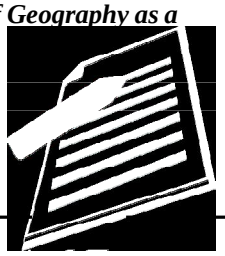

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NATURE OF GEOGRAPHY AS A DISCIPLINE

The proposed course aims at explaining the nature of the subject. It throws light on the importance of geography and describes the nature of geography as a subject. It attempts to enrich knowledge and illustrate basic concepts as well as technical terms which are building blocks of geographic knowledge. Effort, however, has been made to develop the concepts in a graded and sequencial manner and deepen the interest in the subject.

Geography is one of the oldest earth science and its roots date back in the works of the early Greek scholars. The word 'geography' was first used by the Greek scholar Eratosthenes in the third century B.C.

Geo " Earth" and Graphy " to describe" literal meaning of geography is to describe about the earth's surfaces. In other words "Geography is largely the study of the interaction of all physical and human phenomena and landscapes created by such interactions." It is about how,why,and where human and natural activities occur and how these activities are interconnected.

Geography has undergone changes in its approach. The earlier geographers were descriptive geographers. Later, geography came to be developed as an analytical science. Today the discipline is not only concerned with descriptions but also with analysis as well as prediction.

In this lesson you will learn how important geography is in everyday life. This study will encourage you to understsnd your own place and spaces with greater interest.

OBJECTIVES

After studying this lesson, you will be able to:

- appreciate the use of Geography in daily life;
- trace development of Geography as a discipline;

- understand man-environment relationships and their impacts on each other;
- illustrate the systematic and regional approaches of Geography;
- understand various analytical techniques in Geography;
- identify the different branches of Geography and its scope.

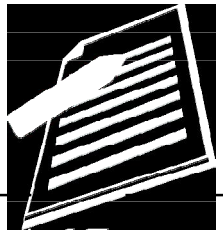
1.1. GEOGRAPHY IN DAILY LIFE

You must have noticed that the earth's surface is ever changing; In general, the natural phenomena like mountains, rivers, lakes etc. change slowly while the cultural elements like buildings, roads, crops, change fast. Travelling from one place to another you notice that the trees number and types of trees change from area to area. All this is because of the continuous interaction between the enviroment in which we live in and the way we use it. The study of Geography is about observing such patterns. Another aspect of geography is to understand the factors or reason behind areal differentiation, how do social, cultural, economic and demographic factors change our physical landscape and create new or altered landscapes by human interventions. For example, human settlements are transformation of forest or barren lands for living purpose by human being.

Geography is often thought of as the art of making and studying maps. Maps give us a much more correct and graphic view of the way the Earth's surface looks compared to a picture of drawing. As earlier, even today geographical information about an area is available through reports, travel diaries and gazeteers. At present maps can be drawn by using satellite images using Geographic Information Systems (GIS) tools. Computers easily convert the information from satelite images into maps to show what changes development can bring about. Such information is of benefit to the society. Such mapmakers are in great demand today. Nowadays geographers, engineers, environmental scientists, city planners, social scientists, and many others learn to use GIS to understand the Earth better.

Geography, not only investigtes what is where on the Earth, but also why it is there. Geographers study the location of the activities, carefully identify patterns using maps and find out the reasons for these patterns. The areas are then described based on the distribution of land forms, population, house type and agriculture. They discover the linkages and movements between places and are able to infer the spatial processes that are working in an area.

Today, all over the world there are problems related to providing food security, health, effective energy use and environmental conservation. Equally important are equality issues and sustainable development. All these can be achieved by using our resources in sustainable ways. Study of geography is, therefore, necessary to learn more about environmental processes and to understand how land use planning can help us to overcome problems.



In brief:

1. Geography is a science of space.
2. Maps are an essential tool of geographers.
3. Digital Geographical Information system is a new tool for making maps.
4. Spatial Planning can be done using both maps and the study of geography

Basic Concepts

Geography has been defined differently through different periods of its history Geographical work in ancient Greece had followed two distinct traditions. One was the mathmatical tradition which was focused on fixing the location of places on the earth's surface, and the other was gathering geographic information through travels and field work. According to them, the purpose of geography was to provide a description of the physical features and conditions in different parts of the world. The emergence of regional approach in geography also emphasied the descriptive character of geography. According to Humboldt, geography is the science related to nature and it studies and describes all material things found on earth. Another important school of thought defined geography as the study of man-environment relationships.

- Geography as a study of the earth's surface.
- Geography as the study of man-environment relationships.

INTEXT QUESTION 1.1

1. What is geography

   _____

2. Why is earth's surface changing

   _____

3. Which are the two distinct traditions followed by Greeks

   (i)_____(ii)_____

1.2 DEVELOPMENT OF GEOGRAPHY

(A) Ancient Period

The earliest records illustrate the interests of scholars in understanding the physical domain of the earth by making maps and astronomical measurements. The Greeks are given the credit of being the earliest geographers, prominent among them being Hower, Herodotus, Thales Aristotle and Eratosthenes.

(B) Pre-Modern Period

This period starting from the middle of 15th century and continuous with 18th early provides us enormous information about the physical and cultural nature of the world by the travels and explorations of early gergrophers. The early seventeenth century witnessed the beginings of a new scientific geography. Christopher Columbus and Vasco de gama, Fesdinend Meghellan and Thomas cook were important explorers and travelles among those. Varenius, Kant, Humboldt and Ritter led the geographers of this period. They contributed in the development of cartography and discovering new lands, and developing geography into a scientific disciplines.

(C) Modern Period

Ritter and Humboldt are frequently referred to us the founders of modern geography. Generally, latter half of nineteenth century is considered as a period of modern geography. The first modern geographer in true sense was Ratzel who built the structure of modren geography on the foundations laid down by classical geographers.

(D) Recent Period

The development of geography during the post Second World War period has been very rapid. The American and European geographers such as Hartshorne have contributed the maximum during this phase. Harthshorne described geography as a science dealing with areal differentiation. The present day geographers look upon regional approach and systematic aproach as complimentary rather than contradictory.

1.3 SCOPE OF GEOGRAPHY

Geography has now acquired the status of science that explains the arrangements of various natural and cultural features on the earth surface.Geography is a holistic and interdisciplinary field of study engaged in understanding the changing spatial structure from past to the future. Thus, the scope of geography is in various disciplines, like armed services, environment management, water resources, disaster management, meteriology and planining and various social sciences. Apart from that, a geographer can help in day to day life like tourism, commuting, housing and health related activities.

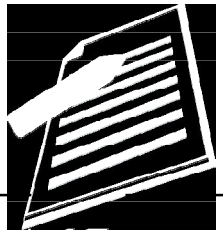
1.4 APPROACHES TO STUDY OF GEOGRAPHY

Today, geography is the only discipline that brings all natural and human sciences on a common platform to understand the dynamics of the spatial configuration of the earth surface. There are two main approaches in geography :

1. Systematic 2. Regional

1. Systematic Approach

A study of specific natural or human phenomenon that gives rise to certain spatial patterns and structures on the earth surface is called systematic study. Ordinarily, systematic geography is divided into four main branches.



(i) Physical geography,

(ii) Biogeography, including environmental geography,

(iii) Human geography,

(iv) Geographical methods and techniques

(i) It deals earth systems like atmosphere (air), the hydrosphere (water), the lithosphere (earth solid rock) and biosphere, which encompasser all of earth's living organisms.

(ii) It focusses on various kinds of forests, grasslands, distribution of flora and fauna, human nature relationships and the quality of the living environment and its implications for human welfare.

(iii) It describes culture, populations, dynamics of social, economic, and political aspects of space.

(iv) It deals with methods and techniques for field studies, qualitative quantitative and cartographic analysis and Geographic Information System and Global positioning system (GIS and GPS) and remote sensing.

- Geography has developed in four periods i.e. ancient period, pre-modern period, modern period and recent.
- Contribution of Harthshorne is pioneering in the field of geography in recent period.
- Geography is a holistic and interdisciplinary field of study engaged in understanding the chaning speatial structure at different territorial levels.

2. Regional Geography

Unlike systematic geography, regional geography starts with the spatial imprints of one or all the systematic geographic processes discernible as regions of different sizes. Regions could be based on a single factor like relief, rainfall, vegetation, per capita income. They could also be multificator regions formed by the association of two or more factors. Administrative units like, states, districts, tehsils also can be treated as regions. The main sub branches of regional geography are:

(i) Regional studies

(ii) Regional analysis

(iii) Regional development

(iv) Regional planning including areas and community planning.

- Two main approaches in geography i,e (i) systematic and (ii) regional
- Systematic geography is divided into four branches.
- Regional geography has also four branches.

INTEXT QUESTION 1.2

1. Which are the four branches of systematic geography.

   (i)_____(ii)_____(iii)_____(iv)_____

2. Name the main branches of regional geography.

   _____

1.5 GEOGRAPHY AND SOCIETY

Geographical thinking and concepts affect our daily decisions in a number of ways–

For example when urban master plans are made or rural development strategies are considered, it is importannt to undersatand the physical structure, climatic conditions and availabilities of resources in an area. The decision to shift industries from city areas would require the extension of industrial land use into farming areas. This would displace farmers and their source of income. Similarly, the construction of a railway line or highway causes ribbon development. Many economic activities concentrate along such corridors. Now a days with the need to provide relief material to all affected persons after a flood or an earthquake requires a good understanding of the geography of the area. Distribution of relief is functional and related to the needs of people, according to climate or terrain.

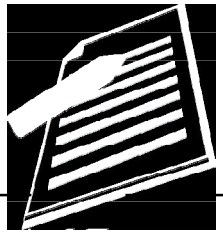
1.6 METHODS AND TECHNIQUES OF GEOGRAPHY

Each branch of systematised knowledge has certain methods / tools and techniques on which it depends to further its basic objectives. Geography too has its tools, techniques and methods. Important among them are globes, maps, diagrams, relief models and spatial analytical methods. Cartography is concerned with preparation of maps and diagrams to show distribution of geographical phenomena. Important methods in geography are deductive and inductive in nature. Various statistical techniques and models are used for regional analysis and to understand spatial distribution and interaction.

(A) Cartography

Most of us are fascinated with maps. “Cartography” is the study and practice of making maps and diagrams. It represents the earth with maps and abstract symbols. Maps have traditionally been made using pen, ink and paper, but computers have revolutionised cartography and with GIS methods one can prepare maps and diagrams with greater choice and efficiency.

Spatial data is obtained from measurement and other published sources and can be stored in a database, from which it can be extracted for a variety of purposes. Current trends in this field are moving away from drawing with ink or paper type



methods of map making towards the creation of increasingly dynamic, interactive maps that can be manipulated digitally. Most commercial quality maps are now made with map making software that falls into one of three main types; Computer aided data management (CAD), Geographic Information Systems (G.I.S) and Global Positioning systems (GPS).

Cartography has grown from a collection of drafting techniquies into an actual science. Cartographers must understand which symbols convey information about the Earth most effectively, and make such maps that will encourage everyone to use the maps to find places or use it for their daily work. A cartographer must learn geodesy and fairly adavnced mathematics to understand how the shape of the Earth affects the distortion of map symbols projected onto a flat surface for viewing.

"Geographic Information Systems" deals with the storage of information about the Earth for automatic retrieval by a computer in an accurate manner. In addition to other sub disciplines of geography, GIS specialists must understand computer science and database systems. Maps have traditionally been used to explore the Earth and to exploit its resources. GIS technology, as an expansion of Cartographic science, has enhanced the efficiency and analytic power of traditional mapping. Now, as the scientific community recognizes the enviornmental consequences of human activities, GIS techology is becoming an essential tool in the effort to understand the process of global change. Various map and satellite information sources can combine in ways that recreate the interactions of complex natural systems. Such visualisation can help to predict what will happen to an area if it is repeatedly flooded, or what changes are expected if a particular industry is located or developed in an area.

Next to Survey of India, inherited from the British Ordinance Survey, the NATMO is a premier organization for mapping in India. Its maps of one million series are well known. The organiszation of the Cartographic Unit in 1960s at the French Institue, Pondicherry, brought a significant impact on the development of Geography in India. Its publication of Vegetation and Soil maps at the scale of 1:100000 were very well received for their cartographic appreciation and resource mapping. This Unit was upgraded in 1995 as a Geomatics Laboratory with an emphasis of computer cartography and GIS.

(B) Quantitative methods in Geography

These aspects of geographical techniques deal with numerical methods most commonly found in geography. In addition to spatial analysis, you are likely to find methods like cluster analysis, discrimnant analysis in geographic studies. These statistical techniques are introduced to you in later chapters and you will find that when you undertake the local area study, you yourself will see how useful these methods are in finding patterns and identifying relationships between space and the activities that are performed in them.

(C) Regional science method

In the 1950s, the regional science movement arose led by Walter Isard. This

provided a more quantitative and analytical base to geographical questions, in contrast to the more qualitative tendencies of traditional geography. Regional Science comprises the body of knowledge in which like regional economics, resource management, location theory, urban and regional planning, transportation and communication, human geography, population distribution, landscape ecology, and environmental quality are examined for regional development.

1.6 BRANCHES OF GEOGRAPHY

Variable phenomena on the earth's surface can be treated seperatehy or in association. They are classified and categorised into physical phenomena and human phenomena. Thus geography has three main branches : Physical Geography, Human Geography and Regional Geography.

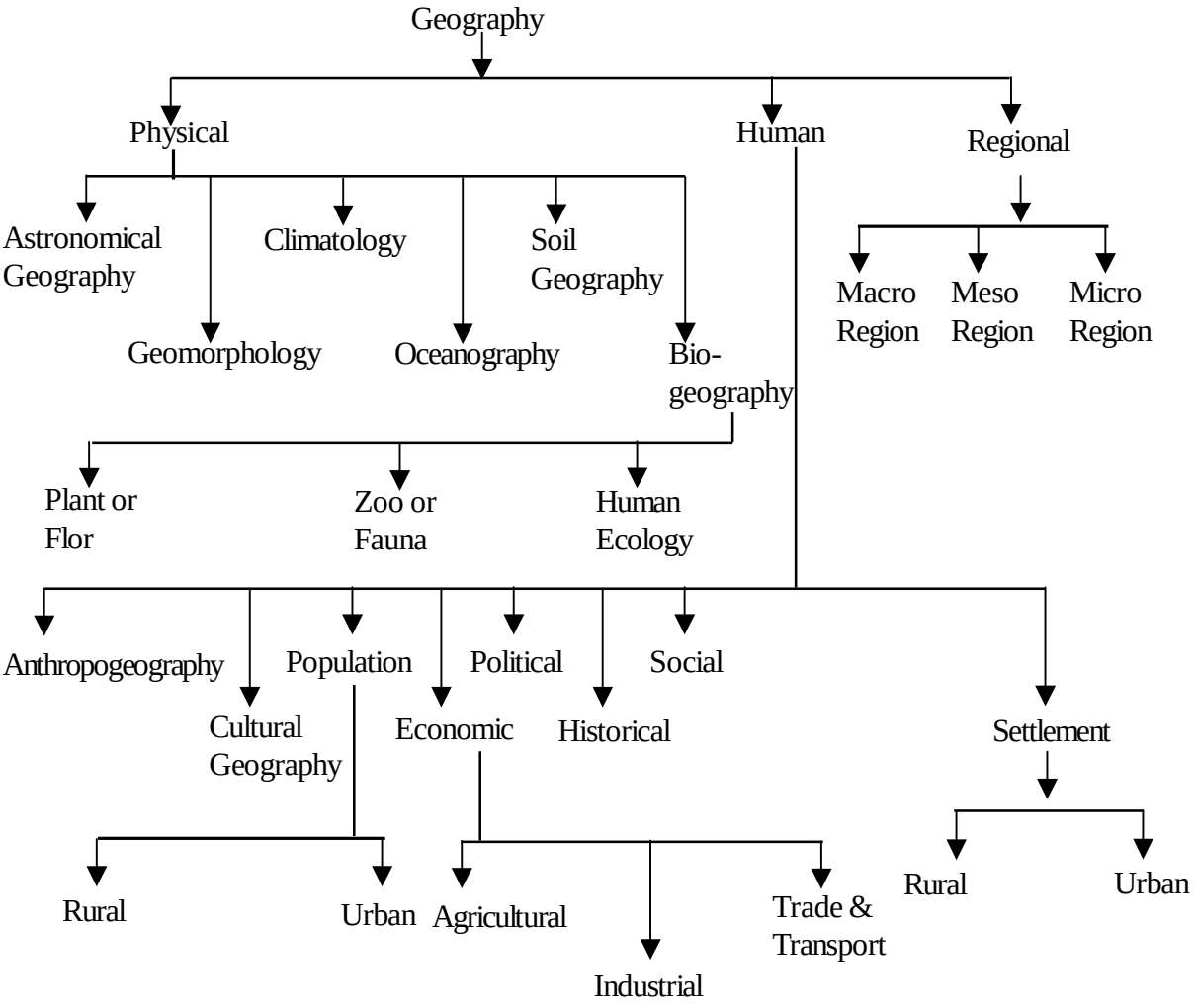


Fig 1.1: Branches of Geography

A. Physical Geography

Physical geography is concerned with the study and explanation of physical phenamena, encompassing the other such fields like geology, meteriology, zoology and chemistry. It became a very popular subject during the later part of the nineteen century. It has a number of sub-branches which treat different kind of physical phenomena.

(i) Astronomical Geography : It studies the celestial phenomena which cancern the Earth's surface particularly Sun, Moon and Planets of the Solar System.

(ii) Geomorphology : It is concerned with the study of the landforms on the Earth's surface. It includes origin and development of landforms through erosional, transportational and depositional processes of water, wind and glaciers.

(iii) Climatology : Climatology is the study of the atmospheric conditions and related climatic and weather phenomena. It includes the study of atmospheric composition, climatic regions seasons, etc.

(iv) Oceanography : It is concerned with the study of various types of Oceanic formate component and processes related to ocean floor depths, currents, corals reefs, and continental drifts etc.

(v) Soil Geography : It studies various soil forming processes, their physicol,chemical and biological constituents, their colour and types, texture, and distribution and carrying capacity etc.

(vi) Bio-geography : It is concerned with the biological phenomena in space, especially in terms of the distribution of various kinds of floral and faunal species. Biogeography may be subdivided into plant or floral geography, animals or faunal geography, and human ecology.

B. Human Geography

Human Geography is the synthetic study of the relationship between human societies and the earth's surface. It is made up of three closely linked components : the spatial analysis of the human population ; the ecological analysis of the relation between human population and its environment and the regional synthesis which combines the first two themes in an areal differentiation of the earth's surface.

Human geography has a number of sub-branches.

(i) Anthropogeography : It largely deals with racial phenomena in their spatial context.

(ii) Cultural geography : It focusses on the origin, components and impact of human culturs, both material and non-material.

(iii) Economic geeography : It refers to the study of the location and distribution of economic activities at the local, regional, national and world scale. Economic geography can be studied under the following heads : Resource geography. Agricultural geography, Industrial and transport geography.

(iv) Political geography : It is the study of political phenomena in their spatial context. Main focus remains for creation and transformation of political and administrative region.

(v) Historical geography : Spatial and temporal trends of geographical phenomena are studied in Historical geography.

(vi) Social geography : It is the analysis of social phenomena in space. Poverty, health, education, livelihood are some important fields of study in social geography.

(vi) Population geography : It is the study of various dimensions of population like its population distribution density, composition, ferrility, mortality, migration etc.

(viii) Settlement geography : It is the study of Rural/Urban settlements, their size, distribution, functions, heirach, and off various other parameters of settlement system.

(C) Regional geography :

Aspects such as delineation of regions, their geographical characteristics and processes of change constitute regional geography.

INTEXT QUESTION 1.3

1. What are the two branches of geography ?
   (i)_____(ii)_____
2. Name the two techniques of geographical study ?
   (i)_____(ii)_____
3. What is Anthropogegraphy ?
   _____

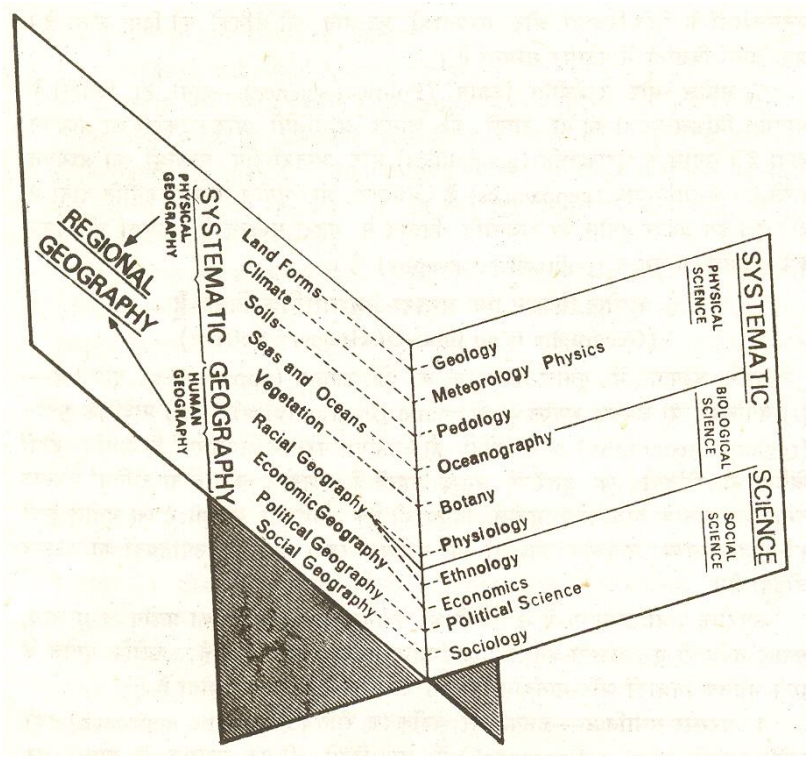


Fig. 1.2 Geography as an integrating science
(Based on Hettner and Harthshorne)

- Geography has three main branches : physical, human and regional.
- Physical geography deals with nature of physical phenomena such as climatology, soil and vegetation.
- Human geography deals with the relationship between human societies and the earth's surface.
- Geography as an inter disciplinary subject.

1.7 GEOGRAPHY AS AN INTERDISCIPLINARY SUBJECT

Geography has its strong relation with mathematices, natural sciences, and social sciences. While other sciences deal with distinctive types of phenomena, geography studies several kinds of phenomena,each already studied by another science. In an integrated manner thus, geography has firmly established itself as a discipline of systhesis. Fig. 1.2 Gives the idea of integrating science

WHAT YOU HAVE LEARNT

Geography is a science of space. Geography is both a natural and social science

as it studies both enviroment and the people. It connects the physical and cultural world. Physical geography studies the earth systems that create natural environment. Human geography is concerned with the political, economic, social, cultural and demographic processes. It is concerned with the different ways in which resources are used.

Earlier geography merely described places. Even though, this is still a part of geography, the pattern of description has changed a lot in recent years.

Geographical phenomena and processes are generally described by two approaches viz. (i) regional and (ii) systematic. Regional approaches are charactrerized by understanding the formation and characterstic of regions. They try to focus on how and why areas are different from each other. Regions can be physical, social, economic, political, demographic etc.

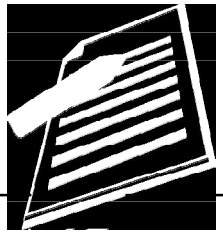
Systematic approach is organized in terms of particular phenomena of general geographic significance. Each phenomena is studied in terms of the relations of its areal differentiations with the others.

Now we understand the cause and impact of natural and human phenomena in creating physical and human landscapes.

Geography has three main branches : Physical human and regional. Physical geography is further subdivided into several other branches namely. geomorphology, climatology, oceanography, soil and biogeography. Human Geography is also subdivided into other branches like, cultural, population, social, economic and political. Regional geography is subdivided in other branches like Macro, Meso and Micro.All these subjects are interrelated to each other.

TERMIANL QUESTION

1. Answer the following questions in brief :
   - (i) Define the term Geography.
   - (ii) Why is geography called the mother of all sciences.
   - (iii) What are the two basic approaches in geography.
   - (iv) What are the four phases of development of geography.
   - (v) Define the terms physical and human geography.
2. Distinguish between the following
   - (i) Systematic and regional geography.



(ii) Physical geograhy and biogeography.

(iii) Population and economic geography.

3. Why is human geography an important part of geography. Explain with suitable explains.

4. Discuss the techniques of geographical studies.

ANSWER TO INTEXT QUESTIONS

1.1

1. Geography is largely the study of the interaction of all physical and human phenomena and landscapes created by such interactions.

2. Earth surface is changing because of the continuous interaction between the environment in which we live in and the way we use it.

3. (i) Mathematical tradition,

(ii) Geographic information through travel and field work.

1.2

1. (i) Physical Geography, (ii) Biogeography,

(iii) Human Geography and (iv) Geographical Methods and techniques.

2. (i) Regional studies, (ii) Regional analysis,

(iii) Regional development and (iv) Regional planning.

1.3

1. (i) Physical (ii) Human

2. (i) Cartography (ii) Quantitive methods or (iii) Regional science method

3. It deals largely with racial phenomena in their spatial context.

HINTS TO TERMINAL QUESTIONS

1. (i) Refer to para one.

(ii) Refer to 1.1

(iii) Refer to 1.4

(iv) Refer to 1.2

(v) Refer to part A and B of 1.6

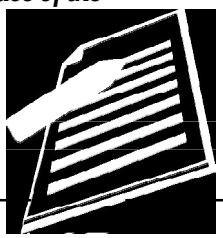
2. (i) Refer to 1.4

(ii) Refer to 1.6 (A)

(iii) Refer to 1.6 (B)

3. Refer to 1.6 (B)

4. Refer to 1.4



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EARTH'S INTERIOR AND ITS MATERIAL

The earth is the only known planet with developed life in the universe. Like most of the celestial bodies, the earth is spherical in shape. You also know that hot water and molten lava eject out from the earth's interior. This indicates that the temperature below the earth's surface is very high. World's deepest mining is limited only to the depth of less than 5 kilometers. These activities can be explained by getting a better understanding of Earth's interior. As we know that the land features seldom retain any fixed form. Their shape is constantly changing. One group of exogenetic forces includes those which weaken and disintegrate the rocks at their original location. The second group consists of indogenetic forces which remove the disintegrated rocks from high lands and deposit them in the Low lands. These two processes have been responsible for disintegrating rocks and shaping new landforms. They are also partly responsible for the formation of soil, which is very important for us.

In this lesson, we will study about the earth's interior and the materials that form the upper portion of the earth's crust. You will also learn about, weathering and its types, the process of gradation and the significance and formation of soils.

OBJECTIVES

After studying this lesson, you will be able to:

- explain the limitations of direct observations of the earth's interior;
- compare the different layers of the earth's interior with reference to thickness, temperature, density and pressure;
- distinguish between rock and mineral;

- classify rocks according to their mode of formation;
- describe the economic significance of rocks;
- explain the term weathering and describe its types with suitable examples;
- explain the various gradational processes changing the face of the land;
- differentiate between degradation and aggradations;
- relate weathering with soil formation and
- explain the various factors contributing to soil formation;

2.1 EARTH'S INTERIOR

It is not possible to know about the earth's interior by direct observations because of its huge size and the changing nature of its internal composition. Through mining and drilling operations we have been able to observe the earth's interior directly only up to a depth of few kilometers. The rapid increase in temperature below the earth's surface is mainly responsible for setting a limit to direct observation inside the earth. The temperature in the earth's interior is so high that it can even melt any tool used for drilling. This fact also restricts deep drilling, thus causing hindrance to direct observation of the materials of the earth's interior.

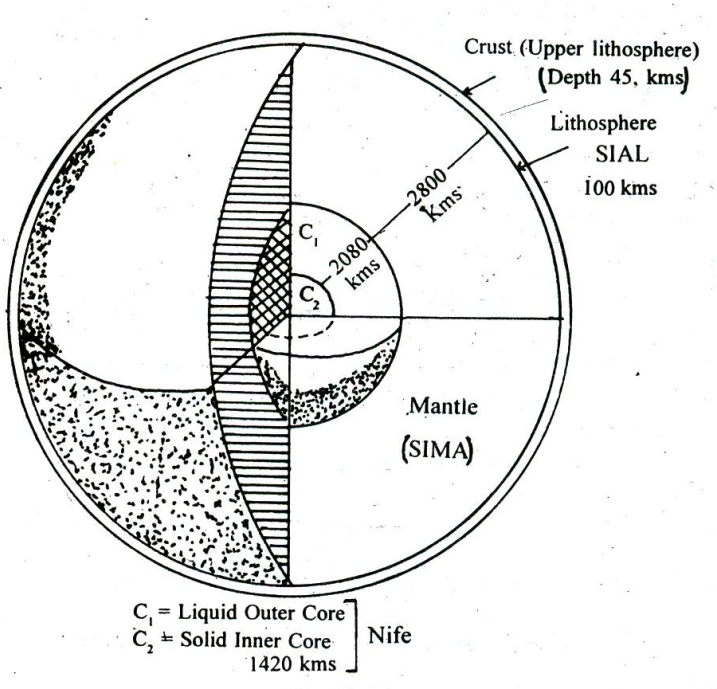
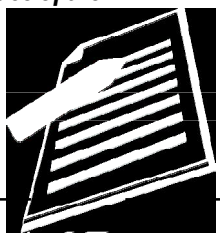


Fig. 2.1 Concentric Zones showing layers of the Earth's interior

The huge size of the earth and increasing temperature with depth has set a limit to direct observation of the earth's interior.



2.2 STRUCTURE OF THE EARTH'S INTERIOR

The above diagram (see fig. 2.1) shows the concentric layers of the earth's interior. The innermost layer surrounding the earth's centre is called core, which is about 3500 kms in radius. Core is the most dense layer of the earth with its density range from 9.5 to 14.5 and sometimes even higher. It is composed mainly of the iron and nickel thus commonly known as **Nife**. (Nickel+Ferrum). Core consists of two sub-layers. The inner one is solid (C_2 of fig. 2.1) and the outer one is semi-liquid (C_1 of fig. 2.1). The layer surrounding the core is known as mantle, a rock shell about 2900 kms thick and is composed of basic silicates. Major constituent elements of mantle are magnesium and silicon, hence, this layer is termed as **Sima** (Silica+Magnesium). The density of this layer varies from 3.3 to 5.7. Mantle is surrounded by the outermost layer of the earth, known as lithosphere and its density varies from 2.70 to 2.95. Major constituent elements of lithosphere are silica (Si) and aluminium (Al), thus this layer is termed as Sial (Silica+Aluminium). The outermost part of the lithosphere in known as crust, normally about 8 to 40 kms thick.

- Core, mantle and crust are the three main concentric layers of the earth's interior.
- Core is the innermost layer and has the highest density. It is made up mainly of nickel and iron.
- Mantle is the layer lying between the core and lithosphere. Its major constituents are silicon and magnesium.
- Crust is the outermost layer of the earth and is mainly composed of silicon and aluminium.

INTEXT QUESTIONS 2.1

1. Give the most important factor limiting direct observation of the earths interior to a few kilometers

   _____

2. Name the three layers of the earth's

   (a)_____(b) _____(c) _____

3. Name the innermost layer of the earth.

   _____

4. What is the density of the core?

   _____

5. Which layer includes the earth's crust?

6. Name the thinnest layer of the earth

2.3 TEMPERATURE, PRESSURE AND DENSITY OF THE EARTH'S INTERIOR

Temperature

Rise in temperature with increase in depth is observed in mines and deep wells. These evidences along with molten lava erupted from the earth's interior, support that temperature increases towards the centre of the earth. The different observations show that the rate of increase of temperature is not uniform from the surface towards the earth's centre.

It is faster at some places than at others. In the beginning this increase is at an average rate of 1^0C for every 32 metres increase in depth. At such a constant rate of increase in temperature, at 10 km depth, the temperature will be approximately 300^0C and at 40 km depth it will be 1200^0C. At this rate, earth's interior should be in a molten state. Yet it is not so because the rocks buried under the pressure of several km thickness of overlying rocks melt at higher temperature than similar rocks at the surface. A basaltic lava rock which melts at 1250^0C at the surface will melt at 1400^0C at 32 km depth. The extra heat required for melting is produced by radioactivity. It is the result of breakdown of atomic nuclei of minerals emitting radiant energy in the form of heat from the rocks.

The behaviour of earthquake waves is another evidence for this phenomenon. They further confirm that the composition of different layers is as variable as is the rate of change of temperature. While in the upper 100 km, the increase in temperature is at the rate of 12°C per km, in the next 300 km it is 20°C per km but is only 10^0C per km below it. Thus the rate of increase of temperature beneath the surface decreases towards the centre. The temperature at the centre is estimated to lie somewhere between 3000°C and 5000^0C.Such a high temperature inside the earth may be due to chemical reactions under high pressure conditions and disintegration of radio active elements.

