

## CHAPTER - 22

# LITHOSPHERE



### After studying this chapter you learn :

- The meaning of lithosphere and its importance.
- The structure of the earth and its composition.
- Structure of rocks.
- About the internal forces-volcanoes, earthquakes, tsunami etc., and their effects on life on the earth.
- The external forces like temperature, wind, rain and rivers.
- The meaning of underground water and its importance.

### Meaning and importance

The outer-most solid layer of the earth is known as the 'Lithosphere' (Litho means 'rock'). This layer is very thick in the continents and quite thin under the sea floor. The lithosphere consists of rocks, minerals, soils etc. Life exists on this layer with the help of the atmosphere and the hydrosphere. Continents are parts of the lithosphere where different land forms like mountains, plateaus, plains, etc., are found.

### Earth's Interior and Composition

*Do you know, what is there inside the Earth?*

Our planet Earth is more than 4.6 billion years old and still in the process of changing. Man is in quest of understanding this change and eager to know more about inside the earth. What is inside the earth is still a mystery for man. With years of study and research human beings have been able to get information about the materials inside the earth up to 10 to 12 kms. Going beyond this depth is very difficult due to the increase of temperature ( $1^{\circ}\text{C}$  for every 32 meters).

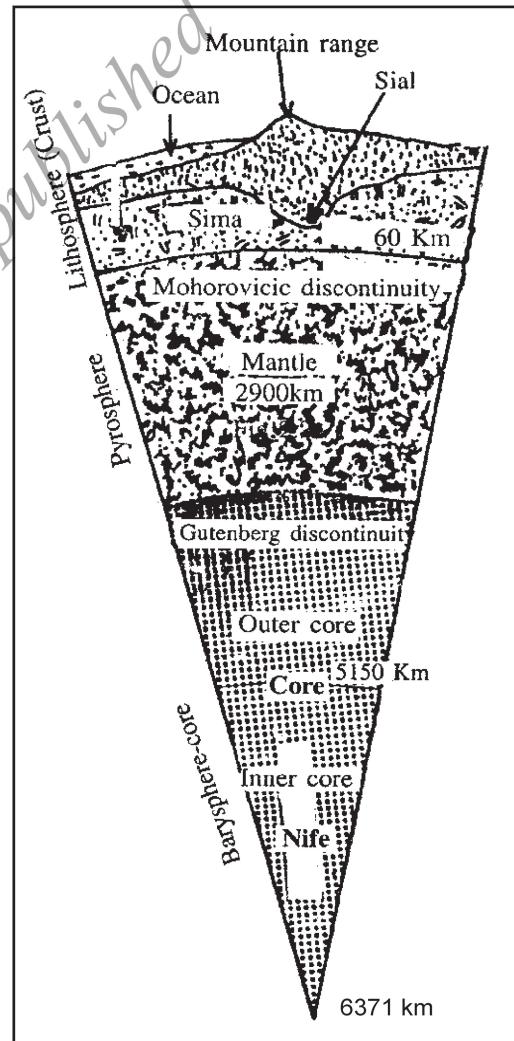
To understand more about the earth's interior humans are dependent on indirect evidences such as seismic waves, volcanic materials etc. The earth's interior comprises of various materials in different forms. On the basis of density of material, chemical composition and physical

state of matter the earth's interior is classified into 3 main layers. They are the Crust, the Mantle and the Core.

**The Crust:** The crust is the uppermost layer of the earth, rich in Silica, Aluminium and Magnesium. The depth of this layer is around 60 kms from the surface. In the upper part of the crust only lighter materials are found. It is called **SIAL** (Silica and Aluminium) or continental crust. The lower part of the crust is rich in Silica and Magnesium and it is called **SIMA** or oceanic crust.

**The Mantle:** The Mantle is the second and the middle layer of the earth. The depth of this layer is up to 2900 kms from the surface. The materials are in semi liquid or partially molten state which is called magma. The mantle is composed of dense and rigid rocks which have predominance of minerals like magnesium and iron. The mantle has two parts a) Upper mantle or the Asthenosphere is partially in a molten condition and b) Lower mantle or the Mesosphere in solid condition. The contact zone of the crust and the mantle is called 'Mohorovicic Discontinuity' or Moho. While the boundary that separates the Mantle from the Core is called 'Gutenberg Discontinuity'. Here the rocks are different in chemical composition from those below and above.

**The Core:** This is the innermost layer of the earth. The depth of this layer is up to 6371 kms from the surface. The most important materials of the core are Nickel and Ferrous (Iron). So it is known as NIFE. The core is divided into two sub layers a) The outer core is known as molten core, where the materials are in liquid and in molten form. b) The inner core known as solid core.



