11

THE WORK OF RUNNING WATER AND UNDERGROUND WATER

11.1 INTRODUCTION

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.

11.2 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.

11.3 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

The force of the river water carries forward the rock material which comes in its way. 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 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 of 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.

INTEXT QUESTIONS 11.1

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)_____.

(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. 11.1)

The transporting power of a river depends mainly upon its velocity and volume of water and the size of the particles constituting the load. The transporting power increases rapidly with the increase in velocity. If the velocity of a stream water is doubled, its transporting power is increased 64 times; while with a similar increase in volume, it is only doubled. Further, a stream can carry a much larger load of fine materials than a load of coarse type.

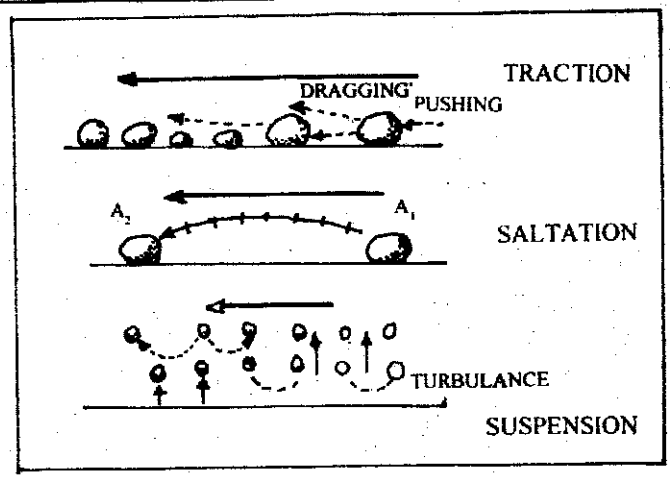


Fig. 11.1 Traction, Saltation and Suspension

* 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.

INTEXT QUESTIONS 11.2

1. Name four ways in which a river transports its load.

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

2. Name the three factors on which transporting power of a river depends.

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

3. When the river velocity is doubled, how many times is its transporting capacity increased ?

   _____ .

(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 11.3

1. Name two conditions which favour the deposition of river load.

   (i)_____ (ii)_____.

2. Name the areas where deposition takes place.

   _____.

11.4 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. 11.2)

(i) The Upper Course : It generally lies in mountainous region and hence the main work of a river is erosion.

(ii) The Middle Course : Here the main work consists of the transportation of the load. There is some amount of deposition and erosion too.

(iii) The Lower Course : Here the deposition of the load is the chief work of the river.

> * 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 it 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.