Pressure

The pressure also increases from the surface towards the centre of the earth due to huge weight of the overlying rocks. Therefore in deeper portions, the pressure is tremendously high. The pressure near the centre is considered to be 3 to 4 million times the pressure of atmosphere at sea level. At high temperature, the material beneath will melt towards the central part of the earth. This molten material under tremendous pressure conditions acquires the property of a solid and is probably in a plastic state.

Density

Due to increase in pressure and presence of heavier materials towards the earth's centers, the density of earth's layers also goes on increasing. Obviously the materials of the innermost part of the earth are very dense as already stated.

INTEXT QUESTIONS 2.2

1. What is the temperature at the centre of the earth?

   _____

2. How much is the pressure at the earth's centre?

   _____

3. Why does the density increase towards the centre of the earth?

   _____

2.4 MATERIALS OF THE EARTH'S CRUST

The outermost part of lithosphere is called crust. This is the most significant part of the earth because it is occupied by humans. The material of the crust is made up of rocks. The rocks are of different types. They are hard like granite, soft like clay and loose like gravel. Rocks have a great variety of colour, weight and hardness.

Rocks are composed of minerals. They are aggregates or physical mixture of one or more minerals. Minerals on the other hand are made up of two or more elements in a definite ratio. They have a definite chemical composition. Crust is made up of more than 2000 minerals, but out of these, 6 are the most abundant and contribute the maximum to this uppermost part of the earth. These are feldspar, quartz, pyroxenes, amphiboles, mica and olivine.

Granite is a rock and its constituent minerals bound together are quartz, feldspar and mica which make it a hard rock. Change in the ratio of these minerals give rise to granites of different colours and hardness. The minerals containing metals are called metallic minerals. Haematite, a major iron ore is a metallic mineral. Ores are metallic minerals which can be profitably mined. Rocks are of immense economic importance to us.

2.5 TYPES OF ROCKS

Rocks differ in their properties, size of particles and mode of formation. On the basis of mode of formation rocks may be grouped into three types:

(a) Igneous

(b) Sedimentary and

(c) Metamorphic

Igneous Rocks

The word igneous is derived from the Latin word 'ignis' meaning fire. Igneous

rocks are formed by the cooling of highly heated molten fluid material, known as magma. The word magma is derived from a Greek word which means 'dough'. It requires a greater quantity of heat to melt the rocks under overlying pressure than at the surface. We do not know the exact depths at which magma forms but probably it is formed at different depths not exceeding 40 km. Molten rocks produce an increase in volume which is responsible for causing fractures or cracks in the crust. The overlying pressure gets weakened along these openings, thus forcing out the magma through them. Otherwise it can't escape due to great overlying pressure.

When magma is ejected to the surface, it is called lava. Igneous rocks are formed from solidified molten magma below or on the earth's surface. As they comprise the earth's first crust and all other rocks are derived from them, these are called the parent of all rocks or the 'primary rocks'. In simple words, all rocks can be described as of igneous origin because at one time or another, they were erupted to the surface: A younger series of igneous rocks is still being formed. About 95% of the volume of outermost 16 km of the earth is composed of them. These are largely hard and massive because of their magmatic origin and are crystalline in appearances.

On the basis of their mode of occurrence, igneous rocks can be classified as : extrusive or volcanic rocks and intrusive rocks.

(i) Extrusive igneous rocks are formed by cooling of lava on the earth's surface. As lava cools very rapidly on coming out of the hot interior of the earth, the mineral crystals forming these rocks are very fine. These rocks are also called volcanic rocks. Gabbro and basalt are very common examples of such rocks. These rocks are found in volcanic areas. Deccan plateau's regur soil in India is derived from lava.

(ii) Intrusive igneous rocks are formed when magma solidifies below the earth's surface. The rate of cooling below the earth' s surface is very slow which gives rise to formation of large crystals in the rocks. Deep seated intrusive rocks are termed as plutonic rocks and shallow depth intrusive rocks are termed as hypabyssal. Granite and dolerite are common examples of intrusive rocks. From this point of view, therefore, igneous rocks can, in accordance with their mode of formation, be classified as (a) Plutonic, (b) Hypabyssal and (c) Volcanic rockmasses. The huge blocks of coarse granitic rocks are found both in the Himalaya and the Decean Plateau.

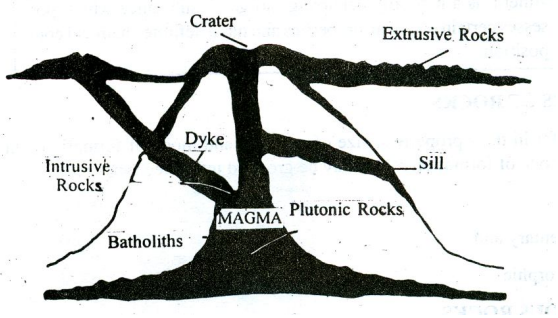
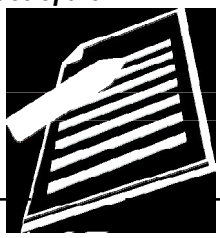


Fig. 2.2 Igneous Rocks



Let us look at the Fig. 2.2. It illustrates that magma, on cooling, produces rocks of different shapes and sizes, depending on the space available after it forces itself into the crust. Common forms of instrusive igneous rocks are batholiths, sills and dykes etc. Batholiths are huge masses of solidified magma. They vary in size; some are as much as several hundred kilometers across and thousands of kilometers thick. They generally form the core of the major mountains, as shown in this diagram. Their irregular dome shaped roofs sometimes appear on the surface after erosion of millions of years. *Sill* is the horizontal intrusion of solidified magma between the layers of pre-existing rocks. *Dyke* is similarly a more or less vertical formation from few metres to several kilometers in length and from few centimeter to hundreds of metres in thickness.

On the basis of chemical properties, igneous rocks are classified into acidic and basic rocks. These are formed as a result of solidification of acidic or basic lava. Acidic igneous rocks are composed of 65% or more of silica. These rocks are light coloured, hard and very strong. Granite is an example of an acidic rock. Basic igneous rocks contain less than 55% of silica and have more of iron and magnesium. These rocks are dark coloured and weak enough for weathering. Gabbro, basalt and dolerite are examples of basic rocks.

- Igneous rocks are formed by the solidification of hot molten material called magma or lava.
- Extrusive igneous rocks are formed by cooling of lava on the earth's surface e.g. basalt, gabbro.
- Instrusive igneous rocks are formed by solidification of magma below the earth's surface, e.g. granite.

INTEXT QUESTIONS 2.3

1. Define the term mineral.

   _____

2. Give the names of any three minerals which are found extensively on the earth's crust.

   _____

3. Give a term for each of the following

   (i) Deep seated intrusive igneous rock.

   _____

   (ii) A hot sticky molten materia1 erupted on the earth's surface.

   _____

4. How are dykes and sills formed?

   (i) _____

   (ii) _____

5. Tick (√) the correct answer

   (i) Igneous rocks are formed due to

   (a) cooling (b) heating (c) neither cooling nor heating

   (ii) Which one of the following is an example of intrusive igenous rock?

   (a) Granite (b) Basalt (c) Gabbro

   (iii) Primary rocks are the result of

   (a) sedimentation (b) solidification (c) metamorphism

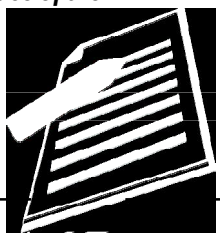
Sedimentary Rocks

These rocks are formed by successive deposition of sediments. These sediments may be the debris eroded from any previously existing rock which may be igneous rock, metamorphic or old sedimentary rock. Sedimentary rocks have layered or stratified structure. The thickness of strata varies from few millimeters to several metres. So these rocks are also called stratified rocks. Generally, these rocks have some type of fossil between their strata. Fossil is the solid part or an impression of a prehistoric animal or plant embedded in strata of sedimentary rocks. Sedimentary rocks are widely spread on the earth surface but to a shallow depth.

The individual rock particles are first broken from rocks and then transported by running water, ocean currents, glaciers or even by wind from one place to another. The process by which rock forming material is laid down is called sedimentation or deposition. It may settle in calmer waters of lakes or oceans or at places where the transporting agent has no longer enough energy to carry them farther. These are identified as riverine, lacustrine (formed by lake), glacial or aeolian (formed by wind) sedimentary rocks with reference to their deposition near rivers, lakes, glacier or deserts respectively.

The sediments are often loose, unconsolidated, soft rock material, in the beginning like sand and clay, but in course of time they get hardened to a compact material by excessive pressure and cementation to form sedimentary rocks. The deposition of sediments in the beginning is generally horizontal but it may get tilted afterwards due to movements in the earth's crust. Sandstone, shale, limestone and dolomite are examples of sedimentary rocks.

Sediments get sorted by the transporting agents. Sediments of different sizes may get bound by cementing material under suitable conditions. Conglomerate is an



example of such a sedimentary rock. This type of formation of consolidated material is termed as mechanically formed sedimentary rock. The consolidation of organic matter derived from plants and animals forms sedimentary rocks of organic origin. Coal and limestone are organic sedimentary rocks. The sediments may also result from chemical reaction. Direct precipitation of minerals from their solution in water may give rise to sedimentary rocks of chemical origin. Gypsum, rock salt and nitre are examples of such sedimentary rocks.

Huge folded mountains of the world like Himalayas, Andes etc. are made up of sedimentary rocks. All the alluvial deposits of the world are also due to sedimentary accumulations. All river basins, particularly their plains and deltas, e.g. Indo-Gangetic plain and Ganga-Brahmaputra delta are good examples of sedimentary accumulations.

- Sedimentary rocks are formed by the successive deposition of sediments.
- These rocks have layered structure, therefore they are also known as stratified rocks.
- Fossil is the solid part or an impression of a prehistoric animal or plant embedded in sedimentary rocks in which they are buried.

Metamorphic Rocks

Most rocks in mountainous regions show an evidence of change. All these in course of time become metamorphic or changed forms of rocks. Metamorphic rocks are formed under the influence of heat or pressure on sedimentary or igneous rocks. Tremendous pressure and high temperature change the colour, hardness, structure and composition of all types of pre-existing rocks. The process which bring about the change is known as Metamorphism and the ultimate products, formed due to operation of such processes are defined as the Metamrphic rocks.

Temperature, pressure stress and access of chemically reactive substances are the main agents, which are responsible for metamorphism. Heat causes the minerals to recrystallise in the rock. The process of change by heat is called thermal or contact metamorphism. When molten magma or lava comes in contact with surrounding rocks, it bakes them and changes them into metamorphic rocks. Similarly the formation of metamorphic rocks due to tremendous pressure is known as dynamic or regional metamorphism. Slate, gneiss, schist, marble and diamond are good examples of metamorphic rocks. Metamorphic rocks are hard and tough in comparison to the parent rocks from which they are formed. Examples of metamorphic rocks are given in the table 2.1 with their parent rock from which they have been formed.

Table 2.1

Parent Rock and its Metamorphic Changed Form

NAME OF THE ROCK	TYPE OF ROCK	NAME OF THE METAMORPHIC ROCK
Limestone	Sedimentary Rock	Marble
Dolomite	Sedimentary Rock	Marble
Sandstone	Sedimentary Rock	Quartzite
Shale	Sedimentary Rock	Slate
Slate	Metamorphic Rock	Phylite/Schist
Coal	Sedimentary Rock	Graphite/Diamond
Granite	Igneous Rock	Gneiss
Phyllite	Metamorphic Rock	Schist

Different types of metamorphic rocks are found all over the world. In India, marble is found in Rajasthan, Bihar and Madhya Pradesh, whereas slates are available in plenty in Orissa, Andhra Pradesh and Haryana. In Kangra and Kumaun regions of Himalaya, slates of different colours are found.

- Metamorphic rocks are formed by the effect of heat or pressure on sedimentary or igneous or even metamorphic rocks.
- Thermal metamorphism is the process by which a rock under-goes change as a result of great heat.
- Dynamic metamorphism is the modification of rock, by tremendous pressure during extensive earth movements.

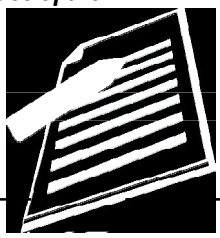
2.6 ECONOMIC SIGNIFICANCE OF ROCKS

Man has been interacting with the surface of the earth since long. With time and advancement in technology he is making different uses of rocks and minerals. The importance of rocks is given below:

(a) Soils: Soils are derived from rocks. Soils provide suitability for that agricultural products that provide food for mention and provide raw material for many industries.

(b) Building Material: Rocks are the source of types of building material directly or indirectly. Granite, gneiss, sandstone, marble and slates are extensively used in the construction of buildings. Tajmahal is made of white marble, Red Forts of Delhi and Agra, are made of red sandstone. Slates are used for roof purposes in different parts of India.

(c) Mineral Source: Minerals are the foundation of the modern civilization. Metallic minerals provide all metals ranging from very precious gold, plati-



num, silver, copper to aluminium and iron. These metals are obtained from different rocks.

(d) **Raw Material:** Certain rocks and minerals are used as raw material for many industries. In cement industry and limestone kilns different type of rocks and minerals are used for production of finished goods. Graphite is used in crucible and pencil manufacturing as raw materials.

(e) **Precious Stones:** Precious stones and metals are obtained from different metamorphic or igneous rocks. Diamond is a precious stone used in jewelry and is a metamorphic rock. Similarly other precious stones like gems, rubies and sapphires are obtained from different type of rocks.

(f) **Fuel:** Fuel in the form of coal, petroleum, natural gas and nuclear minerals are derived from different rocks.

(g) **Fertilizer:** Fertilizers are also derived from some rocks. Phosphatic fertilizers are obtained from phosphorite mineral found in abundance in some parts of the world.

- Rocks and minerals are the main source of all metals, precious stones, solid fuel and raw materials for industries.

INTEXT QUESTIOS 2.4

1. What are rocks?

   _____

2. Classify rocks.

   _____

3. Give single term for each of the following

   (i) Process of the formation of metamorphic rock due to pressure.

   _____

   (ii) Rocks which contain strata.

   _____

   (iii) Rocks formed by the effect of heat or pressure on sedimentary or igneous rocks.

   _____

   (iv) Sedimentary rocks deposited in lakes

   _____

4. Tick (√) the correct answer;

   (i) Marble is

(a) a sedimentary rock (b) an igneous rock (c) a metamorphic rock (d) a plutonic rock

(ii) An example of sedimentary rock is

(a) granite (b) marble (c) sandstone (d) basalt

2.7 WHAT IS WEATHERING?

Weathering is the general term applied to the combined action of all processes that cause rock to disintegrate physically and decompose chemically because of exposure near the Earth's surface through the elements of weather. Among these elements temperature, rainfall, frost, fog and ice are the important ones. Weathering begins as soon as rocks come in contact with one or more than one elements of weather on the surface of the earth. In nature, generally both the disintegration and decomposition act together at the sametime and assist each other. We must remember that the weathered material (i.e. disintegrated and decomposed) lie in situ (i.e. at its original position). In this process no transportation or movement of material is involved other than its falling down under the force of gravity.

- Weathering is the process by which exposed rocks are disintegrated and decomposed in situ (i.e their original position).

2.8 TYPES OF WEATHERING

We can recognize three types of weathering?

1. Physical Weathering
2. Chemcial weathering
3. Biotic weathering

PHYSICAL WEATHERING

When the rocks are broken up into smaller fragments without any chemical change in their composition, it is called physical weathering. The term mechanical weathering is also used for physical weathering.

Physical weathering takes place in different ways in different types of areas. They have been explained here with examples.

(a) Block disintegration

We all know that the successive heating and cooling causes expansion and contraction of the rocks. In hot desert regions, day temperatures are very high while nights are very cold. This high diurnal range of temperature causes successive expansion and contraction of the rocks which tend to enlarge the joints. Finally the rocks disintegrate into smaller blocks. This process is known as block disintegration.

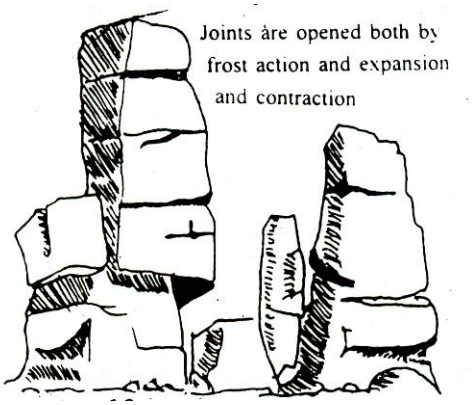


Fig. 2.3: Block Disintegration

(b) Exfoliation

Rocks are generally poor conductors of heat. As a result of intense heating the outer layers of the rock expand rapidly while the inner layers remain almost unaffected by heat. Due to successive expansion and contraction, the outer layer of the rock subsequently peels off from the main mass of the rock in the form of concentric shells. The peeling of rocks in layers by this process is very similar to the peeling of successive layers of an onion. The process is called exfoliation. Almost all rounded forms of dolerite blocks of rocks in Singhbhum district of Bihar are due to this process. Granite domes of Mahabalipuram, particularly *'Krishna Ka Laddu'* and those near Jabalpur on Madan Mahal Hill are good examples, of exfoliation.

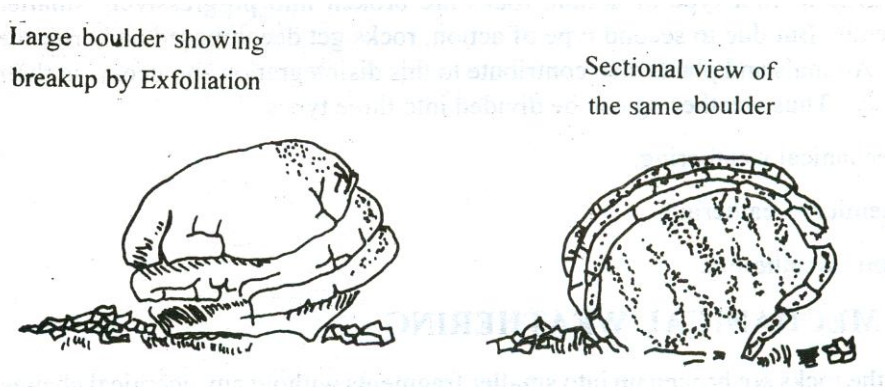


Fig 2.4 Peeling of Layer of the Rock

(c) Frost Action

One of the most important physical weathering processes in cold climates is frost action, the alternate freezing and melting of water inside the joints of the rocks, splits them into fragments. This is because conversion of water into ice increases the volume of water by 10 percent. In cold regions rocks are disintegrated into small particles through this process. It is called frost action.

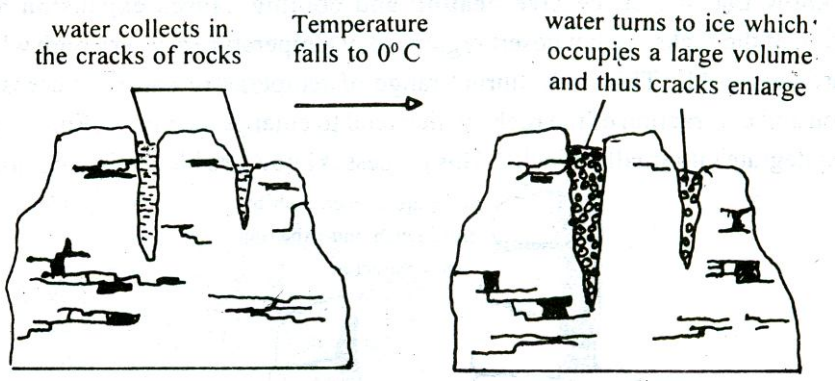


Fig 2.5 Frost Action

- disintegration of rocks into smaller fragments without any change in their chemical composition is called mechanical weathering.
- The rapid heating and cooling of the rocks creates a series of joints and cracks which lends to breaking up into smaller blocks. This process is known as block disintegration.
- A weathering process by which the outer layers of the rock peel out in concentric cells due to difference of temperature in the outer layers is called exfoliation.
- Breaking up of rocks due to freezing of water in the rock joints and cracks, in very cold regions, is called frost action.

INTEXT QUESTIONS 2.5

1. Name three types of weathering.

   (a) _____(b)_____(c)_____

2. In which areas is mechanical weathering more pronounced?

   _____

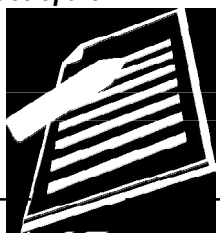
3. Give appropriate technical terms for each of the following statements:

   (a) Peeling of successive layers of rocks like the layers of an onion

   _____

   (b) Widening of joints and cracks due to alternative freezing and melting of water in them

   _____



(c) Disintegration of rocks without any change in their chemical composition

CHEMICAL WEATHERING

Chemical change in the rocks through formation of new compounds or formation of new substances is called chemical weathering. Chemical processes include oxidation, hydrolysis, and acid solution.

- Decomposition of rocks by chemical processes with the help of water and atmospheric gases is called chemical weathering.

Chamical weathering involves four major processes:

(a) Oxidation

This is the process in which atmospheric oxygen reacts with the rock to produce oxides. The process is called oxidation. Greatest impact of this process is observed on ferrous minerals. Oxygen present in humid air reacts with iron grains in the rocks to form a yellow or red oxide of iron. This is called rusting of the iron. Rust decomposes rocks completely with passage of time.

(b) Carbonation

This is the process by which various types of carbonates are formed. Some of these carbonates are soluble in water. For example, when rain water containing carbon dioxide passes through pervious limestone rocks, the rock joints enlarge due to the action of carbonic acid. The joints enlarge in size and lime is removed in solution. This type of breakdown of rocks is called carbonation.

(c) Hydration

This is the process by which water is absorbed by the minerals of the rock. Due to the absorption of water by the rock, its volume increases and the grains lose their shape. Feldspar, for example, is changed into kaolin through hydration. Kaolin on Vindhyan Hills near Jabalpur has been formed in this manner.

(d) Solution

This is the process in which some of the minerals get dissolved in water. They are therefore removed in solution. Rock salt and gypsum are removed by this process.

- Chemical weathering involves the process of oxidation, carbonation, hydration-and solution.

INTEXT QUESTION 2.6

1. In which region is chemical weathering more effective?

_____

2. Which process is involved when gypsum gets dissolved in water?

_____

3. Which process of chemical weathering causes rusting of iron?

_____

4. Which, chemical action is predominant in limestone region?

_____

BIOTIC WEATHERING

Biotic weathering is carried out by plants, animals and man.

(a) Plants

Plants contribute to both mechanical and chemical weathering. The roots of the plants penetrate into the joints of the rocks. They grow longer and thicker. In this manner they exert pressure on the rocks and the rock joints are thereby enlarged and break into smaller fragments.

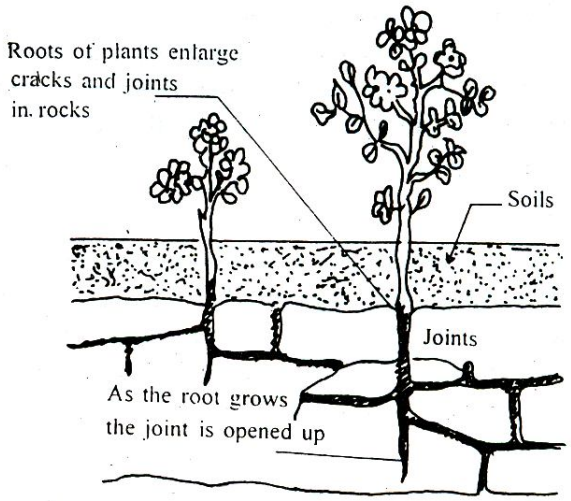
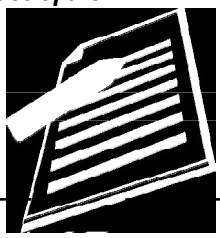


Fig. 2.6 Effect of Vegetation on Rocks

(b) Animals

Burrowing animals like earthworms, rats, rabbits, termites and ants break-down the rocks. These disintegrated rocks can easily be eroded or removed



by wind etc. Hooves of animals break the soil and thus assist soil erosion. The role of earthworms and termites is of special significance. According to scientists, there is a possibility of occurrence of about 1,50,000 earthworms in an acre and they can convert 10 to 15 tonnes of rock mass into good soil and bring it to the surface.

(c) Man

Human beings play a very important role in weathering of various rocks. Man breaks a large amount of rocks in the course of his activities, like agriculture, construction of houses, roads etc. He quarries for mining minerals, thus helps in weathering by breaking, weakening and loosening the rocks.

- Biotic agents like plants, animals and man also contribute to physical and chemical weathering.

INTEXT QUESTIONS 2.7

1. Which important matter is formed by weathering?

   (a) _____(b)_____(c)_____

2. Where does humus in soils come from?

   _____

3. Give examples of two activities of man helping in weathering.

   (a) _____(b)_____(c)_____

2.9 WEATHERING AND SOIL

We have studied the process of weathering and have learnt how different types of land features are produced in areas of different types of climate through this process. Weathering also plays an important role in formation of soil which provides basis for agriculture and world's food supply.

Mechanical weathering of the surface rocks disintegrates the rock and converts it into a fine powder. These small particles are deposited in layers with the help of water. biotic weathering produces humus. This organic matter is formed through the action of plants and animals which helps in the formation of soil. Various processes of weathering help in giving different colours and properties of soil.

- The process of weathering contributes significantly to soil formation besides disintegrated of rocks.

2.10 GRADATION

Exogenetic forces are constantly working to bring about leveling or the gradation of land. They attempt to achieve a condition of balance between erosion and deposition which mean a graded position. The above forces operate through the process called the process of gradation. Agents of gradation like rivers, glaciers winds, sea waves and underground water perform their task with the help of the triple action of weathering, erosion and deposition. The leveling down of elevated portions of the earth's surface is done by erosion. The filling up of depressions is done by deposition of the eroded material transported by the external agents of gradation as spoken earlier.

We have studied that the endogenetic forces of the earth give rise to major landforms on the earth surface and the exogenetic forces level them down.

The work of gradation has two components (a) degradation and (b) aggradation.

(a) Degradation

When rocks are removed by scraping, scratching and cutting as a result of the process of erosion, thereby lowering the elevation of the land, it is called degradation. Degradation, first of all includes the work of weathering that is the movement of scarped and scratched material aided by the great force of gravity. It also includes the work of erosion implying the transportation of the rock material by an agent of gradation. The increase in the movement of rock- debris increases both its erosional and transportational capacities.

(b) Aggradation

Filling up of low-lying areas of depression by eroded material is called deposition. Deposition starts when the agents of gradation lose their force or have obstruction in their way. As a result eroded material is deposited in depressions which not only creates new landforms but also modifies the existing ones.

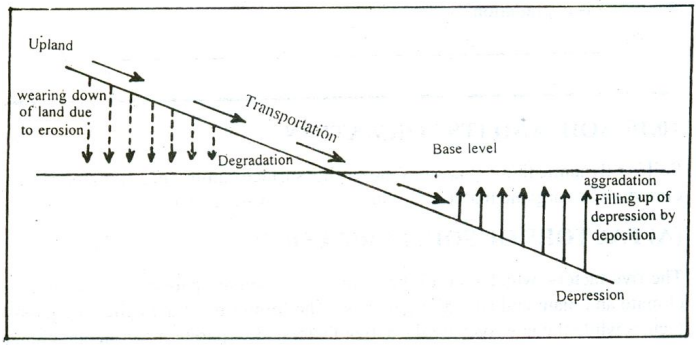
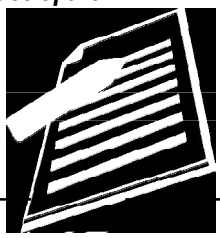


Fig. 2.7 Process of Gradation



Let us now look at the figure. It explains the total process of gradation and its two components-degradation and aggradation. It shows the elevated portions continuously being lowered by weathering and erosion. The debris consisting of the eroded material is transported and deposited in the low lying areas. The surface of the lower areas on the other hand is raised through deposition of this debris. Finally, the position of a uniform or near uniform level is achieved. The process of gradation is not performed by a single agent. It is rather a result of the work of all agents of gradation acting simultaneously. It is however possible for a single agent of gradation to be more active in particular area or at a particular time.

- Levelling and smoothening of land surface is called gradation includes both degradation and aggradation.
- The weathering of the land surface by erosion is called degradation and raising or filling up of depressions by deposition is called aggradation.

INTEXT QUESTIONS 2.8

1. Which process is involved in the levelling of the earth's surface?

   _____

2. Which two processes constitute gradation?

   (a)_____(b)_____

3. Which term is used for raising or filling up of depressions by depositing?

   _____

4. What is degradation?

   _____

2.11 SOIL AND ITS FORMATION

Soil is the uppermost layer of the land surface that plants use and depend on for nutrients, water and physical support.

(A) FACTORS OF SOIL FORMATION

The five factors, which control the formation of soil are parent rock, relief, time, climate and plant and animal organisms. The former three are called the passive factors while the later two are the active factors. The parent material and climate are the most important because these two affect the other factors.

(a) Parent rock

A soil is derived from the underlying rock or the parent rock material con-

taining different minerals. The parent rock gets broken into tiny pieces and is decomposed slowly by physical and, chemical weathering. It furnishes inorganic mineral particles of the soil. The parent rock also influences the rate of soil formation, the chemical composition, colour, texture, structure, mineral content and fertility.

(b) Relief

Topography of an area affects the degree of erosion of the parent rock material and the rate of surface run off of water. thus, the relief affects directly and indirectly the processes involved in soil formation. Steep slopes are subjected to more rapid run-off of surface water than the gentle slopes. Therefore, there is less infiltration of water on steeper slopes, which retards soil forming processes. In addition, rapid run-off on steep slopes often erodes their surface faster than soil can develop. It is because of this that the mountainous topography develops coarse, thin and infertile soil and the plain areas have rich well developed fertile soils.

(c) Time

The soil forming process is very slow. A well developed soil results as an end product of physical, chemical and biological processes operating collectively for a very long period of time.

(d) Climate

It is by far the most important factor in the sense that over a long period of time it not only tends to reduce the difference caused by the parent material but also influences biological activities within the soil. Due to this factor two different parent materials may develop the same type of soil in one type of climatic region. For example, granite and sandstone have developed into sandy soil in dry Rajasthan desert. On the other hand, two different types of soils may develop from the same parent material in two climatic regions. For example, the crystalline granites have developed laterite soils in monsoon regions and non laterite soils in sub humid regions.

The process of weathering, its effectiveness and the type of plant and animal organisms in a region are directly linked with the seasonal change of temperature and distribution and nature of precipitation. Hence, climate plays an important role in soil forming processes.

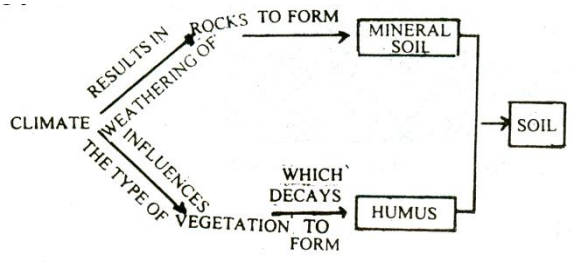


Fig. 2.8 Factors of Soil Formation

(e) Plant and Animal Organisms

Plants and animals play an active role in transforming parent materials into a mature soil. Dead plants and animals contribute to the organic content of the soil. The process of decay, added by bacterial action, transforms organic matter into humus. Humus is responsible for the fertility of the soil. It also enhances water retention capacity of the soil. This organic material helps the soil to support plant life. The plant cover in turn protects rich upper layer of the soil from erosion by increasing the proportion of rainfall entering into the soil rather than running off the surface. It also prevents greater evaporation of soil moisture by its thick canopy, thus allowing soil to mature and become fertile.

- The climate, plant and animal organisms are the active factors of soil formation.
- The parent material, relief and time are the passive factors of soil formation.

(B) SOIL HORIZONS

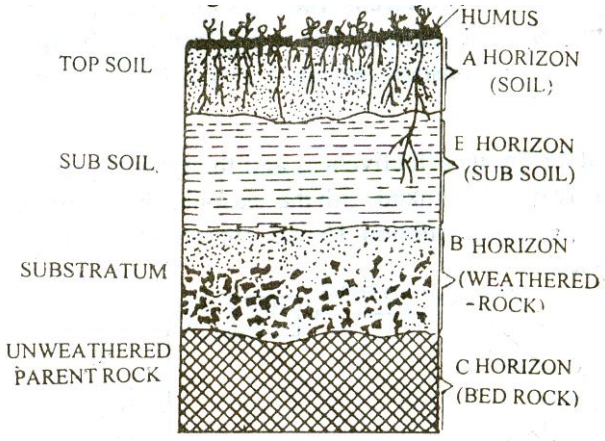


Fig. 2.9: Soil Horizons and Bedrock

A layer of soil which lies more or less parallel to the surface and has fairly distinctive soil properties is known as soil horizon. Soil horizons are distinctive layers found in soils that differ in physical or chemical composition, organic content or structure. The display of horizons on a cross section through the soil is termed as soil profile.

Let's review briefly the main types of horizons and their characteristics.