**Interior of the Earth**

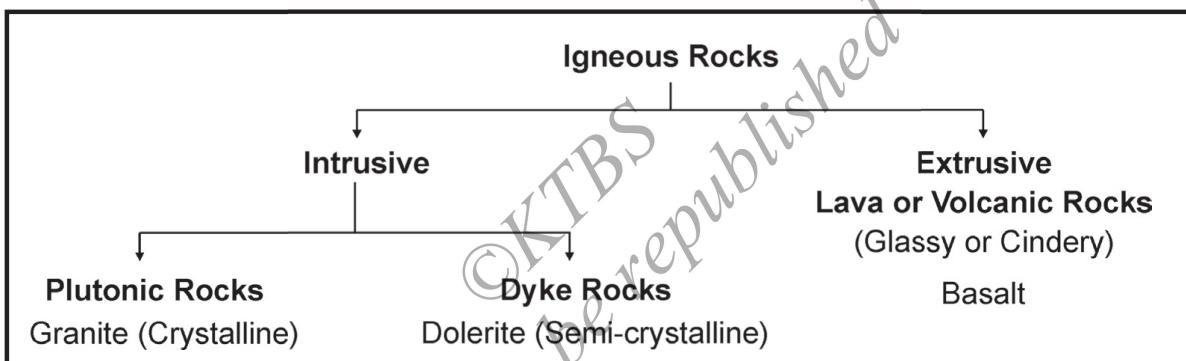
### Facts File

#### Some deepest land mines in the world

1. The Akola peninsula of Russia is around 12 kms.
2. The Kimberly diamond mine in South Africa is around 3.9 kms
3. The Gold mine at KGF in India is around 1.5 kms.

## ROCKS

Rocks are the solid inorganic substances that are found in the crust of the earth. They are aggregates of minerals. Rocks are formed due to various natural processes. On the basis of mode of formation, rocks are classified into three types. They are **(1) Igneous rocks, (2) Sedimentary rocks and (3) Metamorphic rocks.**

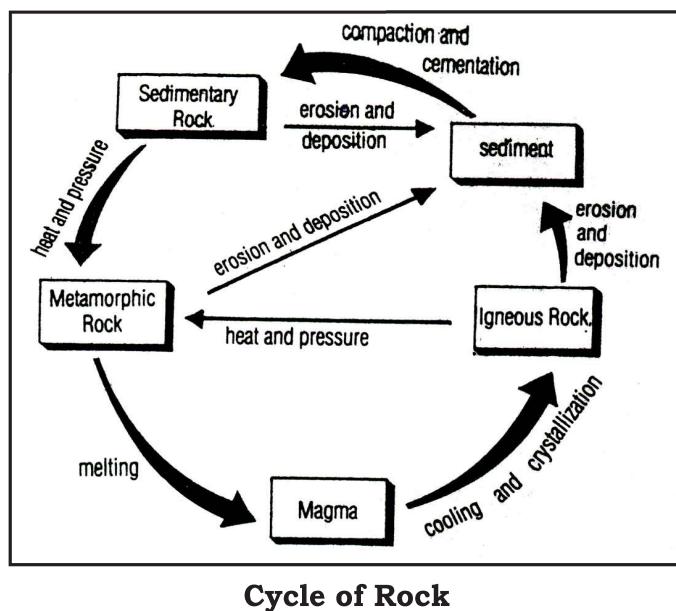


**1. Igneous Rocks :** The word 'Igneous' means 'fire' derived from the Latin word 'Ignis' or Sanskrit word 'Agni'. Igneous rocks are those which have been formed by the cooling of molten matter of the earth. Igneous rocks were the first to be formed, therefore they are also called Primary rocks.

**The two important types of igneous rocks are :**

#### (i) Intrusive igneous rocks

: When the molten materials (magma) of the Earth's interior

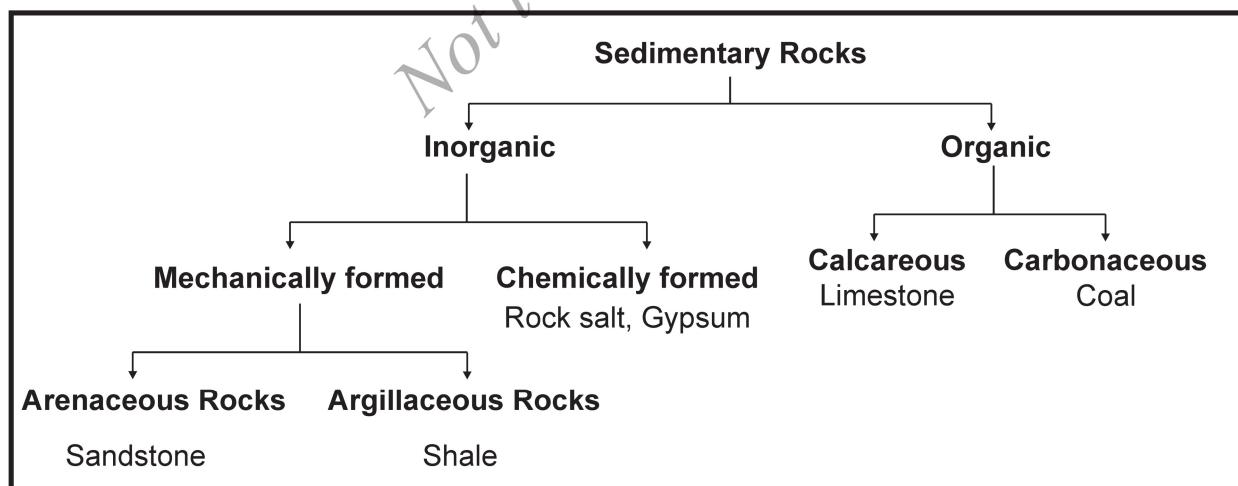


do not reach the earth's surface, they cool and solidify (quite slowly) below the surface and called intrusive igneous rocks. These rocks are made of large crystals and are found at great depth inside the Earth eg., Granite, Diorite and Gabbro.

**(ii) Extrusive igneous rocks:** Rocks formed by solidification of magma above the earth's surface are known as extrusive igneous rocks. These rocks are generally fine grained or glassy because lava after reaching the surface of the earth cools and solidifies quickly eg., Basalt and Andesite.

