different regions of the ionosphere make long distance radio

communication possible by reflecting the radio waves back to Earth.

v) Exosphere: The exosphere is the outermost region of Earth's atmosphere and gradually fades into the vacuum of space. Air in the exosphere is extremely thin or almost airless. The lower boundary of the exosphere is called the exopause. At this altitude barometric conditions are absent. Atmospheric temperature becomes almost constant above this altitude. Exosphere lies at a height of about 500 to 1,000 kilometers from the earth's surface depending on the solar activity. In principle, the exosphere covers distances where particles are still gravitationally bound to Earth, i.e. particles still have ballistic orbits that will take them back towards Earth. The exosphere is a transitional zone between Earth's atmosphere and space.

Check Your Progress:

Q. What is atmosphere?

Q. What is the composition of atmosphere?

Q. Give the structure of atmosphere.

6.3. Insolation and temperature

The heat received from the sun travels in the form of short and long wave's radiation. The temperature of the atmosphere is determined by the rate of insolation i.e. the amount of heat received from the sun by the earth which is released by the earth (long wave radiation) that heats the atmosphere from below. The atmosphere contains various green house gases such as carbon dioxide, ozone and water vapour that absorb out going heat released by the earth after sunset. This phenomenon is termed as the Greenhouse Effect of the atmosphere.

Greenhouse is a glasshouse constructed normally in the temperate belt region for growing plant. As greenery is inside house, it is termed as Greenhouse. Temperature inside the greenhouse is more in comparison of outside the greenhouse. This is possible due to dual properties of glass. Glass is transparent and it is a bad conductor of heat. Hence, the solar radiation enters into the glasshouse, i.e. greenhouse-without any obstruction. There it is converted into heat. This heat is trapped inside the glasshouse. It is important to note that atmospheric gases cannot prevent insolation (short- wave radiation) from reaching the Earth and so the earth's surface gets heated from above. However the heat received by the earth is released in the form of long-wave radiation that is absorbed by the atmospheric gases. As a result the atmospheric temperature is raised this is termed as Greenhouse Effect of the atmosphere.

6.3.1. Greenhouse effect

upwards, the amount and density of these gases decreases with increasing altitude. Hence, the temperature of the atmosphere decreases with increasing altitude in the lower part of the atmosphere, i.e. in the Troposphere. It stops decreasing and starts increasing in the second layer, i.e. in Stratosphere. Again, it decreases with altitude in the third layer, i.e. Mesosphere. On the basis of these variations in temperature characteristics, the atmosphere is divided into following major zones or layers:

6.4. Factors controlling distribution of temperature:

Temperature of different places on surface of the earth is not

same everywhere. This is because the amount of **i**nsolation received at the surface of the Earth is controlled by the angle of the **sun**, the state of the atmosphere, altitude, and geographic location as explained below:

i) **Latitude:** Solar rays are vertical within the tropical belt (i.e. from the Tropic of cancer to the Tropic of Capricorn) vertical rays are concentrated over smaller surface area on the earth as compared to the oblique solar rays. Similarly the resistance offered by the aerosols and other elements in the atmosphere is less in the case of vertical solar rays, than the oblique solar rays. Intensity of solar radiation decreases due to the resistance offered by the atmosphere i.e. due to reflection, diffusion, scattering. Due to these two factors areas receiving vertical solar radiation record higher temperature than the areas receiving oblique solar radiation.

1) Vertical rays are concentrated over smaller area, than the oblique rays. EF < CB
2) Resistance offered by the atmosphere is less in the case of vertical solar rays than the oblique solar rays. DE < AB

Generally temperature decreases away from the equator towards pole.

	Max. Temp.	Min. Temp.
Temperature decreases away from the equator		

ii) **Altitude:** Temperature decreases with increase in altitude from the earth's surface. Solar rays pass through the atmosphere, in the form of short wave radiation. Earth's surface is heated and then it emits heat in the form of long wave radiation Earth radiation. This long wave is absorbed by the water vapour enters into the atmosphere by the process of evaporation from the earth's surface. Co is added to the atmosphere by the processes like burning, combustion etc. As the concentration of water vapour and Co2 is more near to the earth's surface, the lower layers of the atmosphere absorb more heat. As we move towards higher altitude the amount of water vapour and Co2 decreases, so the capacity of the atmosphere to absorb heat. Hence the temperature decreases with increase in the altitude.

iii) **Distance from the Sea:** Temperature characteristics of land and water are different. Land is heated more than water due to solar radiation during day time as solar heat is absorbed and released more slowly by water than by land. Water retains heat for a longer time and hence land becomes cool while water

iv)

This difference in the heating properties of land and water is the main cause of land and sea breezes in the coastal areas. Difference in maximum and minimum temperature is less in the coastal areas but it is more in the interior parts of the continents due to the absence of water.

iv) Angle effect: (Effect of slope): Solar rays are slant in the temperate region. South facing slopes of the mountains in the temperate region of northern hemisphere receive ore sunshine (insulation) than the north facing slopes. Hence vegetation and settlements are found on the sunny slopes (south facing) which are termed as ‘Adret’. The north facing slopes of the mountains in the temperate region, which remain in shade are known as ‘Ubac’ slope. This effect of slope on temperature is termed as the Aspect effect.

v) Ocean Currents: Warm ocean currents are responsible for increasing temperature of the surrounding region. e.g. Coastal areas of west Europe remain warm due to the Gulf stream of the Atlantic Ocean. Similarly cold ocean currents reduce temperature of the surrounding areas, for example Labradaor cold current near Greenland..

vi) Local Winds: Warm local winds increase temperature of the surrounding region and cool local winds reduce temperature of the surrounding region.

vii) Nature of Cloud cover: Solar rays are reflected back due to the cloud cover. Diffused solar radiation reaches earth's surface, due to the presence of cloud cover. Earth radiation is reflected back to the earth due to the cloud cover. Difference in the maximum and minimum temperature is less at the Equator due to constant cloud cover, but desert areas record extremes of stemperature due to the absence of cloud cover.

viii) Duration / length of day: Duration of day is more during summer than in winter hence more solar radiation is received during summer than in winters. Hence temperature is more in summer and less in winter.

Check Your Progress:

Q. Name the factors controlling distribution of temperature.

Q. Explain inversion of temperature in the atmosphere.

Q. Write a note on Ozone Layer.

6.5. Distribution of temperature on the earth:

Distribution of temperature is explained as under:

a) Vertical distribution of temperature: The distribution of the temperature varies vertically as well as horizontally on and above the earth's surface. Generally the temperature goes on decreasing with increasing altitude from the sea level. It is caused due to two reasons:

i) The atmosphere near the earth's surface absorbs most of the long wave radiation. Thus the air gets heated from below that makes air to warm-up and so it rises up. In this process of uplift of warm air it gets expanded that releases the heat and so the temperature goes on decreasing as we move upwards.

ii) Secondly the green house gases such as carbon-dioxide and water vapour are more near the surface of the earth and

become thinner with increasing height. Hence lower atmosphere is warmer while temperature becomes cooler with increasing height of the atmosphere which is limited only to the lower region of the atmosphere.

However at times there is inversion of temperature in the vertical temperature distribution. It occurs when there is absence of winds blowing, the sky is clear, winters are long, air is cold and dry and the land surface is covered with snow.

Inversion of Temperature: Temperature inversion is a condition in which the temperature of the atmosphere increases with altitude in contrast to the normal decrease with altitude. When temperature inversion occurs, cold air underlies warmer air at higher altitudes. It may lead to different weather effects such as Pollutants hazards. Pollutants may get trapped below the inversion as the sky becomes very hazy causing respiratory problems. It usually occurs in high pressure zones, where the air is gradual sinking down in the lower atmosphere.

b) Horizontal Distribution of temperature on the earth: The horizontal distribution of temperature across the globe is governed by various factors. These are absolute location (latitudes and longitudes); relative location (maritime / continental), time (season), duration and intensity of sunlight received (location – equatorial to polar; day and night), soil type and vegetal cover, relief, water bodies, winds, ocean currents, cloud cover. This horizontal temperature distribution can be identified across the globe with the help of isotherms for the months of January and July as best example. The solar rays are perpendicular on the lower latitudes and become slanting as we move towards the higher latitudes. As a result temperatures are higher in the tropical region and lower in the polar region. Tropic of cancer (23 ½ ^{0} North latitude) and Tropic of Capricorn (23 ½ ^{0} South latitude) are the upper latitudinal limits of perpendicular solar insolation receiving maximum heat from the sun. Isotherms are imaginary lines drawn with areas having same temperature. These isotherms generally run from east-to west and are parallel

to the latitudes. These isotherms are irregular in the northern hemisphere due to more land surface with its diversity whereas they are more uniform in the southern hemisphere due to more water surface with less diversity. Variation in temperature is rapid in the higher latitudes hence isotherms are closely spaced whereas temperature variation is relatively slow in the lower latitudes therefore isotherms are widely spaced. Isotherm map for the months of July and January explains the given concept of horizontal distribution of temperature.

Map July and January

6.6. Significance of atmosphere and temperature:

The existence of life on the earth is because of the gaseous envelop of the atmosphere that provides warmth by trapping heat released by the earth and other necessary gaseous elements dissolving in rain water reaching the earth's surface to enter into ecosystem**.**

- **Advantages of the Atmosphere**

Some of the advantages of the atmosphere are as follows:

i) It provides oxygen required for our survival as well as for other forms of life.

ii) It provides carbon dioxide to plants for their survival.

iii) The atmosphere controls the temperature of the Earth, which is essential for the existence of various forms of life in the environment. Without the atmosphere, the temperature of the Earth would have increased to more than 200^0C, which is certainly not suitable for the environment found on the Earth.

iv) The atmosphere (ozone layer) protects us from the harmful effects of the ultra-violet radiation, which is a part of solar radiation.

v) 'Weather' and 'Climate' are the terms used to indicate changes in the atmospheric condition. Our daily and annual activities are associated with weather and climate.

vi)It protects us from the harmful meteors, which are attracted towards the Earth. Many of them are burnt down as they enter into the Earth's atmosphere.

6.7. Conclusion

i) The vertical distribution of temperature, pressure, density, and composition of the atmosphere constitutes atmospheric structure. Spatial variation and distribution in temperature is determined by the season, its geographical location, and the time (day time or night time), and its distance and height from the sea.

ii) A mixture of a number of gases is termed as air that constituents abundantly molecular nitrogen (N2), molecular oxygen (O2), and a little amount of the inert gas argon (Ar). They together constitute 99.9 percent of the mass of dry air. This ratio of the number of each molecule is nearly stable up to a height of about 80 to 90 kilometers from the earth surface. Water vapor (H2O) and carbon dioxide (CO2) are other important gases that absorb and emit long wave radiation, and ozone (O3) gas that absorbs ultraviolet radiation from the Sun as well as some long wave radiation from the Earth. The distribution of these gases therefore affects the vertical temperature distribution.

iii) Temperature thus cools with height throughout the troposphere, but it then warms through the stratosphere, only to cool again through the mesosphere. Finally it heats up in the thermosphere and exosphere. This distribution comes about through changing interactions among shortwave radiation from

the Sun, long wave radiation from the Earth, and various gases in the air.