Four main horizons are important - A,E,B and C. The A horizon is the upper most horizon and rich in organic matter. Next is the E horizon. Clay particles and oxides of aluminum and iron are removed from the E horizon by downward seeping water, leaving behind pure grains of sand or coarse silt. The B horizon receives the clay particles, aluminum and iron oxides, as well as organic matter washed down from the A and E horizons. Beneath the B horizon is the C horizon, which is not considered part of the soil. If consists of the parent mineral matter of the soil.

- Soil profile is the arrangement of the soil into layer like horizons which are physically, chemically and biologically different from each other.

INTEXT QUESTIONS 2.9

1. Name two active factors of soil formation.

   (a)_____(b)_____.

2. Name the three passive factors of soil formation.

   (a)_____(b)_____(c)_____.

3. Fill in the blanks with appropriate word given in the blanks below: (organic material, inorganic mineral particles, biological activities).

   (a) The parent material provides _____ within the soil.

   (b) The climate of a region influence _____ within the soil.

4. Give the Geographical term for each of the following.

   (a) The dynamic, upper layer of earth's crust composed of solid liquid and gaseous substances.

   (b) A vertical arrangement of different layers of soils.

   (c) The horizon of soil rich in humus.

   (d) The horizon of soil ,that accumulates soil colloids.

2.12 SOIL EROSION

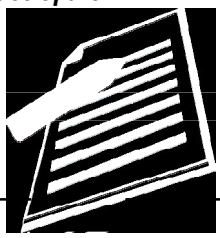
The removal of soil at a greater rate than its replacement by natural agencies (water, wind etc.) is known as soil erosion.

(a) Type of Soil Erosion

Soil erosion is of four types: wind erosion, sheet erosion, rill erosion and gully erosion.

(i) Wind Erosion

Winds carry away vast quantity of fine soil particles and sand from deserts and spread it over adjoining cultivated land and thus destroy their fertility. This type of erosion is known as wind erosion. It takes place in and around all desert regions of the world. In India, over one lakh kilometers of land is under Thar Desert, spread over parts of Gujarat, Haryana, Punjab and Rajasthan states. These areas are subject to intense wind erosion.



(ii) Sheet Erosion

Water when moves as a sheet takes away thin layers of soil. This type of erosion is called sheet erosion. Such type of erosion is most common along the river beds and areas affected by floods. In the long run, the soil is completely exhausted due to removal of top soil and becomes infertile.

(iii) Rill Erosion

The removal of surface material usually soil, by the action of running water. The processes create numerous tiny channels (rills) a few centimeters in depth, most of which carry water only during storms.

(iv) Gully Erosion

When water moves as a channel down the slope, it scoops out the soil and forms gullies which gradually multiply and in the long run spread over a wide area. This type of erosion is called gully erosion. The land thus dissected is called bad lands or ravines. In our country, the two rivers Chambal and Yamuna are famous for their ravines in U.P. and M.P. states.

The controlling factors in the last two types of erosion are the velocity and amount of surface run off, the erodability of the soil, nature of slope, the texture and structure of the soil, nature of precipitation and vegetation cover. The speed and frequency of winds or dust storms and vegetation cover are the controlling factors in wind erosion. Seawaves are responsible for eroding soils along the coasts formed by weak rocks such as limestone etc. This type of erosion is wide spread along Kerala coasts. Substantial soil erosion is also caused by changing river channels and snowfall specially in river basins and hilly regions.

- The removal of soil material naturally or by human action is called soil erosion.
- Soil erosion is of four types : wind erosion, sheet erosion, rill erosion, gully erosion.
- Factors influencing soil erosion are velocity and amount of surface run off, nature of slope, texture and structure of soils and frequency and speed of winds.

2.13 SOIL CONSERVATION

Soil is one of the most important natural resources, which sustains different types of lives directly or indirectly. Moreover, soil forming is a slow natural process. The process of soil erosion not only destroys this wonderful gift of nature in a shorter span of time, It creates new problems like floods, damage to roads and rail bridges, hydro electric projects, water supply and pumping stations.

Soil conservation constitutes those methods which prevent soil from being removed. The methods to control soil erosion of different types in different parts of the world are as under:

(a) Protection of forests : Indiscriminate felling of trees in the forests has been one of the major causes of soil erosion. Since roots of the trees hold the soil material together, it is desirable to protect these trees from such felling. This has led governments to declare forests as reserved in which felling of trees has been banned. This method of soil conservation is most suited to all types of landscapes. Forests are also harbinger of rain which increases the process of soil formation.

(b) Afforestation : Planting of trees along river courses, waste lands and mountainous slopes is another method of soil conservation. It reduces excessive erosion taking place in these regions. Afforestation is also effective in controlling wind erosion along the desert regions. Tree plantation along desert boundary stops swallowing of agriculture land by desert sands. In our country large scale planting of trees is being carried out in Rajasthan, Haryana, Gujrat and Punjab to control the extension of Thar Desert.

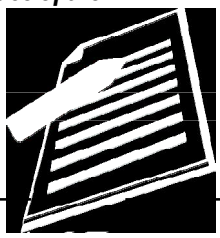
(c) Flood Control : During rainy season, the amount of water in rivers, increases exceedingly which in turn increases soil erosion. Dams are being constructed to control floods and consequently the soil erosion. This can also be done by diverting river water to dry regions through canals and by other well planned methods of water conservation.

(d) Planned Grazing : Over grazing on hill slopes has helped loosening and washing away of soils in these areas. If grazing is carried out in a planned way it will reduce soil erosion by protecting vegetation cover in these areas which are comparatively more prone to soil erosion.

(e) Bunding: Construction of bunds or obstruction is applied in lands affected by gully erosion. This method is not only helpful in controlling soil erosion but also in maintaining soil fertility, conserving water resources and levelling of sloping lands.

(f) Terracing: To conserve poorly developed thin soils on mountain slopes, terracing is another method. Terracing refers to the construction of terraces across the slope in a mountainous region. This helps in controlling soil erosion and using water resources of these areas economically and effectively for growing different crops on these terraces.

(g) Contour Ploughing : This method of soil conservation is most suited to areas having rolling landscape. Ploughing and tilling of land along the contour levels in order to cause furrows to run across the landslope reduces the rate of soil erosion. This method is also applied to maintain the fertility and soil moisture.



(h) Adoption of Strip Farming: This method is most suited in rolling plains and regions situated in arid and semiarid regions. Field are divided into strips and the fanning in one year is done on one strip while the other strip is left uncultivated. The grassy vegetation cover of the left strip controls soil erosion and maintains fertility of soils. Next year, the process is reversed.

(i) Crop Rotation: Crop rotation refers to a systematic succession of different crops cultivated in a given piece of land in order to avoid exhaustion of the soil. Thus, rotation of crops is applied to conserve the fertility of soil from over cultivation of growing continuous crops from where population pressure is more on limited agricultural lands. This method is applied in most of the countries of the world.

(j) Reclamation of Lands: Soil erosion is also being controlled by levelling lands gullied down by water channels and converted in to waste lands or ravines. This methods of soil conservation is most suited in river basins and hilly terrains. Vast areas have been levelled in Chambal and Yamuna ravines, in our country.

- Soil conservation methods include protection of forests, afforestation, bunding, reclamation of lands; controlling floods, over grazing; terracing, strip farming, contour ploughing and crop rotation.

INTEXT QUESTIONS 2.10

1. Fill in the blanks with the appropriate words given in the brackets:

   (a) The complete removal of soil cover is known as _____ (Gullying, wind, sheet erosion)

   (b) _____is the best suited method of soil conservation in desert outskirts, (strip farming, afforestation, bunding)

   (c) Sheet erosion is mostly caused by _____(foods, rains, deforestation).

2. Give the geographical term for each of the following:

   (a) Removal of soil material naturally or by man's action.

   (b) Removal of soil by water channel.

   (c) Planting of trees in deforested lands.

   (d) Removal of soil by dust storms.

   (e) Tilling of land along the contour levels.

WHAT YOU HAVE LEARNT

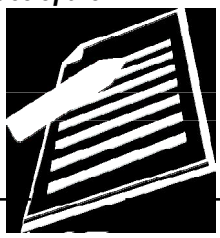
Earth is a spherical body. The direct observations into its interior are limited to a depth of a few kilometers. Temperature, pressure and density increase from the earth's surface to its centre. Earth's interior is divided into three concentric layers; Crust, mantle and core. Crust is the thinnest and outermost layer, mantle middle one whereas core is the innermost and the most dense layer of the earth. The material of the crust is composed of rocks. Rock is composed of one or more minerals. Minerals have a definite chemical composition. On the basis of their mode of formation, rocks are classified into three types - igneous, sedimentary and metamorphic. Igneous rocks are formed by the solidification of molten lava or magma. Granite, basalt and gabbro are examples of igneous rocks. Molten material solidified beneath the earth's surface to form intrusive and above the earth surface to form extrusive igneous rocks. Sedimentary rocks are formed by the consolidation of sediments. These are layered and may contain fossils. Shale, limestone and sandstone which are examples of sedimentary rocks. Metamorphic rocks are formed by the effect of heat or pressure on any pre-existing rock. Rocks are of immense use to us. They provide precious metals and stones, building material and fuel etc. for our use.

Landforms undergo a constant change. The exogenetic forces act upon them to make the surface level.

The rocks undergo various types of changes in their own location under the process of weathering. The rocks become weak due to the impact of the weather elements - temperature, moisture, frost etc. They develop cracks and disintegrate into small boulders, pebbles or fine fragments. This is called mechanical weathering. This type of weathering is more pronounced in areas of hot and dry or very cold climates. Rock minerals undergo chemical changes due to the effect of water and gases as a result of oxidation, carbonation, hydration and solution. This is called chemical weathering. This type of weathering is more important in areas of warm and humid climates. Plants, animals, insects and men are the agents of biotic weathering and they contribute to both mechanical and chemical weathering.

Soil is a natural resource of unestimated value to man as he gets his food, clothing and other things directly or indirectly from it. Soil is a thin layer of loose inorganic and decayed organic matter covering the earth's surface. Differente factors such as parent materials, climate, plants and animal organism, water and time along with processes such as mechanical, chemical and biological are responsible in making this valuable resource. Mature soils develop a profile which constitutes four horizons, each having different characteristics.

Soil erosion is a natural process of destruction and removal of soil material from its place. Running water, winds, sea waves and glaciers are the most active agents of



erosion. Erosion of soils takes place in four ways viz., wind erosion, sheet erosion, rill erosion and gully erosion. Removal of soil cover depends on velocity and speed of water, nature of slope, texture and structure of soils, frequency of dust storms and nature of precipitation. Man through his misdeeds, has also helped natural forces in increasing the problem of soil erosion. Methods to prevent soils from being eroded constitute soil conservation. These methods are protection of forests, afforestation, contour ploughing, terrace and strip farming, bunding, flood control, etc.

TERMINAL QUESTIONS

1. What are the limitations of direct methods in the determination of the earth's interior?
2. Draw and label a diagram showing earth's interior and its density and depth of each layer.
3. Distinguish between a rock and a mineral with suitable examples.
4. Discuss the classification of various types of rocks on the basis of their mode of formation. Support your answer with examples.
5. Explain in brief the economic significance of rocks and minerals.
6. Compare the processes of formation of metamorphic and sedimentary rocks.
7. What is weathering? Name the different types of weathering.
8. How does chemical weathering take place?
9. Differentiate between
   (a) Disintegration and Decomposition
   (b) Degradation and Aggradation
   (c) Oxidation and Solution
10. Explain the process of gradation.
11. How does man become an important agent of weathering?
12. Explain the following processes of weathering by drawing simple diagrams:
    (a) Block disintegration
    (b) Frost action
    (c) By plant action
13. Give a brief account of soil profile. Illustrate your answers with a diagram.
14. Discuss various factors responsible for soil formation.

16. What is soil erosion ? Explain the different ways in which soil is eroded. Discuss the various methods being used to conserve soil.

ANSWER TO INTEXT QUESTIONS

2.1

1. Rapid increase of temperature below the earth's surface
2. (a) Lithosphere (b) Mantle (c) Core
3. Core or Nife
4. More than 11.0
5. Lithosphere
6. Lithosphere

2.2

1. 3000^0C to 5000^0C
2. 3 to 4 million times the atmospheric pressure at sea level.
3. Due to immense pressure of overlying rocks and the presence of heavier materials.

2.3

1. Mineral is a naturally occurring inorganic substance which posseses physical properties and has a definite chemical composition. 2. Feldspar /Quartz/ Pyroxenes/Amphiboles/Mica/Olivine 3. (i) Plutonic rocks (ii) Lava 4. (i) When the magma cools in their sheets in vertical fractures within the earth's crust dykes are formed and (ii) when it solidifies in horizontal starta it is called a sill. 5. (i) cooling (ii) Granite (iii) Solidification

2.4

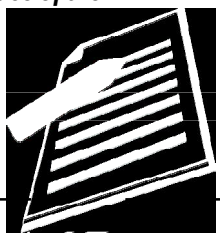
1. Rocks are aggregates of Minerals and are the individual units constituting the crust of the earth. 2. Igneous, Sedimentary and Metamorphic rocks. 3. (i) Dynamic metamorphism (ii) Sedimentary rocks/Stratified rocks (iii) Metamorphic rocks. (iv) Lacustrine 4. (i) a metamorphic rock (ii) Sandstone.

2.5

1. (a) Physical weathering (b) Chemicals weathering (c) Biotic weathering.
2. In dry and very cold regions.
3. (a) Exfoliation (b) Frost action (c) Physical weathering.

2.6

1. In warm and humid regions.
2. Solution



3. Oxidation
4. Carbonation

2.7

1. (a) Plants (b) Animals (c) Man.
2. The cracks in rocks are widened and the rocks are broken.
3. (a) Agriculture (b) Mining

2.8

1. Gradation
2. (a) Degradation or lowering down of raised surfaces.
   (b) Aggradation or raising up of low lying areas.
3. Aggradation.
4. Lowering down of raised portions through erosion of material.

2.9

1. (a) Climate (b) Plant and animal organisms
2. (a) Parent rock (b) relief or topography (c) Time
3. (a) Inorganic mineral particles (b) Biological activities
4. (a) Soil (b) Soil profile
   (c) Top soil (d) zone of weathered parent rock

2.10

1. (a) Sheet erosion (b) Afforestation (c) Floods
2. (a) Soil profile (b) Gully erosion
   (c) Afforestation (d) Wind erosion
   (d) Contour ploughing

HINTS TO TERMINAL QUESTIONS

1. The rapid increase of temperature below the earth's surface. Mining activity restricted to few kilometres. High temperature melts drilling tools.
2. See Fig. 2.1 - Concentric zone showing layers of Earth's interior.
3. Rock is the solid part of the crust composed of minerals. They are aggregates or physical mixture of one or more minerals for e.g. granite. Minerals are inorganic substances made up of one or more elements in a definite ratio, e.g. feldspar. Change in the ratio of minerals gives rise to different rocks.
4. Igneous rocks, sedimentary rocks and metamorphic rocks (give definition of each with examples of each type of rock).
5. See economic significance of rock (para 2.6)

6. Sedimentary rocks are formed due to weathering, erosion and deposition of rock fragments of older rocks which become hard due to compaction, chemical changes or cementation of organic matter, whereas metamorphic rocks are formed due to the pressure and high temperature of the magma when it comes in contact with both igneous and sedimentary rocks.

7. Weathering is a process by which rocks are disintegrated and decomposed in situ. See para 2.7.

8. See para 2.8 under "Chemical weathering".

9. (a) disintegration of rock of physical breaking up or shattering of rock under the influence of temperature or frost action. Decomposition is due to chemical change by which rock minerals break up or get dissolved. Give example of each type.

   (b) See para 2.10 (a) and (b)

   (c) See para 2.8 (a) and (d) under "Chemical Weathering".

10. See para 2.10 (a) and (b) and Fig. 2.7

11. See para 2.8 (c) biotic weathering.

12. See Fig. 2.3, 2.5 and 2.6.

13. Points to be discussed in detail include:

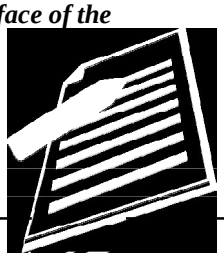
    Meaning of soil profile-refer to 2.11 Section B. Answer is to be illustrated with the help of Fig. 2.9.

14. Points to be elaborated - parent rock, relief, time, climate and plant and animal organism (Active and non-active factors) Importance of each of these points should be highlighted (Refer 2.11 Section A).

15. Soil erosion refer 2.12 Section

    Types of soil erosion - wind erosion, sheet erosion, gully erosion (Refer 2.15 Section)

    Methods to conserve soils - Protection of forests, afforestation, flood control, planned grazing, reclamation of lands, bunding, terracing, contour ploughing, strip farming, crop rotation (Refer to 2.13 Section).



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3

DYNAMIC SURFACE OF THE EARTH

In the previous lesson, we have learnt that the interior of the earth is very hot. Earthquakes and volcanoes are concentrated along a few narrow belts. The type and density of rocks of the crust are variable. The surface features are dynamic in character. This dynamism is due to two forces — endogenetic and exogenetic. Endogenetic forces are those which are caused from below the surface. Due to this, an area may get elevated or gets submerged. These forces try to make the surface irregular while exogenetic froces are those which operate from above the surface. They try to eliminate the irregularities of the surface through the process of denudation about which we will be reading in lesson. In this lesson we will be studying about the endogenetic forces.

OBJECTIVES

After studying this lesson, you will be able to :

- define isostasy;
- describe the variation in relief features on the earth's surface;
- explain the isostatic adjustment by various experiments;
- explain the views of Airy and Pratt and distinguish between the ideas of both;
- explain the concept of continental drift;
- enumerate the evidences of continental drift;
- explain the concept of plate tectonics;
- identify and locate different plates on the world map;

- explain the mechanism of plate movement;
- identify various plate boundaries and associated features;
- explain the distribution of land and water on the globe and
- associate earthquakes and volcanoes with plate boundaries.

3.1 CONCEPT OF ISOSTASY

The term "Isostasy" is derived from "Isostasios", a word of Greek language meaning the state of being in balance. You already know and must have seen that the mountain have many peaks and relatively great heights. Similarly plateau and plain have flat surfaces. They have moderate and lower height, respectively. On the contrary oceanic beds and trenches have greater depths. There is a great difference in height among these features. You also know that the earth is rotating while keeping perfect balance among its various features. Thus, our earth is considered to be in isostatic equilibrium.

Example:- Suppose you are holding one stick each in your both hands vertically with varying heights, say 5' and 15' and you are moving in a particular direction. Do you have any difficulty in maintaining a balance in congruence with your body as well as two sticks together? Definitely, smaller stick will be easy to make a balance than the longer one. It is just because of the centre of gravity. The centre of gravity with smaller stick will be nearer to your holding hand in comparasion to the longer stick. In the same way smaller surface features like plains are more stable than the tall mountains.

A. Isosatic Balance: views of Airy

Airy, a geologist, considered the density of different columns (plains, plateaus, mountains, etc.) to be the same. Hence, he proposed the idea of **'uniform density with varying thickness'**. We know that the upper crust of the earth is made up of lighter material. In this layer, silica and aluminium are found in abundance, hence it is known as 'Sial'. It is less denser than the lower one. Airy assumed that the Sialic crust is floating over the Sima (silica and magnesium, lower denser layer). Crustal layer is uniform in terms of density with varying length of columns. Therefore, those columns are projecting down into the asthenosphere depending upon the proportions of the column. It is due to this reason that the root has developed or the sima has been displaced from below.

To prove this concept, Airy took an example of wooden blocks of various sizes and immersed them into water (Figure 3.1). All blocks are of same density. They get immersed differently in proportion to their sizes. In the same way higher features with great height seen on the surface of the earth have deeper roots whereas short in length has shorter roots beneath. It is the concept of root which is sustaining the higher elevation. He is of the openion

that the landmasses are floating like a boat in the substratum (magmatic asthenosphere). According to this concept, the root beneath the Mt. Everest would be 8848X8 = 70784 metre below the sea level. On this bases Airy has been criticized that the root is not possible to be at such a great depth. Because the root material will melt due to higher temperature found at that depth.

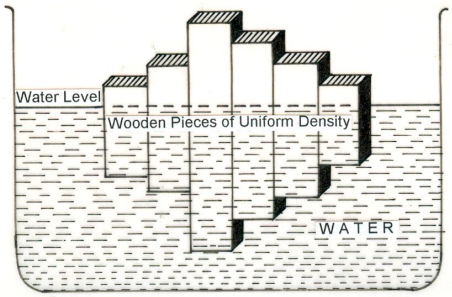


Fig. 3.1(a) :Illustration of the concept of Airy on isostasy

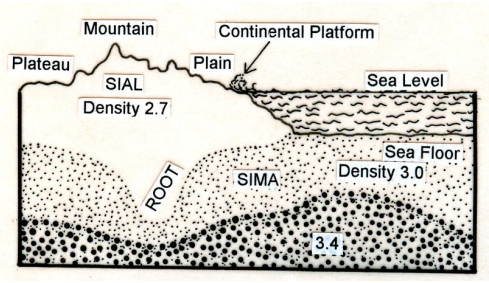


Fig. 3.1(b) : Condition of Isostary (based on A. Holmes and D.L. Holmes)

B. Isostatic Balance: views of Pratt

Pratt considered landblocks of various heights to be different in terms of their density. The taller landmass has lesser density and smaller height features to be denser. In other words, there is an inverse relationship between height and density. If there is a higher column, density will be lesser and if there is a shorter column, density will be higher. Assuming this to be true, he accepted that all blocks of different height get compensated at a certain depth into the substratum. In this way a line is being demarcated above which there is equal pressure with varying heights. Thus, he denounced the root concept of Airy and accepted the 'concept of a level of compensation'. For proving his concept he took a number of metal bars of varying density with same weight and put them into mercury (Figure 3.2). In this way they form a line by all those bars, which he regarded to be the level of compensation.

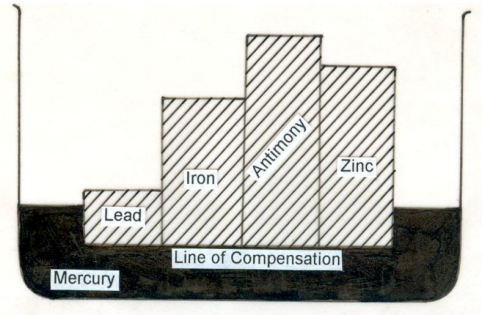


Fig. 3.2a Experiment of the concept of Pratt on Isostasy.

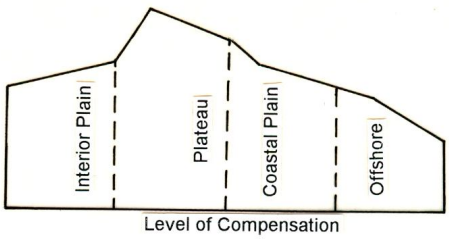


Fig. 3.2b. Illustration of Lithospheric block being compensated

Differences between the views of Airy and Pratt

The differences between the views of Airy and Pratt can more clearly be presented in a tabular form:-

	Views of Airy	Views of Pratt
1.	Uniform density of crustal material.	Varying density of crustal material.
2.	Varying depth upto which root penetrates.	Uniform depth upto which crustal material reaches.
3.	Deeper root below the mountain and smaller beneath plain. (Figure 3.1)	No root formation, but a level of Compensation. (Figure 3.2)

C. Global Isostatic Adjustment

It is quite apparent that there is no complete isostatic balance over the globe. The earth is unstable. Endogenetic forces often disturb the crustal balance. The regular earthquakes and volcanic eruptions along a particular belt do not signify any balance but a sort of adjustment is needed continuously. Endogenetic forces and their tectonic effects are the causes of imbalance on the surface but nature always tries to make an isostatic adjustment with itself.

Exogenetic forces are trying to eliminate the differences on the surface of the earth and in this process they are peeling off, transporting down to far flung places, and depositing them. In this process, isostatic balance is maintained by the underneath flowage of material by subsidence at the place of deposition and upliftment at the peeling of place in their proportion to the denudation (Figure 3.3).

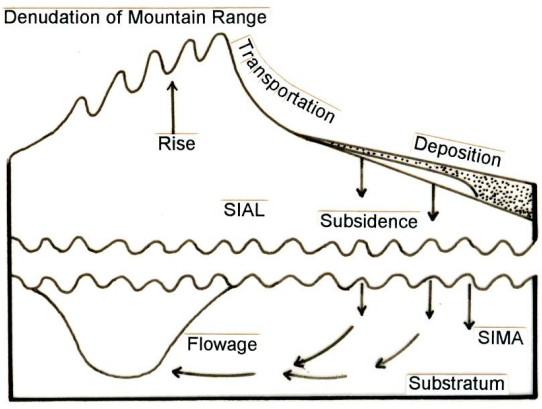
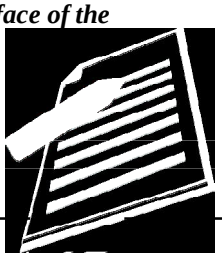


Fig. 3.3 : Mechanism of isostatic adjustment



INTEXT QUESTIONS 3.1

Fill in the blanks:-

1. Isostasy means _____.

2. Airy considered the density of different columns to be _____.

3. Pratt considered landblocks of various height to be different in terms of their _____.

4. According to Airy there is _____ root below the mountain and _____ beneath plain.

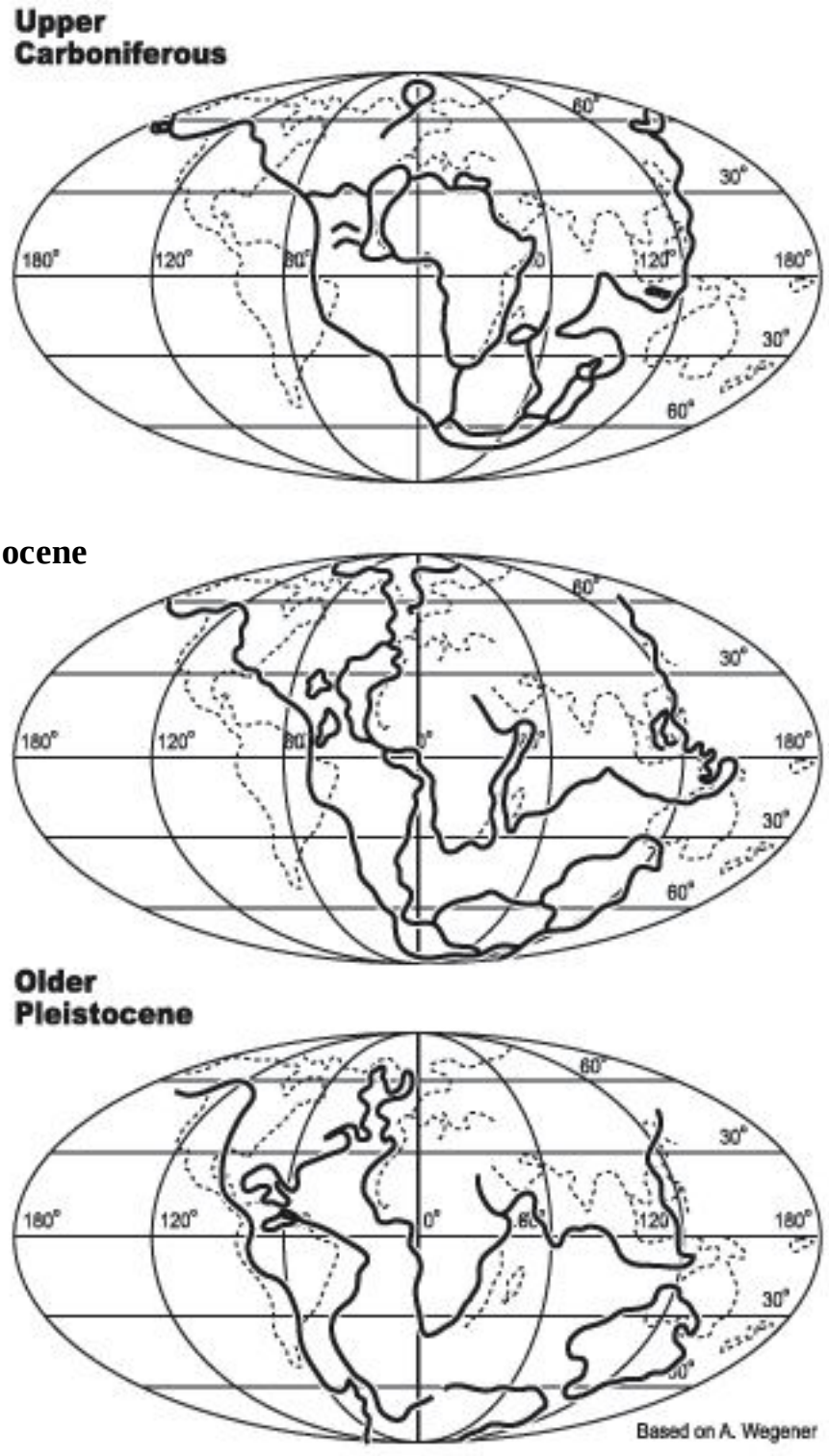
5. Pratt postulated the concept of _____ root formation but a _____ of compensation.

6. Endogenetic forces often _____ the crustal balance.

7. Regular earthquakes and volcanic eruptions along a particular belt does not signify _____ but a sort of continuous_____ _____.

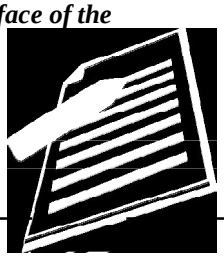
3.2 CONTINENTAL DRIFT

According to Alfred Wegener, the entire landmass of the globe was together about 280 million years ago. It was termed as Pangea, a super continent. The huge water body surrounding the Pangea was known as Panthalasa. From 280 to 150 million years ago, Pangea was broken latitudinally into northern and southern parts known as Laurasia (Angaraland) and Gondwanaland, respectively. Both of them drifted away and in between a shallow sea emerged by filling up the water from Panthalasa. It was known as Tethys sea. Later on Laurasia and Gondwanaland rifted and finally drifted to form the present day distribution of land and water on the earth (Figure 3.4).



Pangea

Fig. 3.4 Pangea



Evidences of Drift

Wegener gave a number of evidences in support of the unification of land-mass in geologic past. They are such which cannot be negated even today.

a. **Jig-saw-fit:-** Eastern coast of South America is identical to Western coast of Africa which fits to a certain depth in the ocean. To a certain extent coastal areas and continental shelves have been modified by oceanic waves through denudation (Figure 3.5)

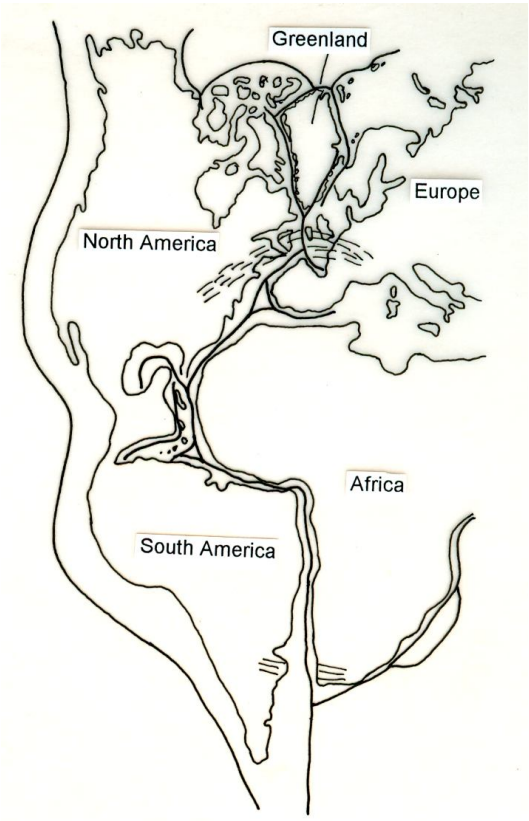


Fig. 3.5 Wegners map of continental drift-Fitting of the continents bording the Atlantic Ocean

b. **Geological similarities:-** The mountain systems of Southern Atalantic coast in South America and Africa show the similarity of the extension in both continents.

c. **Coal and Vegetation evidences:-** The distribution of coal and vegetation over South America, Africa, India and Australia proves that they were together in geological past. The classical glacial deposits during carboniferous period over these landmasses resemble each other which tells the story of togetherness. Today they lie in different climatic zones.