*The rock materials in the liquid or molten state is called 'magma' and when it comes out from the earth is called 'lava'.*

**2. Sedimentary Rocks :** The word Sedimentary is derived from a Latin word 'Sedimentum', which means 'settling down'. Sedimentary rocks are formed by the agency of water, wind and ice. These agents break and erode the igneous rocks, transport those broken fragments and deposit them at certain places. The deposit of these materials often occurs in the form of layers or strata. Therefore sedimentary rocks are called stratified rocks. The sedimentary rocks are formed after the disintegration of igneous rocks. Therefore they are called secondary rocks. These rocks are also called aqueous rocks because they are formed in the water bodies (Lake, Sea and Ocean beds).



**Mechanically formed sedimentary rocks:** Rocks built up by fragments of pre-existing rocks which have been produced by the processes of weathering and erosion eg., Sandstone (Arenaceous rocks) and Shale (Argillaceous rocks).

**Chemically formed sedimentary rocks:** Chemical sediments are commonly formed by the process of evaporation of water containing salts in solution eg., Rock salt, Gypsum etc.

**Organically formed sedimentary rocks:** Organic sediments are those derived by the accumulation of remains of organisms, such as shells of marine organisms, remains of plants and animals eg., Limestone (Calcareous rocks) and Coal (Carbonaceous rocks).

**3. Metamorphic Rocks :**Metamorphic rocks are those which are formed by the process of metamorphism or alteration of pre-existing rocks. Metamorphism means change of form which may be physical or chemical or both by the influence of heat and pressure.

**Example:**

- |                        |                           |
|------------------------|---------------------------|
| a) Granite -> Gneiss   | d) Sandstone -> Quartzite |
| b) Basalt -> Schist    | e) Coal -> Graphite       |
| c) Limestone -> Marble | f) Graphite -> Diamond    |

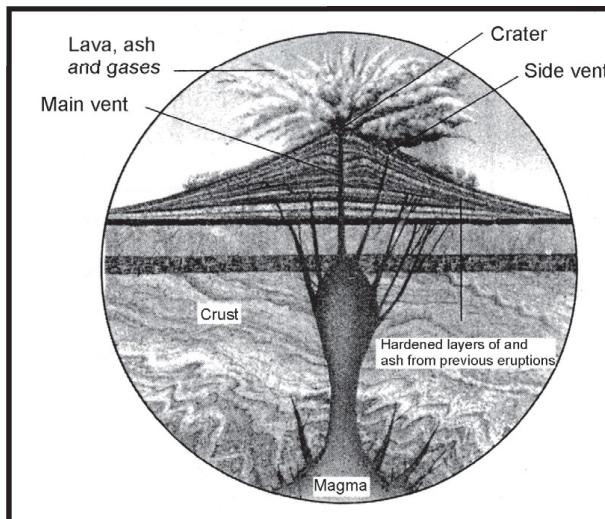
Metamorphic rocks are the hardest rocks on the earth. These rocks supply precious stones. ex :-Sapphire, Ruby and Emerald and Diamonds etc.

### FORCES OF THE EARTH'S CRUST

The Earth has two important forces that change the face of the earth. They are internal forces and external forces.

#### INTERNAL FORCES

These are the forces which originate inside the crust and influence the surface features of the earth eg., Volcanoes, Earthquakes etc. The internal forces are also called Endogenic forces.



**Structure of a volcano**

## VOLCANOES

A volcano is a vent or narrow opening in the Earth's crust connected by a pipe to an underlying magma chamber, through which magma, rock fragments, lava, ash, steam, flames and other gases are emitted from the interior of the Earth. A passage in the earth's crust through which magma and other volcanic materials are ejected is called 'Vent'. The funnel-shaped hollow at the top of the cone of a volcano is called 'Crater'. A large basin-shaped crater bound by steep sides is known as '**Caldera**'.

**Types of Volcanoes :** On the basis of the periodicity or frequency of eruption volcanoes are classified into three types.

**Active Volcanoes:** Volcanoes which constantly eject lava, gases, ashes etc., are known as active volcanoes. There are about 600 active volcanoes in the world eg., Mt. Stromboli and Mt. Etna in Italy, St. Helens in USA, Mauna Loa in Hawaiian islands, Pinatubo in Philippines etc.

**Dormant Volcanoes:** Dormant volcanoes are those which have erupted in the past and are likely to erupt again but have remained inactive for fairly long periods eg., Mt. Vesuvius in Italy, Mt. Fujiyama in Japan, Mt. Kilimanjaro in Tanzania, Mt. Krakatoa in Indonesia.

**Extinct Volcanoes:** Extinct volcanoes are those which were active in the remote geological periods. These are not likely to be active once again eg., Gorongoro in Tanzania, Arthur's Seat in Scotland.

### Facts file

#### **Super volcanic eruptions of the world**

1. Mt. Vesuvius (Italy)
2. Mt. Krakatoa (Indonesia)
3. Mt. Pelee (West Indies)
4. Mt. Fujiyama or Fuji, a volcano worshipped by people of Japan.

**Volcanic materials:** The materials ejecting out from the volcanoes are of three types. **Solid:** Volcanic bombs, cinders, scoria, pumice, dust, ash. **Liquid:** Lava. **Gases:** Sulphur, Hydrogen, Carbon dioxide.