6.8. Questions

1. Explain the composition and structure of atmosphere. Draw suitable diagrams.
2. Discuss the factors determining distribution of temperature. Draw suitable diagram.
3. Describe the horizontal distribution of temperature. Draw suitable diagram.
4. Explain the vertical distribution of temperature. Draw suitable diagram.
5. Examine the importance of atmosphere and temperature giving suitable examples.

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9

Ocean relief features and Salinity of Sea water

Unit Structure:

9.1. Objectives

- To study the morphology of ocean.
- To study the distribution of relief features in Pacific Ocean.
- To study the salinity of sea water.
- To understand the factors responsible for variation in salinity of sea water.
- To study the distribution of salinity of sea water in the world.

9.2. Introduction to Ocean morphology

The configuration of the ocean basin with reference to their nature and various dimensions is known as morphology of

oceans. Different marine provinces form the basis for identification of various relief zones of ocean basins. Oceans cover approximately 65.7% (335 million square kilometers) of Earth's surface. Like the land surface, the ocean bottoms represent various kinds of marine features, i.e. plain, plateau, ridge, deep etc. The knowledge about the relief of ocean floors was very limited in the past centuries but the development of sound recording machine enabled the oceanographers to get more knowledge about the dept and topography of the ocean bottoms.

9.3. Ocean morphology:

A hypsometric **curve** is essentially a graph that shows the proportion of land area that exists at various elevations by plotting relative area against relative height. The **hypsographic curve** is a scientific way of describing the topography of the seafloor.

After the study of hypsographic curve, the ocean and sea bottoms may be demarcated into various relief or depth zones as given below:

i. Continental shelves
ii. Continental slopes
iii. Abyssal or deep sea plains
iv. Ocean deeps

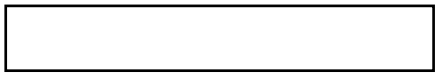

Fig. (1): Hypsographic Curve: A Schematic Representation of the Ocean Floor

i) Continental Shelves:

Continental shelves represent the shallow part, of the ocean and seas. It extends between low tide level and 100 fathoms depth of the sea water. It is almost uniform zone of sea bed with a gentle gradient. The width of the continental shelves varies from coast to coast depending upon the geographical structure and geomorphological nature of the coast. The average width of continental shelves is about 70 km.

The continental shelves are formed by erosion of coastal area by sea waves. Some continental shelves have been formed by deposition of sediments in the sea brought by the rivers. According to some views, the continental shelves were formed due to change in the sea level or subsidence of coastal land by tectonic movement. The formation of continental shelves is also thought due to emergence of the ocean and sea bottom.

The continental shelves have been grouped into following types on the basis of their formation and location:

a) Glaciated shelf,
b) Coral reef shelf,
c) Riverine shelf, and
d) mountainous shelf.

Importance of Continental Shelves:

a) Marine life is abundant due to availability of sunshine. Sunrays penetrate to the depth of the shelf and various kinds of grass, seaweeds and planktons are available. They are used as food for marine animals.

b) Various kinds of minerals like petroleum, natural gas are also found in shelf area.

ii) Continental Slope:

Continental slope is the next depth zone of ocean and sea floor to the continental shelf. It begins with outer edge of the shelf where the gradient of slope becomes steeper abruptly. The average slope of this zone is 4 degree but it varies from place to place. This zone is free from the deposits due to steep slope and about 60 per cent of sediments of continental slope are mud and the rest is composed of sands, gravels and organic remains. It covers smaller area of the oceans and seas. There are five types of slopes:

a) Fairly steep slope dissected by canyons,
b) Gentle slopes with elongated hills and basins,
c) Faulted slopes,
d) Slopes with terraces, and
e) Slopes with seamounts.

The origin of continental slope is still not known, although some may be as the result of large scale earth movement called Plate tectonic. It does not always extend up to deep sea but interrupted by wedge of deposited sediments. The deep waters of the **continental slopes** are very ideal for catching deep-living Rockfishes, Thornyheads, Sablefishes and Dover Sole. Generally, these species are caught as a group.

iii) Abyssal Plain or Deep Sea Plain

Beyond the continental slope a broad and featureless deeper part of the ocean is found. This deep plain is known as Abyssal Plain or Deep Sea Plain. It is found between 2000 to 6000 meters depth. Gradient of slope is very gentle and it appears as uniform flat plain without any relief. Moreover, the deep sea plain is formed by deposition of sediments of especially marine origin. The abyssal plain exerts significant influence upon ocean carbon cycling,

dissolution of calcium carbonate and atmospheric CO2 concentrations over timescales of 100–1000 years. The structure and function of abyssal ecosystems are strongly influenced by the rate of flux of food to the seafloor and the composition of the material that settles.

iv) Ocean Deeps

On the ocean bottom a large number of narrow elongated deep depressions have been recorded by the sound recorder device. Their depth is rather greater than the abyssal plain and some of them reach up to more than 9 kms below sea level. The peculiarity of the distribution of ocean deeps is that they do not occur amidst the ocean bottom but along the coast parallel to the fold mountain. Most of the heat from global warming is absorbed by the oceans as it covers 70% of the Earth's surface and therefore has a capacity to absorb heat a thousand times more than the atmosphere. Oceans are thus the main heat sinks of the earth.

Besides above discussed major relief of the ocean bottoms submarines canyons, submarine ridges, abyssal hills, seamount, guyouts and atolls are also are commonly found in the oceans.

v) Submarine Canyons

A long narrow depression is commonly found on the continental shelves and slopes. These depressions are called as Submarine Canyons. They are usually perpendicular to the coast. Their profiles resemble V-shaped valley with concave rock wall. There are three groups of canyons on the basis of their location and appearance: (1) submarine canyons which begin from continental shelves and extend to the slopes, (2) canyons, which are found at

the mouth of the rivers and extend up to continental slopes, and (3) dendritic canyons which are cut down in many branches.

Submarine canyons are diverse and complex in terms of their origins, hydrography, geologic settings and biodiversity of marine reserves in many locations because of their association with higher biomass and biodiversity.

vi) Abyssal Hills, Seamount and Guyot

Some isolated hills on the bottom of the seas and oceans are called Abyssal Hills. The abyssal hills attaining height of more than 1000mt are called Seamounts. Broad and flat topped seamounts are called Guyots. Atolls, concentric coral reefs and deep wide lagoon are common features in any ocean.

vii) Submarine Ridges

Like mountain chains on land, a long continuous chain of mountains also spread out in the mid of the oceans. They form the longest series of mountains on the earth.

9.4. Bottom Relief Features of the Pacific Ocean

Page 1

Pacific Ocean is the largest and the deepest ocean of the world. It extends from the Antarctic region in the south to the Arctic in the north and lying between the continents of Asia and Australia on the west and North and South America on the east.

Pacific Ocean, like the rest of the world's oceans, was formed millions of years ago and has a unique topography. It

also plays a significant role in weather patterns around the globe and in today's economy.

The Pacific Ocean has a highly varied topography. Oceanic ridges are found in a few places in the Pacific Ocean and they are the areas where new oceanic crust is being pushed up from below the Earth's surface. The Explorer Ridge lies at the northern extremity of the Pacific Ocean. The Jaun de Fuca lies west of Vancouver.

Continental shelves cover rather less area while the deep sea plain occupies largest area of ocean bottom. The depth of the sea plains is also greater than that of sea plains in other oceans.

This ocean is associated with a large number of abyssal hills, sea mounts, guyots, and plateaus like Albatross near western coast of South America. An abyssal hill is a small hill that rises from the floor of an abyssal plain. The greatest abundance of abyssal hills occurs on the floor of the Pacific Ocean. These Pacific Ocean hills are typically 50–300 m in height, with a width of 2–5 km and a length of 10–20 km. They may be created along the flanks of the East Pacific Rise as horsts and graben features, and then become stretched out with the passage of time. Nearly half of the world's seamounts are found in the Pacific Ocean, and the rest are distributed mostly across the Atlantic and Indian oceans. Guyots are flat-topped seamounts. Thousands of guyots, often in chains and clusters, are spotted across the Western Pacific Ocean, especially between the Hawaiian Islands and Japan.

Pacific Ocean is basically known for the island arcs and ocean deeps or trenches. Out of 52 known ocean deeps, 32 are found in this ocean. The Pacific is home to the deepest ocean point in the world - the Challenger Deep in the

Mariana Trench. This trench is located in the western Pacific to the east of the Mariana Islands and it reaches a maximum depth of 35,840 feet. Kurile Trench, Tonga Trench, Aleutian Trench, Japan Trench, Tuscarora Deep, etc are the other important ocean deeps in this ocean. This ocean is exceptionally free from the submarine ridges. The concentration of large number of deeps and island arcs from Aleutian island to New Zealand through Japan is attributed to the subduction of oceanic plate beneath the Asiatic continental plate along the margin of convergence in Pacific Ocean. The northern Pacific Ocean (and also the northern hemisphere) also has more land in it than the South Pacific. There are many island chains and small islands throughout the ocean. The largest island within the Pacific is the island of New Guinea. Volcanic eruption and earthquakes are very common phenomena in this ocean.

The characteristic features of this ocean are the feeble development of continental shelves, absence of any continuous middle dividing rise and abundance of deeps and trenches.