Apart from above evidences put forward by Wegener, other evidences (known later) are also there which support the idea of continental drift.

d. **Evidences from paleomagnetism :–** Paleomagnetism is the study of the direction of pole through ages. Magnetically susceptible minerals like haematite, pyrhotite magnetite etc. get aligned with the magnetic pole of the earth and recorded in the solidification of magma during that time. It is found that periodic changes have occurred and poles have wandered which is not possible for the entire earth. Hence, it is the twist and turn of the landblock and not for the entire earth which has again explained that the continents have shifted their positions.

e. **Sea floor spreading :–** Along the mid Atlantic ridge, magma comes out at the sea bed and gets solidified. A new zone is formed and this process is continuing since millions of years. It is leading for diversion of continental block, and hence the size of the Atlantic ocean is increasing which is termed as sea floor spreading. It is the classical example of the shifting of continents. The explanation of continental drift through sea floor spreading and the study of paleomagnetism is commonly known as Plate Tectonics. (Figure 3.6)

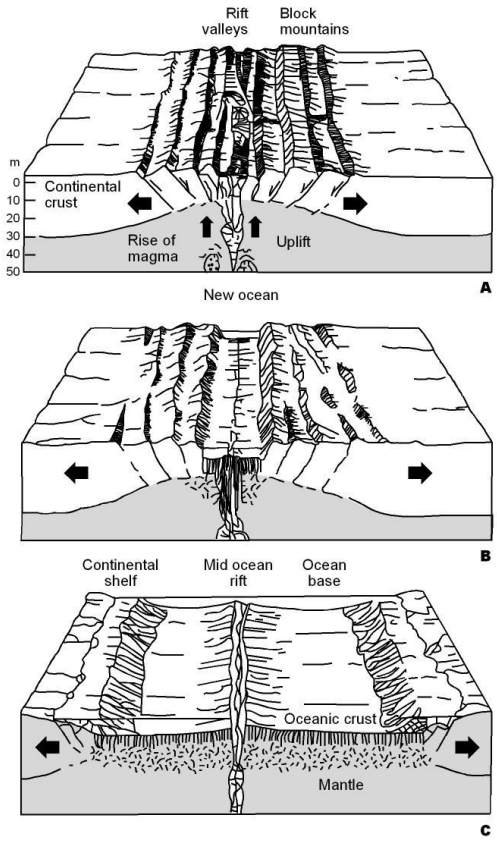
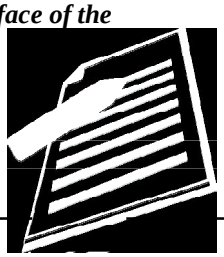


Fig. 3.6 Stages in continental rapture and the opening-up of a new basin



INTEXT QUESTIONS 3.2

1. Fill in the blanks:-
   a. Alfred Wegener termed the supercontinent as _____.
   b. Premordial ocean was known as _____.
   c. Pangaea was broken into two _____ in the north and _____ in the south.
   d. North and South America drifted towards _____.
   e. Tethys sea emerged between _____ and _____ by filling up of the water of _____.
2. Name three evidences of continental drift put forwarded by Wegener -
   a. _____
   b. _____
   c. _____
3. Name two evidences of continental drift, but not mentioned by Wegener
   a. _____
   b. _____

3.3 PLATE TECTONICS

The uppermost outer solid and rigid layer of the earth is called crust. Its thickness varies considerably. It is as little as 5 km thick beneath the oceans at some places but under some mountain ranges it extends upto a depth of 70 km. Below the crust denser rocks are found, known as mantle crust. This upper part of mantle upto an average depth of 100 km from the surface is solid. This solid mantle plus upper crust form a comparatively rigid block termed as lithosphere. Mantle is partially molten between 100 to 250 km depth. This zone is said to be asthenosphere, also known as Mohr discontinuity, a simplification of Mohorovicic, the name of the seismologist who discovered it. All these things you have already read in the previous lesson.

The lithosphere is broken into several blocks. These blocks are known as plates, which are moving over asthenosphere. There are seven major plates. (Figure 3.7)

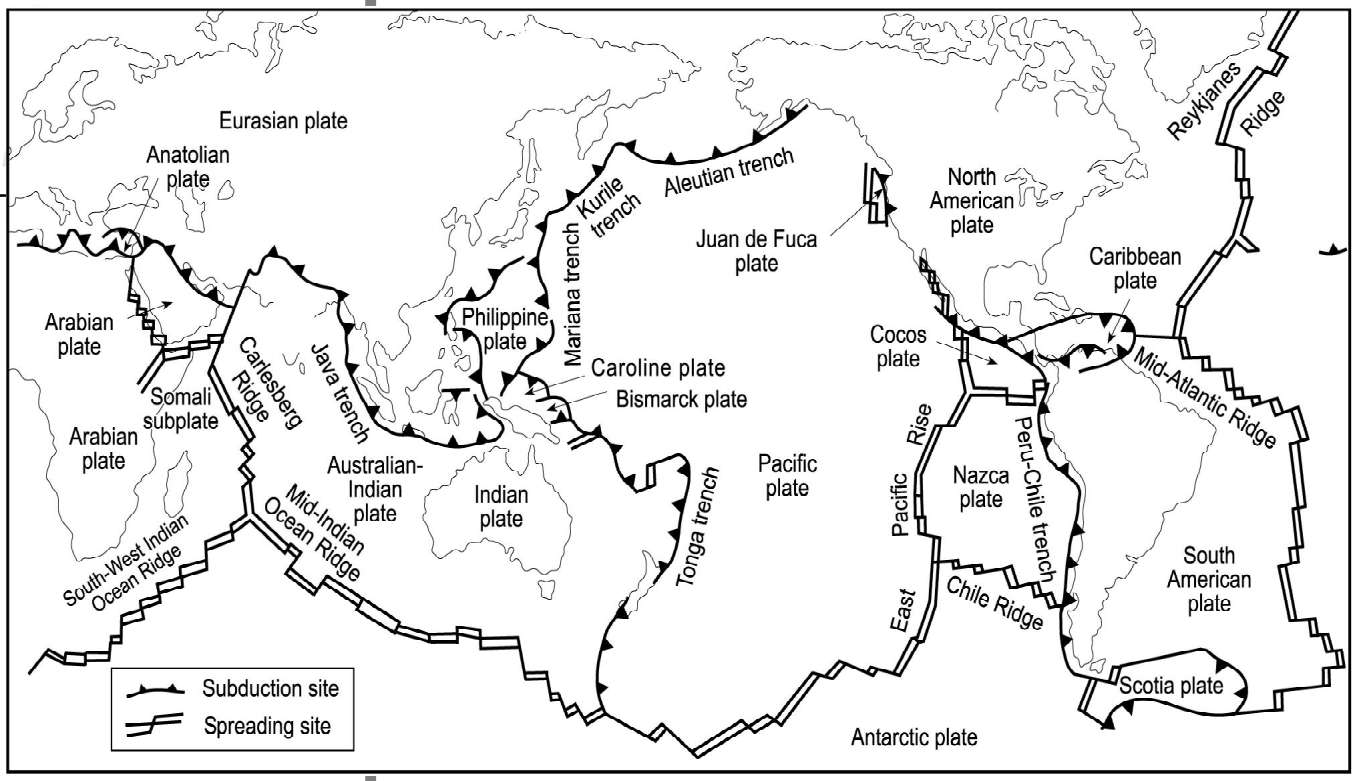


Fig. 3.7 Tectonic plates, spreading sites and subduction sites

1. Eurasian plate,
2. African plate,
3. Indo-Australian plate,
4. Pacific plate,
5. North American plate,
6. South American plate and
7. Antarctic plate.

Apart from these major plates minor plates are about 20 in number, a few important among them are :-

Arabian plate,
Philippine plate,
Cocos plate,
Nazca plate,
Caribbean plate,
Scotia plate, etc.

The major and minor plates constitute the whole surface of the earth.

Plate tectonics is a method or way of understanding the land-water distribution of the earth. Tectonics is a sort of movement of plates. Through the movement,

internal forces are explained which are responsible for the distribution of earth's crust, formation of mountain chains and distribtion of earthquakes and volcanism.

Mechanism of plate Movement

Arthur Holmes, a British geologist, in 1928 – 1929, proposed that convectional currents exist underneath the lithosphere. The centre of convectional current is not exactly known, but it is believed that it has an average depth of about 100 to 250 km below the surface. The inception of the current is initiated by heat generation due to radio-active minerals. Due to integration and disintegration of atomic minerals heat is produced and hence the melting of surrounding rocks. In this way currents start operating. These currents are classified into rising and falling with divergence and convergence activities, respectively.

With rising convectional current, transport of hot and viscous matter takes place upwardly. After reaching about 100 kms below the surface that current gets diverged leading to split into the upper part. The molten material penetrates into the split and thus creation of new surface and the draft of the mammoth plate in opposition direction. It happens below the mid-oceanic ridge. On the other hand two sets of diverging thermal convectional currents brings two plates together and it is called convergent boundary where subduction takes place. Plates of lithosphere are constantly in motion because of convectional currents. Their relative motion depends upon the force operating over them.

Plate boundaries are very important and significant structural features. Boundaries are very distinct and easy to identify. They are associated with newly formed mountain systems, oceanic ridges and trenches. Plates are moving continuously and have relative direction of movement. Based on the direction of movement three types of plate boundaries can, easily, be identified. (Figure 3.8)

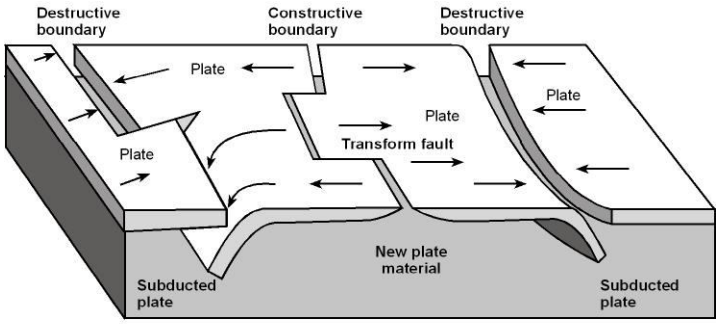


Fig. 3.8 Types of plate boundaries

(i) Divergent boundary
(ii) Convergent boundary
(iii) Fracture or transform boundary fault

The convectional current are caused due to radio-activity. These currents get diverted on approaching the crust layer. Diverging currents produce tension at the contact-zone of crust leading to fracture. Maganatic material penetrates into the fractroges and gets solidified. This continuous process pushes the blocks in opposite direction and creates a new zone, known as “zone of construction”.

At convergent boundary, two adjacent plates come further and further closer to each other and collide. When both sides are of continental nature, a mountain formation is evident. When one of the two is continental and the other maritime again mountain comes into being along the boundary. In this case, continental plate overnides the maritime. When both plates are of maritime, both of them break, subduct and penetrate below and, hence, trenches are formed. Along this boundary earthquakes and volcanic activities are prominent. In all these three situations, surface area is reduced, therefore, this is also known as “zone of destruction”.

Transform fault is the one when two adjacent plates slide past each other. Direction of movement may be along or against but they move parallel to each other. Therefore, neither there is any construction of fresh area nor it has any destruction. Hence, it is known as “zone of preservation”.

Plates are not a permanent features but they vary in size and shape. Plates can split or get welded with adjoining plate. Almost all tectonic activities occur along the plate boundaries.

Prior to the advent of plate tectonic theory, the continental drift theory which was proposed by Wegener was criticized, particularly about the forces. In fact, it was outrightly rejected inspite of apparent evidences. But further reserches about the material of sea floor and paleomagnetism supported the theory but the proposition of plate tectornic theory in 1960’s has solved the problem of the mechanism of movement.

Plate Tectonics Vs Earthquakes and Volcanoes

The distribution of earthquakes and volcanoes over the globe (Figure 3.9) clearly reveals that they are strongly associated with the boundaries of plates. Plate boundaries are the zones where every sort of tectonic activity does take place. The release of energy created because of the movement of plates is manifested in this zone in the form of earthquakes and volcanic eruption.

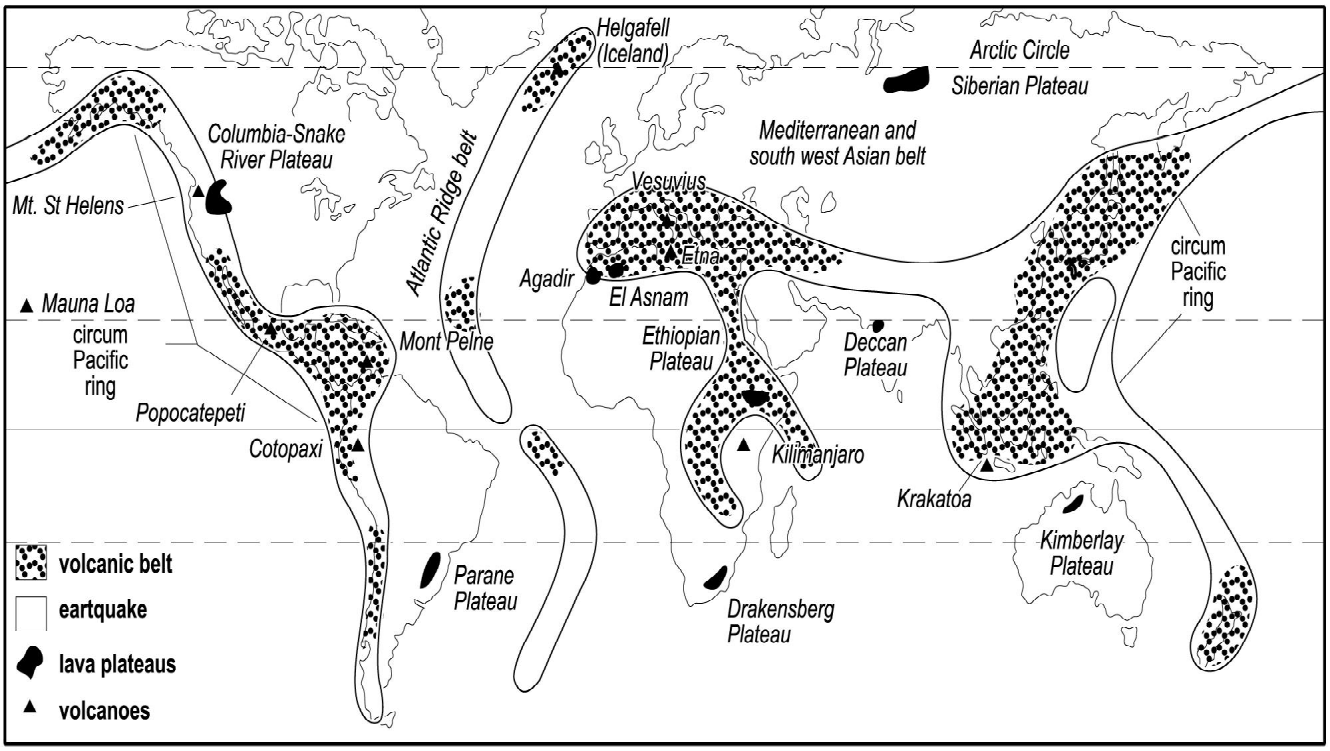


Fig. 3.9 The Major Earthquake and volcanic belts of the world

INTEXT QUESTIONS 3.3

1. Fill in the blanks:-
   a. The uppermost outer _____ layer of the earth is called _____.
   b. Crust and upper part of mantle upto an average depth of _____ is _____.
   c. Lithosphere includes _____ and _____.
   d. Tectonics is sort of _____ of lithospheric plate.
   e. The concept of convectional current was first explained by _____ in _____.
   f. Convectional currents are classified into _____ and _____; they _____ and _____, respectively.
   g. Plate boundaries are associated with _____, _____ and _____.
2. Name seven major plates
   a. _____
   b. _____
   c. _____
   d. _____
   e. _____

f. _____

g. _____

3. Name some important minor plates –

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

4. Enumerate different types of plate boundaries

a. _____

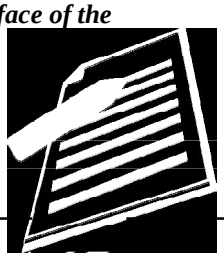
b. _____

c. _____

WHAT YOU HAVE LEARNT

The surface of the earth is dynamic. This dynamism is due to the forces operating from inside the surface (endogenetic forces) as well as on the surface/atmospheric forces (exogenetic forces). It is existing on the earth while itself is rotating and revoling. The surface is irregular. Hence, a sort of dynamic equalibrium is always in operation which is termed as isostasy. Apart from many scholars the views of Airy and Pratt are more distinct. Airy propounded the idea of uniform density of all rocks on the surface but has its roots depending upon the height of the column. A greater root will be found beneath the higher and lofy body of mountains and having smaller root under lower columns like plateau or plain. Pratt accepted that the rocks found on the earth have different densities. At a particulars depth, the weight of all columns of varying height will be compensated. Hence, higher column of mass will have lower density and lower column will have higher density. Therefore, both of them are explaining the same problem of isostatic balance, but with different perspective.

The distribution of land and water on earth surface is not static. It has changed, it is changing and it will change in future too. This changed position is said to be continental drift in crude way which was conceived by Wegener, but the mechanism explained by him was not scientific. Therefore, his ideas of continental drift was denounced inspite of his strong unfutile and testifying evidences.



With the concept of convectional current theory of Holmes and proposition of plate tectonics, a new thinking came in understanding the surface of the earth. Study on paleomagnetism as well as sea floor spreading have supported the plate tectonics theory. According to this theory, the earth surface is made up of several broken blocks of enormous size with great depth considered to be a plate. There are seven bigger size plates and twenty seven smaller size plates. As per the concept of convectional current, their movement takes place in three possible ways. First, two adjacent plates move away (divergent) and where a new zone is constructed. Second, two adjacent plates come closer (convergent) and get subducted and where a zone is destroyed. Third, in which two adjacent plates slide past each other (fracture) where the margins of both plates are preserved. Because of these different tectonic activities, earthquakes and volcanoes are associated with plate margins.

TERMINAL QUESTIONS

1. What is isostasy?
2. Explain the concept of isostasy according to Airy.
3. Explain the isostatic balance of the earth as proposed by Pratt.
4. Differentiate the ideas between Airy and Pratt.
5. Discuss the isostatic balance at global level.
6. Discuss the evidences of continental drift.
7. What is plate? Explain the mechanism of plate movement.
8. Discuss the activities at plate margins.
9. Describe the distribution of earthquakes and volcanoes with the help of plate boundaries.

ANSWERS TO INTEXT QUESTIONS

3.1

1. the state of being balance
2. same
3. density
4. deeper, lower
5. no, level
6. disturb
7. any balance, adjustment is needed.

3.2

1. a. Pangeea
   b. Panthalasa
   c. Laurasia (Angaraland), Gondwanaland
   d. West
   e. Angaraland, Gondwanaland, Panthalasa

2. a. Jig-saw-fit
   b. geological similarities
   c. coal evidences

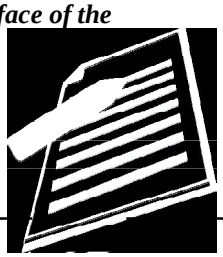
3 a. evidences from paleomagnetism
   b. sea floor spreading

3.3

1. a. solid and rigid, plate
   b. 100 km, solid
   c. upper solid mantle, crust
   d. movement
   e. Arthur Holmes, 1928-29
   f. Rising, falling; diverge, converge
   g. Newly formed mountain systems, oceanic ridges, trenches

2. a. Eurasian plate
   b. African plate
   c. Indo-Australian plate
   d. Pacific plate
   e. North American plate
   f. South American plate
   g. Antarctic plate

3. a. Arabian plate
   b. Philippine plate
   c. Cocos plate
   d. Nazca plate
   e. Caribbean plate
   f. Scotia plate



4. a. divergent boundaries
   b. convergent boundaries
   c. fracture or transform fault/boundaries

HINTS TO TERMINAL QUESTIONS

1. Please refer to section 3.1
2. Please refer to section A of 3.1
3. Please refer to section B of 3.1
4. Please refer to section C of 3.1
5. Please refer to section 3.2
6. Please refer to section 3.2, Evidence of drift.
7. Please refer to section 3.3
8. Please refer to section 3.3
9. Please refer to section 3.3

Notes

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4

EVOLUTION OF LANDFORMS DUE TO INTERNAL FORCES

We live on an unstable earth, the surface of which is uneven. While travelling, we come across a variety of landforms such as mountains, hills, plateaus, plains, cliffs and ravines. We also come across tilted, broken and twisted layers of rocks which are originally deposited in horizontal forms. You have already studied about different types of rocks, their formation and characteristics. There is a close relationship between rock types and the shape of landforms. But all deformation on the face of the earth are due to the continuous influence of internal and external forces. In this lesson, we will study about the internal forces deriving their strength from earth's interior and playing their role in shaping what we see on the earth's crust:

OBJECTIVES

After studying this lesson, you will be able to :

- explain the endogenetic forces and the landforms produced by them;
- distinguish between sudden and slow movements;
- differentiate between vertical and horizontal movement;
- differentiate between folding and faulting;
- explain the causes of volcanic activity;
- describe the different types of volcanoes ;
- locate on the outline map of the world, important volcanoes and areas affected by earthquakes;
- explain the causes of earthquakes and their effects.

4.1 INTERNAL FORCES

The variety in the types of land forms on the earth is the end result of two types of forces working simultaneously and continuously both inside and outside on its surface. The forces which originate from within the earth's crust or inside the earth are called internal or endogenetic forces. The sources providing them energy are the internal heat, chemical reactions taking place within the earth, and the transfer of rock materials on the earth's surface by external forces.

4.2 EARTH MOVEMENTS

Though we generally hear people using phrase like "as hard as rock" and "as stable as the earth", but these phrases are not true. Neither the earth is stable nor are the rocks of which its crust is made, are so hard. Since the origin of earth, there have been major changes in the distribution of continents and oceans, the land and the oceans.The earth has experienced innumerable earth movements which have brought about vast changes in its surface. Some of the examples of these movements are submergence of forest in Bombay harbour, the Mahabalipuran temple now standing on the sea and changes in the ground level in Rann of Kuchchh of India.

The forces working from inside the earth in turn cause movements in its crust.These movements are called earth movements. Since, these movements pertain to or rise from, the movements of the actual structure of the earth's crust, they are also called tectonic movements. The word tectonic is derived from the Greek word, "tekton" which means builders. This word is true to its meaning because these are the earth movements which are constructional and have been responsible for buildings of different types of land forms.

From Figures 4.1. (a) and 4.1. (b) it is quite evident that the physiography of India was entirely different about 60 million years ago. The vast Tethys sea existed in that area where the Himalayan ranges and Indo-Gangetic plain exist. The Tethys sea was gradually filled up by the sediments brought by rivers from the surrounding regions. Later, the sedimentary rocks formed in the beds of this sea gradually emerged in the form of the Himalayas in the north and Indo-Gangetic plain to its south.

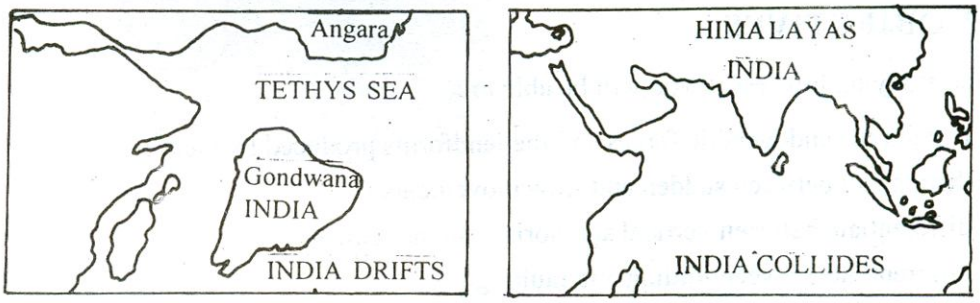


Fig. 4.1 (a) 60 Million Years ago Fig. 4.1 (b) Present configuration

The Malwa plateau and Deccan traps of India, Columbia and Snake Rivers Plateau of North America, Kimberlay Plateau of Australia and Parana and Patagonian Plateaus of South America were also formed by the solidification of molten lava which had escaped from the earth's interior to its surface at different geological times. The evidences clearly show that the surface of our earth never remained the same as it is today and neither it will be the same in future.

- Movements caused by internal or endogenetic forces affecting the earth's crust are known as Earth Movements.
- Earth movements are also called tectonic movements as they help in building the relief features on earth's crust through subsequently or simultaneously undergoing changes.

4.3 CLASSIFICATION OF EARTH MOVEMENTS

The earth movements are classified on various basis. On the basis of time taken by such movements, they are divided into:

(a) slow movement and

(b) sudden movement.

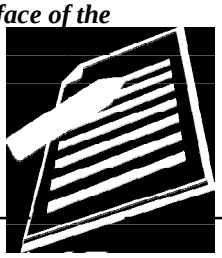
(a) Slow Movement

The movement which bring about changes on the Earth's crust very gradually or slowly taking hundreds or thousands of years and which cover a period much longer than a human life span are called slow movements. These movements act on the earth's crust either vertically or horizontally. Acting vertically, they cause uplift or subsidence of a part of the crust. The raised sea-beaches along the Kathiawar coast of India which contain the shells of marine life clearly point out that this coast was once below the sea level. Similar raised beaches are found In Orissa, Andhra Pradesh, and Tamil Nadu along the eastern coast of India as well. These beaches have been. uplifted to a height ranging between 15 to 30 metres above the mean sea level.

On the other hand there are numerous examples of submergence. Such as the presence of peat and lignite beds found below the sea-level in Sunderban Delta, the submerged forest in Tirunelveli in Tamil Nadu and the submerged forest on the east coast of Bombay Island.

(b) Sudden Movements

Contrary to the slow movements, there are certain movements which bring about abrupt changes in the crust. The examples of such movements are volcanic eruptions and earthquakes. The changes brought about by these two events are so sudden that the courses of rivers undergo a change,



and the lava flow result.in the formation of mountains, uplands and plateaus in a matter of days. Landslides occur in mountainous regions due to these movements.

- Sudden movements bring about abrupt changes on the earth's surface
- Volcanic eruptions and earthquakes are the result of sudden movements
- The movement which bring changes slowly and gradually over a long period of time are known as slow movements.
- Uplift, submergence and subsidence of the earth's crust are the result of slow movements.

INTEXT QUESTIONS 4.1

1. Give geographical term for internal forces

   _____

2. What is Earth Movement?

   _____

4.4 VERTICAL AND HORIZONTAL MOVEMENTS

The slow movements can further be divided into vertical and horizontal movements on the basis of the uplift or subsidence of a part of the Earth's surface.

(a) Vertical movements

Vertical movements originate from the centre of the earth and affect its surface. Consequently large scale uplift or subsidence of a part of the earth's surface takes place. These movements are slow and wide spread and do not bring changes in the horizontal rock strata. These movements are mainly associated with the formations of continents and plateaus, hence these are also known as continent building or plateau building movements. Besides, these movements are also called epeirogenetic movements. 'Epeiros' in Greek language means 'continent' In the previous lesson on rocks, you have studied that sedimentary rocks are deposited and formed in the oceans and seas. The presence of these sedimentary rocks is wide-spread in continents. This clearly shows that these were uplifted or raised to form continents.

Contrary to the above, there are countless evidences of submerged buildings, river -valleys and cities due to subsidence into the sea. Some of such examples include the submerged ancient buildings in Mediterranean in its Crete Island and the ancient city of Dwaraka in Saurashtra, India. These changes clearly point out the downward movement of the Earth's surface.

- Large scale uplift or subsidence create continents, plateaus and oceans.
- Vertical movements are also known as epeirogenetic movements.

(b) Horizontal Movements

There are forces which act on the earth's crust from side to side i.e. horzontally or tangentially. Naturally, they cause a lot of disruption in the horizontal layer of strata as they do involve a good deal of compression and tension of the preexisting rocks since these forces act horizontally or tangentially to the earth's spherical surface. These are known as horizontal or tangential movements.

We can divide them into two types:

(i) Forces of compression, and

(ii) Forces of tension.

(i) Forces of compression: involve pushing of the rock strata against a hard plane from one side or from both sides. To understand their working, let us take a piece of cloth and spread it on the table. Push the cloth with your both hands towards its centre, it will form wrinkles rising into up and down folds. Likewise rock strata also bend in the same fashion when forces of compression act on them from opposite directions. In this way, the compressional forces lead to the bending of rock layers and thus lead to the formation of fold mountains. In them the rock strata primarily of sedimentary rocks get folded, into wave like structure. This process of bending, sometimes warping and twisting of rock strata is referred to as their folding. The upfolds are called anticlines and downfold are called synclines.(Fig 4.2).

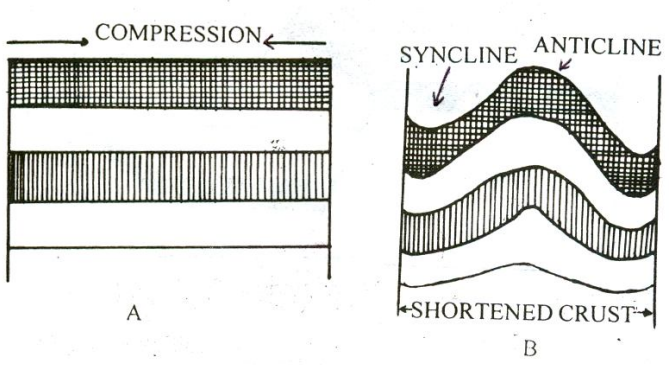


Fig. 4.2 The Earths crust before (A) and after folding (B)

When folding takes place on a gigantic scale, it represents the mountain building process. Most of the great mountain chains of the world viz, the

Himalaya, the Rockies, the Andes, the Alps and others of this sort have been formed by compressional forces resulting in mountain building on a large scale. These are also called Orogenetic Movements.

- Horizontal movements are produced by forces of compression and tension.
- Folding is the bending of rock strata due to compression.
- Upfolds are called anticlines and downfolds synclines.
- Folding on gigantic scale results in mountain building movement generally referred as orogeny.

(ii) Forces of tension: are produced when these forces are working horizontally in opposite directions i.e, away from a given plane or point. Under the operation of intense tensional forces, the rock strata is broken or fractured. As a result cracks and fractures develop. The displacement of rocks upward or downward from their original position along such a fracture is termed as faulting. The line along which displacement of the fractured rock strata takes place is called the fault line. Like wise the plane along which displacement of rock strata takes place is known as fault plane (Fig.4.3)

- Forces of tension produce faults.
- The plane along which displacement of fractured rock strata takes place is called its fault plane.

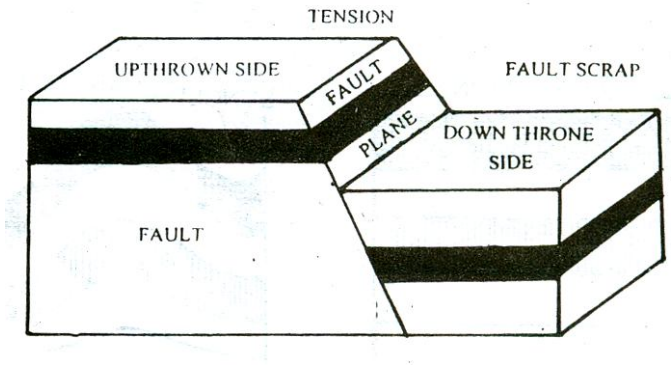


Fig.4.3 A Fault

Forces of compression give rise to the operation of the forces of tension. Thus faults are closely related to the formation and occurrence of folds. It implies that folding generally leads to or is accompanied by fracturing and faulting in rock strata.

Faulting results in the formation of well known relief features such as rift valleys and the block mountains. A rift valley is formed by sinking of rock strata lying between two almost parallel faults. (fig. 4.4). The classical

examples of rift valleys in the world include the Midland Valley of Scotland, the Rhine Valley, the Valley of Nile, the Dead Sea basin and the Great Rift Valley of East Africa comprising few lakes of this region. Some geographers are of the opinion that the Narmada and Tapti valleys are also rift valleys. The coal deposits of the Damodar valley are said to be originally laid in a synclinal trough resembling a rift valley.

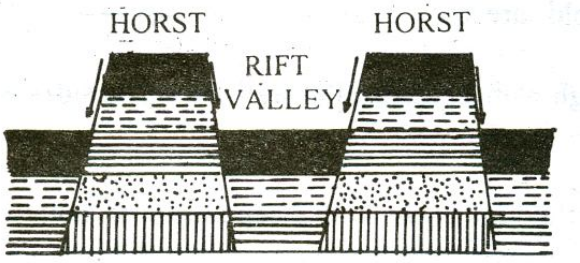


Fig. 4. 4 A Rift valley and Block mountain

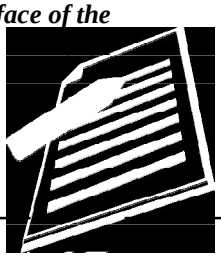
A rift valley is a trough with steep parallel walls along the fault lines. Such a valley is also called a graben. A rift valley may also be formed by upliftment of two blocks along the fault line. These uplifted blocks are called horsts or block mountains. The well known examples of horsts are the Vosgesand the Black forest mountains on both sides of Rhine rift valley and the Plateaus of Palestine and Trans Jordan.

The escarpments (escarp/faces see Fig 4.3) are the characteristic features of rift valleys and horsts. They are very steep or have highly precipitous slopes in a continuous line facing one direction. The escarpments of Western Ghats ones looking the Arabian Sea are thought to be the result of faulting. The escarpments of Vindhyachal Mountain are also ascribed to the faulting and formation of narrow Narmada Valley.