**Distribution of Volcanoes:** Volcanoes occur in many regions of the world, including islands, young mountain ranges and plateaus of the continents. Most important regions are: **1. The Circum-Pacific Belt or Pacific Ring of Fire:** Coastal margins of the Pacific Ocean consisting of Philippines, Japan, USA, Central America, South America etc. **2. Mid-Atlantic Belt:** Iceland, West Indies **3. Mid-Continental Belt:** Italy, Spain, France, Greece, Turkey etc., **4. Important Islands:** Hawaii, Indonesia.

## EARTHQUAKES

Earthquake is a shock or series of shocks or tremors, due to a sudden movement of crustal rocks generated within the crust or mantle.

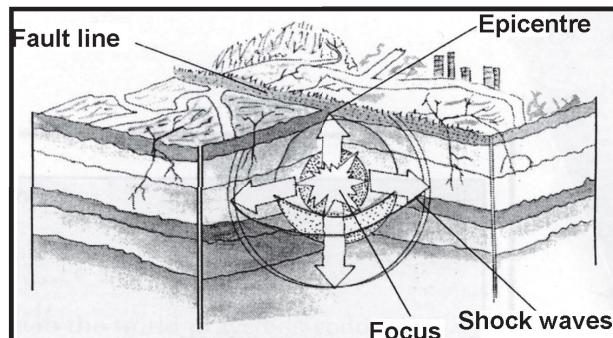
The point of origin of the earthquake in the earth's crust is called the Seismic focus or Hypocentre.

The point on the earth's surface vertically above the seismic focus is called the Epicentre.

The scientific study of earthquakes is called Seismology. The origin, time, velocity and direction of seismic waves are recorded by an instrument known as Seismograph.

## Causes of the Earthquakes

**Plate Tectonics:** The earth's crust consists of many major and minor plates. These plates are not stationary. The plate boundaries are dynamic places and are the primary location of earthquake activity (Circum-Pacific Belt).



**Actions of Earthquake**

**Volcanic Eruptions:** Volcanic earthquakes are caused by gas explosions (Krakatoa volcano of Indonesia).

**Faulting:** A fault consists of a fracture in a rock along with a great deal of displacement takes place. Earthquakes occur when movement of plates takes place along a line of fracture (San Andreas fault of California in USA).

**Man made factors:** Over interaction of man with nature is also one of the main causes of the occurrence of many of the earthquakes. The extraction of minerals, deep underground mining, huge dams and reservoirs, nuclear tests etc., (Koyna dam in Maharashtra, Hoover dam in USA).

## **Earthquake Waves**

The earthquake or seismic waves originate in the seismic focus and travel towards the epicentre in ripples or concentric circles. The three important earthquake waves are:

**1. Primary Waves (PW):** Primary waves are also known as longitudinal or compressional waves. These are the fastest earthquake waves and the first waves to reach the surface. They can pass through solid, liquid and gaseous matters.

**2. Secondary Waves (SW):** Secondary waves are also known as transverse or distortional waves. These waves cannot pass through liquids. They reach the epicentre after the primary waves.

**3. Surface Waves (LW):** Surface waves are also called long waves. They are the slowest earthquake waves but are responsible for the highest destruction on the surface of the earth.

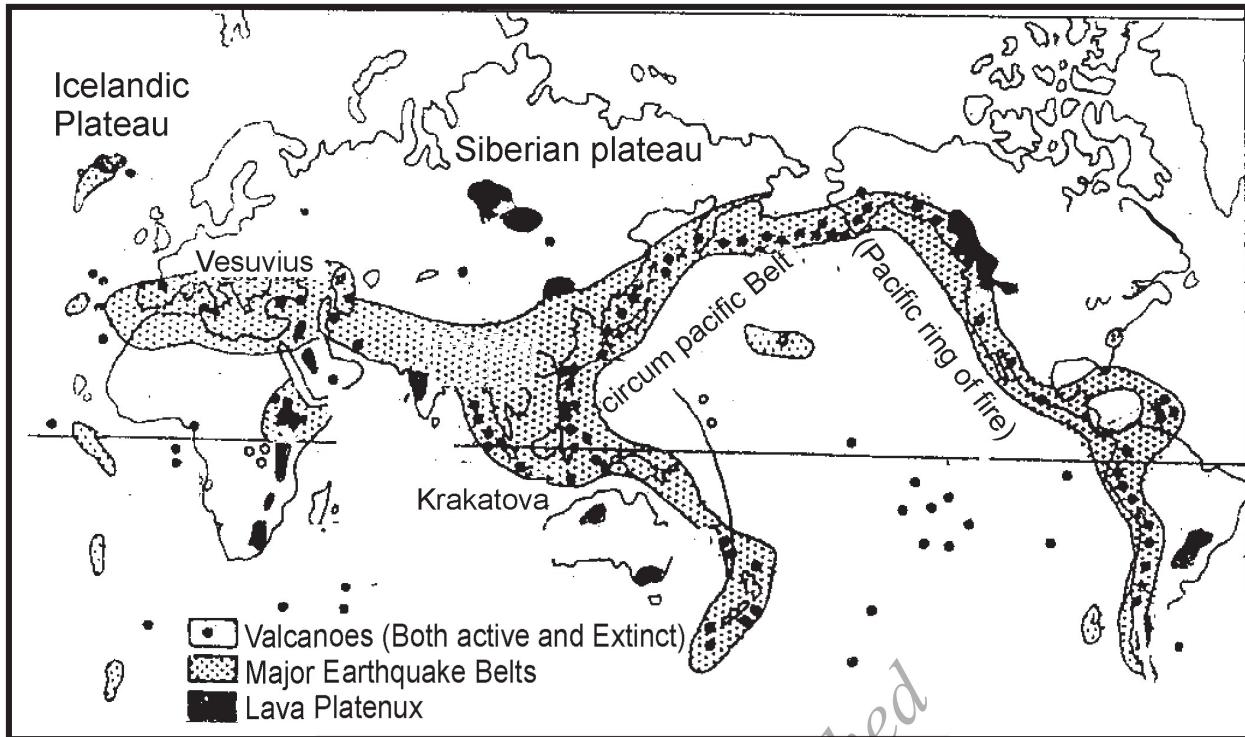
The magnitude and intensity of earthquakes is recorded by using **Richter scale**.