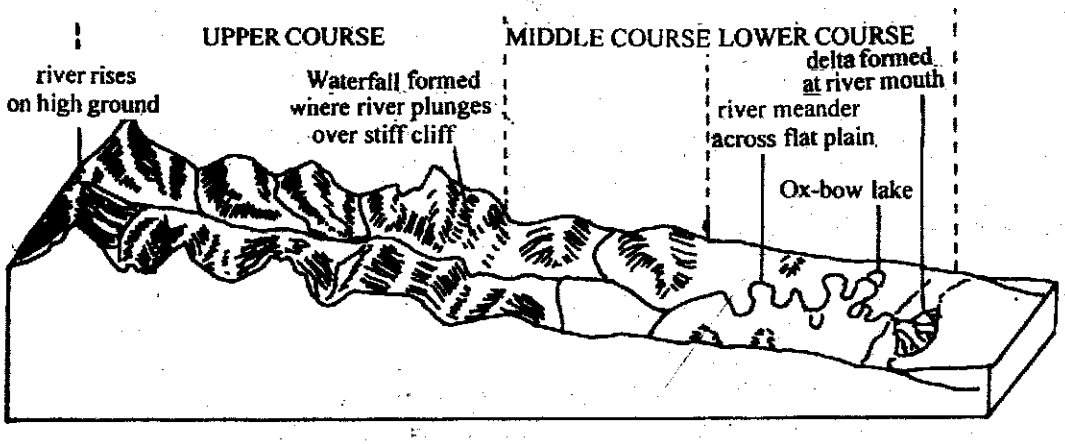
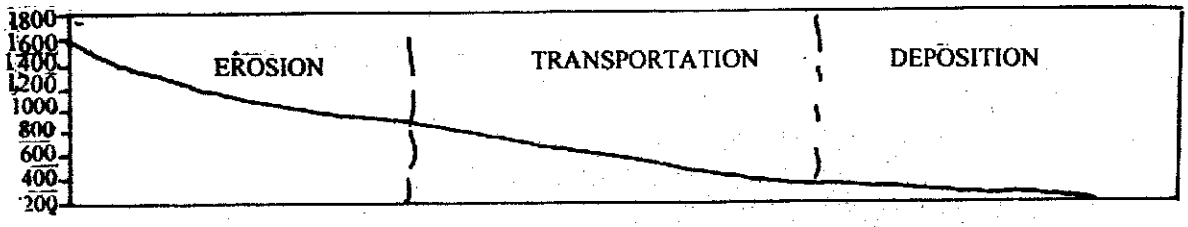
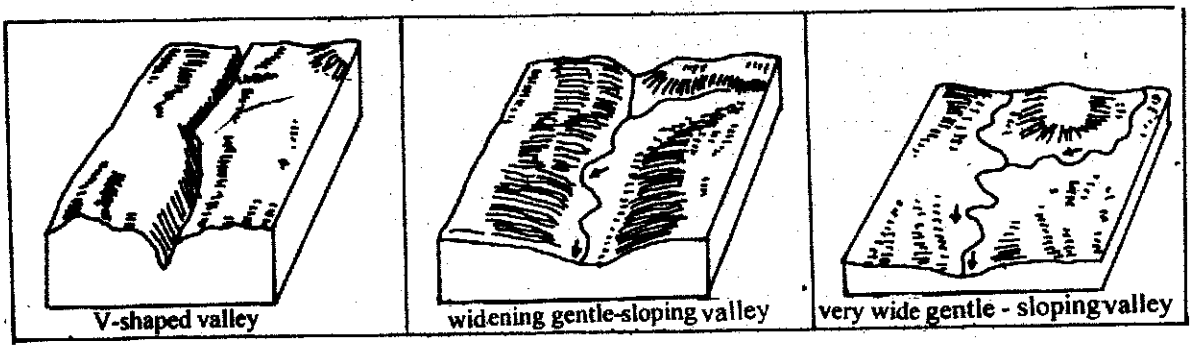


Fig. 11.2 (a) The Upper, Middle and Lower Courses of River





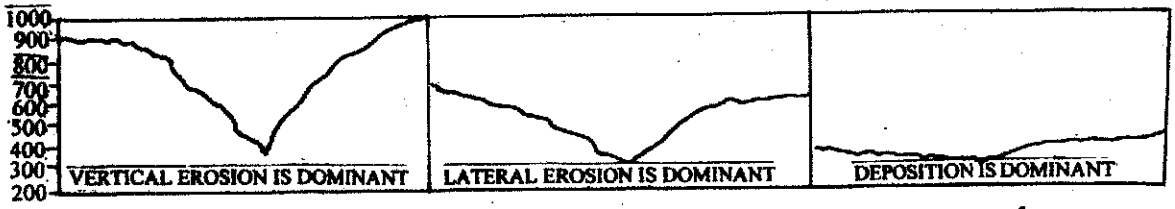


Fig. 11.2 (b) The Graded Long Profile and Cross-section of a River Valley from Source to Mouth

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.

(a) RAPIDS, CATARACTS, AND WATERFALLS

These are liable to occur in any part of the river course, but they are numerous in the mountain course where changes of gradient are more abrupt and frequent. Due to the unequal resistance of hard and soft rocks traversed by a river, the outcrop of a band of hard rock may cause a river to 'jump' or 'fall' down-stream. Rapids are formed, where river waters bounce over outcrops of hard rocks, resulting in turbulent flow (See Fig. 11.3)