- Faulting leads to the formation of rift valleys, horsts and escarpments.
- A rift valley is a trough with steep parallel walls along the fault line.
- A horst is a uplifted land mass with steep slopes on both the sides.
- An escarpment is a very steep slope in a continuous line along a fault.

INTEXT QUESTION 4.2

1. Name the earth movements caused by forces of compression.



2. Give geographical term for mountain building movements.

_____

_____

4.5 VOLCANOES

Have you ever seen an active volcano. Even if you have never seen a volcano, you have probably seen pictures or films of erupting volcanoes. These conical forms are one example of the land forms we will study in this chapter.

A volcano is a vent or an opening in the earth's crust through which molten rock material, rock fragments, ash, steam and other hot gases are emitted slowly or forcefully in the course of an eruption. These materials are thrown out from the hot interior of the earth to its surface. Such vents or openings occur in those parts of the earth's crust where rock strata are relatively weak.

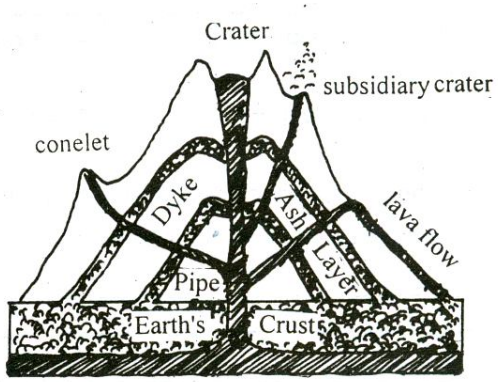


Fig. 4.5 A Volcanic Cone

You may be wondering why such eruptions take place. Actually, vo1canoes are evidence of the presence of the intense heat and pressure existing within the earth. Hot molten rock materials beneath the solid outer crust is known as magma. When this magma is thrown out from the magma chamber to the earth's surface it is known as lava (Fig 4.5). The magma and the gases stored within the earth's surface keep trying to come out to the surface through a line of weakness anywhere in the crust. The tremendous force created by magma and its gases creates a hole in the crust and the lava spreads out on the surface along with ash and fragmented rock material. The process by which solid liquid and gaseous materials escape from the earth's interior to the surface of the earth is called vulcanism.

- A volcano is an opening in the earth's crust through which molten rock material are thrown out slowly or forcefully depending upon the force of eruption.
- The cause of volcanic eruption is the excessive pressure exerted by the magma and hot gases on the earth's crust.

- The process by which solid, liquid and gaseous materials escape from the earth's interior to its surface is known as Vulcanism.

The volcanic materials accumulate around the opening or hole taking the form of a cone. The top of the cone has a funnel shaped depression which is called its crater (Fig 4.5).

(A) TYPES OF VOLCANOES

Volcanoes are classified on the basis of the nature of vulcanism. The basis include the frequency of eruption, mode of eruption or fluidity and the manner in which volcanic material escapes to the surface of the earth.

On the basis of the frequency of eruption, volcanoes are of three types:

(i) Active

(ii) Dormant and

(iii) Extinct.

The volcanoes which erupt frequently or have erupted recently or are in action currently are called active volcanoes. Important among these include Stromboli in Mediterranean, Krakatoa in Indonesia, Mayon in Philippines, Mauna loa in Hawai Islands and Barren Island in India. The volcanoes which have not erupted in recent times are known as dormant volcano. They are as such the 'sleeping volcanoes'. Important among these are Vesuvious of Italy, Cotopaxi in South America.

Contrary to these two, there are volcanoes which have not erupted in historical times. These are called extinct volcanoes. Mount Popa of Myanmar (Burma) and Kilimanjaro of Tanzania are important extinct volcanoes. It is not, always very simple to categorise a volcano as dormant or extinct. For example the Vesuvious and Krakatoa became suddenly active after lying dormant for hundreds of years.

- On the basis of the frequency of eruption, volcanoes are classified into active, dormant and extinct volcanoes.
- Active volcanoes are erupting currently or have erupted recently.
- Dormant are those volcanoes which have erupted at least once in human history and are not active now.
- Extinct volcanoes are those which have not erupted during long human history.

On the basis of mode of eruption, volcanoes are divided into two types:

(i) Central type of volcanoes and

(ii) Fissure type volcanoes

When the eruption in a volcanoe takes place from a vent or a hole, it is called a central type of volcano. Different types of domes or conical hills are formed by this type of erruption depending on the nature of erupted materials. Majority of volcanic eruptions in the world are of this type. The other characteristic of this mode of eruption is that it is marked by violent explosion due to sudden escape of gases and molten rocks through the hole. Visuvious and Fuji-yama belong to this group of volcanoes.

Sometimes, deep elongated cracks develop due to earthquakes or faulting. The magma starts flowing through them quietly. This mode of eruption is called fissure type of eruption. This eruption helps in the formation of thick horizontal sheets of lava or a low dome shaped volcano with broad base. It may also form what are identified as lava plateaus, and lava shields, Deccan Traps of India is one example of fissure type of eruption.

- Central type of volcanoes erupt from a vent or hole and result in the formation of a conical hill.
- Fissure type of volcanoes erupt through a crack or fissure and cause formation of plateaus and shields.

On the basis of the fluidity of lava there are two types of volcanoes :

(i) Volcanoes of basic lava and

(ii) Volcanoes of acid lava.

Since the basic lava is rich in metalic minerals and has a low melting point, it has greater fluidity. In this type of eruption, lava flows far and wide quietly with greater speed and spreads out in thin sheets over a large area. Thus, it leads to the formation of shields and lava domes. The shield volcano of Hawaian Island in Pacific ocean is one of these volcanoes.

Contrary to basic lava, acid lava is rich in silica and has a relatively high melting point. Therefore: it is highly viscous and solidifies quickly. Hence, the, acid lava volcanoes cause the formation of usually higher land features with steeper slopes. Acid lava cones are of steeper slopes than basic lava shields. (Fig. 4.6).

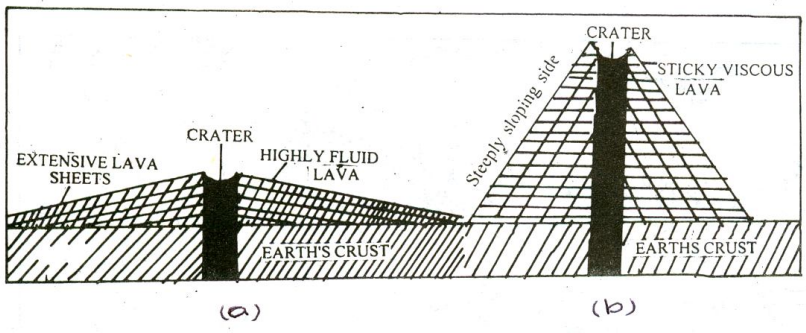


Fig. 4.6 (a) Basic lava shield (b) Acid lava cone

Notes

- Basic lava is highly fluid and flows readily and extensively. It causes the formation of shields.
- Acid lava is highly viscous. This type of eruption of steep sided cones.

(B) DISTRIBUTION OF VOLCANOES

There are about 500 volcanoes in the world. Most of these volcanoes are found in three well defined belts, The Circum-Pacific belt, the Mid-World Mountain belt and the African Rift Valley belt. Thus, volcanoes are closely related to the regions of intense folding and faulting. They occur along coastal' mountain ranges, on islands and in the mid-oceans. Interior parts of continents-are generally free from their activity. Most of the active volcanoes are found in the pacific region. About 83 active volcanoes are located in Mediterranean region (Fig. 4.7).

Circum-Pacific region has the greatest concentration of volcanoes, that is why, it is called 'Pacific Ring of Fire', This ring extends along Andes mountains of south America to Alaska and from the Aleutian Islands to Japan, Philippines, Indonesia to NewZealand.

The Mid-world mountain belt occupies the second position with regard to the numbers of volcanoes. It runs from Alps in Europe to Asia Minor and crossing through Himalayan region joins the Circum-Pacific belt. The African rift valley region ranks third. Most of the volcanoes are extinct here. Mt. Cameroon is the only active volcano which is situated in Central West Africa.

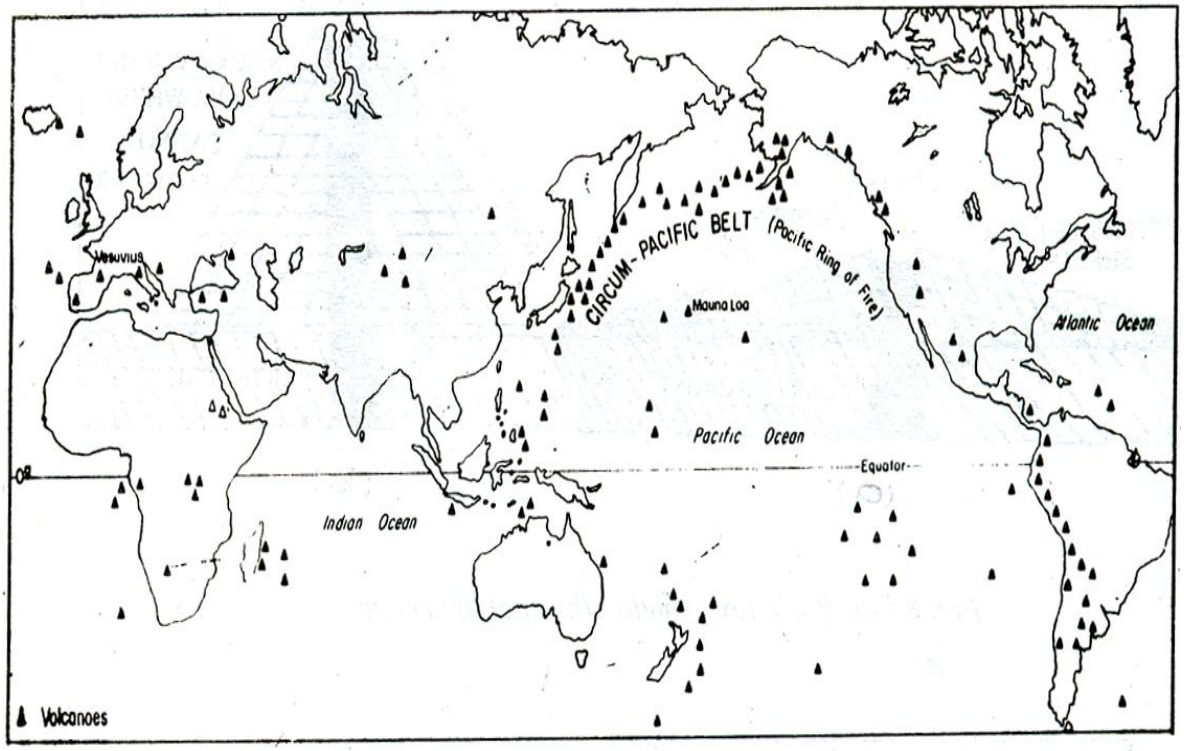


Fig. 4.7 The Distribution of Volcanoes

- There are about five hundred volcanoes in the world. They are located in three well defined belts namely the Circum-Pacific, the Mid World Mountain and East African Rift Valley belts.
- Most of the active volcanoes are located in Circum-Pacific belt which is known the Pacific Ring of Fire.

INTEXT QUESTIONS 4.3

1. Answer the following questions:-
   (i) Name the process by which magma is ejected out of the earth's interior

   _____

   (ii) Name three types of volcanoes on the basis of the frequency of eruption.
   (a) _____(b)_____(c)_____
   (iii) Name two types of volcanoes on the basis of the mode of eruption
   (a)_____ (b) _____
   (iv) State two types of lava on the basis of their fluidity
   (a)_____ (b) _____

4.8 EARTH QUAKE

You have probably seen television news accounts of disastrous earthquakes and destruction caused by them. An earthquake is a motion of the ground surface, ranging from a faint tremor to a wild motion capable of shaking building apart. The earthquake is a form of energy of wave motion transmitted through the surface layer of the earth.

All the earthquakes are not of the same intensity. Some of them are very severe, others are very mild and still others are not even noticed. Major or strong earthquakes are only a few. Though our earth experiences many earthquakes everyday, however the frequency of earthquakes varies largely from place to place. The network of seismographic stations all over the world records dozens of earthquakes every day. But, occurrence of severe earthquakes is limited to a few regions. The instrument used for recording the earthquakes is known as seismograph. 'Sesamos' is a Greek word which means an earthquake.

The point within the earth's crust where an earthquake originates is called the focus. It is also referred as seismic focus. It generally lies within the depth of 60 kilometres in the earth crust.

The point vertically above the focus on the earth's surface is known as 'epicentre'. The impact of the earthquake is carried from the point of its origin by earthquake waves. These earthquake waves originating from the focus travel in all directions. But their intensity is the highest at the epicentre That is why the maximum destruction occurs at and around the epicentre. (Fig 4.8). The intensity of vibrations decreases as one moves away from the epicentre in all directions.

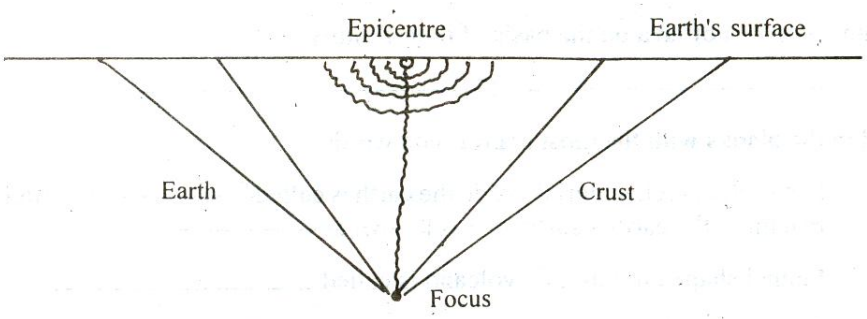


Fig 4.8 Focus and epicentre of an earthquake

- An earthquake is a motion of the ground surface, ranging from a faint tremor to a wild motion capable of shaking buildings apart.
- A seismograph is an instrument used for recording earthquakes.
- Focus is the point within the earth's crust where the earthquake originates.
- The epicentre is the point on the earth's surface vertically above the focus.

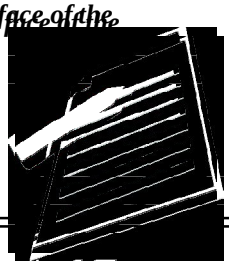
(A) CAUSES AND EFFECTS OF EARTHQUAKES

Folding, faulting and displacement of rock strata are the main causes of earthquakes. Some examples of this type of earthquakes are the San Francisco earthquakes of California in 1906, the Assam earthquakes of 1951, the Bihar earthquakes of 1935.

The second important cause lies in the plenomenon of volcanic eruption. The violent volcanic eruptions put even the solid rocks under great stress. It causes vibrations in the earth's crust. But, these earthquakes, are limited to the areas of volcanic activity. Its important example is the earthquake which continued for six days preceeding the eruption of Mauna Loa volcano of Hawaii Island in 1868.

Minor earthquakes often accompany or are the result of landslides, seepage of water causing the collapse of the rocks of cavern or underground mines and tunnel. These are least damaging earthquakes.

Violent earthquakes are generally very disastrous. They may themselves cause land-slides, damming of river course and occurance of floods, and sometimes, the depressions leading to the formation of lakes. An earthquake often forms cracks and fissures in the earth's crust. It changes the drainage system of an area as was witnessed in Assam after its 1951 earthquake. Earthquakes also



cause vertical and horizontal displacement of rock strata along fault line. They prove most catastrophic and devastating when they cause fires and seismic sea waves. Such tidal waves are called Tsunamis. These waves may wash away coastal cities. Buildings and bridges collapse causing death of the thousands of people. Lines of transport, communication and of electric transmission get disrupted. The after effect of earthquake is spread of epidemics like cholera.

(B) DISTRIBUTION OF EARTHQUAKES

The occurrence of earthquake is a phenomenon of almost every part of the world. But, there are two well-defined belts where they occur more frequently. These belts are the Circum-Pacific belt and the Mid-world mountain belt.

The first belt i.e., the Circum Pacific comprises the western coast of North and South America; Aleutian Islands and island groups along the eastern coasts of Asia such as Japan and Philippines. As it encircles the Pacific Ocean from end to end, it is named as such. The earthquakes in this belt are associated with the ring of mountains and volcanoes. It is estimated that about 68 percent of earthquakes of the world occur in this belt alone.

The second belt-extend from Alps with their extension into Mediterranean the Caucasus and the Himalayan region and continues into Indonesia. About 21, percent of total earthquakes of the world originate in this belt. Remaining 11 percent occur in the other parts of the world.

- Most of the earthquakes of the world occur in two belts namely the Circum Pacific and Mid world mountain belts.

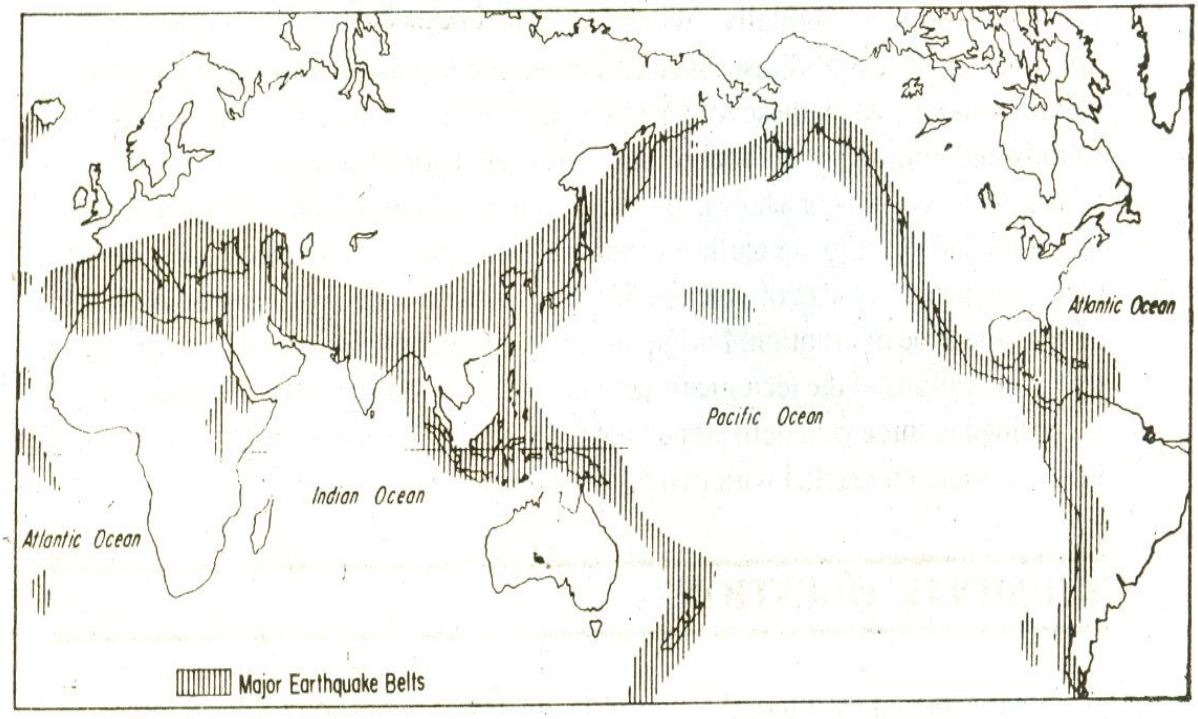


Fig. 4.9 Major Earthquake Belts

INTEXT QUESTIONS 4.4

1. Define is earthquake?

   _____

2. Which instrument record the earthquake waves?

   _____

3. Define 'Focus'.

   _____

4. How is 'Tsunami' caused ?

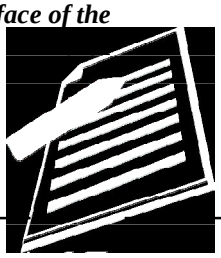
   _____

WHAT YOU HAVE LEARNT

Land forms of different types present on the earth's surface are the result of continuous work of both internal and external forces. Internal forces are responsible for creating inequalities in altitudes of different relief features. These forces originate in the interior of the earth. They are also known as endogenetic forces. These forces cause movements of the earth's crust which are called earth movements. Slow movements bring slow and gradual changes in the relief features while sudden movements bring abrupt and rapid changes. Internal forces affect the earth into two way radially and horizontally. When they affect radially they cause subsidence or upliftment of the earth's crust. Such earth movements are called vertical movements. Contrary to this; when these forces affect horizontally or side to side, they result in folding and faulting of the rock strata. These are called horizontal movements. Volcanoes are landforms marking the eruption of lava at the earth's surface. The shape and size of volcano depends on the frequency of eruption, fluidity of lava and type of eruption. Earthquakes are vibrations of the earth's crust cause by the operations of the tectonic forces and. volcanic activity. The volcanic activity is confined to three well defined belts of the world. The occurrence of earthquakes is also closely connected with two of these belts.

TERMINAL QUESTIONS

1. What is meant by internal forces? List causes of the origin of these forces.
2. Give four examples to prove that the earth's crust is unstable.
3. Draw diagrams to show
   (i) Displacement of rock strata along a fault plane,
   (ii) Anticline and synclines of rock strata.
4. Differentiate between vertical and horizontal movements.
5. Distinguish between folding and faulting.



6. What is a volcano? Describe different types of volcanoes with examples.
7. Distinguish between acid and basic lava and land forms developed by each of them.
8. What causes an earthquake?
9. List the effects of earthquakes on earth's surface.
10. Define the following terms:

    (a) Fault plane (b) Central type eruption (c) Fissure type eruption (d) Dormant volcano.

11. Locate and label the following in the outline map of the world :

    (a) An active volcano in India (b) A volcanic plateau in south America. (c) A rift valley in Europe (d) An extinct volcano in Myanmar (e) An extinct volcano in Africa (f) A volcano in Hawaii island.

ANSWER TO INTEXT QUESTIONS

4.1

1. Endogenetic forces
2. Movement caused by internal forces affecting the earth's crust are known as 'Earth Movement'.

4.2

1. Horizontal movements 2. Orogenetic movements

4.3

l. (i) Vulcanism (ii) (a) Active (b) Dormant (c) Extinct (iii) (a) Central type (b) Fissure type (iv) Basic lava (b) Acid lava

4.4

1. An earthquake is a motion of ground surface, ranging from a fain tremor to a wild motion capable of shaking building apart.
2. Seismograph
3. This point within the earth's crust originate of called the 'Focus'.
4. The seismic sea waves which originate due to earthquake in octaves, are called 'Tsunami'.

HINTS TO TERMINAL QUESTIONS

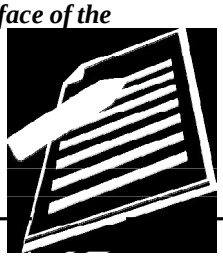
1. Refer to Section 4.1

2. Refer to Section 4.2
3. Refer to Figure 4.1
4. Refer to Section 4.4
5. Refer to Section 4.4 (b) (i) and (ii)
6. Refer to Section 4.5
7. Refer to Section 4.6
8. Refer to Section 4.6
9. Refer to Section 4.6 (A)
10. (a) The plane along which displacement of rock strata takes place is known as fault plane.

    (b) When the eruption in a volcano takes place from a vent or hole, it is called central type eruption

    (c) When the eruption takes place through deep elongated cracks, it is known as fissure type eruption

    (d) The volcanoes which have not erupted in recent times is known as dormant volcano.
11. Refer Maps.



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THE WORK OF RUNNING WATER AND UNDERGROUND WATER

In the previous lesson we have learnt that the ultimate result of gradation is to reduce the uneven surface of the earth to a smooth and level surface. These agents produce various relief features over the course of time. Amongst all the agents of gradation, the work of running water (rivers) is by far the most extensive. In this lesson we will study how running water and underground water act as agents of gradation and help in the formation of different relief features.

OBJECTIVES

After studying this lesson, you will be able to :

- explain the three functions of running water viz erosion, transportation and deposition, in the different parts of the river's course;
- explain with the help of diagrams the formation of various erosional and depositional features produced by the action of running water;
- explain the cause of fluctuating water table from place to place and season to season;
- explain with the help of diagrams the formation of various relief features formed by underground water;
- distinguish between (i) stalactites and stalagmites, (ii) wells and artesian wells, (iii) springs and geysers.

5.1 THE THREE FUNCTIONS OF A RIVER

Running water or a river affects the land in three different ways. These are known as the three functions of a river. They are (i) erosion (ii) transportation and (iii) deposition. Throughout its course a river displays all the three activities to some extent.

(1) EROSION

Erosion occurs when overland flow moves soil particles downslope. Weathering and erosion supply this rock material which is the load of the river. This load acts as the grinding tool. It thus helps in cutting the bottom and sides of the river bed, resulting in deepening and widening of the river channel.

Both the cutting and removal of rock debris by the river is called river erosion. The work of river erosion is accomplished in four different ways, all of which operate together. These four ways are:

(a) Corrasion or Abrasion

As the rock particles bounce, scrape and drag along the bottom and sides of the river, they break off additional rock fragments. This form of erosion is called corrasion. This is the mechanical grinding of the rivers against the banks and bed of the river. Corrasion takes place in two different ways :

(i) **Lateral Corrasion:** This is sideways erosion which widens the river valley.

(ii) **Vertical Corrasion :** This is the downward erosion which deepens the river valley.

(b) Corrosion or Solutions

This is the chemical or solvent action of water on soluble or partly soluble rocks with which the river water comes in contact. For example, limestone or calcium carbonate, when it comes in contact with water, it is easily dissolved and removed in solution.

(c) Hydraulic Action

This is the mechanical loosening and sweeping away of material by the sheer force of river water itself. No load or material is involved in this process. Some of the water splashes against the river banks and enters into cracks and crevices. This undermines the soft rocks with which it comes in contact. It picks up the loose fragments from its bank and bed and transports them away.

(d) Attrition

This is the wear and tear of the transported materials themselves when they roll and collide with one another. In the process the coarser boulders are broken down into smaller pieces. The angular edges are smoothened and rounded to form pebbles.

(2) TRANSPORTATION

River carries rock particles from one place to another. This activity is known as transportation of load by a river. The load is transported in four ways.

(a) Traction

The heavier and larger rock fragments like gravel, pebbles etc. are forced by the flow of river to roll along its bed. These fragments can be seen rolling, slipping, bumping and being dragged. This process is known as traction and the load is called traction load.

(b) Saltation

Some of the fragments of the rocks move along the bed of a stream by jumping or bouncing continuously. This process is called saltation.

(c) Suspension

The holding-up of small particles like sand, silt and mud by the water as the stream flows is called suspension.

(d) Solution

Some parts of rock fragments are dissolved in the river water and are thus transported (See fig.5.1)

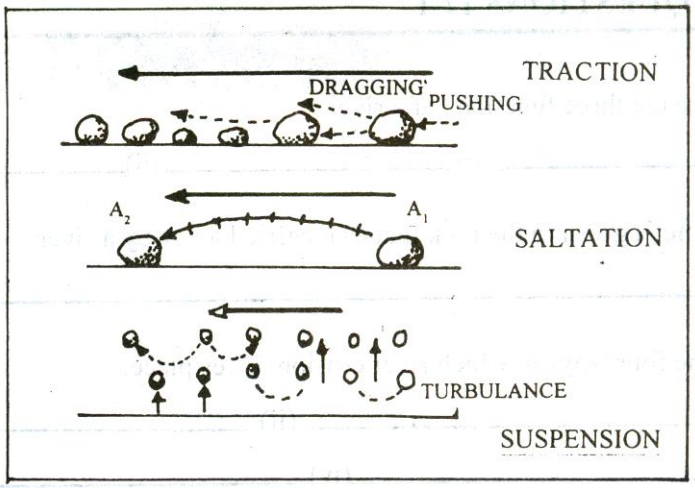


Fig. 5.1 Traction, Saltation and Suspension

- The river transports its load in four ways viz. traction, saltation, suspension and solution.
- The transporting power of a river mainly depends upon its velocity, volume and size of particles.

(3) DEPOSITION

When the stream comes down from hills to plain area, its slope becomes gentle. This reduces the energy of the stream. The decrease in energy hampers transportation; as a result part of its load starts settling down. This activity is known as deposition. Deposition takes place either due to decrease in slope or due to fall in the volume or velocity of river water. Deposition takes place usually in plains and low lying areas. When the river joins a lake or sea, the whole of its load is deposited.

- Deposition takes place either due to decrease in slope or decrease in volume or velocity of water.

INTEXT QUESTIONS 5.1

1. Which are the three functions of a river?
   (i)_____(ii) _____(iii) _____
2. What name is given to the rock material carried away by a river?
   _____
3. Name the four ways in which river erosion takes place.
   (i) _____(ii) _____(iii) _____
   (iv) _____
4. Name four ways in which a river transports its load.
   (i) _____(ii) _____(iii) _____
   (iv) _____
5. Name two conditions which favour the deposition of river load.
   (i) _____(ii) _____
6. Name the areas where deposition takes place.
   _____

5.2 DEVELOPMENT OF A RIVER VALLEY

The erosional and depositional land features produced and modified by the action of running water may be better understood if we note the stages through which a stream passes from its source to its mouth. The source of a river may lie in a mountainous region and the mouth may meet the sea or lake. The whole path followed by a river is called its course or its valley.

The course of a river is divided into three sections:

(i) The upper course or the stage of youth

(ii) The middle course or the stage of maturity

(iii) The lower course or the stage of old age. (See Fig. 5.2)

- Upper, middle and lower are the three courses into which a river valley is divided.

(i) THE UPPER COURSE

The upper or mountain course begins from source of the river in hilly or mountainous areas. The river tumbles down the steep slopes and as a result its velocity

and eroding power are at their maximum. Consequently valley deepening assumes its greatest importance at this stage. Normally, weathering also plays its part on the new surfaces exposed along the banks of the stream. The weathered rock material is carried into the stream partly through the action of gravity and partly by rain water flowing into the river. Weathering helps in widening a valley at the top giving it a typical 'V' shaped cross section. Such valleys are known as 'V' shaped valleys.

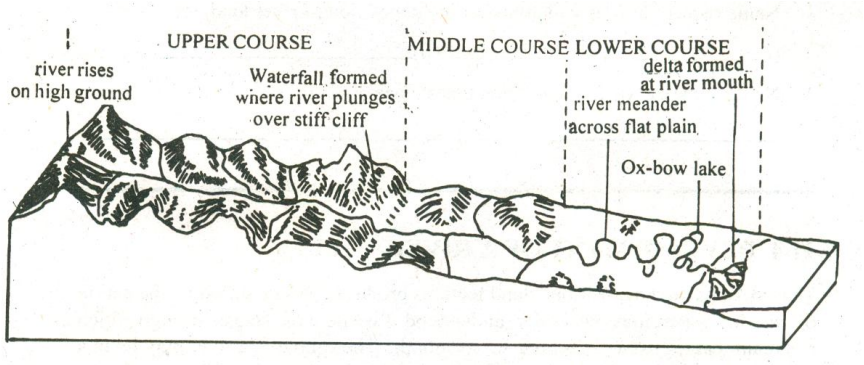


Fig. 5.2 (a) The Upper, Middle and Lower Courses of River

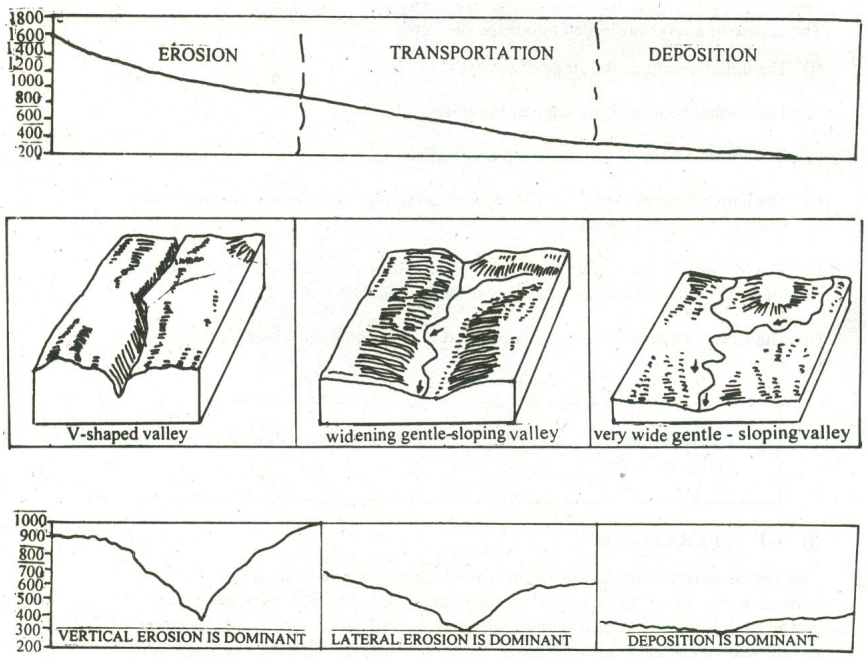


Fig. 5.2(b) The Graded Long Profile and Cross-section of a River Valley from Source to Mouth

If the bed rock is hard and resistant, the widening of the valley at its top may not take place and the down cutting process of a vigorous river may lead to the formation of a gorge i.e. a river valley with almost vertical sides.