The Earthquakes are very dangerous and destructive. They cause large-scale deaths, loss to property, landslides, flash floods, damage to bridges, roads, railway lines etc.

**Tsunami:** Tsunami is a large sea wave occasionally experienced along the coasts of Japan and in other regions caused by an underwater earthquake. In Japanese language 'Tsunami' means 'harbour waves'.

### **Facts file**

1. On 26th Dec, 2004 a Tsunami in the Indian ocean swept the coastal low lands of Indonesia, India, Sri Lanka, Thailand etc.
2. On 11th Mar, 2011 a Tsunami in the Pacific ocean caused huge damage in the eastern coastal regions of Japan (Fukushima, Sendai, Miyagi etc).
3. Some seismic recording centers of India: Gowribidanur, Kodaikanal, Pune, Hyderabad, Dehradun.



## Earthquakes and Volcanic Regions

### EXTERNAL FORCES:

External forces are the natural forces that modify the surface of the earth. The important forces are temperature, wind, rainfall, snowfall, river, glacier etc., These forces act on the surface of the earth and constantly change its features.

**Weathering:** Weathering is the wearing away or breaking down or gradual disintegration of rocks by agents (Temperature, rainfall, wind etc.) present in the atmosphere. The three types of weathering are:

- Mechanical weathering:** When the rock is broken and disintegrated without any chemical alteration, the process is called Physical weathering or Mechanical weathering. The important processes of mechanical weathering are Granular disintegration, Block disintegration and Exfoliation. The agents of mechanical weathering are temperature, wind, frost etc.
- Chemical weathering:** Chemical weathering is mainly brought about by the action of substances dissolved in rainwater. This type of weathering results in changing the composition of minerals

present in the rocks. There are four types of chemical weathering. They are:

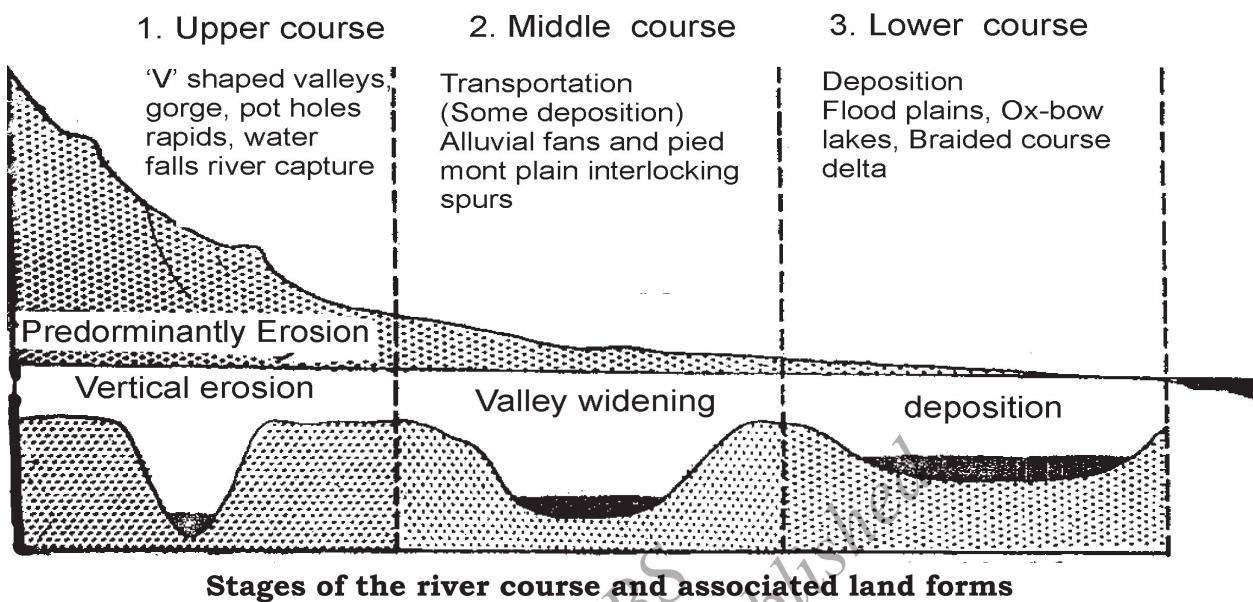
- a. **Oxidation:** In this type of chemical weathering oxygen dissolved in water reacts with certain minerals, especially iron, to form oxides.
  - b. **Carbonation:** When the rainwater falls on limestone rocks, the calcium carbonate present in the rocks absorbs carbon dioxide from rainwater and becomes calcium bicarbonate.
  - c. **Hydration:** Hydration is the process by which some minerals in crystalline form absorb water and become a powdery mass. Feldspar is a common rock forming crystalline mineral.
  - d. **Solution:** When the rain falls on the surface of the land, rainwater dissolves soluble minerals present in the rocks.
3. **Biological weathering:** Living organisms like plants, animals and human beings play a role in one way or another in the weathering of rocks. This type of weathering includes both physical and chemical weathering. (a) **Plants:** Growth and expansion of roots. (b) **Animals:** Burrowing animals, earthworms, rabbits, rats. (c) **Human beings:** Mining, quarrying, construction works.