Check your progress:

1. What do you understand by morphology of ocean?

2. With the help of hypsographic curve explain different relief features of ocean basin.

3. Explain with examples various relief features found in the Pacific Ocean.

SALINITY OF SEA WATER

9.5. Introduction to salinity of Ocean:

Salinity is defined as "the ratio between the weight of the dissolved materials and the weight of the sample sea water". Salinity is expressed as gram percentage (%). Salinity can be measured using a Handled Refractometer, Hydrometer or Conductivity Meter. Salinity of the oceans and seas vary in open seas. Usually where there is free mixing of fresh water, the proportion of salinity remains constant, but where free mixing is absent, variation is seen. The average salinity of the sea water is 34.5%. The total amount of salt in sea water is gradually increasing every year. This is because it is brought from the land every year. Ditmar, during his Challenger Expedition in 1844, reported the existence of 47 types of salts in sea water.

a) Sources of Salinity:

i) In areas where temperature is high evaporation will be greater leading to lower dilution of salt. Together with high temperature if humidity is also low then salinity will be high.

ii) Secondly, if fresh water is continuously added in the form of precipitation, rivers or icebergs, then salinity will not be high.

b) Factors Controlling Salinity in an Ocean

i) Rate of Evaporation:

There is direct positive relationship between the rates of evaporation and salinity. Greater the rate of evaporation higher is the salinity. The sub-tropical region has highest

salinity. Here the sky is clear for more periods in a year, land is relatively more in this latitudinal belt, and sources of fresh water supply are relatively low. All this contributes towards higher rates of evaporation and so more salinity in the sea water.

ii) Precipitation:

Higher the precipitation lower the salinity, lower the precipitation, higher the salinity. This is the reason why the regions of high rainfall are associated with comparatively lower salinity than the regions of low rainfall.

iii) Influence of river water:

Though the rivers bring salt from the land to the ocean, big and voluminous river pours down immense volume of fresh water into the seas and so the salinity is reduced at their months. For example: - comparatively low salinity is found near of mouth of the Ganga, the Congo, the Nile, the Amazon, St. Lawrence etc. The influence of river water is more pronounced in the unclosed seas. For example: - the Danube river reduces the salinity in Black Sea [18%].

iv) Atmospheric Pressure & Wind Direction:

Anticyclone conditions with stable air and high temperature increases salinity of the surface water of the oceans. Sub-tropical High Pressure Belt represents such conditions to cause high salinity. Wind also helps in the redistribution of the salt in the oceans and seas as winds drive away saline water to less saline areas resulting into a decrease of salinity in the former and increase in latter.

v) Circulation of Ocean Water:

Ocean current affects the spatial distribution of salinity by mixing sea water.

9.6. World Distribution of Salinity

The latitudinal distribution shows that there is a low salinity at the equator ranging from 34 to 35.5% because of high rainfall and the large number of days with overcast sky. The region between 20-40 degrees N and 10-30 degrees S are the region of high salinity due to large number of cloudless days, which increase heat and promotes evaporation. Sargasso Sea (37%) S. E. Brazil (37%) Western Australia (36%) and near Peru-Chile (36.5%) are the high salinity zones.

After obtaining maximum in the lower middle latitudes salinity again decreases to 31% in the northern hemisphere and 33% in southern hemisphere that is (40 – 60 degrees N and S). Further pole ward salinity decreases due to the melting of ice. The average salinity for northern hemisphere is 34% while in South it is 35%. This is attributed to the fact that in the south a comparative less of mixing and less addition of fresh water takes place and there is absence of land.

Salinity either decreases or increases with depth according to that nature of water mass. Generally there is a decrease with increase of depth. At the equatorial region of Indian Ocean salinity increase with depth (34% to 35%) At the southern boundary of the Atlantic surface salinity is 33% increasing to 34.5% and still deeper it reaches up to 34.8%. Generally it can be said that in high latitude salinity increases with depth due to denser water mass found at the bottom.

Check your progress:

1. **Define salinity of sea water. Examine the factors influencing salinity of sea water.**
2. **Account for the differences in the distribution of salinity sea water in the world.**

9.7. Conclusions:

The study of ocean morphology has helped to understand the types of submarine relief features in the ocean basin**.** The relative importance of different oceanic relief features provide with different types of resources required either for bio-geo-chemical cycle functioning or directly as resources in the form of marine organisms, minerals and fossil fuels. The temperature balance of the earth is largely maintained by the oceanic surface as it absorbs huge amount of global heat.

Salinity of oceanic water is governed by different factors. Differences in salinity provides different of bio-reserves in oceanic waters besides deriving salts from sea water.

9.8. Questions:

1. What do you understand by morphology of ocean?
2. Explain the importance of ocean morphology.
3. Examine the distribution and location of bottom relief features of Pacific Ocean.
4. 'Salinity of sea-water varies in different areas'. Explain giving reasons.
5. Account for the distribution of salinity of sea water in the world.

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10

TIDES AND OCEAN CURRENTS: CAUSES, TYPES AND EFFECTS

Unit Structure:

10.0. OBJECTIVES:

- To study the origin and different types of tides.
- To understand the significance of tides.
- Understanding of origin of ocean currents.
- To study the factors responsible for formation of ocean currents
- To study the distribution of different types of ocean currents of Atlantic Ocean.
- To study the effects of ocean currents on the atmosphere and human activities.

10.1. INTRODUCTION:

The sea water rises regularly twice a day at regular intervals. This periodic phenomenon of alternate rise and fall in the level of the

seas is known as tides. Tides are produced as a gravitational interaction of the earth, moon and the sun. The nature and magnitude of tides vary from place to place.

10.2. TIDES – ORIGIN, TYPES AND SIGNIFICANCE OF TIDES:

a) **Origin of tides**: Origin of tides is due to the gravitational force exerted by the moon, the sun and the earth. As the position of the moon in the planetary system is close to the earth than the sun, the gravitational pull exerted by the moon is therefore twice as strong as that of the sun. Whereas the sun though bigger in size in at greater distance from the earth hence its influence is relatively less. The magnitude of the tides therefore is determined by the position of the moon in relation to the earth.

Diagram

b) **Following are different types of tides:** These tides are determined by the position of the moon, the sun and the earth with reference to the rotation and revolution of the earth and the moon around itself and the sun respectively.

Spring Tide: Highest tides known as **'Spring Tide'** occur on two days in a month i.e. on full moon and new moon days, i.e. when the moon, the sun and the earth are almost in a line.

Diagram

Neap Tide: Lowest amplitude tides called as **'Neap Tide'** occur when the moon is at first and last quarter of full moon, and the position of the sun and the moon are at right angles to the earth. During this period the pull exerted by the sun and the moon tend to balance each other resulting in the occurrence of lowest amplitude of tides.

Diagram

ii) Aphelion and Perihelion Tides:

The proximity of the Moon in relation to Earth and Earth in relation to the Sun also has an effect on tidal ranges. Earth moves around the Sun in an elliptic orbit that takes a little over 365 days to complete. Its gravitational force is greatest when the Earth is at perihelion i.e. the position when it is closest to the Sun in early January; and gravitational force is least when the Earth is at aphelion position i.e. farthest from the Sun in early July. The Perihelion tides occur when the Earth, Moon and Sun are aligned at perigee and perihelion, resulting in the largest tidal range seen over the course of a year. So, tides are enhanced when the Earth is closest to the Sun around 2nd January of each year. Tides are reduced during aphelion when it is furthest from the Sun i.e. around 2nd July.

Diagram

iii) Daily and Semi-diurnal tides: is classified on the basis of time interval between the tides. These are:

- **Diurnal tides:** The tides occurring at the interval of 24 hours 52 minutes daily are called diurnal or daily tides.
- **Semidiurnal tides:** Tides occurring at the interval of 12 hours 26 minutes are called as semi-diurnal tides

c) Significance of Tides:

i) Inland Navigation in rivers: Tides generally help in making some of the rivers navigable for ocean-going vessels. For example river Rhine, Elbe, Danube in Europe, River Thames in London, River Mississippi In U.S.A., River Hooghly in Kolkata.

ii) Desilting of river mouths: Tides clear away the sediments brought by the rivers and thus maintains the depth of water near the coast that provides natural harbor for fishing and shipping.

iii) Tidal energy: The tidal force is also used as a source for generating electricity. For example France and Japan have installed power stations that convert tidal energy into electricity.

iv) Fishing activity: A large amount of fish are brought to the coast during high tides that provides easy fish catch for fishermen to earn their livelihood and a source of nutrient food, feed, and fertilizer to man, his animals and cultivable land respectively.

Check your progress:

1. Explain the origin of tides with the help of a diagram.
2. Discuss different types of tides with suitable diagrams.
3. Examine the importance of tides in human life.

10.3. ORIGIN OF OCEAN CURRENTS:

The general movement of a mass of oceanic water in a definite direction is called ‘ocean currents’. Ocean currents originate in all parts of the world and are most powerful of all features of the ocean because they drive oceanic waters for thousands of kilometers.

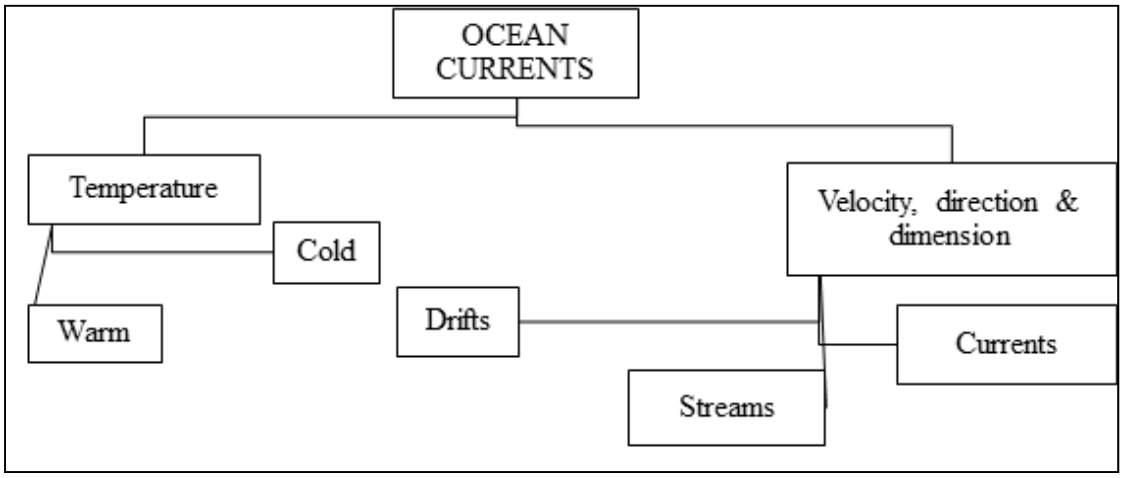


Fig: 1: Classification of Ocean Currents

The currents in the oceans are originated due to combined effects of several factors acting internally as well as externally which are as follows:

1. **Factors related to the Oceans**: Local variations in the physical properties of the ocean e.g. pressure gradient, temperature differences, salinity differences; density variations etc. generate ocean currents.

(i) Temperature Difference – Water moves from high temperature belts to lower temperature belts. Thus, currents from the equator move towards the pole. But, subsurface water also moves from poles towards equator to compensate the loss of water. Hence, temperature is an effective phenomenon.

(ii) Salinity Difference – Oceanic salinity affects the density variation causes ocean currents. Salinity increases the density of ocean

water. If two areas having equal temperature are characterised by varying salinity, the areas of high salinity will have greater density than the areas of low salinity. Ocean currents on the water surface are generated from the areas of less salinity to the areas of greater salinity. Such system of surface and sub-surface currents caused by salinity variation is originated in open and enclosed seas.

(iii) Density Difference – Difference in the density of oceanic water is the main cause for the movement of oceanic water as oceanic currents. Water moves from the areas of lower density to areas of higher density.