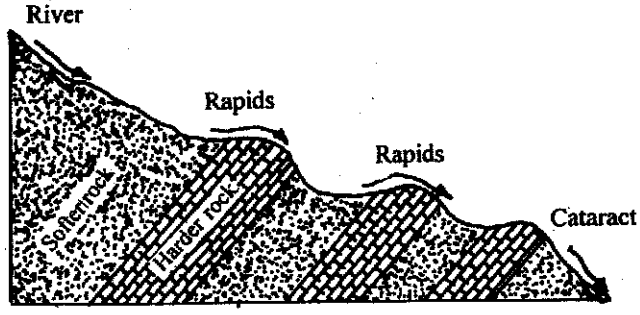


Fig. 11.3 Cataract - A series of Rapids

A series of rapids of greater dimension is also known as cataracts. When rivers plunge down in a sudden fall of some height they are called waterfalls. (See Fig. 11.4)

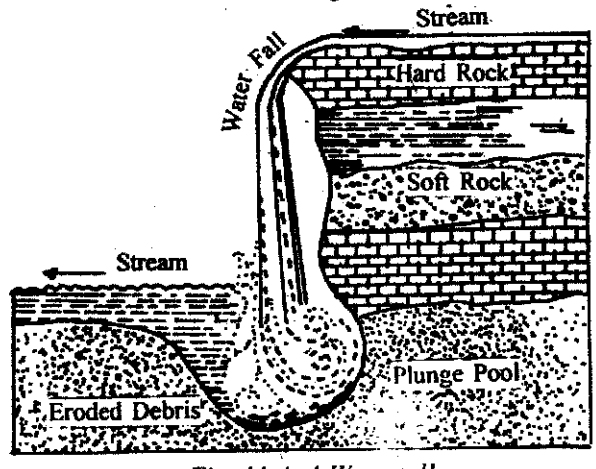


Fig. 11.4 A Waterfall.

The most prominent waterfall in India is the Jog or Gersoppa falls on the river Sharawati in Karnataka State (height 260 metres). Sivasamundram falls on the Kaveri river are 91 meters high. The Dhuandhar Falls on river Narmada near Jabalpur are famous for their picturesque scenery and large volume of water. The Niagara Falls in North America and Victoria Falls in Africa are among the most famous waterfalls of the world.

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

INTEXT QUESTIONS 11.4

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 _____

(c) The Waterfall mainly occurs in the _____ course of a river.

(ii) THE MIDDLE COURSE

In the middle course, lateral corrasion tend 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. 11.5)

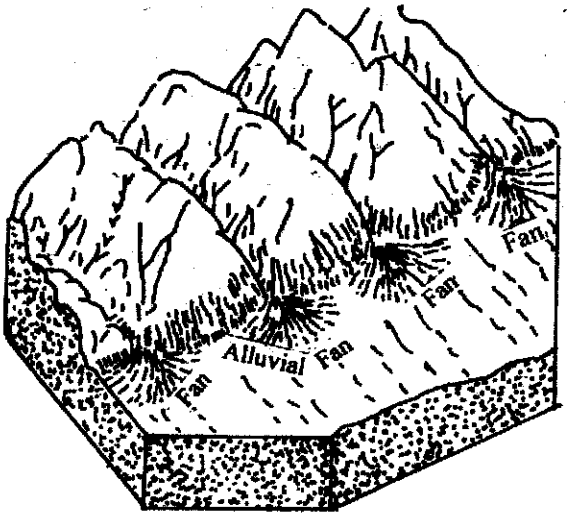


Fig. 11.5 Alluvial Fans

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 terms 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.

INTEXT QUESTIONS 11.5

1. 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 _____.

2. How is a piedmont alluvial plain formed?

_____.

(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. 11.6)

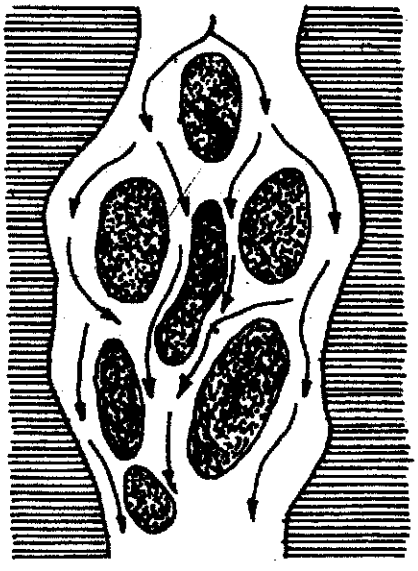


Fig 11.6 Braided Stream

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. 11.7)

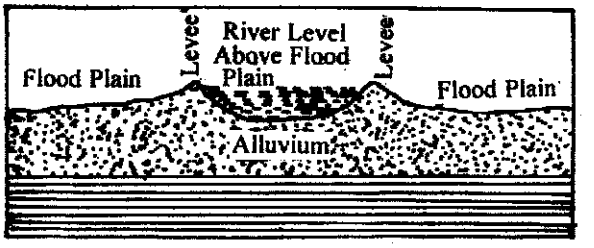


Fig 11.7 Flood Plain and Levees

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 off from the main stream, takes the form of an oxbow lake (See Fig. 11.8).