## DENUDATION

**Agents of Denudation:** Denudation is the action of changing landscape or changing the surface of the earth by various natural agents such as Rivers, Glaciers, Underground water, Wind, Sea waves etc., The work of these natural agents are Erosion, Transportation and Deposition. These processes produce distinct relief features.

**River:** A mass of fresh water flowing from its source to mouth along a definite course is called 'River'. The river is a most prominent agent of denudation. The place where a river takes its birth is called 'Source' and 'Mouth' is the point where it meets sea or ocean. 'Tributaries' are the feeders or small streams which supply water to river along its course. The point where a tributary joins the main river is called 'Confluence'.

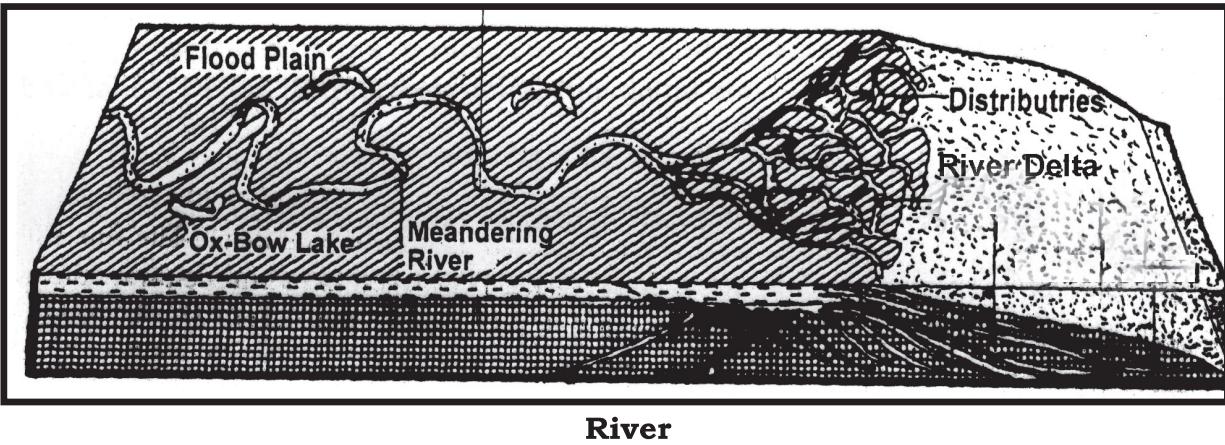
**Course of the River:** The course of a river from its source to mouth is divided into three stages. These stages are Upper course, Middle course and Lower course.



**The Upper Course:** Vertical erosion is most common due to steep slopes leading to deepening of valleys, resulting in the formation of gorges, canyons, 'V' shaped valleys, waterfalls (Angel falls, Niagara falls, Jog falls).

**The Middle Course:** In the middle course, the river path has a moderate slope and velocity is less than that in the upper course. The volume of water increases when many tributaries join the main river. The main work of the river in this stage is transportation of sediments and little deposition. The important landforms in this stage are Alluvial fans, Meanders.

**The Lower Course:** In this stage the slope of the river course is very minimum. The volume of river water is more and deposition is the main work of the river. The important landforms in this course are Flood plains, Natural levees, Ox-bow lakes, Deltas (Sundarban delta, Nile delta).



**"The work of river is called "Fluvial Cycle".**

#### **Facts File:**

Estuary – Tidal mouth of a river broadening into the sea / ocean.

Delta – A fan shaped, low lying area of deposits at a river mouth.

**GLACIER :** Glaciers are slowly moving, compacted masses of ice and snow found in the high mountains and polar regions. The mass of ice or snow is pulled down by its weight and due to the force of gravity.

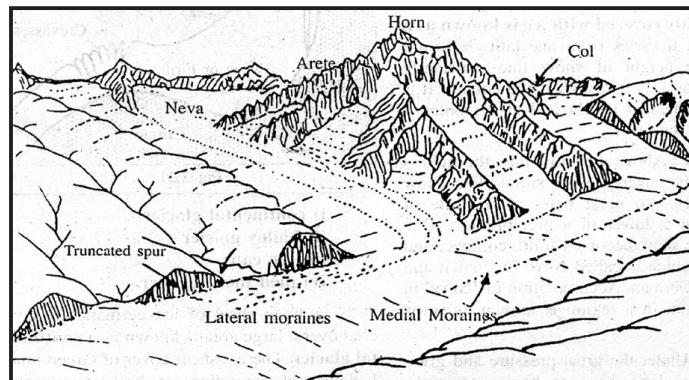
**Types of Glacier:** Glaciers are divided into two types a)Continental glaciers and b)Mountain glaciers.

**Continental glaciers:** Continental glaciers are extensive ice sheets found in polar regions eg., Greenland and Antarctica.

**Mountain or Alpine or Valley glaciers:** The glaciers found in the Polar regions regions are called Mountain glaciers.

Glacier as an agent of denudation performs the work of erosion, transportation and deposition. The erosional work of glaciers is mainly side cutting. The landforms resulting by this are Cirque, Horn, Arete, 'U' shaped valleys, Hanging valleys, Rock steps etc.