2. Factors related to atmospheric pressure: Ocean currents are greatly influenced and controlled by atmospheric pressure and its variation, wind direction, rainfall and evaporation etc. These are:

(i) Air pressure and Winds – Water moves from higher pressure areas to lower pressure areas in the form of currents, due to differential water levels.

(ii) Rainfall and Evaporation – The sea water levels becomes relatively higher in the areas of low evaporation and high rainfall than those areas which record low rainfall but high evaporation. Low evaporation coupled with high rainfall lowers the amount of salinity and thus reduces water density. This mechanism results in the rise of sea level. On the other hand high evaporation and low rainfall increases salinity and water density and thus lowers the sea level. Thus, surface ocean currents are generated from the area of low water level.

10.4 OCEAN CURRENTS OF THE ATLANTIC OCEAN:

The type and movement of ocean currents is determined the temperature conditions of the sea water in the ocean. Following are the types of ocean currents found in the Atlantic Ocean.

1. <u>North Equatorial Current (warm)</u>

Normally, the north equatorial current is formed between the equator and 10^0 N latitude. The current is generated because of upwelling of cold water near the west coast of Africa. This warm current is also pushed westward by the cold canary current. On an average, the north equatorial warm current flows from east to west but this saline current is deflected northward when it crosses the mid-Atlantic Ridge near 15^0 N latitude. It again turns southward after crossing over the ridge. This current, after being obstructed by the land barrier of the east coast of Brazil, is bifurcated into two branches e.g. (i) **Antilles Current** (ii) **Caribbean Current**.

2. <u>South Equatorial Current (warm)</u>

South equatorial current flows from the western coast of Africa to the eastern coast of America between the equator and 20^0latitude. This current is more constant than the north equatorial current. In fact, this current is the continuation of the Benguela current. This warm current is bifurcated into two branches due to obstruction of land barrier in the form of the east coast of Brazil. The northward branch after taking north westerly course merges with the north equatorial centre near Trinidad while the second branch turns southward and continues as Brazil warm current parallel to the east coast of America. This current is basically originated under the stress of trade winds.

3. <u>Counter-Equatorial Current (warm)</u>

The counter equatorial current flows from west to east in between the westward flowing strong north and south equatorial currents. This

current is less developed in the west due to stress of trade winds. In fact, the counter current mixes with the equatorial currents in the west but it is more developed in the east where it is known as the Guinea Stream. The counter – equatorial current carries relatively higher temperature and lower density than two equatorial currents.

4. Gulf Stream (warm)

The Gulf Stream is a system of several currents moving in north-easterly direction. This current system originates in the Gulf of Mexico around 20^0N latitude and moves in north easterly direction along the eastern coast of North America and reaches the western coast of Europe near 70^0N latitude.

(i) **Florida Current**: This current is the northward extension of the north equatorial current. These current flows through Yucatan channel into the Gulf of Mexico, thereafter the current moves forward through Florida Strait and reaches 30^0N latitude.

(ii) **Gulf Stream:** The Florida current after having the water of Antilles current is known as Gulf Stream beyond Cape Hatteras. This current is very wide and warm and is separated from the Sargasso Sea to its right (in the east) and relatively cold water near the coast to its left.

(iii) **North Atlantic Current**: The Gulf Stream is divided into many branches at 45^0 N latitude and 45^0W longitude. All the branches are collectively called as North Atlantic Drift or current.

5. Canary Current (cold)

The Canary Current, a cold current, flows along the western coast of North Africa between Madeira and Cape Verde. In fact, this current is the continuation of north Atlantic Drift which turns southward nears the

Spanish Coast and flows to the south along the Coast of Canaries Island.

6. Labrador Current (cold)

The Labrador Current, an example of cold current, originates in the Baffin Bay and Davis Strait and after flowing through the coastal waters of Newfoundland and Grand Bank merges with the Gulf Stream around 50^0W latitudes.

7. Brazil Current (warm)

This current is generated because of the bifurcation of the south equatorial current because of obstruction of the Brazilian coast near Sun Rock. The northern branch flows northward and merges with the north equatorial current while the southern branch known as the Brazil current flows southward along the east coast of South America up to 40^0S latitude.

8. Falkland Current (cold)

The cold waters of the Atlantic Ocean flows in the form of Falkland cold current from south to north along the eastern coast of South America up to Argentina. This current becomes most extensive and developed near 30^0S latitude.

9. South Atlantic Drift (cold)

This current is originated because of deflection of the Brazil warm current eastward at 40^0S latitude due to deflective force of the rotation of the earth. The South Atlantic Drift, thus, flows eastward under the influence of the westerly's.

10. Benguela Current (cold)

The Benguela current, a cold current, flows from south to north along the western coast of South Africa. In fact, the South Atlantic Drifts turns northward due to obstruction caused by the southern tips of Africa.

Further northward this current merges with the South Equatorial Current.

Diagram

10.5. EFFECTS OF OCEAN CURRENTS:

The climate of the coastal region is also influenced by ocean currents. Ocean currents therefore influence agricultural and other economic activities of coastal regions. Following are the effects of Ocean Currents:

i) **Brings Precipitation**: Warm ocean currents provide moisture to the winds blowing from the sea to the land. It helps in reducing the temperatures and so leads to precipitation (rainfall/snowfall / drizzle etc). For example Gulf Stream near western coastal Europe, North Atlantic drifts along the eastern coast of Mexico and USA, Brazilian current along the eastern coast of Brazil.

ii) **Weather and Climate:** Warm Ocean currents of tropical move towards Polar Regions to provide water. While cold ocean current of polar region bring cool water to tropical water areas. This exchange warm and cool water has a moderating climatic effect on temperate coastal regions. High temperatures during summers of coastal regions in temperate areas with cold and dry climate are brought down by the presence of these warm winds. For example north Atlantic drift (warm) current, which flows along the western coast of Canada, makes the region much warmer than other places on the same latitude.

iii) **Scanty Rain / no rain**: Cold current are devoid of any moisture and so the winds blowing from the sea are dry with no moisture. These

coastal regions therefore receive scanty rain or no rain. For example Kalahari Desert and Benguela cold current of South Atlantic Ocean.

iv) **Confluence of ocean currents and fishing grounds**: Places where cold and warm currents meet are ideal for the growth of Plankton that forms food for fish. These regions thus support a large number of fish to develop as major fishing grounds of the world. Newfoundland on the eastern coast of North America is the meeting point of the Warm Gulf Stream current and the cold Labrador Current.

On the other hand these places with confluence of warm and cold current also give rise to the formation of thick fog that reduces visibility and so are dangerous for shipping. It may cause accidents of ship since the shipping traffic is heavy in this North Atlantic Ocean.

v) **Shipping and Navigation**: Ships sailing with ocean current gains natural speed, which helps to save fuel and time. Ships moving against a current lose speed. Warm currents keep the Arctic regions free from icebergs, which can be dangerous for ships. Besides it keep ports free from freezing during winters thus making shipping possible throughout the year.

10.6. CONCLUSIONS:

From the present study it is very clear that tides also play an important role in influencing the weather and climate of the coastal regions. They help in the functioning of aquatic ecosystem in the coastal waters that facilitates fishing activity. Ocean currents largely govern the temperature of waters in the sea. They influence the weather conditions along the coast and play dominant role in the

temperate coastal areas. In addition Ocean currents help the shipping and navigation activities in the areas that are favourable.

10.7. QUESTIONS

1) How are tides formed? Draw suitable diagram
2) Explain different types of tides with neat diagrams.
3) What is the importance of tides in human life?
4) What are the causes and effects of ocean currents?
5) What is the significance of ocean current?
6) Define current and describe the types and distribution of current in Atlantic Ocean.

11

Practical Part A: Landforms

Unit Structure:

11.0. Objectives

- The study of landforms is facilitated with the help of contours.
- Value of contour, it spacing and shape helps to identify the nature of slope and the relief feature of the area.
- The drawing of profiles facilitates the nature of surface landform.
- Drawing of different types of relief and river profile assist in comparative analysis of nature of relief between the regions.

11.1. Introduction:

In physical geography it is very important to understand the nature of landform features for planning purposes and to study the type of associated landuse. There are different techniques used for understanding the relief features. Topographic maps represent natural and man-made features of the earth's surface. Relief features in Topographical maps are represented with the help of contour lines. Data of relief is represented on maps with the help of isopleths technique called contours. Contours are the most commonly used quantitative technique for representing relief. Contour lines are imaginary lines joining points of equal elevation above mean sea level. Since contour lines represent a

particular elevation therefore two different contour lines will never intersect each other. However two or more contour lines can meet each other at a point to represent a cliff / caves. Thus expertise in contour reading helps to identify the three dimensional relief at that point on a map and its corresponding relief features on the ground. Representation of landforms and terrain features by contour lines is covered

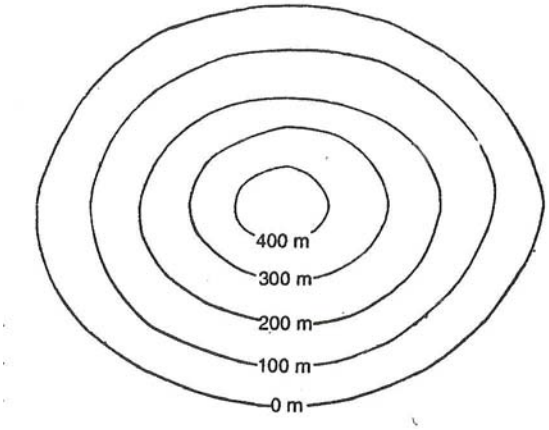
in this chapter to explain the basics of contour drawing and understanding of relief.

11.2. Contour and Interpolation of contour lines:

A) Contours are imaginary lines joining places having the same elevation above mean sea level. A map representing landforms of an area by contour is called a contour map. Method of depicting relief features with the help of contours is very useful and multi-resourceful. The contour map helps to understand the nature of topography of an area.

Earlier, ground surveys and leveling methods were used to draw contours on topographical maps. However the invention of topography and subsequent use of aerial photography have reduced the importance of conventional surveying, leveling and mapping methods. In the contemporary period these aerial photographs are used for topographical mapping.

Contours are drawn at different vertical intervals (V.I.) viz: '0' meter, '100' meters, and '200' meters etc. above the mean seal level **Figure 11.1.**



Contours: Figure 11.1.

This is known as contour interval which is ‘100’ meters between two consecutive contours which remains constant on the contour map.

This contour interval is usually constant on a given topographical map. The horizontal distance (H.E.: Horizontal Equivalent) varies from place to place depending upon the nature of slope. The horizontal distance between two points is large when the slope is gentler (i.e. the consecutive contours are spaced apart) and distance is less when the slope/gradient is steeper (i.e. consecutive contours are closely spaced) on the topographical map.

