## River Erosion

*River erosion involves four processes, these are*

**Hydraulic Action** It refers to the force of moving water which is able to remove loose material such as fine gravel or sand lying on the bed of the channel. It is also able to weaken solid rock by surging into cracks in the rock. But hydraulic action effects very little erosion if the river has little or no load.

**Abrasion** Rock particles carried by a river are through against the sides of the channel and are dragged along the rock bed. This causes further erosion, which adds to the load. The larger the particles in the load, the more rapid is the erosion. Eddies in a river's flow whirl pebbles ground in hollows on the bed of the channel, thereby causing them to get deeper. These depressions are called *pot holes*.

**Attrition** The mechanism by which the particle size of any material is reduce by frictior during transport by ocean waves wind or running water, note that attrition differs from abrasion and corrasion.

**Solution** The process by which matter is changed from a solid or gaseous state into a liquid state by combination with a solvent. It is one of the less important forms of chemical weathering, in which solid rocks are dissolved by water. It is of some significance in the case of calcareous rocks acted upon by rain water, which has become slightly acidic owing to its accumulation of carbon dioxide from the atmosphere.

### Ways of River Erosion

*River erosion operates in three ways*

**Vertical erosion** by which a river deepens its channel.

**Lateral erosion** by which a river wears away the sides of its channel. This is particularly effective along the outside banks to meanders.

**Headward erosion** by which a river increases its length. Water that flows out of the ground is called a spring. Sometimes a spring develops where the water table meets the surface. If a spring lies at the head of a valley, the outflowing groun dwater wears away material around it and this enables a river to cut back slowly into the hillslope behind the spring. The process is called spring sapping.

## Characteristics of River

River acts as a system consisting of one main channel w tributaries flowing into it. A river system which lies in basin is bounded by a divide called *watershed*. Bey watershed the river is drained by another system. River systems in the sense that the mass of water and sedimen is balanced by that leaving the system.

*A typical river system has three sub-systems*

**Transporting System** The main trunk stream acts as chan for the movement of water and sediment from the collecti to the ocean. While transportation is the major p deposition also occurs where meandering occurs, *i.e.*, oscillates back and forth and also overflows its banks floods. Thus, all the three processes: erosion, transporta deposition occur in the transportation system of a river.

**Dispersing System** This system consists of many distrib the mouth of the river where sediments and water is di into ocean, lake or dry basin. Deposition of coarse sedime dispersal of fine grained sediments and water are the processes involved.

**Collecting System** It consists of a vast network of tributa the head water region. These tributaries collect wate sediment and then funnel them into the main system. The of the whole pattern resembles a tree, and hence, it is kno *dendritic patterns*. The collecting system has an initial netw tributaries and even the smallest tributaries have their system of tributaries making the real number of st phenomenal.

## Erosional Landform

### V - Shaped Valley

Valleys start as small and narrow rills, the rills will gradu develop into long and wide gullies, the gullies will further deep widen and lengthen to give rise to valleys. Depending up dimensions and shape, many types of valleys like V-shaped vall gorge, canyon etc can be recognised.

### Gorge

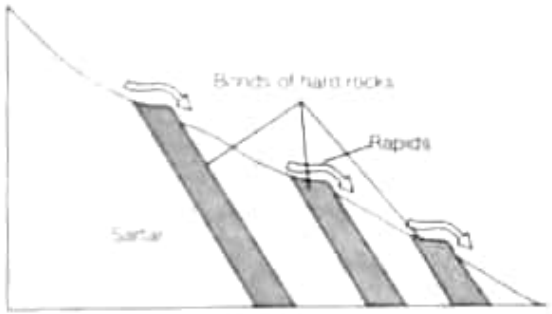
It has a steep precipitous wall within which a narrow river confined. It can result from channel deepening as a result recession of fall that has happened with Niagara gorge. E continent has example of gorges. The Indus, Sutlej, Brahmapu and Arun form gorges in the Himalayan region where they antecedent streams other examples are the Rhine gorge in Eur and the Zambezi gorge in Africa.

