Department of Geology G.G.M Science College Jammu

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Unit-3

3.1. Fluvial Process: River Profile, Drainage Pattern, Erosional and Depositional Features Produced By Rivers

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FLUVIAL PROCESS:

Fluvial processes are associated with rivers and streams and the landforms created by them. Such **processes** play an important role in the denudation of land surfaces and the transport of rock materials from higher to lower levels.

RIVER PROFILE

The slope of the long profile (along the course) of a river is expressed as a graph of distance from source against height. The **long profile** of a **river** shows changes in the height of the course of a **river** from its source to its mouth. A **long profile** is concave and the slope becomes gentler towards the mouth of the **river**. **The vertical erosion** or down cutting of river water deepens its channel, whereas the lateral **erosion** widens it.

The **cross profile** of a river changes from the **upper to lower course. This is due to the** result of changes in energy of river and the processes that the river carries out. In the upper course, the valley and channel are narrow and deep as a result of the large amount of vertical erosion and little lateral erosion.

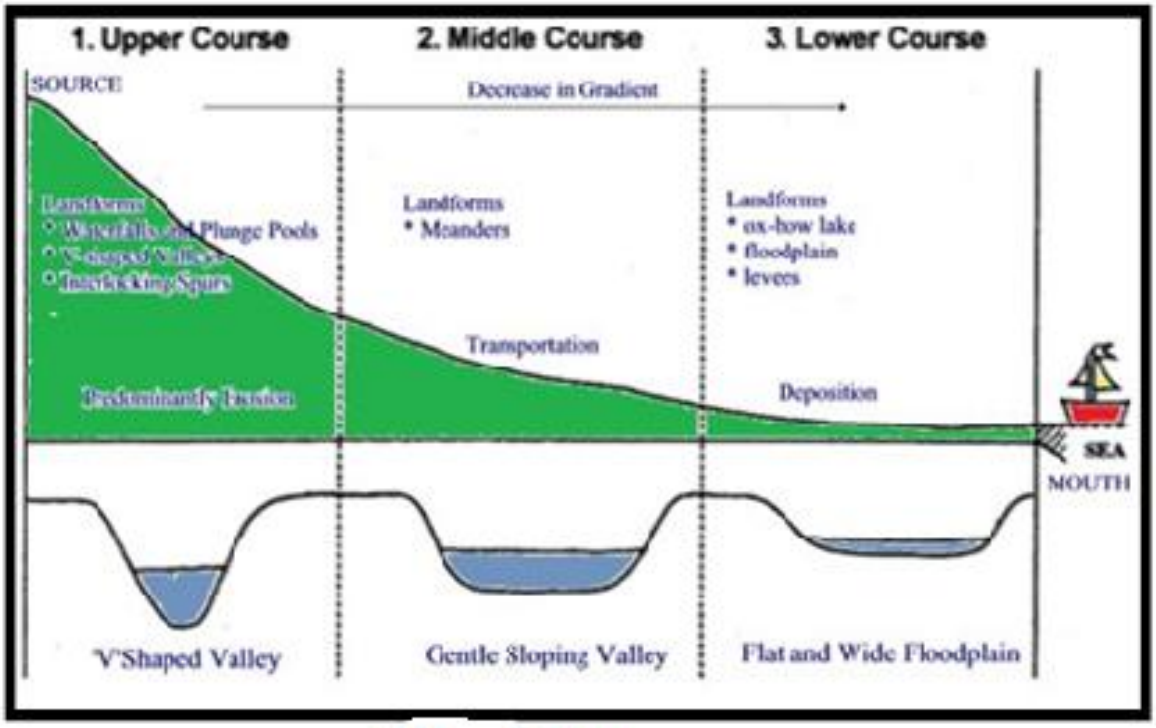


Fig.3.1a

DRAINAGE PATTERN

Drainage systems is also known as river systems, are the patterns formed by the streams, rivers, and lakes in a particular drainage basin. The drainage pattern of an area is the result of the **geological time period, nature, and structure of rocks, topography and slope.** A drainage basin is the region from which a stream receives runoff through flow, and groundwater flow. The number, size, and shape of the drainage basins found in an area vary.

Drainage patterns of the fluvial are classified into different types, these are;

- Dendritic drainage pattern
- Parallel drainage pattern
- Trellis drainage pattern
- Rectangular drainage pattern
- **Annular drainage pattern**
- Radial drainage pattern
- Centripetal drainage

Dendritic drainage pattern. Dendritic drainage systems show a tree like pattern. In this pattern there are many contributing streams which are like twigs of a tree which joined together into the tributaries of the main river **(Fig.3.1b)**. They develop where the river channel follows the natural slope of the terrain. Dendritic systems form in V-shaped valleys; as a result, the rock types must be