In India, deep gorges have been cut by the Brahmaputra and the Indus in the Himalayas. Deep gorges also develop in limestone regions and in rocks lying in dry climates. The narrow and very deep gorge or the canyon with vertical walls is also known as 'I' shaped valley. A canyon is 'very deep gorge with steep sides running for hundreds of kilometers, e.g. Grand Canyon of the river Colorado in U.S.A. Some of the more outstanding features that are developed in the upper course of a river include rapids, cataracts, cascades and waterfalls.

- The land features carved by a river in its upper course are gorges, canyons, 'V' shaped valleys, rapids, cataracts, and waterfalls.

(ii) THE MIDDLE COURSE

In the middle course, lateral corrasion tends to replace vertical corrasion. Active erosion of the banks widens the 'V' shaped valley. The volume of water increases with the confluence of many tributaries and this increases the river's load. Thus work of the river is predominantly transportation with some deposition. Rivers which sweep down from steep mountain valleys to a comparatively level land drop their-loads of coarse sand and gravels as there is sudden decrease in velocity. The load deposited generally assumes a fan like shape, hence it is called an alluvial fan. (See Fig. 5.3)

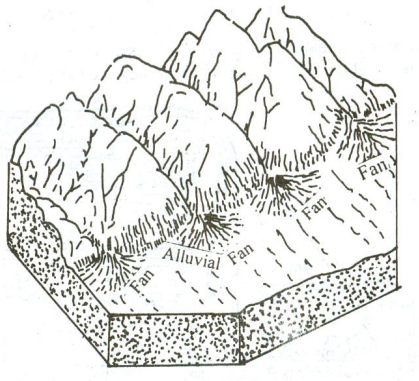


Fig. 5.3 Alluvial Fans

Sometimes several fans made by neighbouring streams often unite to form a continuous plain known as a piedmont alluvial plain, so called because it lies at the foot of the mountain.

In this section even minor obstacles force a river to swing in loops to go round the obstacles. These loops are called meanders, a term derived from the winding River Meanderes in Turkey.

- Some of the land features formed by a river in its middle course are alluvial fans, and meanders.

(iii) THE LOWER COURSE

The river moving downstream across a broad, level plain is heavy with debris brought down from the upper and middle courses. Vertical corrasion has almost ceased, the lateral corrasion still goes on to erode its banks further. The work of the river is mainly deposition, building up its bed and forming an extensive flood plain. Many tributaries join the river and the volume of water increases, coarse materials are dropped and the fine silt is carried down towards the mouth of the river. Large sheets of material are deposited on the level bed and the river splits into a maze of channels. Such a stream is called a braided stream (See Fig. 5.4)

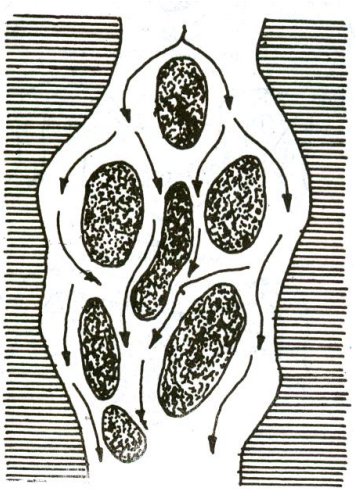


Fig. 5.4 Braided Stream

During annual floods large quantities of sediments are spread over the low lying adjacent areas. A layer of sediments is thus deposited during each flood gradually building up a fertile flood plain. A raised ridge of coarse material is formed along each bank of the river. Such ridges are called levees. (See Fig. 5.5)

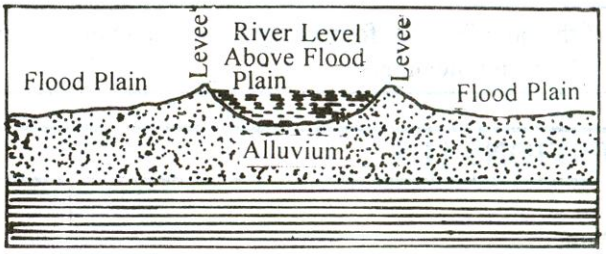


Fig. 5.5 Flood Plain and Levees

In the lower course of the river, meanders become much more pronounced. The outer bank or concave bank is so rapidly eroded that the meander becomes almost a complete circle. A time comes when the river cuts through the narrow neck

of the loop. The meander, now cut of from the main stream, takes the form of an oxbow lake (See Fig. 5.6).

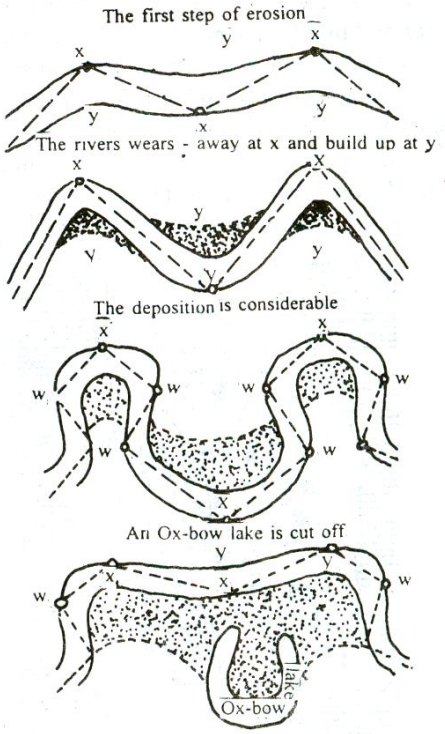


Fig. 5.6 Stages in the Formation of a Oxbow lake

This lake gradually, turning into swamps disappears in course of time. Numerous such partially or fully filled oxbow lakes are marked at short distance from the present course of river like the Ganga.

Upon entering a lake or a sea, the river deposits all the load at its mouth giving rise to the formation of a delta (See Fig. 5.7). Delta is a triangular relief features with its apex pointing up stream and is marked as a fan-shaped area of fine alluvium. The Greek letter (Δ) pronounced delta closely resembles the triangular delta of the river Nile. Some deltas are extremely large. The Ganga-Brahmaputra Delta is the largest delta in the world.

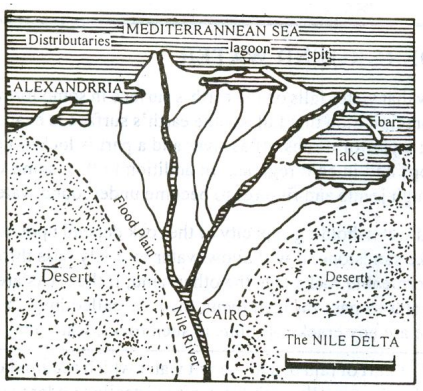
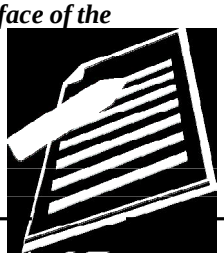


Fig. 5.7 Formation of a Delta



The following conditions favour the formation of deltas:

(1) active vertical and lateral erosion in the upper course of the river to supply large amount of sediments;

(2) tideless, sheltered coast;

(3) shallow sea, adjoining the delta and

(4) no strong current at the river mouth which may wash away the sediments.

Due to the obstruction caused by the deposited alluvium, the river discharge its water through several channels which are called distributaries. Some rivers emptying into sea have no deltas but instead they have the shape of a gradually widening mouth cutting deep inland. Such a mouth is called estuary. The formation of estuaries is due to the scouring action of tides and currents. But in most of the cases the original cause is the subsidence of the earth's crust in the area of the outlet. The two west flowing rivers of India, the Narmada and the Tapi do not form deltas. They form estuaries when they join the Arabian Sea.

- In the lower course land features produced by river are meanders, flood plains, braided steam, oxbow lakes, deltas and estuaries.

INTEXT QUESTIONS 5.2

1. Fill in the blanks:
   (a) The course of river from its source to mouth has been divided into three parts.
   These are (i)_____ (ii)_____ (iii)_____
   (b) A narrow and steep sides valley is called a _____.
2. Fill in the blanks
   (a) The winding sections or loops of a stream are known as _____.
   (b) The load deposited by a river at the foot of a mountain while descending from it, is called _____.
3. How is a piedmont alluvial plain formed?
4. Fill in the blanks
   (a) The meander completely cut off from the main river takes the form of a lake which is known as_____.
   (b) A number of branches of the main river carrying water to the sea are called _____.
   (c) A triangular shaped land feature made by a river at its month is called _____.
   (d) Instead of deltas, rivers Narmada and Tapi form _____.

5.3 UNDERGROUND WATER

Seepage and water-holding capacity of the rock depend upon its space. If the rock is porous like sandstone, it will allow water to easily pass through it. Such rocks are called permeable rocks. On the other 'hand, if the rocks are not porous and do not allow water to pass through them, they are called impermeable rocks. However, if there are any cracks or joints in such rocks, water may pass through them.

- The part of rain or snow- melt water which accumulates in the rocks after seeping through the surface is called underground water.
- The rocks through which water can pass easily are called permeable rocks, and the rocks through which water cannot pass through are called impermeable rocks.

Although the amount of underground water varies from one place to another, its role in shaping the surface features of the earth is quite important. Most of its work is confined to subsurface areas though it plays an important role on surface also.

5.4 WATER TABLE

The water table marks the upper surface of the saturated zone of the ground water, where pores are completely full of water. The zones or horizons of permeable and porous rocks which are fully filled with water are called the zones of saturation. The upper level of this zone, below which the rocks are completely saturated with water is called the underground water level or the water table.

- The rocks containing underground water are called aquifers.
- The underground horizon of porous and permeable rocks which is filled with water is called zone of saturation.
- The level of underground water, below which the rocks are fully filled with water is called water table.

5.5 TYPES OF WATER TABLE

The level of the ground water table always fluctuates. It is never the same in any area. The level of the water table is controlled by the nature of land surface, variation in the amount of rainfall and the character of the underlying rocks. Water table is generally higher in areas of high precipitation and also in areas bordering rivers and lakes. Water-table changes according to seasons. It is higher in rainy season and lower during summers. On the basis of the variability, the water-table is of two type: (a) The permanent water table and (b) The temporary water table.

(a) Permanent Water Table

When the water table is stable or static and never falls below a particular level, it

is called the permanent water-table. It is not affected by seasonal change. Wells dug upto this depth provide water in all seasons. They are perennial wells.

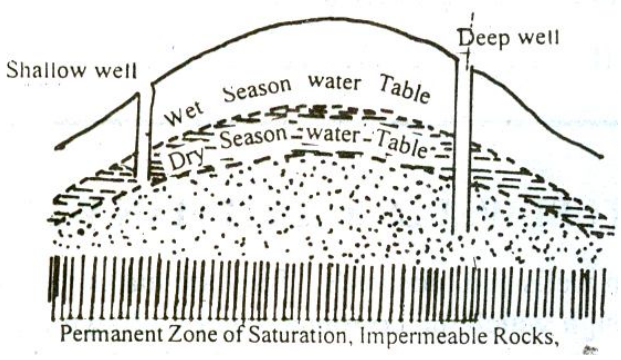


Fig. 5.8 Water Table

(b) Temporary Water Table

This is also known as seasonal water table. The level at which the water-table is not stable, keeps changing with season is called temporary water table. It means that during the wet season, the water table will be higher than it is during the dry season. It is the water table of the wet season that is temporary. Wells dug upto this level are not perennial. They dry up during the summer season. (See Fig. 5.8). You might have seen wells drying up during the summer season and becoming filled with water during the rainy season. It is because such wells are dug upto the temporary water-table.

- Nature of land surface, variations in amount of rainfall and the nature of rocks affect the underground water table of any area.
- The level below which the water table never falls is called the permanent water table.
- The water table which changes with seasons is called the temporary or seasonal water table.

INTEXT QUESTIONS 5.3

1. Fill in the blanks with the appropriate word given in the bracket against each statement.

   (a) The water which accumulates in the rocks after seeping through the surface is called_____(underground water, water-table)

   (b) The rocks filled with underground water are called _____(Zones of Saturation, acquifers)

2. Name two types of water- table.

   (a)_____(b) _____

3. Name three factors affecting water-table.

(a)_____(b) _____(c) _____

5.5 WELLS, TUBEWELLS & ARTESIAN WELLS

You must have seen wells and tubewells. They are man made holes dug into the earth's surface through which underground water is drawn for drinking purpose and for irrigation. They are either bored mechanically as in the (case of tubewells) or are dug by man (as in the case of wells) to reach a permanent water table.

A special type of well in which water rises automatically under its own pressure to the surface, either through a natural or a man made hole is called an artesian well. The name artesian has been derived from the province of Artoi in France, where the first well of this type was dug. Certain conditions are prerequisite of an artesian well.

(a) Arrangement of Rocks : For an artesian well, there should be layer of permeable rock lying between two impermeable rock layers. In such case, water present in the permeable rock does not escape. (See fig. 5.9)

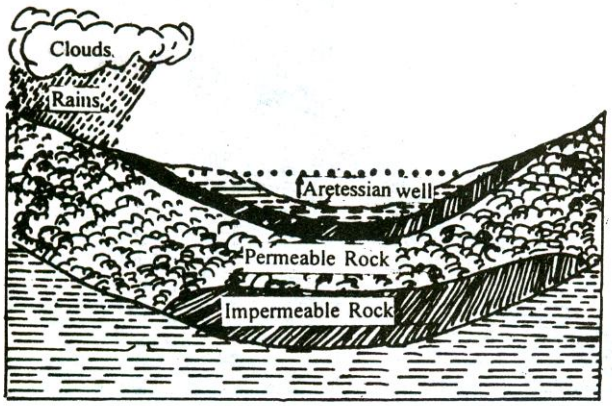


Fig 5.9 Artesian Well

(b) Structure of Rock Strata: Second condition for the occurrence of artesian wells is that the rock must have a synclinal or tilted structure.

(c) Intake Area of the Rock: It is necessary that the permeable rock should be exposed at the ground surface, so that rock can soak rainwater. This intake area should be sufficiently high so that enough hydraulic pressure will be developed to force the water upward in the well.

(d) Availability of Water: There should be sufficient amount of precipitation of infiltration of water in the area where the permeable rock is exposed at the surface.

- A man-made hole on the earth's surface through which underground water is obtained is called a well.
- A well in which water flows out automatically under its own pressure is called an artesian well.
- The necessary conditions required for occurence of artesian wells are - arrangement of rocks, structure of rock strata, high intake area of the permeable rocks and availability of water.

5.6 SPRINGS & GEYSERS

Springs are surface outflow of ground water through an opening in a rock under hydraulic pressure. In such cases the aquifer is either exposed at the surface or it underlies an impermeable rocks. The amount of water in the aquifer depends upon the amount of rainfall in that area, landform characteristic and the size of the aquifer. (See fig. 5.10)

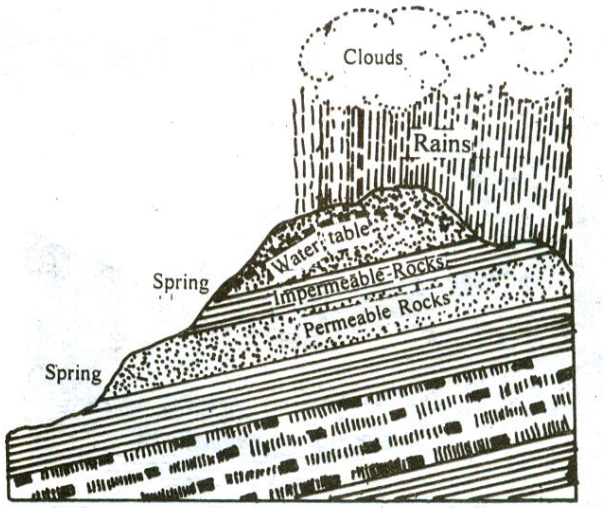


Fig. 5.10 Formation of Spring

(a) Hot Spring

Sometimes the water that flows out of the spring is hot. Such springs are called hot springs. They generally occurs in areas of active or recent vulcanism. In volcanic regions the underground water gets heated up by coming in contact with hot rocks or steam. Hot springs are found in many parts of India, especially in the Himalaya in Jammu and Kashmir and Himachal Pradesh. They also occur in Uttarakhand, Jharkhand, Haryana and Assam. Manikaran in Kulu Valley, Tatapani near Shimla, Jwalamukhi in Kangra, Sohna in Haryana, Rajgir and Sitakund in Jharkhand and Badrinath in Uttarakhand have hot springs.

(b) Geyser

Springs emitting hot water and steam in forms of fountains or jets at regular inter-

vals are called geysers. The term geyser has been derived from Icelandic word *geysir*. In case of a geyser, hot water is ejected violently because of the pressure created by steam. The water does not come out continuously but it flows out intermittently. The period between two emissions is sometimes regular. The best example of geysers working at a regular interval is the Old Faithful in the Yellowstone National Park of U.S.A which is situated in the Rocky Mountain region. Its regularity is so accurate that tourists correct their watches by it. Geysers are found in Iceland, Yellowstone National Park of U.S.A and the northern part of New Zealand. (See Fig. 5.11)

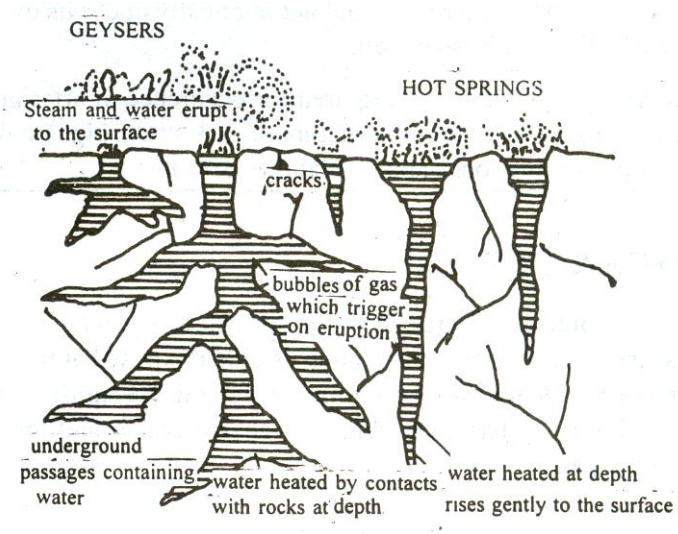


Fig. 5.11 Geyser

- The surface outflow of ground water through an opening in a rock under hydraulic pressure is called a spring.
- They can be hot or cold water springs.
- A geyser is a hot spring in which water is forced out by steam pressure at intervals.

INTEXT QUESTIONS 5.4

1. Give one word answers for the following questions:

   (a) In which province of France was the first artesian well dug?

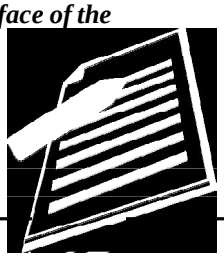
   _____.

   (b) Name the place in Kulu Valley where hot springs are found

   _____.

   (c) In which country is Old Faithful geyser located?

   _____.



(d) What should be the shape of the rock strata for occurrence of the artesian wells?

_____.

5.7 LANDFORMS PRODUCED BY UNDERGROUND WATER

Underground water is also an agent of gradation like surface water. It also does the work of erosion, transportation and deposition, which results in formation of a number of picturesque topographical features. Topographical features formed by underground water can be seen particularly, in an highland composed of limestone on a large scale. This distinctive topography formed due to the action of underground water in limestone region is known as Karst topography. 'Karst' word comes from the Karst region of Adriatic Sea coast in Croatia (Yugosalvia) where such formations are noticeable. This region is made up of limestone rocks, where underground water is the most active agent of gradation.

- The distinctive topography formed by underground water in limestone region is called Karst topography
- Mechanical weathering and solution of limestone in water help the erosional work of underground water.

The topographical features created by the work of underground water on limestone are of two types.

(a) Topographical features formed on the surface, like sink holes and swallow holes.

(b) Topographical features formed underground like caverns, stalactites and stalgmites.

(i) Sink Holes

A sinkhole is a surface depression in a region of limestone or chalk terrain. Some sinkholes are filled with soil washed from nearby hillsides, while others are steep-sided, dugholes. They develop where the limestone is more susceptible to solution, weathering or where an underground cover near the surface has collapsed.

(ii) Swallow Holes

They are cylindrical in shape lying underneath the sinkholes at some depth. In limestone regions, the surface streams often enter the sinkholes and then disappear underground through swallow holes. It is so, because these holes are connected to the underground caverns on their other side.

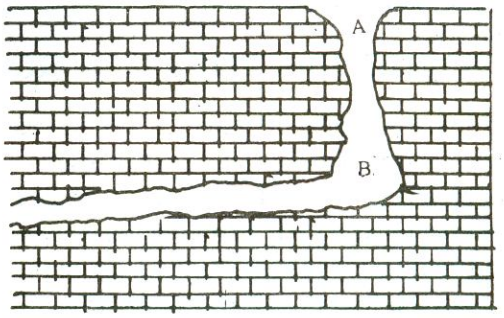


Fig. 5.12 A Sinkholes on the Surface of Limestone Rock
B-Swallo Holes at the bottom of a Funnel Shaped Sinkhole

(iii) Caverns

Caverns are interconnected subterranean cavities in bedrock formed by the corrosions action of circulating underground water on limestone. They are found near Dehradun in Uttarakhand and in Almora in Kumaon Himalayas. The caves of Kotamsar in the tribal district of Bastar in Chhattisgarh are famous caverns of India.

- The funnel-shaped depressions in limestone regions are called sink holes.
- Cyclindrical shape tubes lying underneath the sink holes are called swallow holes.
- Underground caves formed due to solvent action of underground water in limestone region are called caverns.

(iv) Stalactites and Stalagmites

They are the major depositional features formed in the caverns in limestone regions. The water containing limestone in solution, seeps through the roofs of the caverns in the form of a continuous chain of drops. A portion of the water dropping from the ceiling gets evaporated and a small deposit of limestone is left behind on the roof. This process continues and deposit of limestone grows downwards like pillars. These beautiful forms are called stalactites.

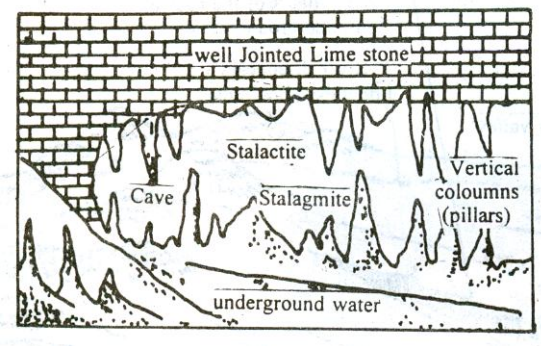


Fig. 5.13 Stalactites and Stalagmites

When the remain in portion of the water dropping from the roof of the cavern falls on the floor, a part of it is again evaporated and a small deposit of limestone is left behind. This deposit grows upward from the floor of the cavern. These type of depositional features are called stalagmites. As the process grows, both stalactite and stalagmite often join together to form vertical columns in the caverns.

- Solid conical depositional features hanging from the cavern's roofs are called stalactites.
- Broad conical pillars developing on the floor of the caverns in limestone regions are called stalagmites.

INTEXT QUESTIONS 5.5

1. Answer following questions in one or two words:

   a. Name the cavern located in Chhattisgarh.

   _____.

   b. In which country is "Karst" region located.

   _____.

   c. Name three regions of the world where hot spring and geysers are found

   (i)_____(ii)_____(iii)_____

   d. Name two topographical features formed on the surface through the activity of underground water.

   (i)_____(ii)_____

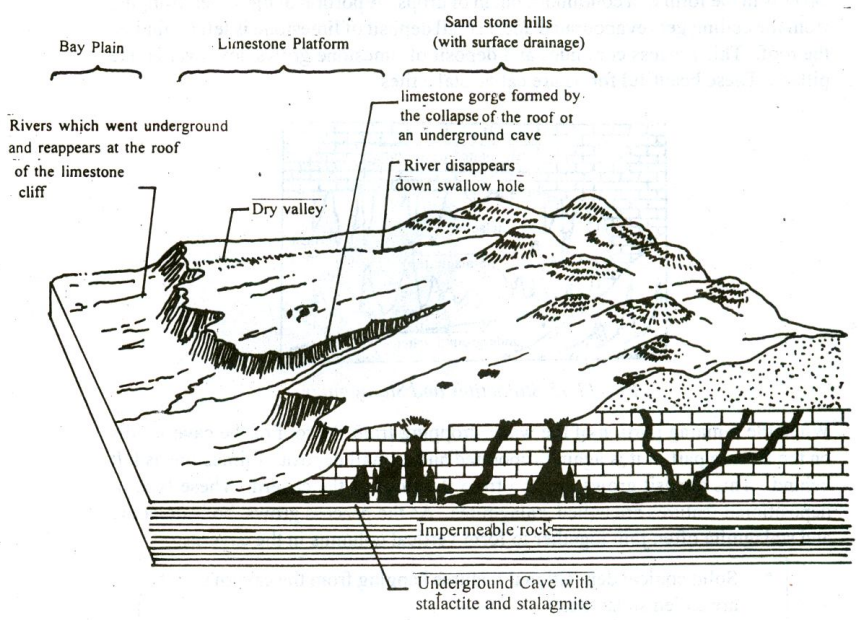


Fig. 5.14 : Limestone Landscape

WHAT YOU HAVE LEARNT

Among the agents of gradation, the running water is most effective and important.

A river has three fold action- (a) erosion (b) transportation (c) deposition. The rock material carried by river water is called its load. The ability of a river to move rock material depends upon- (a) the speed of water (b) the volume of water (c) the land structure and (d) the size, shape and weight of load. The work of river erosion is accomplished in four different ways-corrasion, corrosion, hydraulic action and attrition. The river transports its load in four different ways-by traction, saltation, suspension and solution. The deposition starts in plains and low lying areas. The whole path followed by a river is called its course. The course of a river is divided into three sections-(1) the upper course (2) the middle course (3) the lower course. The upper course lies in mountain. Here vertical cutting is more important. The land features produced are gorges, canyons, rapids, waterfalls. The middle course lies at the junction of mountain and plains. Here the work of river is mainly transportation with some deposition. The land feature produced is meander. The lower course lies in the plain area. Here the work of river is mainly deposition. The land features produced are ox-bow lakes, braided streams, alluvial and flood plains, delta and estuary.

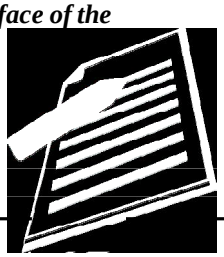
The water which percolates inside the earth is called underground water. The upper limit of underground water is called water-table. The level of water table is not uniform but it varies seasonally. Consequently the water-table is of two types permanent water table and temporary water table. Underground water comes to the surface through wells, tubewells and springs. Wells and tubewells are manmade holes dug into the earth surface through which water is obtained. In addition to these ordinary wells, there is a special type of well in which water flows out automatically under hydraulic pressure. They are called artesian wells. Surface outpour of ground water that from rock opening under its own pressure is called a spring. Sometimes the water flows out of springs is hot, such springs are called hot springs. When the hot springs emits water in the form of a fountain, they are called geysers. Geysers are found mainly in Iceland, Yellowstone National Park, USA and New Zealand.

Underground water does the work of erosion, transportation and deposition which result in number of topographical features. The major depositional features made by underground water are stalactites and stalagmites, which develop in the caverns.

TERMINAL QUESTIONS

1. Answer briefly the following questions :

   (a) In what different ways does a river transport its load?



(b) List out factors which affect (1) energy of a stream and (2) carrying capacity of streams.

(c) In what different ways is the work of river erosion accomplished?

2. Distinguish between the following pairs:

(a) estuary and deltas (b) flood plain and braided stream

3. The following landforms have been formed by rivers. Group them under erosional and depositional features.

Gorge, V -shaped valley, meander, flood plain, alluvial fan, and canyon.

4. Explain the formation of the following with suitable diagrams:

(a) Oxbow lake (b) Delta

5. Explain systematically the work of river as an agent of gradation at each of the three stages of its course.

6. Answer the following questions in brief:

(a) Explain the meaning of the term underground water.

(b) How do streams in limestone regions suddenly disappear?

(c) Why is construction of rails and roads difficult in areas of sinkholes.

(d) Permanent watertable and temporary watertable.

(e) Sinkhole and swallow hole. (f) Stalactite and stalagmite.

(g) Permeable rocks and impermeable rocks. (h) Hot spring and geyser.

7. What is meant by 'Karst' topography? Name any five topographical features of karst topography and explaion any two of these with the help of diagrams.

ANSWERS TO INTEXT QUESTIONS

5.1

1. (i) Erosion (ii) Transportation (iii) deposition
2. Load
3. (i) Corrasion (ii) Corrosion (iii) Hydraulic action (iv) Attrition.
4. (i) Traction (ii) Saltation (iii) Suspension (iv) Solution.
5 (i) decrease in slope or in velocity of water (ii) decrease in volume of water.
6. Plains, low laying areas, lakes and seas.

5.2

1. (a) (i) upper (ii) middle (iii) lower course. (b) Gorge

2. (a) Meanders (b) Alluvial fan

3. By deposition of load at the foot of mountains.

4. (a) Oxbow lake (b) Distributaries (c) Delta (d) Estuaries.

5.3

1. (a) Underground water (b) Acquifers,
2. (a) Permanent water table (b) Temporary water-table.
3. (a) Nature of surface (b) Rainfall (c) Nature of rocks.

5.4

1. (a) Arto region (b) Manikaran (c) U.S.A. (d) Synclinal or titled.

5.5

(a.) Kotamsar b. Croatia (Yugoslavia) c. (i) Iceland (ii) Yellowstone National Park, USA (iii) New Zealand

d. (a) Sinkholes (b) Swallow holes.

HINTS TO TERMINAL QUESTIONS

1. (a) The river transports its load in four ways by traction, by saltation, by suspension and by solution.

   (b) (i) Slope, velocity, structure of river bed. (ii) Velocity, volume and size of particles.

   (c) The work of river erosion is accomplished by corrasion, corrosion, hydraulic action and attrition.

2. (a) Estuary- The funnel shaped mouth of river, where tides flow in and out and where fresh water and sea water mix. They are formed by drowning of coastal lowlands by a relative rise of sea level.

   Delta - A more or less triangular and level tract of alluvium formed at the mouth of river and traversed by the distributaries of the river.

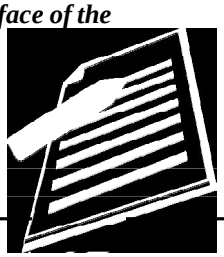
   (b) Flood Plain - A plain bordering a river formed as a result of sediments deposited by a river and is generally liable to flooding.

   Braided stream - A river that gets divided into a network of interconnected channels, forming bars and sand island in between.

3. Work of Erosion - Gorge, 'V' shaped valley, Meander, Canyon.

   Work of Deposition- Meander, Flood plain, Alluvial Fan.

4. (a) Ox-Bow lake- The meanders develop in the middle course of the river. In course of time the strip of land between two loops becomes



narrower and narrower till the river cuts through this strip and takes a straight course. The former loop or meander is left behind completely cut off from the main channel forming an Ox-bow lake.

(b) Delta- A more or less triangular and level tract of alluvium formed at the mouth of river and traversed by the distributaries of the river.

5. River is the most important agent of gradation. The river has three stages. It remains busy doing the work of gradation in the three stages,

Upper Stage:- Gorge, waterfall, canyons are formed.

Middle Stage: Meanders, alluvial fans are formed.

Lower Stage:- Flood plains, braided stream, ox-bow lake, delta and estuary, are formed by the river.

6. (a) Underground water is that part of the rainwater which percolates through the ground and accumulates below the surface, is called underground water.

(b) A large number of sinkholes and swallow holes are found in limestone regions. The water of the streams enters these openings and the surface flow becomes underground. In this manner the streams in the limestone regions become underground.

(c) Construction of roads and railways is difficult in regions having a large number of sink holes and swallow holes due to which the level of the ground sinks in such regions.

(d) Permanent water table: This is the level of the water under the surface below which the water-table never falls. This water-table is not affected by seasonal change. Wells dug upto this depth are never dry. (See fig. 5.8)

Temporary water-table: In some regions the water-table is not permanent and it keeps changing with seasons. The water-table changing with seasons is called temporary water-table. Wells dug upto this depth become dry during the dry season.

(e) Sink holes: These are funnel-shaped openings in the limestone region. Their depth varies from 3 to 9 metres and the diameter of the mouth is more than one metre. (See Fig 5.12) Construction of roads and railways is difficult in areas having a large number of sink holes.

Swallow holes: They are cylincdrical tube-like openings which are connected to the lower part of the sink hole. Rivers of the limestone regions become underground through swallow holes.

(f) Stalactite: A portion of the water dropping from the ceiling gets evapourated and a small deposit of limestone is left behind on the roof. This process continues and deposit of lime stone grows downwards like pillars. These beautiful forms are called stalactites.