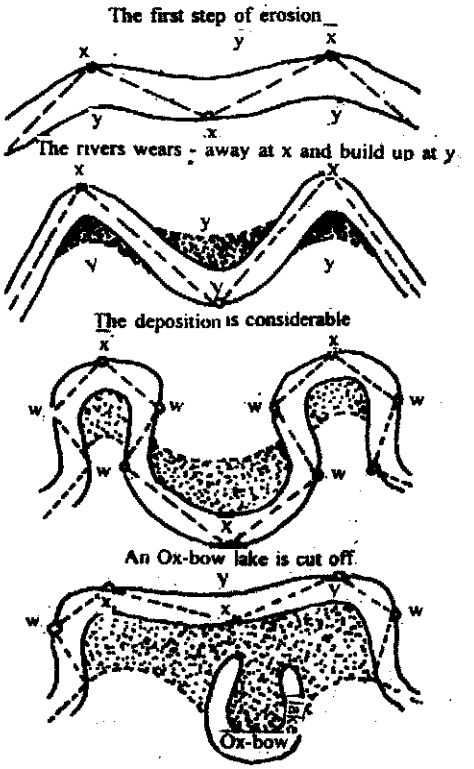


Fig. 11.8 Stages in the Formation of an Oxbow lake

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. 11.9). 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.

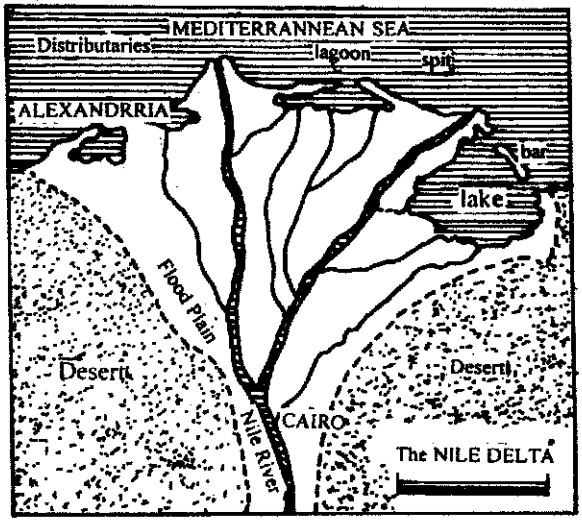


Fig. 11.9 Formation of a Delta

The following conditions favour the formation of deltas :

(1) active vertical and lateral erosion in the upper course of the river to supply extensive 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 11.6

1. 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 _____.

11.5 UNDERGROUND WATER

We all know that water falls on the earth's surface in some form of precipitation. A part of the precipitation that falls on the earth's surface is evaporated back into the atmosphere; a part of it runs off as river and a part is locked up as snow or ice on mountain tops and in cold regions. In addition to this, some water sinks into the ground through joints and fissures to become undergound 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.

Underground water is very important for us. It can be obtained through wells, tubewells and springs. It supplies water for domestic, agricultural and industrial purposes. It provide moisture in the soil for plant growth. It also supplements water in rivers and lakes. Thus it is an important gift of nature.

11.6 WATER TABLE

The water that passes through the rocks cannot go very deep. There is a limit to the depth to which water can pass through. In most of the cases impermeable rocks underlies the permeable rocks. Rainwater can reach only upto the layer of the impermeable rocks. As water cannot pass through these rocks, it accumulates in the pore spaces of the permeable rocks. Such water filled rocks which act as containers and transmitters of water are called aquifers. The zones or horizons of permeable and porous rocks which are fully filled with water is called the zone 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.