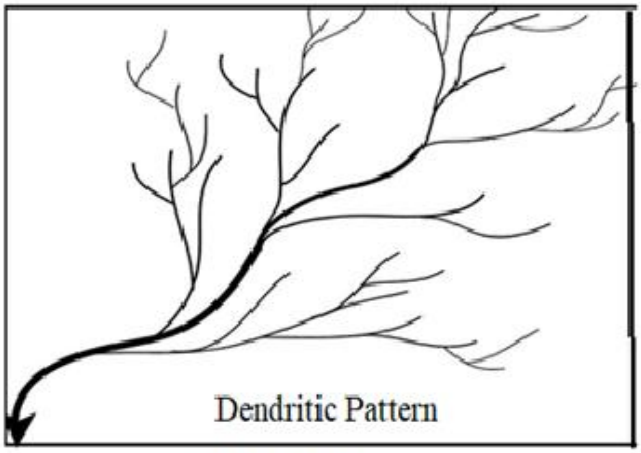
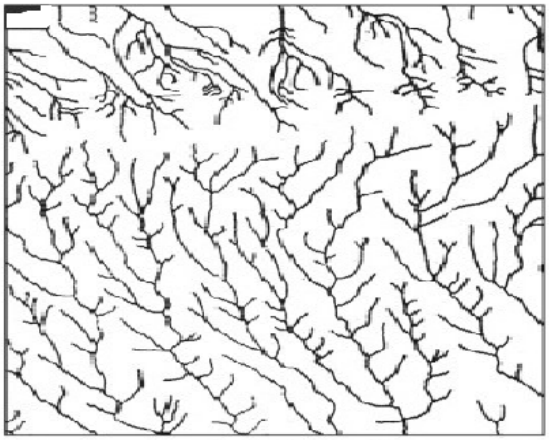


Fig.3.1b

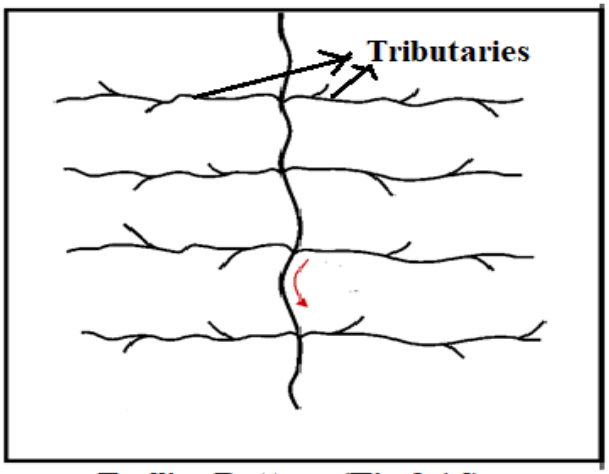


Parallel Pattern (Fig.3.1c)

impervious and non-porous.

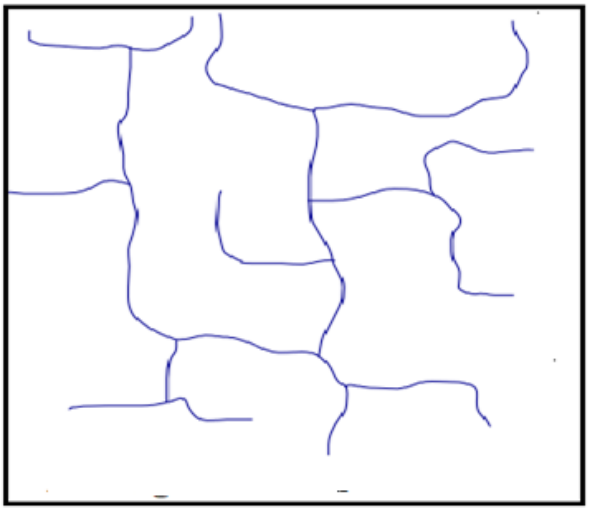
Parallel drainage pattern. A parallel drainage pattern of rivers is caused by steep slopes with some relief. This system forms on uniform and steep sloping surfaces, elongate landforms of resistant rocks. The streams are swift and straight, with very few tributaries, and all flow in the same direction **(Fig.3.1c).** A parallel pattern sometimes indicates the presence of a major fault that cuts across an area of steeply folded bedrock.

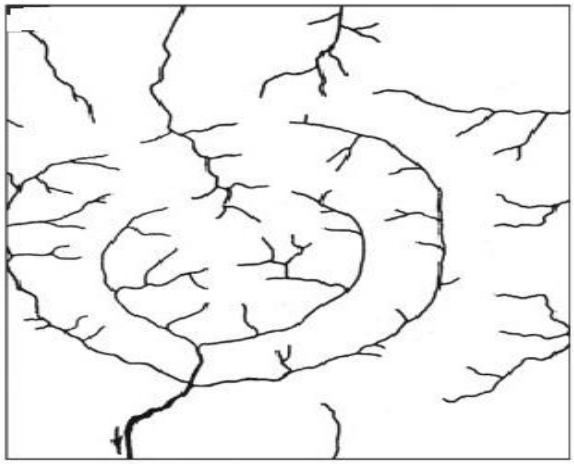
Trellis drainage pattern. A **trellis drainage pattern** occurs when tributaries join a river and erode a valley at right angles in a **pattern (Fig.3.1d).** This **drainage patterns** occur mostly in areas where rock can erode easily along weak areas in them. They form where hard and soft rocks exist parallel to each other. Trellis drainage is characteristic of folded mountains, such as the Appalachian Mountains in North America and in the north part of Trinidad**.**