Following are some of the basic characteristics of contour lines:

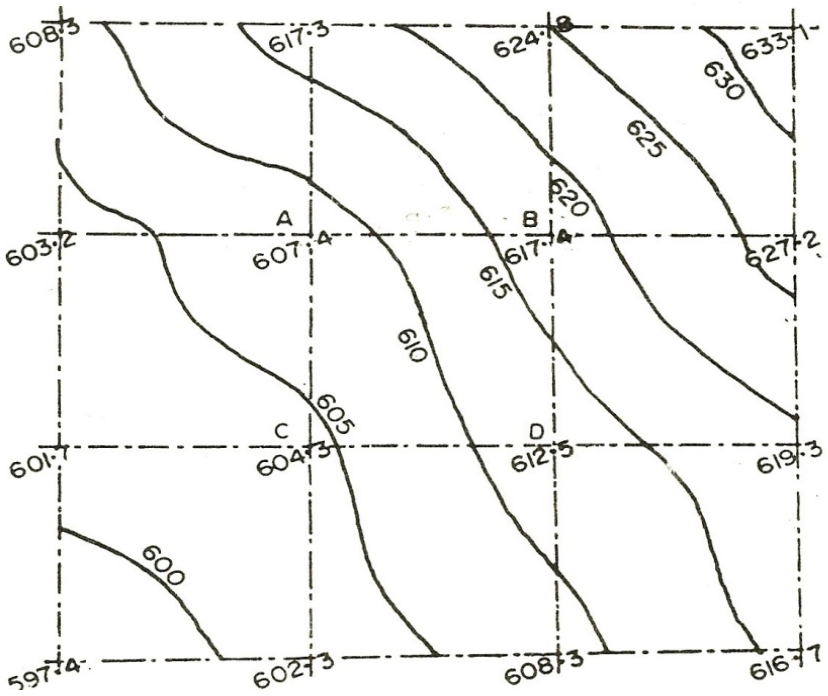
- A contour line is drawn to represent the places having equal height.
- Contour lines and their shapes represent the height and slope or gradient of a landform.
- Closely spaced contours reveal steep slope and widely spaced contours represent gentle slope.
- It is important to note that when two or more contour lines meet at a point they represent features of vertical slope such as waterfalls or cliffs.
- It is important to note that two contours of different height will never intersect each other.

B) Interpolation of contour lines by Arithmetic method:

It is a process of spacing the contours proportionately between the plotted ground points by arithmetic method. It is assumed that the slope of ground between two points (height/depth) is uniform.

In this method the positions of contour points between the guide points are located by arithmetic calculations. For example, let A.B.D, and C can be the guide points plotted on the map having elevations of 607.4, 617.3, 612.5 and 604.3 feet respectively **(figure 11.2).** Let A B = B D = C D = C A = 1” on the plan and let it be required to locate the positions of 605, 610, 615 feet contours on this lines. The vertical difference in elevation between A and B is (617.3 – 607.4) = 9.9 feet. Hence the distances of the contours points from A will be:

- Distance of 610 ft contour point = 1/9.9 * 2.6 = 0.26” (approx).
- Distance of 615 ft contour point = 1/9.9 * 7.6 = 0.76” (approx).



Interpolation of contour lines: figure 11.2.

These two contour points may be located on AB. Similarly, the position of the contour points on the lines AC, CD, BD and also AD and BC may be located. Contour lines may then be drawn through appropriate contour points as shown in figure **(figure 11.2).**

Check your progress:

Q. Define Contour and explain its importance.

Q. Which method is used for drawing contours?

11.3. Identification of Contour landforms through cross sections:

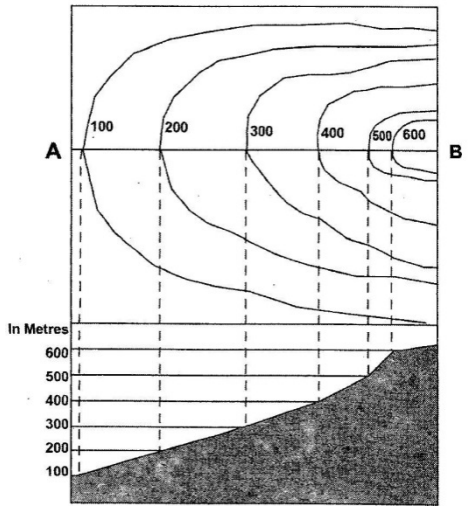
Landforms of any area are associated with different types of slopes and relief features. These landform features and slopes are identified and studied with the help of contours by drawing cross sections using topographical map of that area.

Following are few cross sections of slopes and landforms drawn with the help of contours:

a) **Types of Slope:** Slope can broadly be classified into gentle, steep, concave, convex, uniform, undulating/irregular, and terraced. The

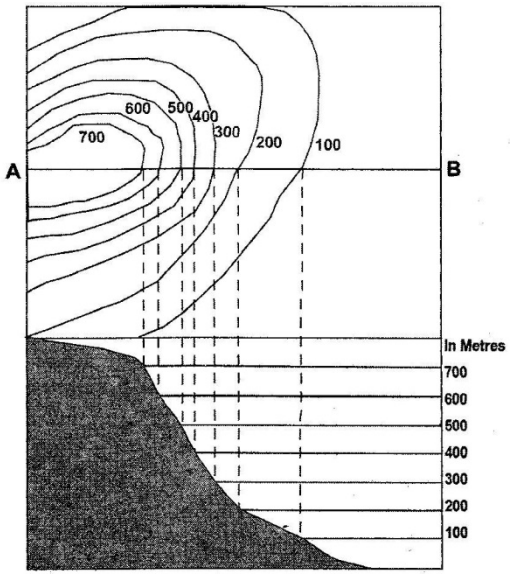
landform with varying slopes would reveal contours of distinct spacing pattern on the topographical map.

i) **Gentle slope:** The angle or degree will be low when a slope is gentle. In gentle slope the contours are widely spaced **Figure 11.3.**



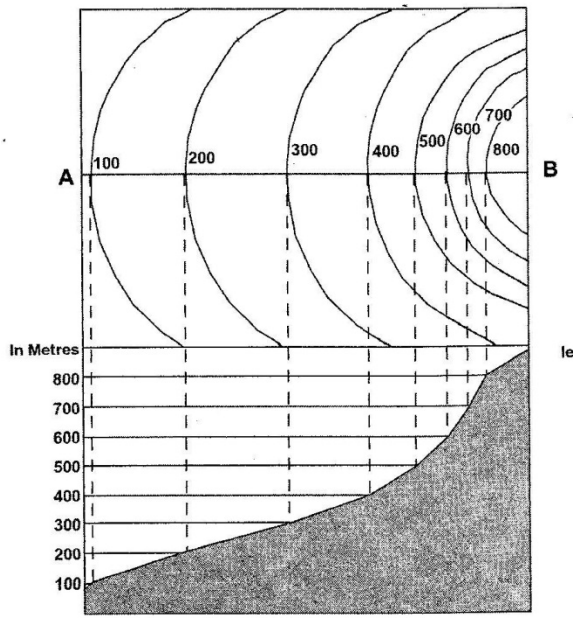
Gentle slope: Fig. 11.3

ii) **Steep slope:** The angle or degree will be high when a slope is steep. In steep slope the contours are closely spaced **Figure 11.4.**



Steep Slope: Fig. 12.4

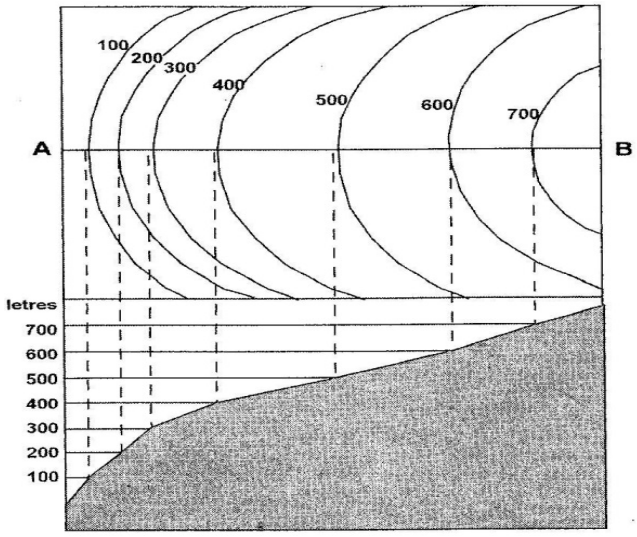
iii) **Concave slope:** The landform has gentle slope in its lower elevation and steeper slope in its higher elevation. Thus the contours in lower elevation are spaced apart and in higher elevation are closely spaces revealing a concave slope of the land at that place **Figure 11.6.**



Concave Slope; Fig.11.6

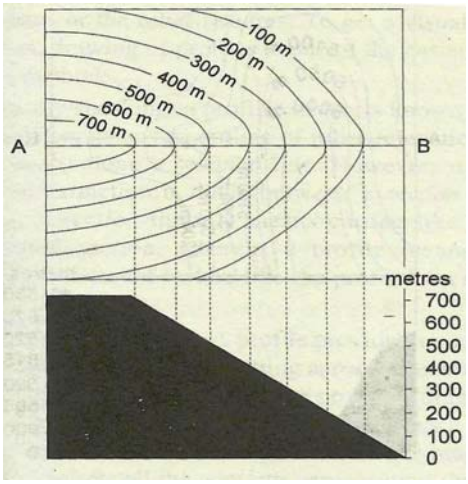
iv) **Convex slope:** The landform has steeper slope in its lower elevation and gentler slope in its higher elevation. **Figure 11.7.**Thus the contours are spaced closely in lower elevation are widely in higher elevation revealing a convex slope of the land at

that place.