The transportation and the deposition work of glaciers



**Work of Glacier**

goes almost together. The important depositional landforms produced by glaciers are Moraines, Drumlins, Esker, Kames, Outwash plains, Till plains etc.

'Moraines' are the most important landforms of the glaciated region. Moraines are of four types. **a) Lateral moraines:** Rock debris deposited along the sides of the glacial valley. **b) Medial moraines:** When two lateral moraines meet, it forms medial moraines. **c) Ground moraines:** Rock materials found on the floor or at the bottom of the glacial valley. **d) Terminal moraines:** The glacial deposits found at the end of the glacier.

***The work of Glacier is called "glacial cycle."***

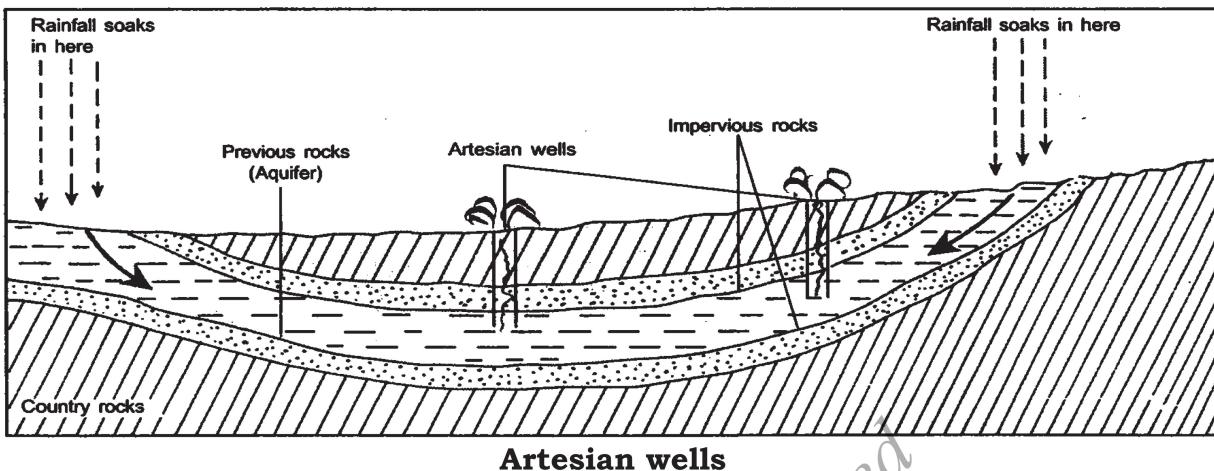
## **UNDERGROUND WATER**

Underground water is the subsoil water found on account of percolation or seepage of water into the ground. The underground water which seeps into the ground passes through various layers of rocks. The rocks which allow the water to percolate are called 'pervious' or 'porous' rocks and the rocks which do not allow the water inside are called 'impervious' or 'non-porous' rocks. The porous rock beds which hold large amount of underground water are called aquifers. The pervious rocks allow and hold water and form springs. A Spring is a place where the underground water comes out naturally.

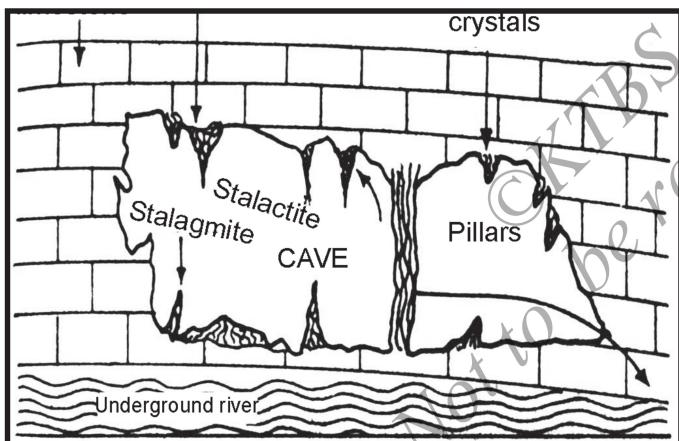
### **Types of spring:**

- 1. Perennial spring:** It is a spring through which water comes out continuously.
- 2. Intermittent springs:** These are springs through which water comes out intermittently (not continuous) and they are also called 'Periodic spring'.
- 3. Hot springs:** Whenever warm or hot water comes out naturally it is called hot spring or thermal spring. They are usually found near the volcanic regions.
- 4. Geyser:** Geysers throw a jet of hot water (like a fountain) and steam into the air at regular or irregular intervals eg., Old Faithful in Yellowstone National Park of USA.

**5. Artesian wells :** When underground water is stored in a basin shaped layer between two non-porous rocks, the water cannot come out naturally. If an artificial hole is made to the porous rock, the water comes out like a fountain. These are called Artesian wells. These wells are common in Australia.