11.7 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 also responds to surface relief, therefore it is generally lower on steep slope and mountainous regions as it follows the slope of the surface during its movement from higher to lower elevations. 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.

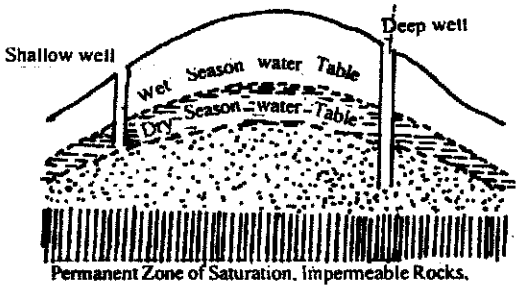


Fig. 11.10 Water Table

(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. 11.10). 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 11.7

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) _____

11.8 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 tube wells) 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 permeble rock does not escape. (See fig. 11.11)

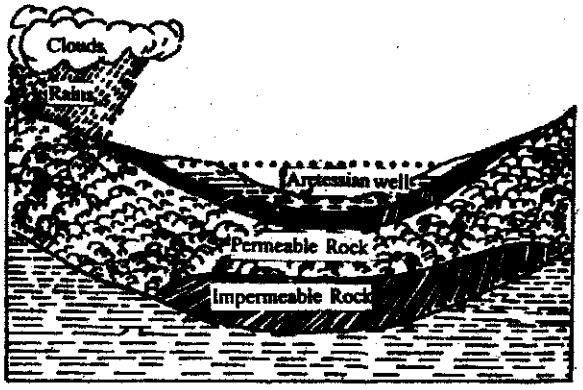


Fig 11.11 Artesian Well

(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 rain water. 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.

11.9 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. 11.12)

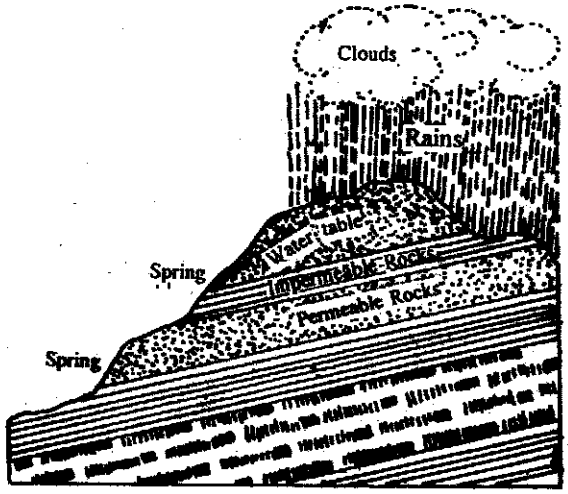


Fig. 11.12 Formation of Spring

(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 Uttar Pradesh, Bihar, Haryana and Assam. Manikaran in Kulu Valley, Tatapani near Shimla, Jwalamukhi in Kangra, Sohna in Haryana, Rajgir and Sitakund in Bihar and Badrinath in Uttar Pradesh have hot springs.

(b) Geyser

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

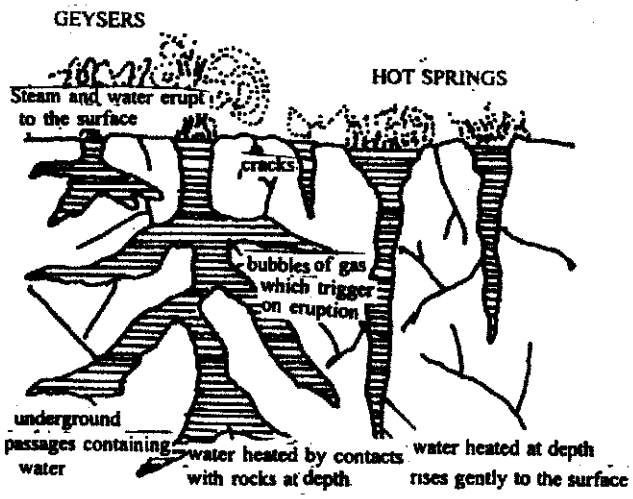


Fig. 11.13 Geyser

steam. The water does not come out continuously but it flows out intermittently because the opening in the surface is very narrow and it does not allow a continuous flow of water and steam. The period between two emissions is sometimes regular. The best example of geysers working at a regular inerval 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. 11.13)

* The surface outflow of ground water through an opoening 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 11.8

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?