Stalagmites: When the remaining portion of the water dropping from the roofs of the cavern falls on the floor a part of it is again evaporated and a small deposit of limestone is left behind. This deposit grows upward from the floor of the cavern. These type of depositional features are called stalagmites.

(g) **Permeable rock:** The rock through which water can percolate are called permeable rocks. **Impermeable rocks:** The rocks through which water cannot percolate are called impermeable rocks.

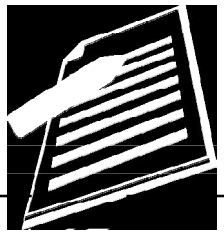
(h) **Hot springs:** The springs emitting hot or warm water are called hot springs. These springs are found in areas of present or past volcanic activity. In such regions the underground water gets heated up by coming in contact with hot rocks or steam.

Geysers: Hot springs emitting hot water and steam at almost regular intervals are called geysers. The water in geysers is ejected with force as in case of a fountain.

7. For Karst topography see following figures 5.12, 5.13 and 5.14

(i) Sinkholes (ii) Swallow holes (iii) Caverns (v) Stalactites (iv) Stalagmites.

See description of these figures in Section 5.8.



6

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THE WORK OF MOVING ICE, WIND AND SEA WAVES

You have learnt in the previous lesson about the gradational role of running water and underground water. In addition to these two agents, moving ice, wind and sea-waves too are powerful agents of gradation. These three agents too perform the threefold function of erosion, transportation and deposition. In other words, they are removing the weathered material, transporting it from the elavated ground and are depositing the same into low lying areas. This process also tends to 'grade' or 'level off' all irregularities on the surface of the earth in the areas of their operation. We will learn during the course of this lesson how each of these three agents of gradation functions as well as note the details of topographical features formed by each of them.

OBJECTIVES

After studying this lesson, you will be able to :

- define glacier, snow-line, snowfield, continental and valley glaciers;
- explain with the help of diagrams the formation of main erosional and depositional features produced by glaciers;
- differentiate among the various types of moraines;
- explain the features formed by the wind with the help of diagrams;
- explain with the help of diagrams the various relief features formed by sea-waves;
- give examples of features formed by these three agents of gradation preferably from India.

6.1 SNOW - FIELDS

In regions where the temperature always remains below freezing point, precipita-

tion occurs in the form of snowfall. Wherever the rate of snow melting or its evapouration is lower than the rate of snowfall in a year, snow accumulates into great mass of ice. Permanently snow covered regions of this type are called snow - fields. Snow - fields occur in polar regions and on high mountainous areas. Snowfields are always found above the snow line. Snow line is an imaginary line above which there is permanent snow. The height of the snow - line is not uniform and is affected by latitude, amount of snowfall, direction of winds and slope.

- Region permanently covered by snow and ice is called snow- field.
- Snowline is the lowest limit of permanent snow. Factors affecting snowline are-latitude, amount of snowfall, direction of winds and slope of the land.

6.2 GLACIER

In region experiencing snowfall, the snow keeps on accumulating in layers one above the other. Its overlying pressure is applied to the underlying snow. It is so great that snow in lower layers becomes granular, hard and compact. The pressure also quickens the melting of some of the snow, which on refreezing starts turning into a granular ice. Again it is the pressure of the overlying layers which makes this solid mass of ice mobile. This great mass of ice moving more under its own weight is called a glacier. Its velocity is very low and it moves from a few centimetres to a few metres in a day.

Types of Glaciers

On the basis of their location or area of origin, glaciers are divided into two types:

(i) continental glaciers and (ii) valley glaciers.

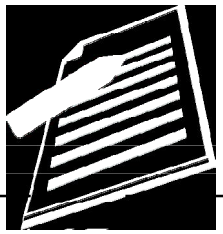
(i) Continental Glaciers

A thick ice sheet covering vast area of land is called a continental glacier. The thickness of ice in such regions goes upto thousands of metres. Glaciers of this type build up at the centre and move outward in all directions. Continental glaciers of today are found mainly in Antarctica and Greenland. The precipitation in these regions occurs in the form of snow. It gets accumulated year by year because of relatively slower rate of its melting.

(ii) Valley Glaciers

When a mass of ice from the high mountainous regions starts moving down into the pre-existing valleys, it is called a valley glacier or a mountain glacier. The shape of the valley glaciers depends on the valley it occupies. Where the valley is broad, the glacier spreads outwards and where the valley is narrow, the glacier contracts.

The longest glacier in India is the Siachen Glacier in Karakoram range which is 72 kilometres long. Gangotri Glacier in Uttarakhand is 25.5 kilometres long. There are many smaller glaciers in other parts of the Himalaya. Their length varies from 5



to 10 kilometres. The two important rivers of India, the Ganga and Yamuna, originate from Gangotri and Yamunotri glaciers respectively.

- A moving mass of ice and snow is called a glacier. Glaciers are of two types-continental glaciers and valley glaciers.

INTEXT QUESTIONS 6.1

Answer the following questions briefly:

1. What is the name given to a moving mass of ice and snow?

   _____.

2. What is the name given to the areas lying above the snow-line?

   _____.

3. What is the name given to the lowest limit of snow - fields?

   _____.

4. Name two types of glaciers.

   (a) _____

   (b) _____

6.3 LANDFORMS PRODUCED BY GLACIER

Like running water and underground water, glacier also does the work of erosion, transportation and deposition. Although the zone of action of glaciers is rather limited, topographical features made by them are frequently found spread over even in areas once affected by glacial action. .

(A) Erosional work of glacier

As a glacier moves over the land, it drags rock fragments, gravel and sand along with it. These rock fragments become efficient erosive tools. With their help glacier scrapes and scours the surface rocks with which it comes in contact. This action of glacier leaves behind scratches and grooves on rocks.

The landforms created by glacial erosion are:

(i) Cirque (or Corrie)

Snow collects at the upper end in a bowl shaped depression, is called cirque. Layers of snow in the process of compaction and recrystallization are called firn. Sometimes the deepest parts of these hollows are occupied by accumulated-water, to form Corrie Lake (or Tarn).

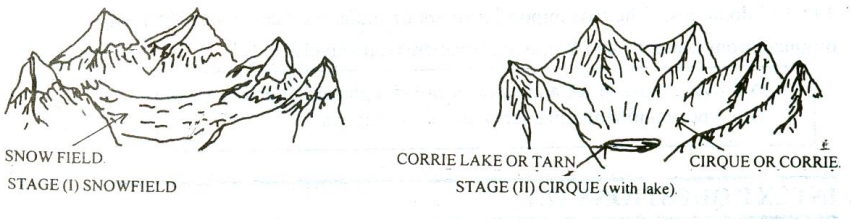


Fig. 6.1 Formation of Cirque

(ii) 'U' - shaped Valley

The glacier does not carve a new valley like a river but deepens and widens a preexisting valley by smoothening away the irregularities. In this process the glacier broadens the sides of the valley. The shape of the valley formed in this manner resembles the letter 'U'. It is therefore called a 'U' - shaped valley. (See Fig. 6.2). Such a valley is relatively straight, has a flat floor and nearly vertical sides.

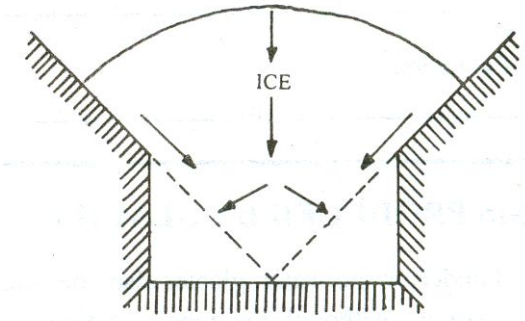


Fig. 6.2 U-shaped Valley

(iii) Hanging Valley

Just like tributary streams of river, there are tributary glaciers also which join the main glacier after moving over their mountainous path. These tributary glaciers like the main glaciers carve U - shaped valleys. However, they have less volume of ice than the main glaciers and thus their rate of erosion is less rapid. As a result their val1eys are smaller and not as deep as that of the main glacier. Due to this difference in deepening; the valley of the tributary glacier is left at a higher level than that of the main glacier. The val1ey of the tributary glacier just looks like hanging downwards at the point of its confluence with the main valley. This type of a topographical feature is cal1ed a hanging val1ey. This feature is visible when ice has melted in both the val1eys. (See Fig.6.3 and 6.4). When the ice in the hanging valley melts, a waterfall is formed at the point of confluence of this stream with the main river.

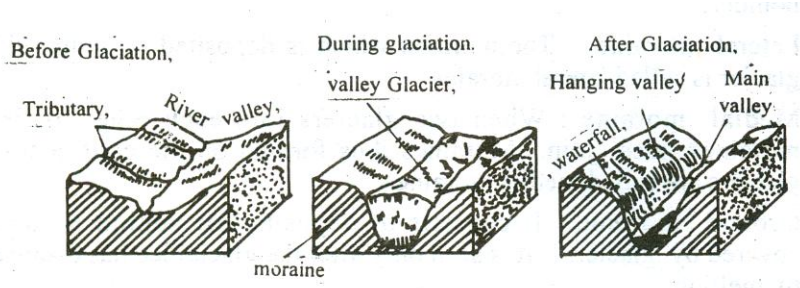


Fig. 6.3 Stages in the development of a glaciated valley

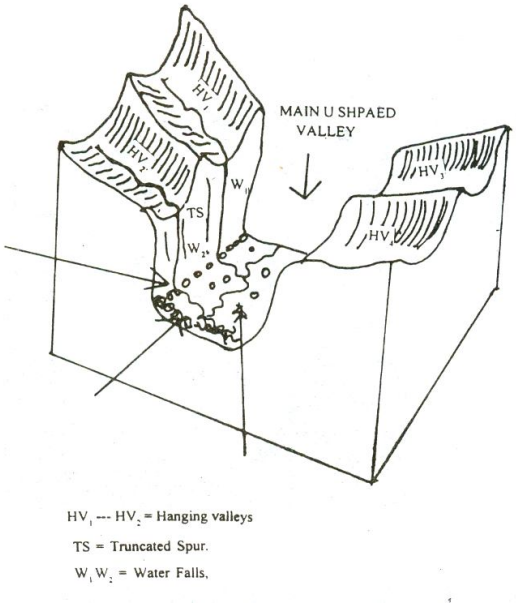


Fig. 6.4 Main Features of a Glaciated Valley

- The main erosional features formed by a valley glacier are (i) Cirque(or Corrie), (ii) U-shaped valley and (iii) hanging valley.

(B) Transportational work of Glacier

Although the glacier moves very slowly, it drags with it large boulders and rock fragments. Glacier gets this material from the mountain slopes, valley sides, valley bottom and from air. This material is called the load of glacier.

(C) Depositional work of Glacier

When the glacier melts or retreats, it deposits its load in different parts. The debris thus deposited are called moraines. Depending upon their location in the valley. moraines are of four types:- (i) terminal moraine, (ii) lateral moraine, (iii) medial moraine and (iv) ground moraine. (See fig. 6.5)

(i) Terminal Moraine : When the glacier melts, the debris are deposited at the end of the valley glacier in the form of a ridge. It is called terminal moraine. Morainic material ranges from fine clay to large angular boulders.

(ii) Lateral moraine: The moraine which is deposited on either side of a glacier is called lateral moraine.

(iii) Medial moraine: When two glaciers join each other their lateral moraines also join. Moraines thus formed on the confluence of two glaciers are called medial moraines.

(iv) Ground moraine: It consists of deposits left behind in areas once covered by glaciers. It is seen only after the glacial ice has disappeared by melting.

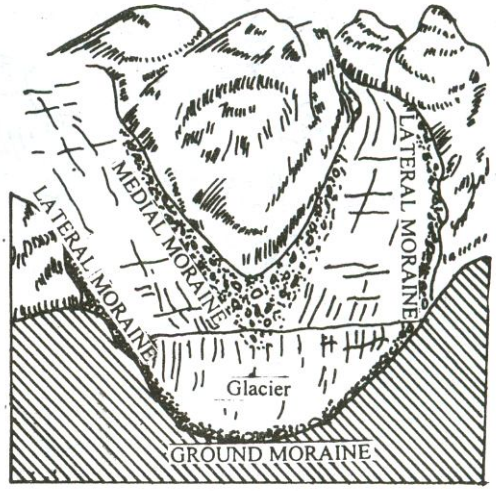


Fig. 6.5 A Glacier with Small Tributaries (showing moraines)

- Morains are accumulation of angular blocks of rocks, boulders, pebbles and clay that has been deposited by melting glacier or ice-sheet at the edges.
- The moraines deposited at the end of the valley glacier is called terminal moraine.
- Moraine deposited on the sides of the glacier is called the lateral moraine.
- Moraine deposited at the confluence of two glaciers is called the medial moraine.
- Moraine deposited at the bottom of the glacier is called ground moraine.

INTEXT QUESTION 6.2

1. Name three topographical features made by glacial erosion.

   (a) _____(b)_____(c)_____

2. Name one topographical feature made by glacial deposition.

_____

3. Name three functions of glacier.

(a) _____(b)_____(c)_____

6.4 LANDFORMS PRODUCED BY THE WIND

Wind action moves mineral particles when they are in a dry state and unprotected by a vegetation cover. These conditions are found in deserts and semiarid regions of the world, as well as on sandy shorelines.

(A) EROSION BY WIND

Wind performs three kinds of erosional work abrasion, attrition and deflation. Loose particles laying on ground surface may be lifted into the air or rolled along the ground by wind action. In the process of wind abrasion, wind drives sand and dust particles against an exposed rock or soil surface. When the wind borne material strike against each other, they are reduced in smaller particles. This process is known as attrition.The removal of loose particles from the ground is termed "deflation".

Landforms Produced by Wind Erosion

Some of the topographical features made by wind erosion are as follows: **(i) Mushroom Rocks (Or Rock Pedestals)**

When rocks, consisting of alternate hard and soft layers are subjected to wind abrasion, differential erosion results. The soft layers are easily eroded but the hard layer's resist erosion. As a result of undercutting near the base (due to greater amount of sand and rock particles being transported close to the ground), the resulting feature resembles a rock pillar shaped like a mushroom, It is aptly called rock pedestal or mushroom rock, Such formations are common in the Sahara Desert, and are also seen near Jodhpur. (See fig. 6.6)

Fig. 6.6 Mushroom Rock

(ii) Wind Eroded Basins

A land form produced by deflation is a shallow depression called a "blowout". The Quattara depression in Egypt is perhaps the finest example of such a hollow.

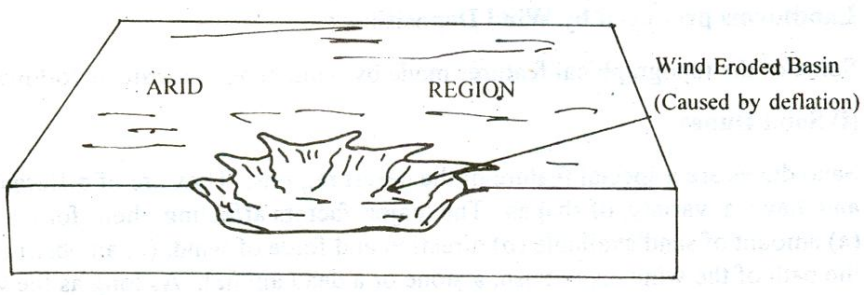


Fig. 6.7 Wind Eroded Basin

- Mushroom rocks are formed in the desert regions by means of wind erosion.
- Wind-eroded basins are formed by wind deflation.

(B) TRANSPORTATION BY WIND

Wind is an important agent of transportation in the arid region. The transported material is sometimes deposited in areas very far away from the place from where the dust particles have been picked. Winds blowing from Gobi Desert carry dust to the northern parts of China. In our country also winds blowing from Thar Desert bring dust particles to western Uttar Pradesh and the adjoining parts of Haryana & Punjab. This transported material is deposited in the fertile plains of Uttar Pradesh.

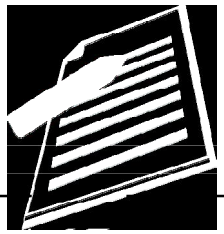
(C) DEPOSITION BY WIND

Under certain conditions, the material transported by wind starts getting deposited at a particular site along its running track. The conditions favouring it are:

(i) When the amount of dust particles present in the air exceed its carrying capacity, a part of the material being transported is deposited. This is the material which is in excess of the transportation capacity of the wind.

(ii) When the speed of the wind is reduced, its carrying capacity is also reduced. The material in suspension is thus deposited.

(iii) When an obstruction comes in the path of the wind, air has to rise above this obstruction. When it rises, the velocity of the wind is reduced and it starts dropping its load. This material is deposited in the form of a mound at the foot of the obstruction.



Landforms produced by Wind Deposition

Some of the topographical features made by wind deposition are as follows:

(i) Sand Dunes

Sand dunes are a special feature of the desert regions. They are of different types and have a variety of shapes. The major factors affecting their formation are (a) amount of sand available (b) direction and force of wind, (c) an obstruction in the path of the wind e.g. a bush, a stone or a dead animal. As long as the wind is strong enough to carry the sand, the sand dunes are mobile and they keep on shifting from one place to another. If vegetation or a line of trees starts growing on the dunes they become fixed. They also become stationary when they are blocked by a hillock. In case there is no such obstruction, sand dunes may bury agricultural land, plains and settlements.

There are two main types of sand dunes:

(a) Barchan

One common type of sand dune is an isolated heap of free sand called a barchan, or crescentic dune. This type of dune has the outline of a crescent, and the points of the crescent are directed downwind. On the upwind side of the crest, the sand slope is gentle and smoothly rounded. They are found in large numbers in the Sahara Desert.

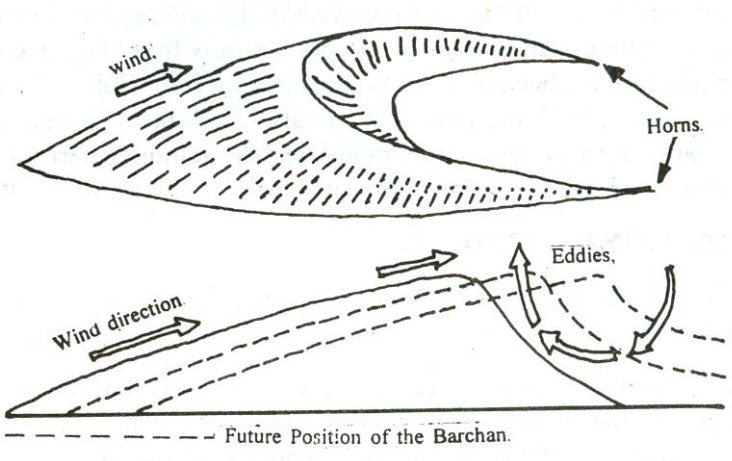


Fig. 6.8 Barchan and its Migration

(b) Seif Dunes

These are long, narrow ridges of sand that lie parallel to the direction of the prevailing winds. The winds blow straight along the corridors between the lines of dunes, sweeping the corridors clear of the sand, However, eddies set up in the winds blow towards the sides of the corridors, depositing sand there to form these nar-

row elongated dunes. Seif dunes are common in the western part of the Thar Desert of India.

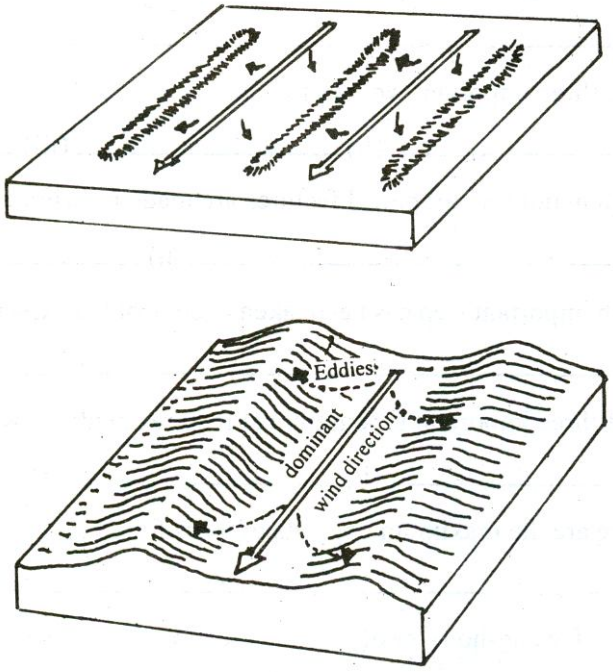


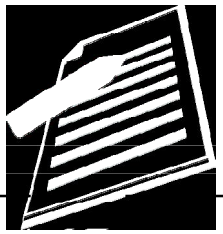
Fig. 6.9 Seif Dunes

(c) Loess

In several large areas of the world, the surface is covered by deposits of wind-transported silt that has settled out from dust storms over many thousands of years. This material is known as loess.

Loess tends to break away along vertical cliffs whenever it is exposed by the cutting of a stream or grading of a roadway. It is also very easily eroded by running water and is subject to rapid gullying when the vegetation cover that protects it is broken. The thickest deposits of loess are in northeast china, where a layer over 30m deep is common and a maximum thickness of 100m has been measured. Besides China, deposits of loess occur in Mississippi Valley of North America and north of Central European Upland in Germany, Belgium and France. Loess deposits are found in Austalia also.

- Depositional work of wind results in formation of topographical features like sand dunes, Barchan, seif dunes and loess.



INTEXT QUESTIONS 6.3

(a) In which region is the work of wind more effective?

_____

(b) Name three important works of wind.

(i)_____(ii)_____(iii)_____

(c) Which major topographical features are made by wind erosion?

(i) _____ (ii)_____

(d) Name three important topographical features made by wind deposition.

(i)_____(ii)_____(iii)_____

(e) Where are the maximum deposits of loess found?

_____.

6.5 LANDFORMS PRODUCED BY SEA WAVES

We are aware of the fact that the water in the oceans is never at rest. The tides, waves and ocean currents contribute to the restlessness of ocean. Their continuous effect on coast creates a number of relief features. The work of sea waves as an agent of gradation includes erosion, transportation and deposition. A number of topographical features are made through these actions of waves. Such features are found in the coastal regions. Let us study the work of sea waves in some more details.

(A) EROSION BY SEA WAVES

Sea waves have a great erosive force. In their role of an erosional agent they perform four functions. When the sea water loaded with rock fragments and sand attack the coastal rocks it is called *abrasion*. The rock particles present in the water hit against each other and break into progressively smaller particles. This process is called *attrition*. Thirdly the broadening of cracks and crevices in the cliffs along the coast due to the attack of the sea waves is called the *hydraulic action*. The rocks made up of limestone are subjected to *solution action* by the sea waves. All these processes help in formation of new features on the coastal margins.

- The three major works of sea waves are erosion, transportation and deposition.
- Abrasion, attrition, solution and hydraulic action are the processes which help in erosion by the sea waves.

Landforms Produced by sea Wave Erosion

Waves, like streams erode the coastal rocks with the help of rock fragments present in the water. Due to the continued erosion by waves, the coastline keeps retreating and a number of topographical features are formed in the process. Some of the important features made through sea wave erosion are mentioned here:

(i) Sea Cliff

The maximum impact of the sea waves is observed on the lower part of the coastal rocks and consequently the lower part of the rocks is eroded more rapidly than the upper part. This results in the formation of a hollow under the rock and with the passage of time this excavation in the lower part of the rock keeps on becoming larger.

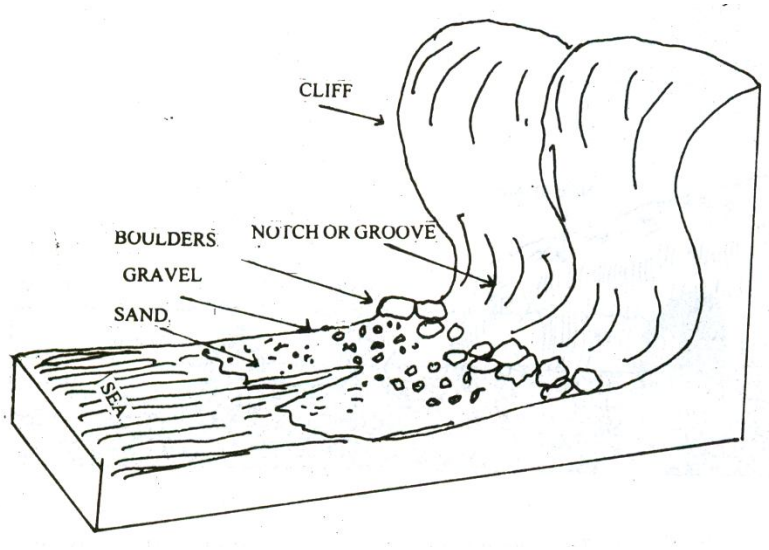
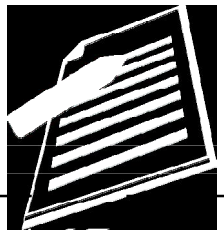


Fig. 6.10 A Sea Cliff

The upper part of the rock is thus left projecting out towards the sea. After sometime, this projecting part fall into the sea under its own weight. As a result a vertical wall is left. This vertical wall is called a cliff. In India a number of sea cliffs are found along the Konkan Coast of India.

(ii) Sea Caves

When the upper part of the coastal rock is hard and the lower part is soft, the erosion is not uniform. The lower part of the rock in such circumstances is eroded much faster than the upper part. Due to differential erosion a hollow is created in the lower part of the rock. When the waves pound against this hollow, air present in the hollow gets compressed. When the wave comes out of the hollow, the pressure on air is also released and it expands. Due to continuous compression of the air in the hollow, the rocks are subjected to a great pressure and they break. in this process, the hollows in the lower part of the rock keep on enlarging. With



passage of time they attain the form of caves and are known as sea caves. Formation of caves depends upon the nature of the coastline and the force of the waves.

(iii) Sea Arches

When a part of coast extends to some distance into the sea, sea waves working from opposite directions cut a passage through the soft rocks. In the initial stages, this passage is a narrow hole but it enlarges into a broad arch. These broad door-like features are called sea arches or natural bridges.

(iv) Sea Stacks

When the roof of an arch is broken by erosion or under its own weight or due to any other reason a part of the original rock remains standing as a solitary mass. It may be the rock forming the side of the arch. This type of a feature is called a sea-stack. Stacks are of a number of types depending upon their shape and the nature of the rocks. Sometimes they take the shape of islands but such islands are not permanent. Small underwater stacks are known as stumps.

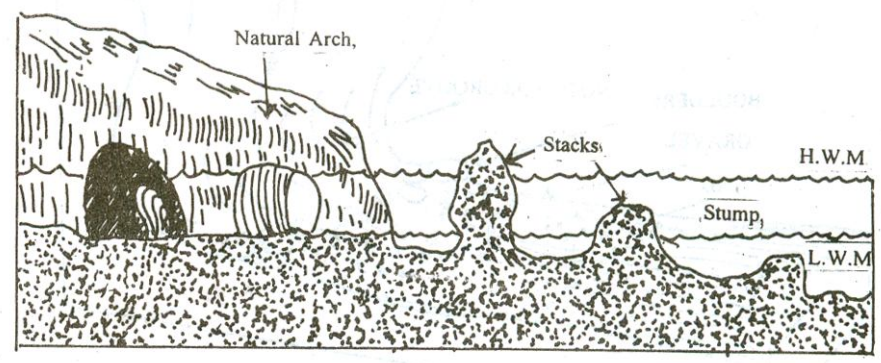


Fig. 6.11 Topographical features made through wave erosion

- Wave erosion is responsible for the formation of sea cliffs, sea caves, sea arches and sea stacks.

(B) Transportation by Sea Waves

Sea waves, currents and tides are the main agents of transportation of eroded material in the coastal regions. However, the role of waves is more important in connection with the formation of coastal relief features. The material deposited on the coasts by the rivers and glaciers etc. is removed and transported by the waves. Transportation by sea waves is carried out in two ways:

(i) Removal and transportation, towards the sea, of the material deposited by river etc. on the coast.

(ii) Carrying of material found in the sea to the coastal areas. During this process, the oceanic materials like pearls, conches and other shells are brought to the coast.

- Transportation by sea waves is responsible for ocean ward transportation of the material deposited on the coast and coastward transportation of the material found in the sea.

(C) Deposition by Sea Waves

Sea waves are helpful in the deposition of the material eroded from the coastal areas. Oceanic current are also helpful in deposition of the transported material. Deposition of the material along the coast is selective. The larger particles are deposited first therefore they are found near the coast. On the other hand, the finest particles are deposited last and they are deposited generally away from the coast. This selective deposition is sometimes altered or affected by a change in the intensity or force of the waves. Thus it is sometimes possible to find very fine particles deposited near the coast where generally larger particles are deposited.

A number of topographical features are formed due to deposition by waves and currents. Some of these topographical features are discussed here:

(i) Beach

Most of the material eroded and picked up by the waves is deposited near the coast. Due to this deposition, the sea becomes shallow and a part of the coastal area is raised above the water level. This raised portion is almost like a flat plain of a platform formed of gravel and sand. This type of depositional features along the coast is called a beach. Beaches are centres of tourist attraction. Marina Beach of Chennai and Kovalam Beach of Thiruvananthapuram are the famous beaches of India.

(ii) Sand Bar

Sometimes the deposits of sand and gravel laid down by waves and currents form embankment, separating shoreline from the sea. They thus form barriers between the sea and the mainland. Such deposits are called sand bars. They sometime pose difficulties in navigating.

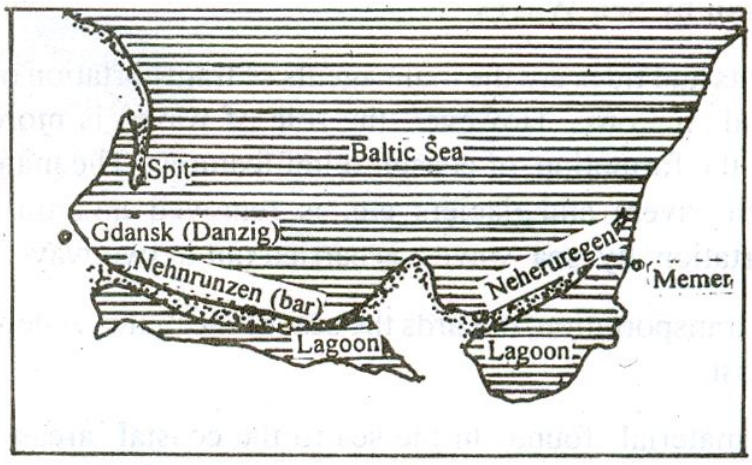


Fig 6.12 Sand Bar and Spit

(iii) Spit

When one end of a bar is attached to the coast and other extends into the sea, it is called a spit. These spits are formed by the accumulation of materials brought by waves like sand and gravel.

(iv) Lagoon

Sometimes due to deposition of waves and currents both the ends of the bar join to enclose a part of the sea water between the coast and the bar. This enclosed part of the sea forms a lake of saline water. This saline water lake is called a lagoon.

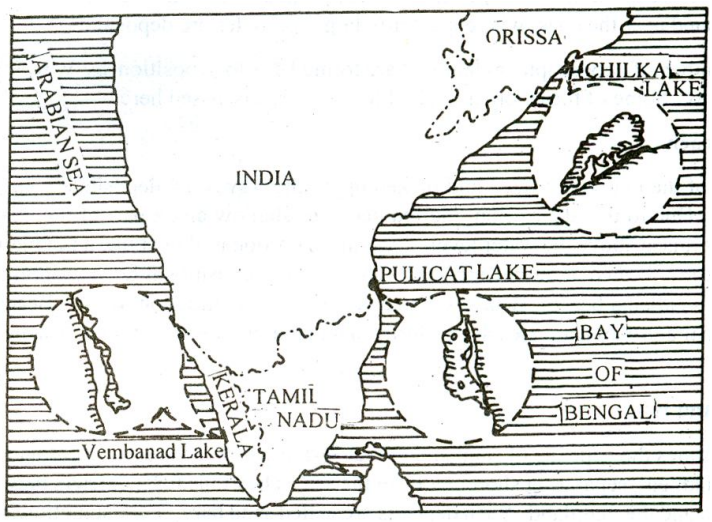


Fig. 6.13 Map showing Famous Lagoons of India

Sometimes the lagoons are formed due to wave erosion also. A lagoon is generally connected with the sea through a narrow passage. The Chilka and Pulicate lakes on the north-eastern coast and lake Vembanad on Kerala coast are examples of lagoon lakes in India.

- Topographical features like beaches, bars, spits and lagoons are formed by the action of waves.

INTEXT QUESTIONS 6.4

1. Fill in the blanks

   (a) Cutting of coastal rocks by sea waves is known as their _____work.

   (b) The four processes contributing to erosional action of sea waves are:

   (i) _____(ii)_____(iii)_____(iv)_____

(c) Sea cliff is a result of _____ action of sea waves.