## Canyon

It has a remarkable similarity with gorge in that, it also has steep slopes, narrow river bed and a predominant vertical erosion. The narrowness of the valley is determined by both vertical erosion and humidity of the area. The Grand Canyon, Colarado is very deep but, its walls are not vertical because it passed through an arid zone where frost weathering and other forms have tended to open the V.

## Rapids

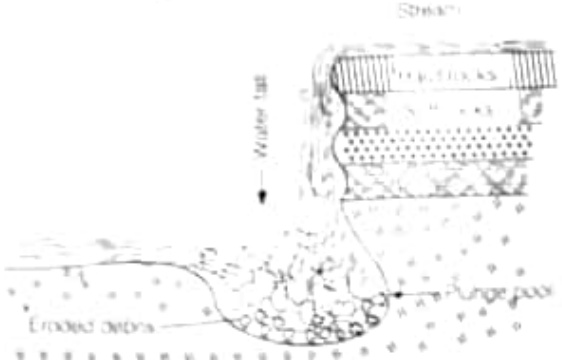
It is a most characteristic feature in upper course of a river. The occurrence of the band of a hard-rock along the path of a river makes it jump over or fall downwards. This leads to the formation of rapids at places where the trad valley bottoms offers greater resistance to the erosion that the strips above and below it. Some rapids can be rendered harmless for navigators by blasting.




Rapids

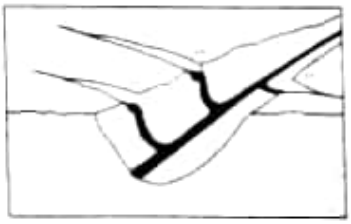
## Waterfall

When especially small rivers tumble down almost verticals from a height along its course. These are called the *waterfalls*. A bar of resistant rock lying across a river valley leads to the formation of a waterfall or a series of rapids, as in the case of Niagara falls of North America (120 m drop) and Victoria falls (68 m) on Zambezi rivers in South Africa or a plunge down the edge of a plateau like river Zaire of Africa.




## Hanging Valley

In glaciated areas at points where tributary stream joints the mainstream, the over-deepening of the main valley leaves the side valley hanging high above the valley of the master stream. A waterfall is noticed at the point where the tributary stream falls down into the mainstream.



Hanging Valley

In our country, **Jog or Gersoppa falls** on a tributary of the Cauvery river in Karnataka are seen recording a plunge of 260 m in a single fall at the edge of Western Ghats. The Dhunandhar falls in the marble rocks near Jabalpur are only of 9 m, but are famous on account of their scenery and by volume of water. The river Indravati in Bastar District of Madhava Pradesh falls from over a cliff from a height of 27 m and Subarnarekah river near Ranchi creates 97m high Hundroo falls in Chhotanagpur plateau.

## Potholes and Plunge Pools

Over the rocky beds of hill-streams, more of less circular depressions called *potholes* form because of stream erosion aided by the abrasion of rock fragments. Once a small and shallow depression forms, pebbles and boulders get collected in those depressions and get rotated by flowing water and consequently, the depressions grow in dimensions. A series of such depressions eventually join and the stream valley gets deepened. At the foot of waterfalls also, large potholes quite deep and wide, form because of the sheer impact of water and rotation of boulders. Such large and deep holes at the base of waterfalls are called *plunge pools*. These pools also help in the deepening of valleys. Waterfalls are also transitory like any other landform and will recede gradually and bring the floor of the valley above waterfalls of the level below.

# River Transport

All the material that a river transports is called its *load*. A river transports its load in four ways by *traction* (the dragging of large pieces of material such a pebbles along its bed), by *saltation* (the bouncing of smaller pieces over its bed), by *suspension of light material*, such as silt and mud, in the water and by *solution of certain minerals*, which dissolve in water. A river transports its load until it has insufficient energy to transport it any further. When this happens, the load is deposited.