   _____.

11.10 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.

Limestone is a rock which is readily soluble in water containing carbon dioxide. Rain water carrying carbon dioxide absorbed from the atmosphere forms a mild

acid. This acid acts on limestone and dissolves it. Limestone rocks have numerous joints and fissures through which surface water percolates and disappears underground. After disappearing down the rocks, water starts flowing as underground channels. Aided by mechanical corrasion and solution of limestone in water, it gradually erodes the limestone rocks.

* 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

They are funnel-shaped depressions which have an average depth of three to nine metres. The diameter of the depression near the surface is more than one metre. They are formed by the enlargements of cracks in the rock due to the solvent action of water. For example, in India, sink holes are found in limestone region of Meghalaya. In areas where sink holes are large in number, construction of railways and roads becomes very difficult.

(ii) Swallow Holes

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

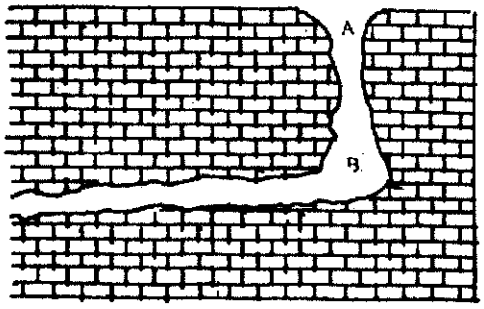


Fig 11.14 A Sink holes on the Surface of Limestone Rock

B-Swallow Holes at the bottom of a Funnel Shaped Sink Hole

(iii) Caverns

Underground caves formed due to solvent action of underground water in limestone region are called caverns. They are special features of limestone regions. The surface water becomes underground through sink hole and swallow holes. After reaching underground it dissolves the limestone rocks and carves out a network of caverns. They are found near Dehradun in Uttar Pradesh and in Almora in Kumaon Himalayas. The caves of Kotamsar in the tribal district of Bastar in Madhya Pradesh are famous caverns of India.

- The funnel-shaped depressions in limestone regions are called sink holes.
- The 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 evapourated 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.

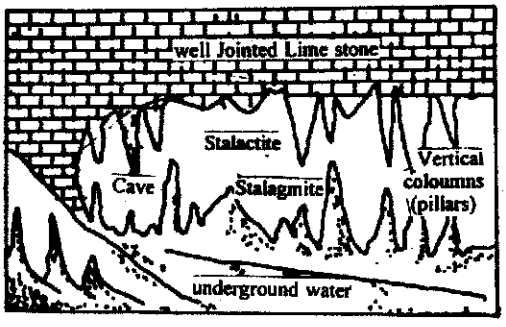


Fig. 11.15 Stalactites and Stalagmites

When the remaing 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 11.9

1. Answer following questions in one or two words :

   a. Name the cavern located in Madhya Pradesh.

   _____ .

   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) _____ .