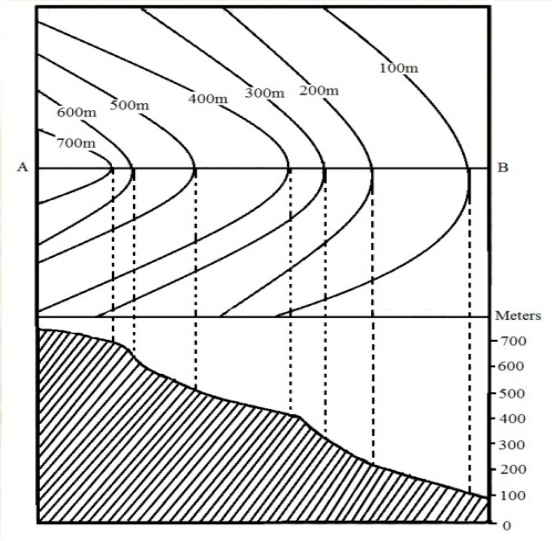
Convex Slope; Fig.11.7

v) **Uniform Slope:** When the slope of an area increases or decreases per unit horizontal distance uniformly is called as uniform slope. **Figure 11.8**



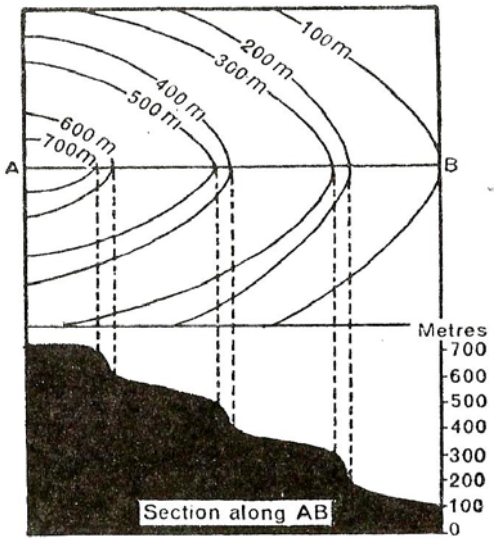
Uniform Slope: Fig.11.8

vi) **Undulating/irregular Slope:** It is a slope where the gradient changes with short horizontal distances that can be gentler or steeper thus producing concave and convex slopes. **Figure 11.9**



Undulating/irregular Slope: Figure 11.9

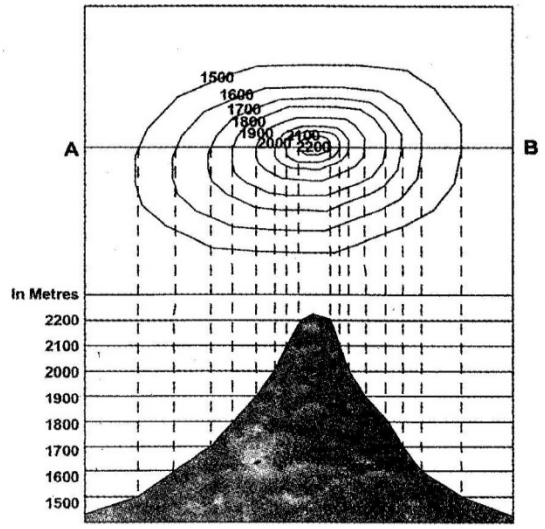
vii) **Terraced/ Stepped Slope**: The contours of terraced slope alternately rise gently and then steeply with increasing altitude of the landform. **Figure 11.10**



Terraced/ Stepped Slope: Figure 11.10

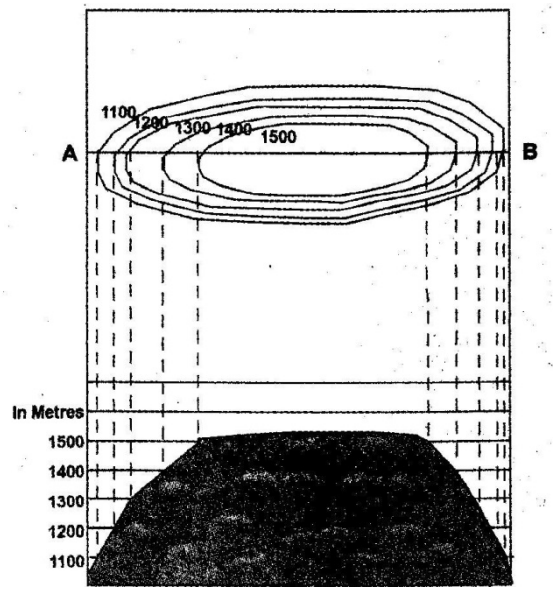
b) **Types of landforms:** Following are some of the important types of landforms that can be studied by drawing cross section across the contours:

i) Conical Hill / A mount: Conical hill rises almost uniformly from the surrounding land. A Conical hill with uniform slope and narrow top is represented by concentric contours spaced almost evenly at regular intervals. **Figure 11.11**



Conical Hill / A mount: Fig.11.11

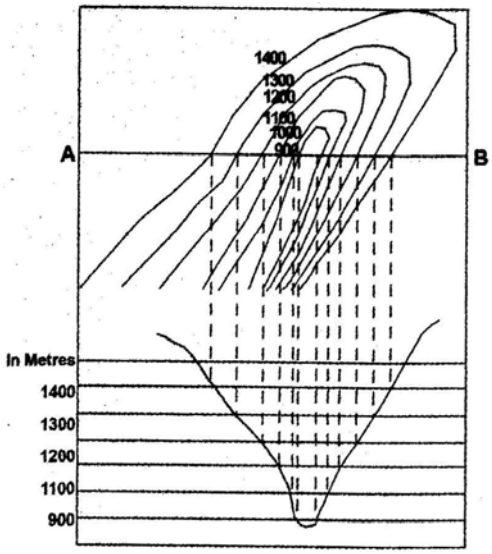
ii) Plateau: A widely stretched flat topped highland, with relatively steeper a side rising above the adjoining plain or sea is called a plateau. The contour lines representing plateau are rectangular in shape which are normally close spaced at the margins with inner most contour showing wide gap between its two sides **Figure 11.12**



Plateau: Fig.11.12

iii) Valley ('V' and 'U' Shaped valley): Valley is a land with deeper steep sides lying between two highlands formed due to lateral erosion by a river or a glarier.

'V' shaped valley: it resembles the letter 'V'. A V shaped valley occurs in mountainous areas.

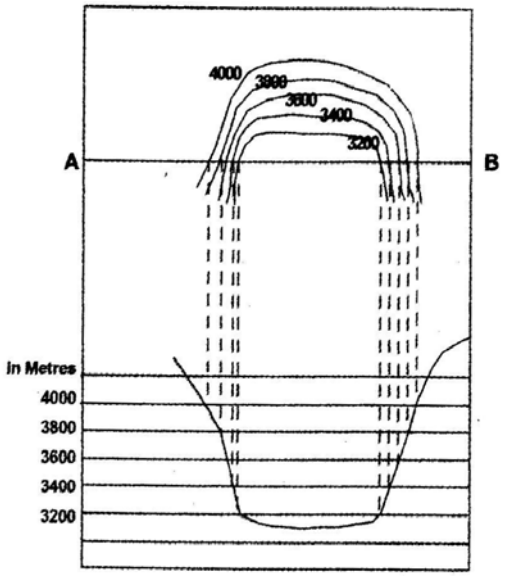


'V' shaped valley: Fig.11.13

The lower most part of the V shaped valley is shown by the inner most contour line with very small space between two consecutive contours and the lowest value (lowest elevation) of the contours is assigned to it.

The contour value increases outwards with uniform intervals for all other contour lines. **Figure 11.13**

'U' shaped valley: A U shaped valley is formed by strong lateral erosion of glaciers at high altitudes. The flat wide bottom and steep sides makes it resemble the letter 'U'. The lowermost part of the U shaped valley is shown by the inner most contour line with a wide gap between its two sides. The contour value increases outwards with uniform intervals for all other contour lines.**11.14**



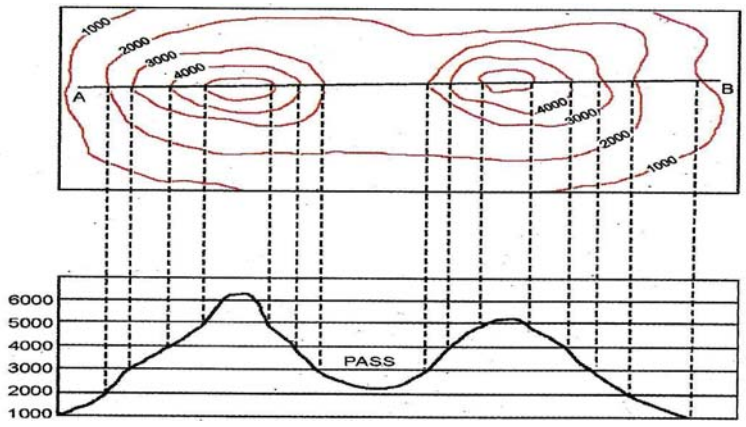
'U' shaped valley: Fig.11.14

v) Pass, Saddle, Col and Gap: These landform features are noticed in hilly regions.

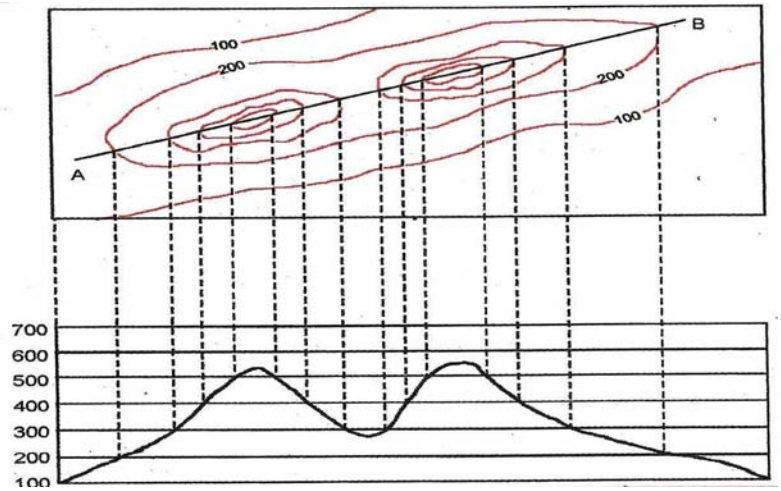
(a)Pass: A Pass is found between two hills or mountains and serve as a land route across the hill/ mountain range(**Figure 11. 15 a).**

(b)Saddle: It is a shallow depression between two peaks **(Figure 11. 15 b).**

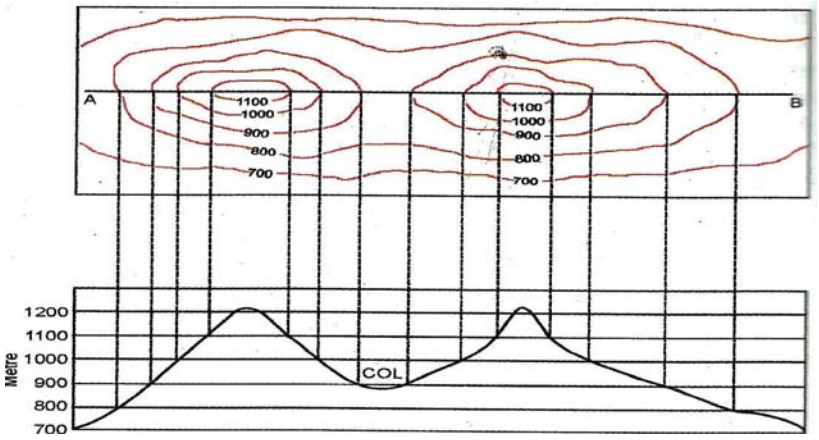
(c)Col: A Col is formed between the ridges of a water-shed (**Figure 11. 15 c).**