A river loses energy when its gradient decreases, when its channel widens, when it meanders and when its volume decreases, e.g., after a flood. During flooding, the volume increases and the river's energy also increases. This results in increased erosion, which in turn leads to an increase in the river's load. When the floods

The river now has too great a load, its power to erode decreases and deposition takes place. The erosion achieved by a river depends upon its velocity and its discharge. The greater the discharge, the greater the total energy.

# Depositional Features

## Causes of Deposition

1. Break in slope, where the stream leaves the hills and enters a plain.
2. Widening of valley floor allows flooding to occur.
3. Contact with quiet water. When swift flowing stream enters quiet waters or lakes.
4. Where rivers debouch into the sea.
5. Where stream peters out as in arid and desert regions causing a decrease in river energy and allowing sediments to be laid.

## Meanders

We saw that a river begins to meander in its initial stage, when outcrops of resistant rock in its path. But, there are no such our crops in flood plains, where meanders are developed to their maximum extent. Riffles and pools may form the clue to understanding the cause of these meanders.

## A Riffle

This is an area of shallower, faster-flowing water perhaps caused by bars of sideman on the river bed. A pool is an area of deeper, slower-flowing water. Energy is used upto erode the bed of the river in the areas of riffles, but energy builds up in the areas of pools because there is little if any erosion. This stored energy is used up in the next riffle.

# Alluvial Fans and Cones

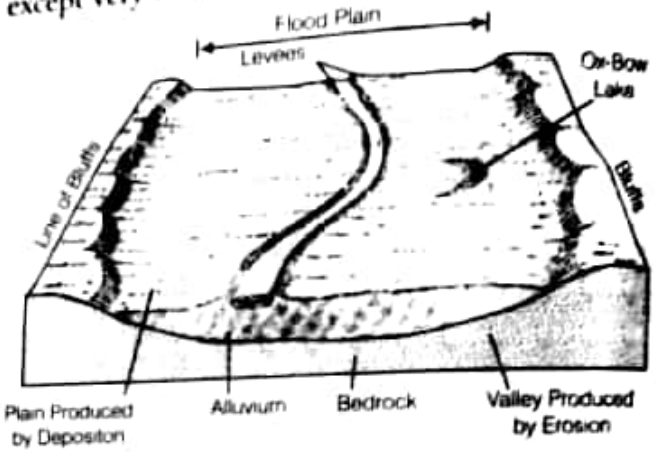
Where a heavily laden stream reaches the plain, its velocity is checked, it widens and much of its load is deposited. The deposited sediments spreads out as an alluvial fan. Deposition results from the sudden decreases in velocity as the stream emerges from the steep slopes of the upland and flows across the adjacent basin, with its gentle gradient.

An alluvial cone is a type of alluvial fan, but one in which the slope angles are steeper and the deposited material is generally coarser and thicker having been transported by ephemeral or short lived torrents, emerging from a high rocky massif at a mountain front or valley side.

## Flood Plain

A flood plain often has areas of marsh and numero usually crescent shaped and called ox-bow lakes. The remnants of meanders that have been cut off. When the flood, it spills over its channel and often covers the wh flood plain which it deposits sediment. When a river over channel, deposition takes place on the banks of the cha this produces a ridge like feature known as a levee.

As the members move down the valley, they swing from to the other, undercutting the bluffs and eroding th further. The Wairan river, New Zealand has many cut ox-bow lakes as well as meanders. The flood plain eve becomes so wide that the members no larger reach the side valley, except very occasionally.




A Flood Plain

## Natural Levees and Point Bars

These are some of the important landforms found associated flood plains. Natural levees are found along the bank of rivers. They are low, linear and parallel ridges of coarse dep along the banks of rivers, quite often cut into individual mou During flooding, as the water spills over the bank, the velocit the water comes down and large sized and high specific gr materials get dumped in the immediate vicinity of the ban ridges. They are high nearer the banks and slope gently away the river.