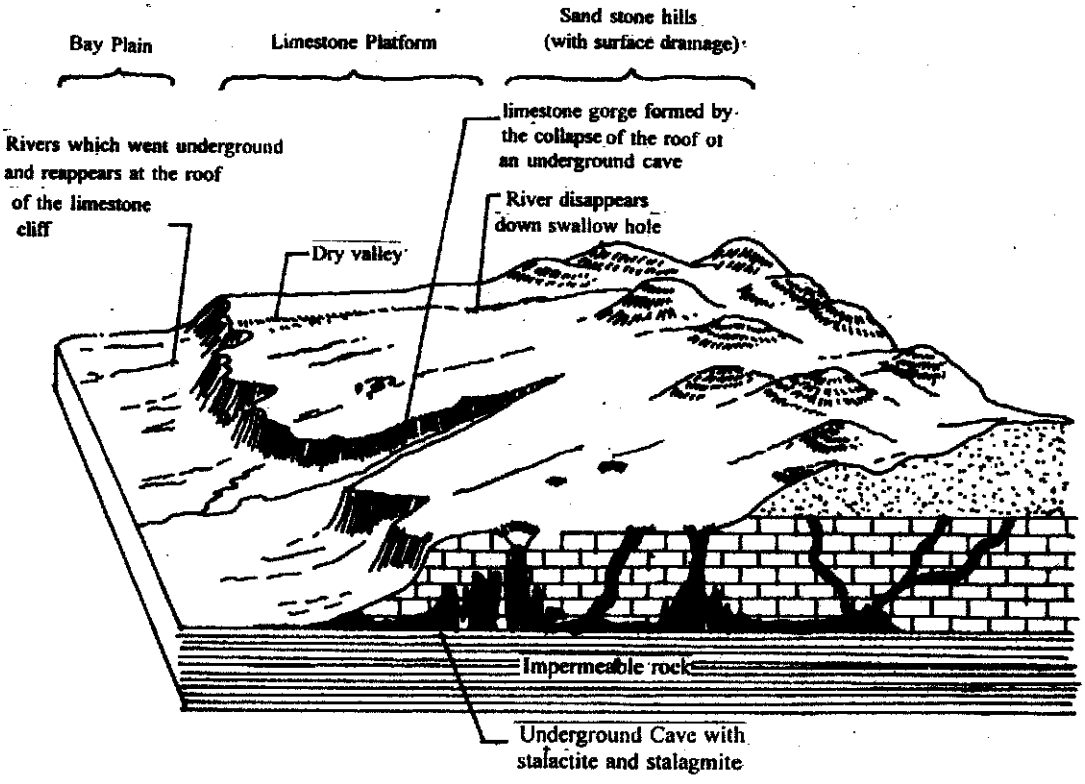


Fig. 11.16 Limestone Landscape

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 tansports 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, alluviarfans 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 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 form of a fountain, they are called geysers. Geysers are found mainly in Iceland, Yellowstone National Park, U S A 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) How are waterfalls formed? Explain it with suitable diagram.

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

2. Distinguish between the following pairs:-

   (a) rapids and waterfalls (b) estuary and deltas (c) 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, waterfall, alluvial fan, and canyon.

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

   (a) Oxbow lake (b) Delta (c) Waterfall (d) Caverns (e) Spring

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 sink holes.

   (d) Permanent watertable and temporary watertable.

   (e) Sink hole 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 explain any two of these with the help of diagrams.

CHECK YOUR ANSWERS

INTEXT QUESTIONS

11.1

1. (i). Erosion (ii) Transportation (iii) deposition
2. Load
3. (i) Corrasion (ii) Corrosion (iii) Hydraulic action (iv) Attrition.

11.2

1. (i) Traction (ii) Saltation (iii) Suspension (iv) Solution.
2. (i) Velocity (ii) volume of water and (iii) size of particles.
3. 64 times

11.3

1. (i) decrease in slope or in velocity of water (ii) decrease in volume of water.
2. Plains, low laying areas, lakes and seas.

11.4

(a) (i) upper (ii) middle (iii) lower course.

(b) Gorge (c) Upper

11.5

1. (a) Meanders (b) Alluvial fan
2. By deposition of load at the foot of mountains.

11.6

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

11.7

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.

11.8

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

11.9

(a.) Kotamsar b. Croatia Yugoslavia c. (i) Iceland (ii) Yellowstone National Park, U S A (iii) New Zealand d. (a) Sink holes (b) Swallow holes.

TERMINAL QUESTION

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) When river plunges down in a sudden fall of some height then the waterfalls are formed, mostly in a hilly areas.

   For diagram consult fig. 11.4

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

2. (a) Rapids- The portions of a river with accelerated current, where it hops, skips and jumps, are known as rapids.

   Waterfalls- A sudden descent of water over a big step in the bed of a river.

   (b) 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.

   (c) 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, Waterfall.

   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.

   (c) Waterfall- When river plunges down in a sudden fall of some height, the fall is called a waterfall. The most famous waterfall in India is the Jog or Gersoppa waterfall.

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:- George, 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 sink holes 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. 11.10)

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 11.14) 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 evapourated and a small deposit of lime stone 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 11.14, 11.15 and 11.16

(i) Sink holes (ii) Swallow holes (iii) Caverns

(iv) Stalagmites (v) Stalactites.

See description of these figures in Section 11.10.