2. Name any three relief features made through erosional action of sea waves.

(i)_____ (ii)_____ (iii)_____

3. Name two important factors on which the formation of the sea caves depends.

(i) _____(ii) _____

4. Which action of waves is responsible for the formation of spit

_____.

5. Classify following relief features made by erosional and depositional action of waves:

Sea stack, Bars, Sea caves, Sea cliffs, Beaches and Arches.

Categories:

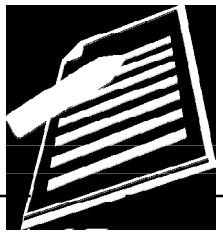
(i) Made through erosion (1) _____(2)_____(3)_____

(ii) Made through deposition (1) _____(2)_____(3)_____

WHAT YOU HAVE LEARNT

In areas where the temperature always remains below freezing point, precipitation occurs in the form of snow. Therefore, these areas are covered with snow. Such regions are called snow-fields. Snow-fields are found always above the snowline. Snowline is that line above which the snow never melts completely. Moving ice is called a glacier. They are of two types- continental glaciers and valley glaciers. Glaciers do the work of erosion, transportation and deposition through which a number of topographical features are formed. The major topographical features of glacial erosion are the 'U' -shaped valleys and hanging valleys. The major depositional features of glacial action are the moraines. There are three types of moraines-terminal moraine, lateral moraine and medial moraine. Topographical features made by glaciers are found in areas of high altitude and high latitude.

Wind like running water, moving ice and underground water, is an important agent of gradation. Action of wind is more effective in arid and semi-arid regions. Wind erodes the rocks, transports the broken material and deposits it in different areas. These three actions of wind are known as erosion, transportation and deposition. Erosinal work of wind include abrasion, attrition and deflation. One of the major topographical features made by wind erosion is mushroom rock which resembles an umbrella in shape. The transportation work of wind is also extensive, the broken particles of rocks are transported to thousands of kilometres. Deposition of the transported material results in formation of a number of topographical features. The important ones among these are the sandunes and loess.



The most important agent shaping coastal landform is wave action. The important works of waves are the breaking up of the rocks, removal of broken material and laying down of this material in different parts of the coastal areas. These three actions of waves are called erosion, transportation and deposition. Erosion by waves is achieved through the processes of abrasion, attrition, hydraulic action and solution. Erosion by sea waves results in formation of topographical features like sea cliff, sea caves, arches and stacks. Transportation work of waves makes possible seaward movements of the material accumulated on the coast and coastward movement of the material found in the sea. Depositional work of sea waves is responsible for formation of topographical features like bars, spit, beaches and lagoons.

TERMINAL QUESTIONS

1. Answer the following questions in brief:

   (i) What is snowline?

   (iii) What is a hanging valley? How is it formed?

2. Distinguish between the following:

   (a) Continental glacier and valley glacier. (b) V-shaped valley and U-shaped valley.

3. Name the major relief features formed by glacial erosion and deposition and explain the process of formation of each with the help of diagrams.

4. In which region is the work of wind more effective? Why is it so?

5. Explain the three processes which help in the wind erosion.

6. How is a mushroom rock formed? Explain with the help of a diagram.

7. Where is the greatest deposits of loess found?

8. Which topographical features are formed through erosional action of sea waves? Explain the mode of formation of each.

10. How is a beach formed? Name two important beaches of India.

11. Differentiate between:

    (i) Erosional and depositional work of wind.

    (ii) Solution action and hydraulic action of sea-waves.

    (iii) Lagoon and beach.

ANSWERS TO INTEXT QUESTIONS

6.1

1. Glacier. 2. Snowfield. 3. Snow-line 4. (a) Continental glaciers, (b) Valley glaciers.

6.2

1. (a) U-shaped valley (b) Hanging valley (c) Cirque
2. Moraine
3. (a) Erosion, (b) Transportation, (c) Deposition

6.3

(a) Desert and semi-desert regions.

(b) (i) Erosion (ii) Transportation (iii) Deposition

(c) (i) Mushroom rock, (ii) Wind eroded basin

(d) (i) Sand dunes (ii) Barchans or Seifdunes, (iii) Loess

(e) In North China

6.4

1. (a) Erosional (b) (i) Abrasion, (ii) Attrition, (iii) Hydraulic action; (iv) Solution. (c) Erosional
2. (i) Sea cliffs (ii) Sea caves (iii) Sea arches (iv) Sea stack (any three)
3. (i) Nature of the coastline (ii) Force of waves
4. Depositional work.
5. (i) Made through erosion: Sea stacks, cliffs, caves, arches.

   (ii) Made through deposition: Bars, beaches.

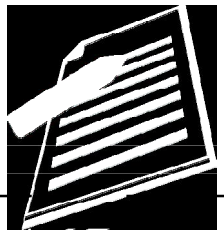
HINTS TO TERMINAL QUESTIONS

1. (i) Snowline is an imaginary line above which there is Permanent snow.

   (ii) Refer to section 6.3 (a) (iii) for answer draw the diagram (Fig. 6.4) given on that page.

2. (a) (i) Continental glacier: A large area covered with ice and snow.

   (ii) Valley glacier: is formed when ice and snow start moving from high mountains into some pre-existing valleys. This moving mass of ice and snow is called a valley glacier.



(b) U-shaped Valley: Due to a steep slope in the higher mountainous regions, the flow of the rivers is very rapid. They erode the bottom of their valleys at a higher rate and this results in the formation of a V-shaped valley. (See figure in the foregoing lesson).

U-shaped valley: Glaciers do not form their valley as the river does. They flow through some old valleys. Such narrow valleys are broadened and deepened by the glaciers to form U-shaped valleys. U-shaped valleys are deep and steep-sided and they are formed through erosion on the valley floor and the valley sides. (See Fig. 6.2).

3. Major relief features formed by glacial erosion are (i) U-shaped valley, (ii) Hanging valley. Major relief features formed by glacial deposition are: (i) Lateral moraines, (ii) Terminal moraines, (iii) Ground moraines, (iv) Medial moraines.

4. In arid or desert regions

Due to partial or total absence of vegetation cover, the wind fins the conditions ideal for blowing over vast areas uninterrupted. Besides mechanical weathering breaks the rocks into small particles which are easily blown away.

5. The three processes are abrasion, attrition and deflation. (For details Refer to Section 6.4 (A).

6. Mushroom rock is formed by wind erosion. (For details and see Section 12.6 (i).

7. Greatest expanse of loess deposits is found in North China. Where a layer over 30M is common and a maximum thickness of 1000M has been measured.

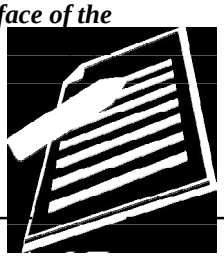
8. The major topographical features made through wave erosion are sea cliffs, sea caves, sea arches and sea stacks. (For details of their mode of formation refer to section 6.5 (A).

9. Beaches are formed through depositional work of : Sea waves. Two famous beaches of India are Marina Beach of Chennai and Kovalam Beach of Thiruvananthapuram. (For details of mode of formation see Section 6.5 (C) (i).

10. (i) Breaking lip and frictional reduction of rocks by wind is called erosion and the process of laying down of wind-borne material is called deposition. (For details refer tdsection 6.4 (A) and (C).

(ii) The term hydraulic action refers to the process of broadening of the rock joints and cracks by the pressure exerted by air entrapped in the coastal "rocks. The term solution refers to the action of water on the soluble rocks like limestone. Such rocks are dissolved by water and thus eroded. (For detail refer to Section 6.5).

(iii) Lagoon and beach are both formed through depositional action of waves. A beach is a raised portion on the sea coast made through deposition of sand and gravel. A lagoon is the enclosed part of the sea separated from the open sea by an enlarged bar. (For details refer to 6.5 (C) (i) and (iv).



7

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MAJOR LANDFORMS AND THEIR ECONOMIC SIGNIFICANCE

You have learnt in the previous lesson that the landforms found on the earth's surface are the result of interplay between internal and external forces. The soft rocks are easily worn down by these forces. While the relatively harder rocks are not so easily worn down. Therefore, rocks have a great influence on the landforms developed in an area. The internal forces are perpetually elevating the earth's surface and the external forces about which you will study in the next lessons are constantly wearing down such elevations to make ,the surface level. This is how various landforms are formed by constant action of agents of gradation. These landforms are not only the physical features of the earth's surface but also the basis of human civilization. The major landforms found on the earth's surface are mountains, plateaus and plains. In this lesson, we will study the major landforms of the earth and their economic importance for us.

OBJECTIVES

After studying this lesson you will be able to :

- differentiate among the three major landforms found on the earth's surface;
- explain the process of formation of various landforms with the help of illustrations;
- classify mountains on the basis of their mode of formation;
- discuss the usefulness of mountains to man;
- list different types of plateaus and describe their economic significance;

- enumerate major types of plains and explain their influence on human life;
- locate major mountains, plateaus and plains on the outline map of the world.

7.1 MOUNTAINS

Mountain, plateau and plain are broad by present day land features of the earth's surface produced by the deformation of its crust. Among them, mountains are the most awe-inspiring landform. About 27% of the earth's surface is covered by the mountains. Generally, they are uplifted portions of the earth's surface which are much higher in contrast to the surrounding areas. But all uplifted or elevated areas are not mountains. In fact height and slope together give rise to a particular form of land which we identify as a landform. For example, the elevated portion in Tibet, which is about 4500 metres high above sea level, is called a plateau and not a mountain.

It may also be remembered that the formation of a mountain range takes millions of years. During these years, the internal forces of the earth uplifting the land are fighting against erosion wearing it down. In order to form one Mt. Everest, internal forces must push up the land faster than the external forces constantly eroding it. Therefore, mountains are those uplifted portions of the earth's surface which have steep slopes and small summit area rising more than thousand metres above the sea level. Mountains have the maximum difference of height between their high and low portions.

- The uplifted portions of the earth's surface with steep slopes and small summit area rising above 1000 metres and formed over a period of million of years are called mountains.

7.2 CLASSIFICATION OF MOUNTAINS

On the basis of their mode of formation, the mountains have been classified as:

(a) Fold Mountains
(b) Block Mountains
(c) Volcanic Mountains
(d) Residual Mountains

(a) Fold Mountains

We have studied in the last lesson how folds are formed in the rock strata by the internal earth movements. Mountain range mainly consisting of uplifted folded sedimentary rocks are called fold mountains. When these rocks are subjected to horizontal compressional forces for millions of years, they get

bent into up and down folds. This leads to the formation of anticlines and synclines. Such earth movements occur from time to time and lift the folds to a considerable height which result in the formation of fold mountains.

- The mountains which have been formed by the uplift of mainly the folded sedimentary rock strata under compressional forces are called fold mountains.

Fig. 7.1 Distribution of Important Fold Mountains of the World

The Himalayas in Asia, the Alps in Europe, the Rockies in North America and the Andes in South America are the most prominent fold mountains of the world, (See fig. 7.1). Since these mountain ranges were formed during the most recent mountain building period, they are known as young fold mountains. Some of these mountain ranges, for example, Himalayas, are still rising.

(b) Block Mountains

Block mountains are also formed by the internal earth movements. When the forces of tension act on the rocks, they create faults in them. When the land between the two almost parallel faults is raised above the adjoining areas, it forms a block mountain. It may also occur when land on the outer side of the faults slips down leaving a raised block between them. The rocks composing the fault levels may be flatlying or even folded. Block mountain is also called horst (see fig. 7.2). The Vosges in France, Black Forest Mountains in Germany and Sierra Nevada in North America are the typical examples of block mountains.

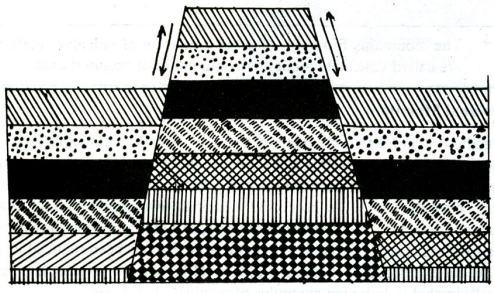


Fig. 7.2 Block Mountain or Horst

- The mountain formed by the uplift of land between faults or by the subsidence of land outside the faults is known as block mountain.

(c) Volcanic Mountains

We have learnt in the previous lesson that the interior of the earth is extremely hot. Due to high temperature deep inside the earth rocks turn into a molten magma. When this molten rock material is ejected to the earth's surface during volcanic eruption, it accumulates around the vent and may take the form of a cone. The height of the cone increases with each eruption and it takes the form of a mountain. As these mountains are formed by the accumulation of volcanic material, they are known as volcanic mountains or mountains of accumulation (see fig.7.3). Mount Mauna Loa in Hawaii Islands, Mount Popa in Myanmar, Vesuvius in Italy, Cotopaxi in Equador and Fuji Yama in Japan are examples of volcanic mountains.

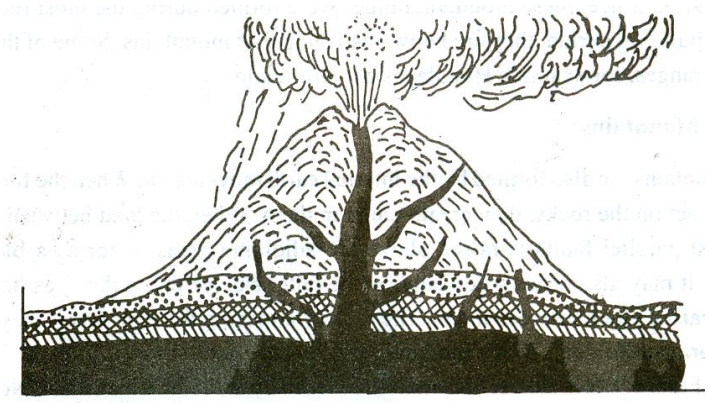


Fig. 7.3 Volcanic Mountains

- The mountains formed by the accumulation of volcanic material are called volcanic mountains or mountain of accumulation

(d) Residual Mountains

The weathering and different agents of erosion – rivers, winds, glaciers etc. are constantly acting on the earth's crust. As soon as an elevated mountain range appears on the earth's surface, the agents of gradation begin their work of leveling it down. To a large extent, the process of wearing down depends on the shape and structure of the rocks. After thousands of years, soft rocks are worn down into sand and the hard rocks are left standing up in the area that has been reduced in height. These are called residual mountains (fig.7.4). Hills like the Nilgiris, the Parasnath, the Rajmahal and the Aravalis in India are examples of residual mountains.

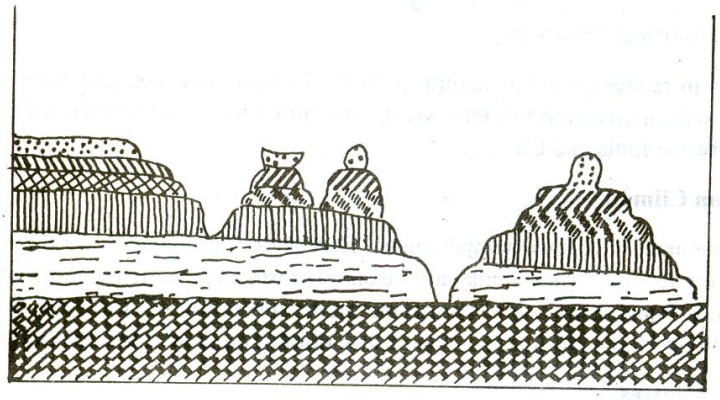


Fig. 7.4 Residual Mountains

- The elevated regions that have escaped weathering and erosion and appear in the form of mountains are called residual mountains.
- On the basis of their mode of formation, the mountains can be classified as Fold Mountains, Block Mountains, Volcanic Mountains and Residual Mountains.

7.3 THE ECONOMIC SIGNIFICANCE OF MOUNTAINS

Mountains are useful to us in the following ways :

(a) Storehouse of Resources

Mountains are the storehouse of natural resources. Large resources of minerals are found in mountains. The Appalachian range in the United States is well-known for coal and limestone deposits. We get timber, lac, medicinal herbs and wood for making pulp from the forests of the mountains. Tea and coffee plantations and some fruits orchards have been developed on mountain and hill slopes.

(b) Generation of Hydro-electricity

Hydro-electricity is generated from the waters of perennial rivers in the mountain regions. The mountainous countries like Japan, Italy and Switzerland, which suffer from the shortage of coal have developed hydro-electricity.

(c) Abundant Sources of Water

Perennial rivers rising in the snow fed or heavily rain fed mountains are the important source of water. They help in promoting the irrigation and provide water for many other uses.

(d) Formation of Fertile Plains

The rivers that originate in the high mountain region bring silt alongwith water to the lower valleys. This helps in the formation of fertile plains.

The great alluvial plain of northern India has been formed by the rivers Ganga, Sutlej and the Brahmaputra.

(e) Natural Political Frontiers

The mountain ranges do act as natural political frontiers between countries and protect them from invasions to some extent. The Himalaya have formed a political frontier between India and China.

(f) Effect on Climate

Mountainous areas have lower temperatures. They serve as climatic divide between two adjoining regions. The Himalaya for example form a barrier to the movement of cold winds from Central Asia towards the Indian subcontinent. They also force the South West Monsoons to ascend and cause rainfall on their southern slopes.

(g) Tourist Centres

The pleasant climate and the beautiful scenery of the mountains have led to their development as centres of tourist attraction. The tourist and hotel industries get an additional encouragement in such regions. Shimla, Nainital, Mussorie and Srinagar are some of the important hill stations of India which attract tourists all over the world.

INTEXT QUESTIONS 7.1

1. Name the three major landforms found on the earth's surface.

   (i)_____ (ii)_____ iii) _____

2. Answer in brief

   (a) From which rock type have the fold mountains been formed?

   _____

   (b) By which forces are the fold mountains formed?

   _____

   (c) Name the four important hill stations of India.

   (i) _____ (ii)_____

   (iii) _____ (iv) _____

3. Write the type of mountain in the brackets:

   (a) The Black forest ( )

   (b) The Nilgiris ( )

   (c) The Fuji Yama ( )

   (d) The Andes ( )

7.4 PLATEAUS

The plateaus cover about 18% of the earth's surface. This landform has a large elevated area on its top unlike a mountain and has nearly even surface out there.Very often rivers or streams cut out deep valleys and gorges in a plateau region. In place of its original smooth topography, it then changes into a disected plateau. A plateau, however remains much higher above the sea level of the nearby areas. Though normally 600 metres above sea level, there are plateau of Tibet and Bolivia, more than 3600 metres above sea level.

A plateau is an elevated area of more or less level land on its top. It has a large area on its top and steep slope on its side.

7.5 CLASSIFICATION OF PLATEAUS

On the basis of their geographical location and structure of rocks, the plateaus can be classified as:

(a) Intermontane Plateaus

(b) Piedmont Plateaus

(c) Continental Plateaus

(a) Intermontane Plateau

The plateau which are bordering the fold mountain range or are partly or fully enclosed within them are the intermontane plateaus (Fig 7.5). Vertical movements raise this extensive landforms of nearly horizontal rocks to thousands of metres above sea level. The extensive and over 4500 metres high plateau of Tibet is one such example. It is surrounded by folded mountains like Himalaya, Karakoram, Kunlun, Tien Shah on its two sides. The plateau of Colorado is another well known example, over one km high into which rivers have cut the Grand Canyon and a series of gorges. The plateau of Mexico, Bolivia and Iran are all other examples of this type.

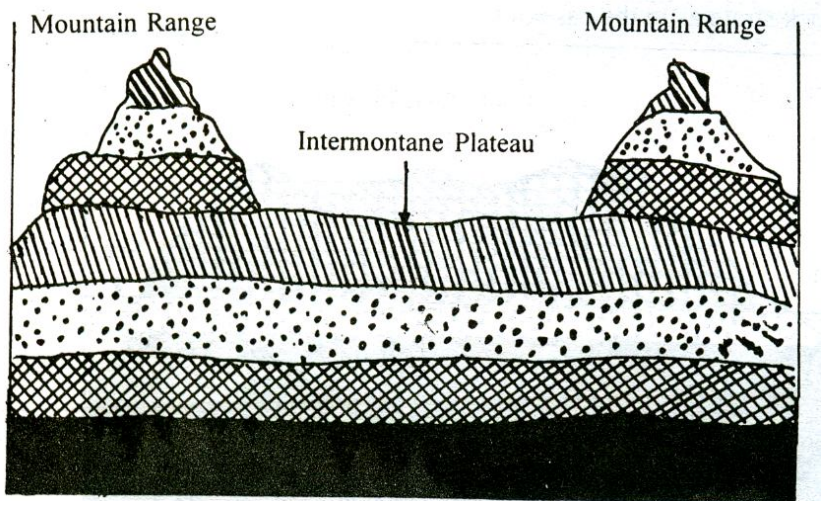


Fig. 7.5 Intermontane Plateau

(b) Piedmont Plateau

The plateaus that are situated at the foot of the mountains and are bounded on other sides by a plain or an ocean are called piedmount plateau Fig. 7.6. The plateau of Malwa in India, those of Patagonia facing the Atlantic ocean and the Appallachian situated between the Appalachian Mountain and the Atlantic Coastal Plain in U.S.A are their examples. In their case, the areas once high have now been reduced by various agents of erosion. For this reason, these are also called the plateaus of denudation.

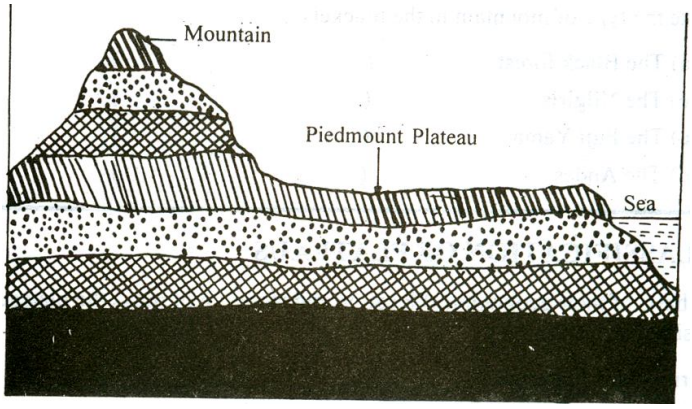


Fig. 7.6 Piedmont Plateau

(c) Continental plateau

These are formed either by an extensive continental uplift or by the spread of horizontal basic lava sheets completely covering the original topography to a great depth. The volcanic lava covered plateau of Maharashtra in India, Snake River Plateau in North West USA are the examples of this type. These are also, called the ptateau of accumulation.

All continental plateaus show an abrupt elevation in contrast to the nearby lowland or the sea (fig.7.7). As compared to other, these plateaus, cover a vast area like the Great Indian Plateau and those of Arabia, Spain, Greenland, Africa and Australia. They may be tilted on one side without any disturbance in the horizontal nature of underlying rock strata as in the case of Great Indian plateau.

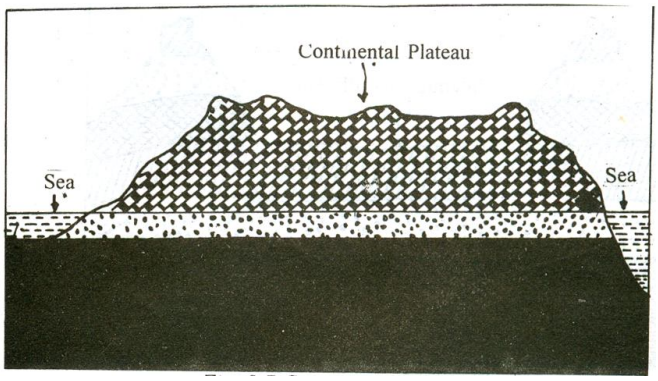
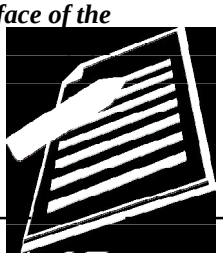


Fig. 7.7 Continental Plateau



- The plateau which are bordering or are enclosed within high mountain ranges are called intermontane plateau.
- The plateaus formed by the uplift of large areas or by the gradual spread and acumulation of basic lava sheets are called continental plateau.
- The plateaus which are situated at the foot of mountains and are bounded by a plain or an ocean on the other side are called piedmont plateaus.

[redacted] prevalence of a patchy or the slow development of agriculture and building of roads on the plateaus. This factor also explains why the plateaus are sparsely populated. Nevertheless plateaus are extremely useful to mankind in the following ways:

(1) Storehouse of Minerals

Most of the minerals in the world are found in the plateaus. Besides, the extraction of minerals is relatively easier on plateaus. These minerals are indispensable as raw material for our industries. We get gold from the Plateau of Western Australia; copper, diamonds and gold from the Plateaus of Africa and coal, iron, manganese and mica from the Chota Nagpur Plateau in India.

(2) Generation of Hydel-power

Rivers falling down the edges of plateaus form water-falls. These water-falls provide ideal sites for generating hydel-power.

(3) Cool Climate.

The higher parts of the plateaus even in tropical and sub-tropical regions have cool climate. Hence they have attracted Europeans to settle there and develop their economy e.g. South and East Africa.

(4) Useful for Animal-rearing and Agriculture

Plateaus have large grassland areas suitable for animal-rearing specially sheep, goat and cattle. They provide a veriety of products such as wool, milk, meat and hides and skin. The lava plateaus as compared to all other plateau are richer in agriculture since their soil is very fertile.

- Plateaus are useful because of the presence and easier way of extracting minerals and favouring generation of hydro-power. Their suitable climate and sometimes fertile soils are helpful for developing animal-rearing and agriculture.

(a) Name the three types of plateaus.

(i) _____ (ii) _____ (iii) _____

(b) Name three natural resources for which plateaus are well known

(i) _____ (ii) _____ (iii) _____

(c) Write against each of the following the type of plateaus to which it belongs:

(i) The plateau of Patagonia _____

(ii) The plateau of Bolivia _____

(iii) The Decean plateau _____

[redacted]ost important landforms found on the earth's surface. A low-lying relatively flat or slightly rolling land surface with very gentle slope and minimum local relief is called a plain. Plains occupy about 55% of the earth's surface. Most of the plains have been formed by the deposition of sediments brought down by rivers. Besides rivers, some plains have also been formed by the action of wind, moving ice and tectonic activity. Plains have an average height of less than 200 metres.

- A low-lying relatively flat or slightly rolling land surface with very gentle slope and minimum local relief is called a plain.

[redacted], plains can be classified into the following types:

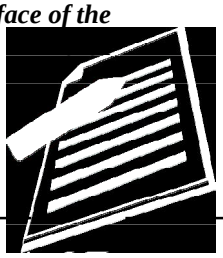
(a) Structural plains,

(b) Erosional plains and

(c) Depositional plains:

(a) Structural plains

These plains are mainly formed by the uplift of a part of the sea-floor or continental shelf. These are located on the borders of almost all the major continents. The south eastern plain of the United States formed



by the uplift of a part of the Gulf of Mexico is an example of this type of plain. The structural plains may also be formed by the subsidence of areas. One such plain is the central low-lands of Australia.

(b) Erosional Plains

These plains are formed by the continuous and a long time erosion of all sorts of upland. The surface of such plains is hardly smooth. These are therefore also called peneplains which means almost a plain. The Canadian shield and the West Siberian plain are examples of erosional plains.

- The plains formed by uplift or subsidence of an area are called structural plains.
- The plains formed by the continuous long term erosion of uplands are called erosional plains.

(c) Depositional plains

Fragments of soil, regolith, and bedrock that are removed from the parent rock mass are transported and deposited elsewhere to make on entirely different set of surface features–the depositional landforms. When plains are formed by river deposits, they are called riverine or alluvial plains. The Indo Gangetic plain of the Indian sub-continent, the Hwang-Ho Plain of North China, the Lombardy Plain of the Po river in Italy and the Ganga-Brahmaputra Delta Plain in Bangladesh are examples of alluvial plains.

The deposition of sediments in a lake gives rise to a lacustrine plain or a lake plain. The Valley of Kashmir and that of Manipur are examples of two most prominent lacustrine plains in India.

When plains are formed by glacial deposits they are called glacial or drift plains. Plains of Canada and North-Western Europe are examples of glacial plains.

When wind is the major agent of deposition, they are called loess plains. Loess plains of North- Western China are formed by the deposits of loess-air-borne fine dust particles.

- depositional plains are formed by the deposition of sediments brought down by rivers, glaciers and winds.
- depositional plains are sub-divided into alluvial, lacustrine, glacial and loess plains.

[redacted]owing ways:

(1) Fertile Soil

The plains generally have deep and fertile soil. Since the plains have a flat surface, the means of irrigation are easily developed. Both these factors have made the plains agriculturally so important that they are often called 'food baskets of the world'.

(2) Growth of Industries

The rich agricultural resources especially of alluvial plains have helped in the growth of agrobased industries. This has given employment to millions of people and has registered a marked increase in the national production and per capita income. Since the plains are thickly populated, plenty of labour is available for the intensive cultivation and for supplying work force for industries.

(3) Expansion of Means of Transport

Since the plains have an even surface it favours the building of roads, airports and laying down of railway lines.

(4) Centres of civilization

The plains have been the centres of many modern and ancient civilizations. The major river valley civilizations of the world have flourished in the plains only. Hencs, they are aptly referred to as the cradles of civilization. For example, there are the civilization of the Indus and the Nile Valley.

(5) Setting-up of Cities and Towns

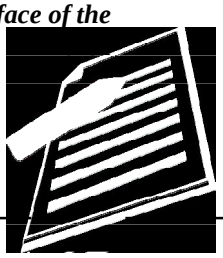
Easy means of transport on land, the growth of agriculture and industries in plains have resulted in the setting-up and expansion of cities and towns. The most developed trade-centres and ports of the world are found in the plains only. Rome, Tokyo, Calcutta, Yangoon (Rangoon), Varanasi, Paris and other famous cities are situated in the plains. As much as 80% of the world's population lives in the plains.

- Plains are useful to man due to their fertile soils, growth of ~~industries, development of transport, setting up of cities & towns~~ and making them attractive as craddles of human civilisation.

[redacted]

(a) Name the three major types of plains.

(i) _____(ii) _____(iii) _____



(b) To which category do the following plains belong?

(i) Lombardy Plain of Italy _____

(ii) The Plain of North-Western China _____

(iii) The Plain of Northern Canada _____

2. Name two civilizations that flourished in the river valleys.

(i) _____(ii) _____.

3. Give two examples of lacustrine plains?

(i) _____ (ii)_____

[redacted]s surface are the mountains, the plateaus and the plains. Besides the structure of rocks, the external and internal forces acting on the earth's surface also play a significant role in the development of these landforms. The landforms on the earth's surface have influenced human life in different ways. Fertile plains have been formed by the rivers originating in the mountains. These rivers are our perennial source of water for irrigation and other purposes. The plateaus are often described as the storehouse of minerals. Many of our major industries are dependent on the constant supply of these minerals. Besides this, the density of population is also influenced by the landforms. The plains including some of the valleys located in the mountain are teeming with people. Compared to the plains, the mountains and the plateaus have an uneven surface that is why they are generally sparsely populated.

[redacted]f mountains found in the world and describe the formation of each type.

2. Describe how plateaus are useful to man.

3. Why are the plains called 'cradles of civilization'?

4. Describe the significance of mountains.

5. Distinguish between the following:

(i) The intermontane plateau and the continental plateau.

(ii) The block mountain and the volcanic mountain.

(iii) The structural plain and the depositional plain.

6. Locate and label the following on the outline map of the world.

   (a) Rockies and Alps mountain ranges;

   (b) Patagonia and Tibetan plateaus;

   (c) Central low land of Australia and Hwang-Ho plains.

1. (a) Mountain (b) Plateau (c) Plain
2. (a) Sedimentary rocks (b) Horizontal compressional force (c) (i) Shimla (ii) Nainital (iii) Mussorie (iv) Sri nagar.
3. (a) Block mountain (b) Residual mountain (c) Volcanic mountain (d) Fold mountain .

7.2

(a) (i) Intermontane plateau (ii) Piedmont plateau (iii) Continental plateau

(b) (i) Mineral resources, (ii) water & soils, (iii) grassland

(c) (i) Piedmont plateau (ii) Intermontane plateau (iii) continental plateau.

7.3

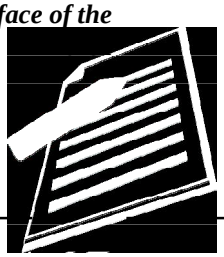
1. (a) (i) Structural, (ii) Erosional and (iii) Depositional

   (b) (i) Alluvial plain, (ii) Loess plain and (iii) Erosional plain

2. (i) The Indus valley civilization (ii) The Nile valley
3. (i) Valley of Kashmir (ii) Manipur plain

HINTS TO TERMINAL QUESTIONS

1. See para 7.2 - classification of Mountains. Give examples of each type of mountain and illustrate your answer with diagram.
2. See para 7.6
3. Expand on the following points-availability of fertile soil, development of means of transport, growth of industries, development of trading centre. Give examples of different civilization which flourished on plains.
4. See para 7.3.



5. (i) See para 7.5 (a) and (c)

   (ii) See para 7.2 (b) and (c)

   (iii) See para 7.8 (a) and (c)

6. See Maps.