Pass: Figure 11. 15 (a)

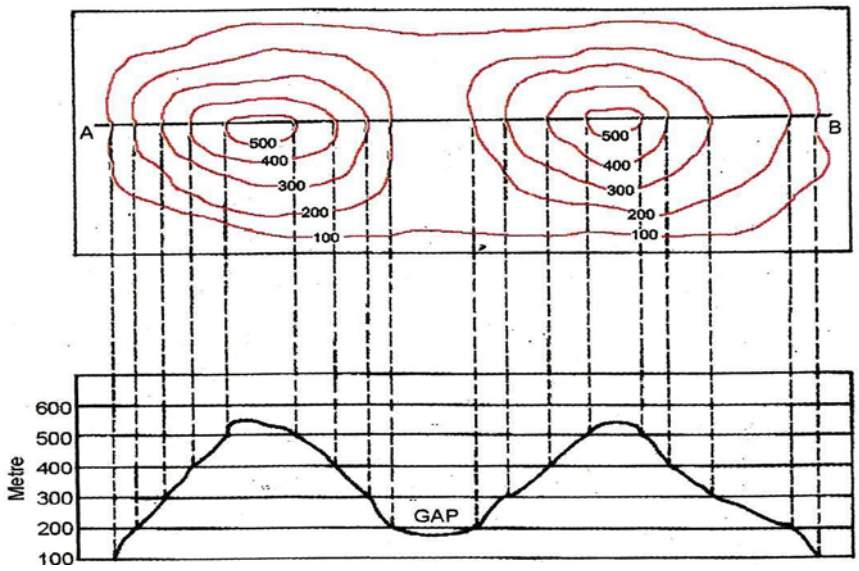


Saddle: Figure 11. 15 (b)



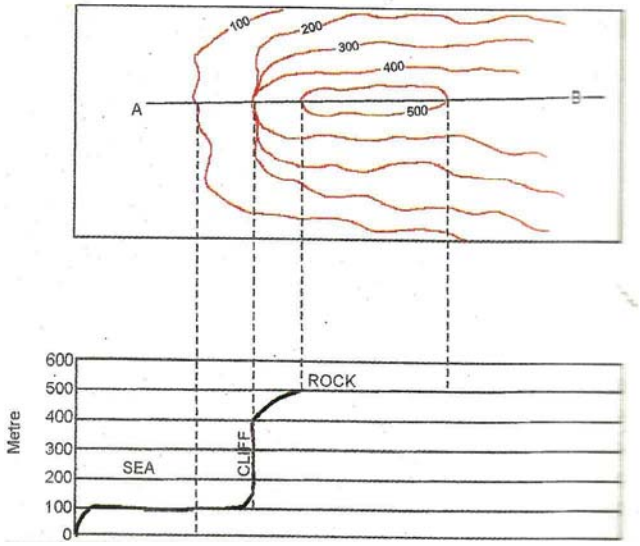
Col: Figure 11. 15 (c)

(d) Gap: A gap is a low depression close to the ground found between a ranges of hills (**Figure 11. 15 d).**



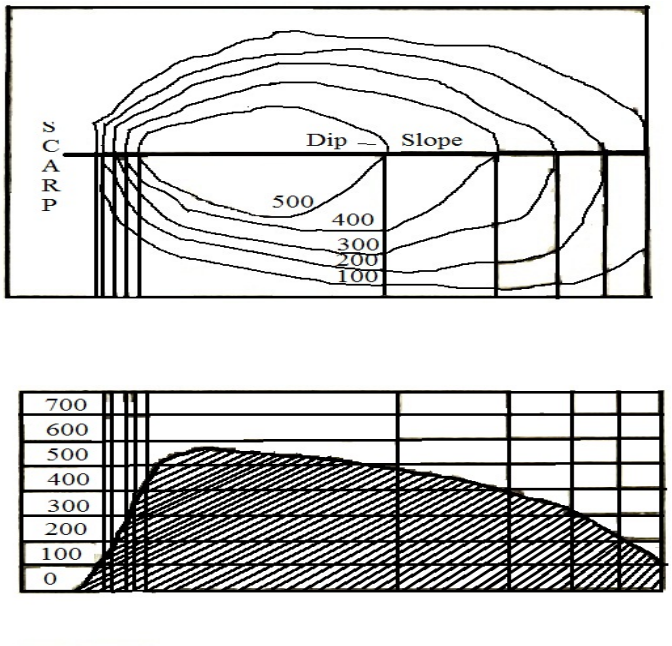
Gap: Figure 11. 15 (d)

vi) Cliff: A cliff is a steep and straight rock wall in the Rocky Mountains or rocky coast, or rocky hills. Cliff is characterized by sudden steep slope where three to four or more contour lines meet at one point. **Figure 11.16**



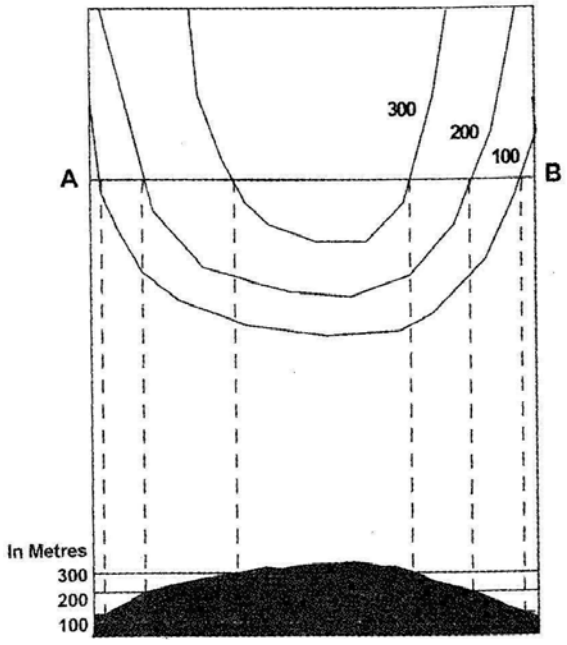
Cliff: Fig.11.16

i) **Escarpment/ Scarp:** an escarpment is a long abrupt and steep slope of a hill/ a ridge/ or a plateau. It is formed as a result of faulting or the erosion of an inclined hard rock. **Figure 11.17**



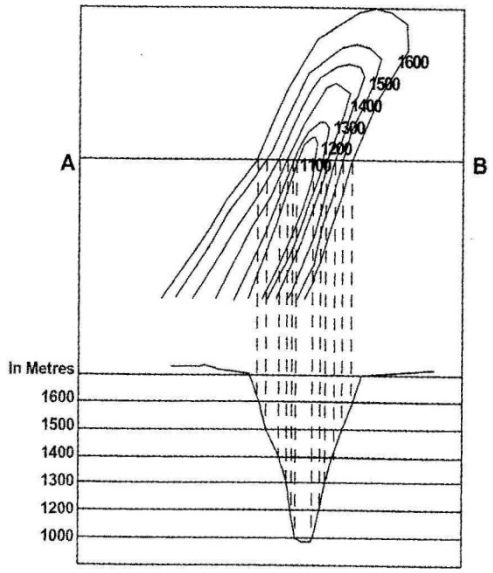
Escarpment/ Scarp: Figure 11.17

ii) **Spur:** A spur is an outward projection of high ground into a lower one. It is represented as an outward bulged in the contour lines **Figure 11.18.** In a spur higher contour bends towards the lower contour.



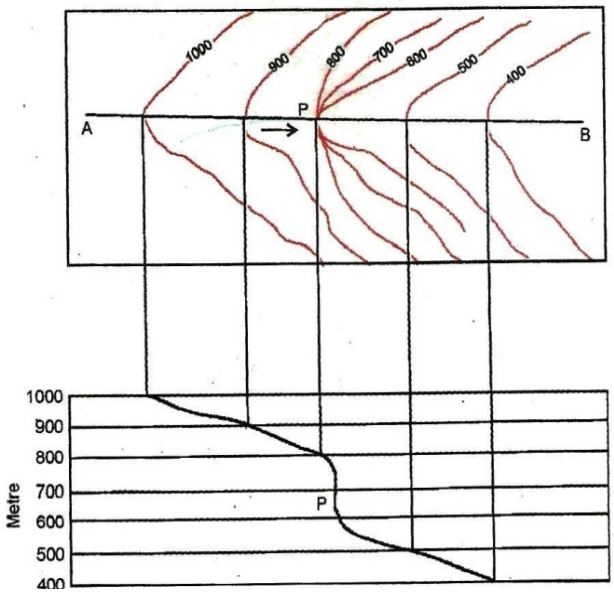
Spur: Figure 11.18

iii) **Gorge:** A Gorge is a deep narrow valley with very steep slopes. A Gorge usually develops in a region of hard rock's where the river carves out a steep sided valley for itself due to its enormous capacity of vertical cutting. **Figure 11.19**



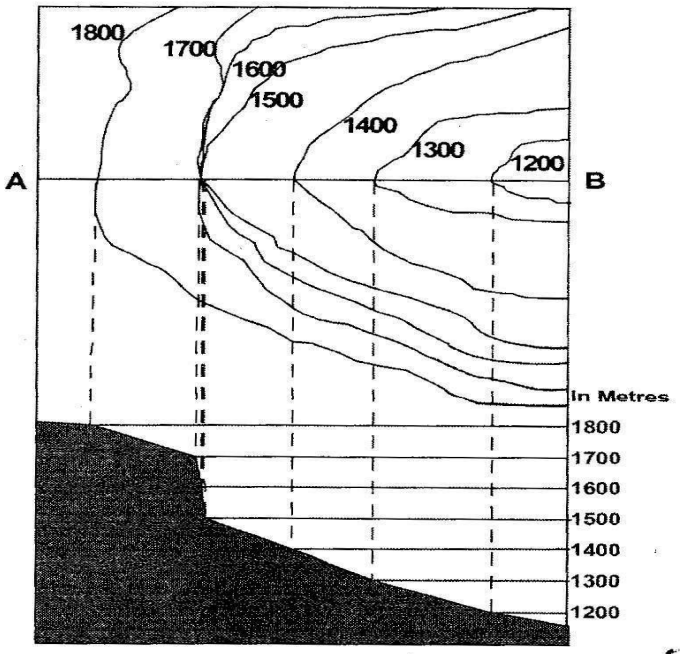
Gorge: Figure 11.19

x) Rapid and Waterfall: A waterfall is created in the channel of a river that has a steep vertical slope with flowing water. A waterfall is observed where two or more contour lines meet at a point in the bed of a river.