Artesian wells



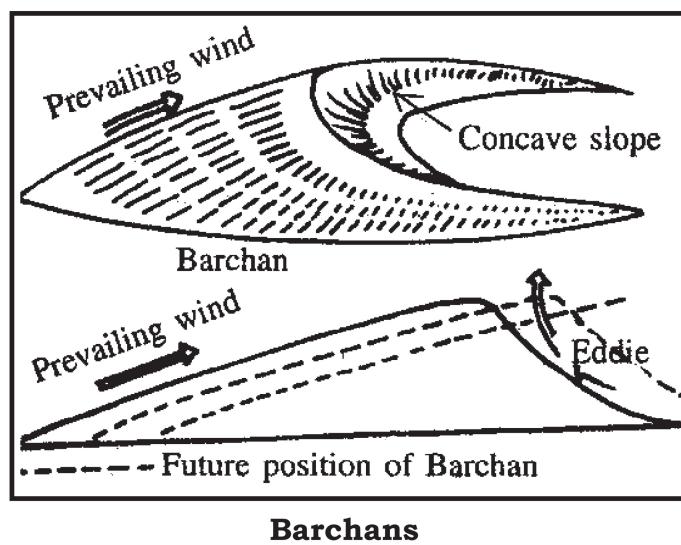
Activity of Under ground water

Lopies, Sinkholes, Limestone caves, Stalactites, Stalagmites, Calcite pillar etc.

#### Facts File : Limestone caves

1. Akalagavi (Ulavi) caves of Uttara Kannada in Karnataka
2. Belum and Bohra caves of Andhra Pradesh

Underground water performs the work of erosion, transportation and deposition. The work of underground water is predominant in limestone region. The important landforms associated with the underground water are



Barchans

*Relief features formed by underground water in limestone region is called '**Karsttopography**'.*

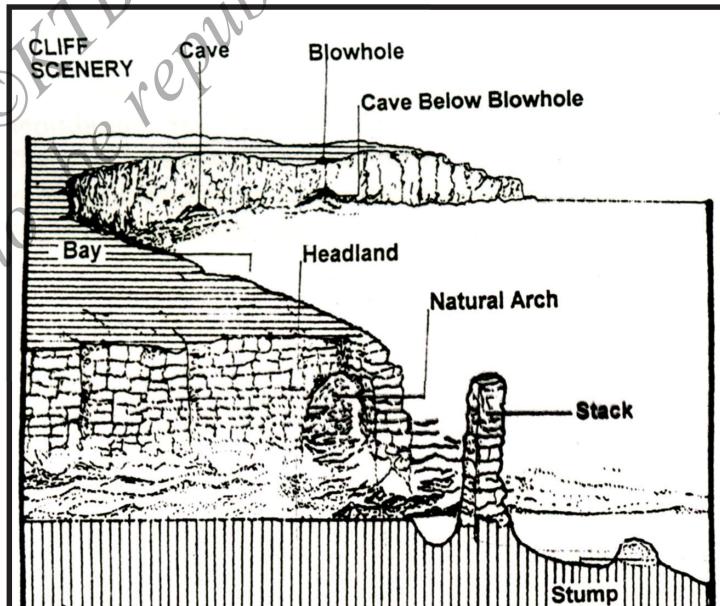
## **WIND**

The denudation work of wind is common in the arid or desert regions. When the winds of high velocity blow over desert areas they erode, transport and deposit materials to produce different landforms. The important landforms associated with the erosional work of the wind are Rock pedestals, Mushroom rock, Inselberg. The depositional landforms are Sand dunes – Longitudinal sand dunes, Barchans and Loess deposits.

**Barchans** are semi-circular or crescent shaped sand deposits most common in the deserts. Loess is the sand particles found beyond the borders of deserts (Yellow soil in China).

**Work of wind is called “Aeolian cycle”.**

**SEA WAVES :** Like all other agents, sea waves are also an important exogenic agent of denudation. Sea waves are the regular undulation of water on the sea or ocean. The work of sea waves is significant along the sea shore or coasts. The important landforms associated with sea waves are Cliff, Sea cave, Sea stack, Sea arch, Headland, Sand bars, Beaches, Lagoons etc.



**Sea Waves**

## **EXERCISES**

### **I Fill in the blanks with suitable words :**

1. The continental crust is also called \_\_\_\_\_.
2. Vast basin shaped volcanic mouth is \_\_\_\_\_.
3. The most destructive earthquake waves are \_\_\_\_\_.
4. Stalactites and Stalagmites are most common in \_\_\_\_\_.
5. The Beaches are formed by \_\_\_\_\_ work.

### **II Answer the following questions :**

6. Mention the three major layers of the interior of the Earth.
7. Name the types of volcanoes on the basis of frequency of eruption.
8. Mention the important earthquake zones of the world.
9. What is weathering? Name the three main types of weathering.
10. Name the landforms associated with the work of river.

### **III. Match the following :**

- | <b>A</b>      | <b>B</b>             |
|---------------|----------------------|
| 11. SIMA      | a) Earthquake        |
| 12. Sandstone | b) Yellow soil       |
| 13. Epicentre | c) Oceanic crust     |
| 14. Geyser    | d) Sedimentary rock  |
| 15. Loess     | e) Underground water |

### **IV Define the following :**

- |                            |                         |
|----------------------------|-------------------------|
| 16. Aqueous rocks          | 20. Tsunami             |
| 17. 'Pacific ring of fire' | 21. Continental glacier |
| 18. Mechanical weathering  | 22. Hot spring          |
| 19. Carbonaceous rocks     | 23. Carbonaceous rocks  |

**V Terms to remember :**

- |                                       |                      |
|---------------------------------------|----------------------|
| 24. NIFE                              | 27. Mountain glacier |
| 25. Arenaceous and Argillaceous rocks | 28. Aeolian cycle    |
| 26. Tectonic forces                   | 29. Beaches          |

**VI Activities :**

30. Collect the different rocks from your environment.
31. Visit nearest falls and know how they are formed ?

\* \* \*

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