The levee deposits are coarser than the deposits spread by waters away from the river. When rivers shift laterally, a seri natural levees can form. Point bars are also known as mea bars. They are found on the convex side of meanders of rivers and are sediments deposited in a linear fashion by flow waters along the bank. They are almost uniform in profile a width and contain mixed sizes of sediments. If there more are ridge, narrow and elongated depressions are found in bet the point bars. Rivers build a series of them depending up water flow and supply of sediment. As the rivers build the bars on the convex side, the bank on the concave side will activity.

## raided Stream

he lower river plain is haracterised by an excess deposit f the load on the floor of the hannel because of the reduction in s carrying capacity of the slow owing stream. The stream which hus gets divided into a networks f channels forming bars of sand nd islands is known as a *braided* tream.

Braided Stream

**Ox-Bow Lake** The flow of water through a meander has a corkscrew characteristic. This results in active lateral erosion along the concave bank of the meander. The neck of land separating the two ends of a meander is at last cut through, usually when the river is in flood. Deposition on the convex bends of the meander gradually seals the ends of the meander turning it into an ox-bow lake. Prior to this forming, the cut off meander forms a cut-off. After an ox-bow lake has formed, the bed and the banks of the river are steadily raised by deposition and in time, the river lies above the level of the ox-bow lake. ox-bow lakes gradually lose their water as vegetation and sediment fill them in.

### Smart Facts

- The word meander is derived from the name of a small winding river 'meanders' in Turkey.
- Cotahuasi canyon of Peru is the world's deepest canyon. This is cut by the Rio Cotahasi, a tributaary of the Rioscona, to a depth of approximately 3354 m. It is twice the depth of the Grand canyon which is only 1737m deep.

## Delta

In its lowest reaches a rivers load is usually large and all the available energy of the river is used to transport this. The load consists of alluvial material, mainly sand, silt and clay. When the river enters the sea, its velocity decreases, which reduces its ability to carry all of its load. Therefore, deposition take place.

This happens in the rivers estuary and out to sea. The heaviest material is deposited first, *e.g.*, sand followed by silt whilst the lightest material, the clay, is carried out to sea before it is deposited. The sediment deposited in the estuary (mouth) builds up in layers to form a gently sloping platform. In time, the platform may extend up to the surface and above, when it is called a delta. delta is a low-lying swampy plain which gradually becomes colonised by various types of plants.

*Following conditions are necessary for the formation of a delta*

1. The velocity of a river must be sufficiently low to allow most of its load to be deposited as the river reaches
2. River must have a large load.
3. The river's load must be deposited faster than it can be removed by the action of tides and currents.

*There are three basic types of delta*

1. **Bird's Foot** This delta consists of very fine material that is silt and it has a few long distributaries bordered by levees that put out from the shore. this type of delta forms when the power of the waves and current is low. The delta of Mississippi in USA and the delta of the Omo river in Ethiopia are good examples.

The Mississippi Delta of USA

2. **Arcuate** This delta consists of both coarse and fine sediment and it has the shape of an inverted crescent. It is crossed by numerous distributaries. Some examples of this types are the deltas of the Niger, the Nile, the Hwang- Ho, the Indus, the Ganga, the Irrawaddy and the Mekong etc.

Nile Delta

3. **Estuarine** This delta is formed from materials deposited in the submerged mouth of a river. It takes the shape of the estuary. The delta of the river Seine, France, Delta of the river Vistula, Poland and the delta of Ob, Russia are the best examples of this type of delta.

# Landforms Associated with Glacial

Masses of ice moving as sheets over the land or as linear flows down the slopes of mountains in broad through like valleys mountain and valley glaciers are called *glaciers*. The movement of glaciers is slow unlike water flow. The movement could be a few centimeters to a few metres a day or even less or more. Glaciers move basically because of the force of gravity. Numerous changes have occurred to the pattern of climates of the Earth during its long geological history. The scenery in parts of Britain, Europe and North America reflects periods in the Earth's history when large areas were buried beneath thick sheets of ice and glaciers. Such periods are known as *ice ages* and the last of these occurred in the Pleistocene period.