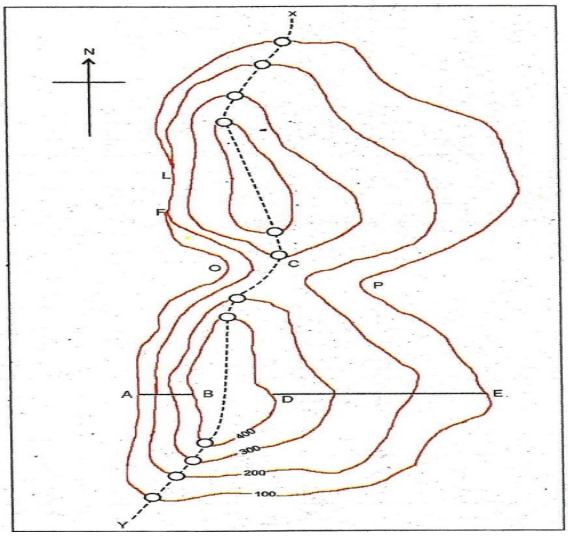
Rapid: Fig. 11.20 (a)

A rapid is a miniature waterfall. Generally they are found upstream from the main water fall. Sometimes they occur independently. A rapid also has a considerable slope hence the contours liens are closely spaced while crossing the valley. Rapids are a step like structure formed due to erosion of soft rock and resistant hard rock overlaying each other. **Figure 11.20(a), (b).**



Water-Fall: Figure 11.20 (b).

xi) Water-shed / Water divide: A watershed is the land area from where water flows on the either sides of the slope and develops small rills/streams. These are well identified in the hilly/mountainous regions. **Figure 11.21.**



Water-shed / Water divide: Fig. 11.21

Check your progress:

Q. Explain different types of slopes with the help of diagrammatic representation.

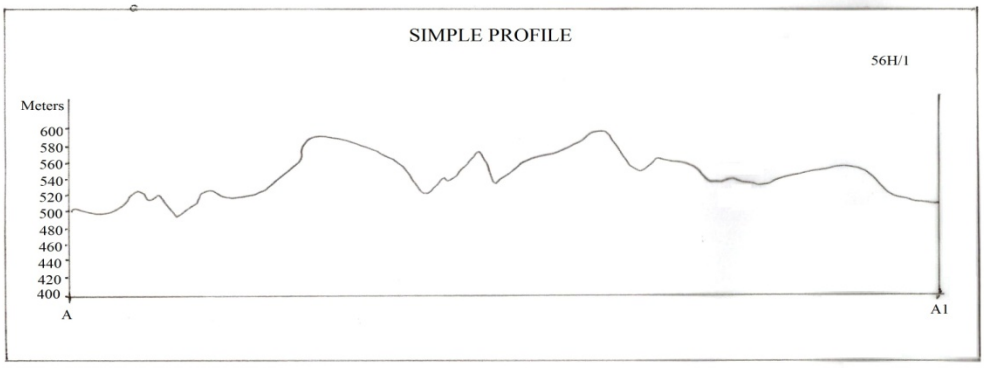
Q. Explain different types of relief features with the help of diagrammatic representation.

11.4. Relief Profiles – importance and types:

A relief profile is a line which shows the rise and fall of the surface of the ground along a chosen line on a map. One of the advanced techniques of representation of relief is to draw a relief profiles. A profile of a relief feature acts as a visual aid in its description and interpretation. Hence it is of particular interest to geographers and especially geomorphologists who are interested in the analysis of landforms and in the process of their upgradation and degradation. Identifying landform features with the help of contours is complex whereas profiles are relatively easy and useful in understanding the relief features.

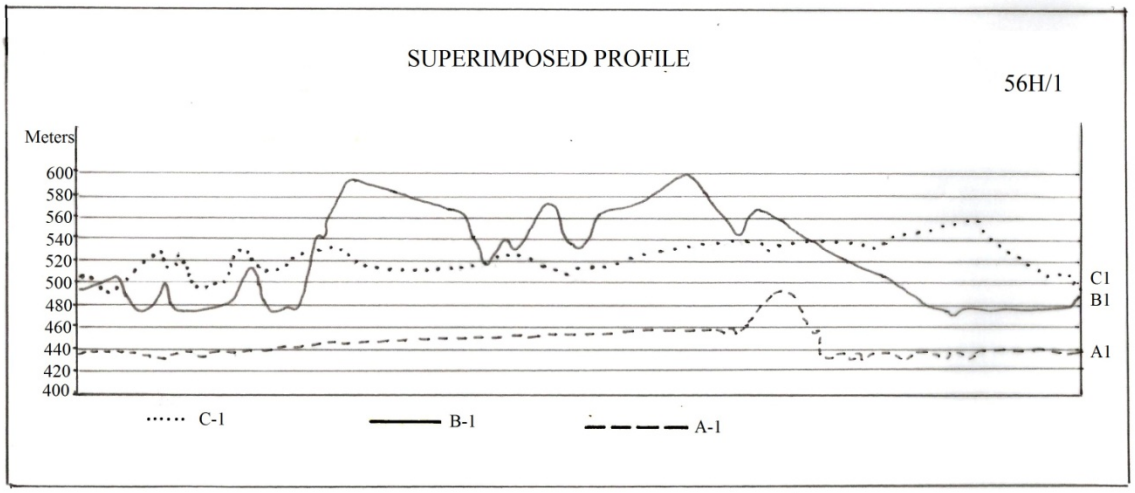
Broadly speaking, a profile which is also known as a section means an outline of a relief (elevation or depression) along a selected line. However, sometimes a distinction is made between a section and profile. A Section is usually a cutting taken for a geological section, whereas a profile is a outline of the surface relief feature like profile of a river valley.

i) **Serial / Simple profile:** These are made by drawing a series of profile or parallel profiles for showing features like a coastline; edges of plateau; a series of spurs; a transverse profile of a river; a junction of two contrasting topographical features etc. Figure 11.22 explains the construction of a simple profile.



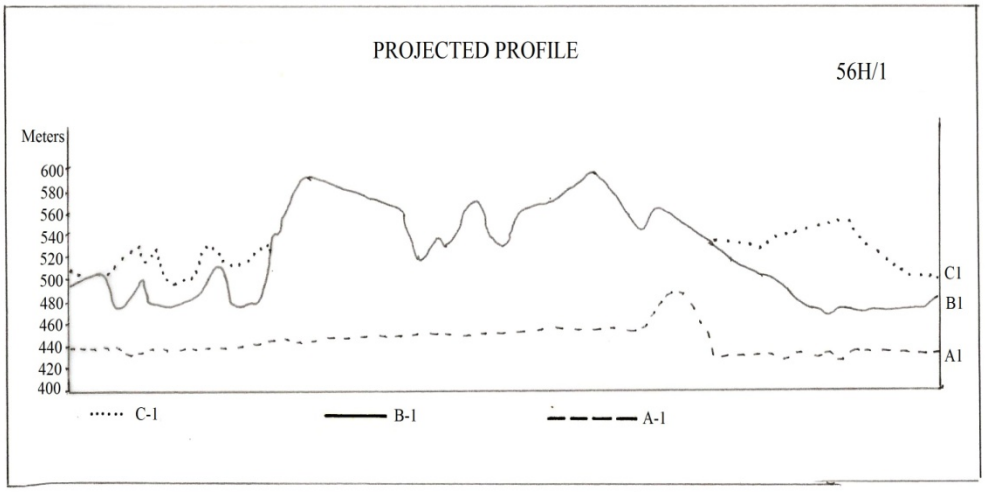
Serial / Simple profile: Figure 11.22

ii) **Superimposed Profile:** When a series of profile are superimposed on a single plane it is called as superimposed profile. These successive profiles are numbered for getting clarity. Such profiles are generally used for representing landforms with certain morphological uniformity as shown in **Figure 11.23**. In other cases the serial profile are more useful.



Superimposed Profile: Figure 11.23

iii) **Projected Profile:** In the superimposed profiles, the successive parallel profiles are placed on a common base line. However, the lower parts of the profiles are hidden behind the higher intervening altitudes.

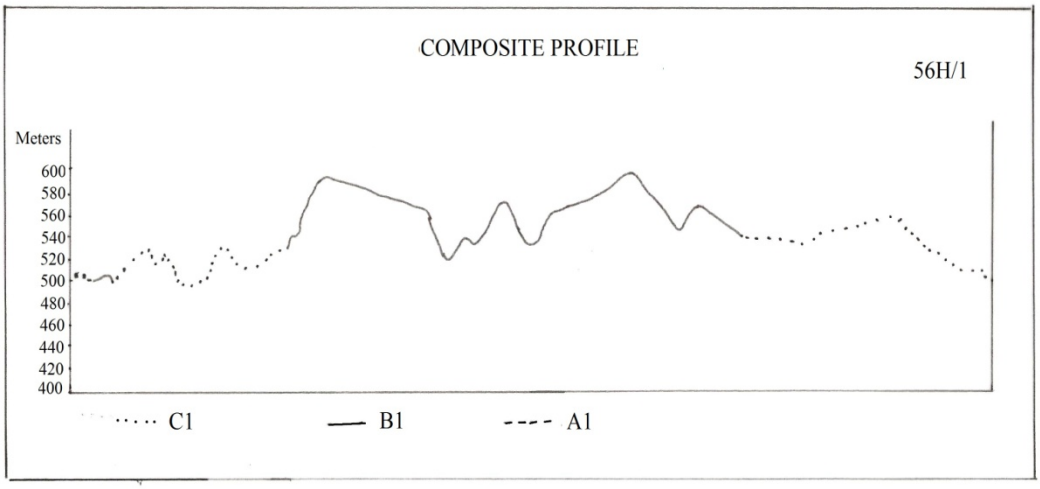


Projected Profile: Figure 11.24

If only the visible parts of successive profiles are represented on a common framework one gets a panoramic view of foreground, middle

ground and the sky line. Such profiles are known as projected profile or compressed profile as shown in **Figure 11.24.**

iv) Composite Profile: If the superimposed profile of a landform is viewed carefully one can discern at the farthest end of such a profile, a summit line, the skyline which provides a general outline of the concerned landform features as viewed from a distance. This skyline can be represented by a profile or a line drawn by joining the highest parts of a series of parallel profiles. Such a profile is known as composite profile. Such profiles can be used for a comparative analysis of the terrain types in a region or between regions **Figure 11.25.**



Composite Profile: Figure 11.25

Check your progress:

1. What do you understand by the term relief profile?
2. Give different types of profile
3. Explain the use of profile in the study of landforms.

Conclusion: This module therefore explains the importance of quantitative techniques in identifying different types of slopes and landform features. Comparative analysis and spatial differentiation is therefore possible with the help of such geographical techniques used in practical geography.

Questions:

1) Explain giving examples the importance of contours in the identification of landform features.

2) What is a relief profile? Giving different types of profiles explain their importance.

3) Draw the cross sections and profile given in figure 11.4 to 11.25

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