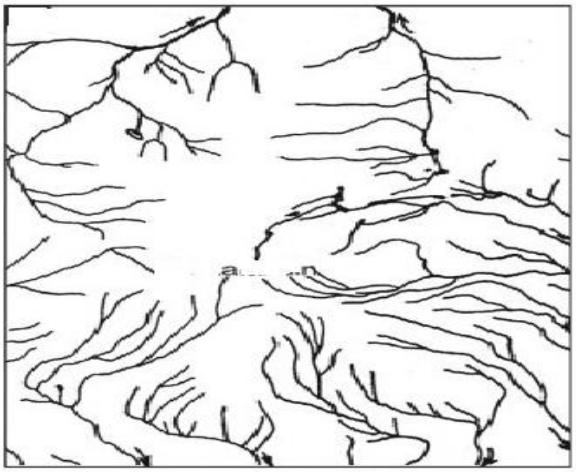
Trellies Pattern (Fig.3.1d)

Rectangular drainage pattern: This pattern develops on rocks that are of uniform resistance to erosion, the rocks must have two directions of jointing at approximately right angles. As the joints are usually less resistant to erosion than the bulk rock therefore erosion opens the joints and streams develop along the joints. This forms a stream system in which streams join larger streams at right angles **(Fig.3.1e)**. This pattern is found associated with the Arun River in Nepal.


Rectangular Pattern(Fig.3.1e)



Annular Pattern, (Fig.3.1f)



Radial pattern, (Fig.3.1g)

Annular drainage pattern: This is a ring like **pattern** subsequent in origin and is associated with maturely dissected dome or basin structures**(Fig.3.1f).**

Radial drainage pattern: In radial drainage system, the streams radiate outwards from a central high point. Volcanoes, tops of mountains, domes and laccoliths shows radial pattern. In India the Amarkantak range and Ramgarh crater show the best example of radial drainage pattern **(Fig.3.1g).**

The centripetal drainage: The centripetal drainage system is similar to the radial drainage system, with the only exception is that they have streams ending into a low land rather originating from it.

EROSIONAL FEATURES

Erosion is the movement of rock particles once they have been detached by the action of natural agents of weather and others like roots of plants. Erosion can also be defined as transportation of loosened rock pieces from a higher elevation to a lower point with the action of natural agents. Erosion of the rocks is caused by four processes, these are i) Attrition, ii) Abrasion, iii) Solution, iv) and Hydraulic Action.

In Attrition the rock material carried by the running water colloids each as a result they breaks each other into smaller and smaller rock angular fragments.

During the transportation of the sediments these scraps the bed rocks and banks causing them to breaks into smaller fragments, such type of erosion is called

“Abration”. The river water reacts with the bed rocks and surrounding rocks and carries them away in solution which is another type of river erosion.
The compression of the air in the cracks of the bed rock and river banks increases the pressure which causes the explosion result in breaking of rocks in to smaller pieces. Such type of river erosion is called Hydraulic action.

There are various features which are formed by the different types of river erosion. These are;

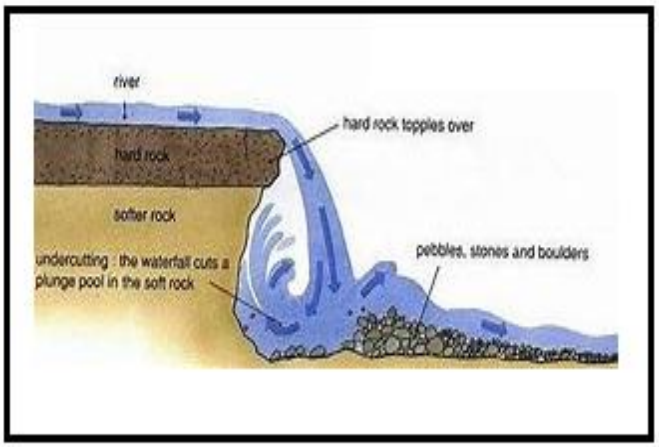
1. POT HOLES

These are cylindrical or bowl-like depressions in the rocky beds of streams, which are excavated in the floors of the streams by extensive, localized abrasion **(Fig.3.1h).** These are commonly formed in the softer bed-rocks of the stream floor. Pot-holes may vary in dimensions ranging from a few centimetres to several metres.

Pot holes, (Fig.3.1h)

2. WATERFALLS:

River flows over uneven surfaces and sometimes rock layers vary in their hardness. The harder bed may withstand erosion by river, while the softer ones are relatively quickly eroded causing a local difference of elevation in the channel. Two types of situation may rise in this case.



Waterfall,(Fig3.1i)

i). if a hard rock dips gently down the stream, that the steepness is not so pronounced , the river passing over it generally forms a **Rapid** which bare the water falls of small dimensions.

ii). If the hard rock bed is horizontal or dips gently up the stream, the river will erode away partially the softer rocks beneath it. The hard rock may stand as a ledge where from water jumps down, falling on lower beds with increased velocity giving rise to what is known as a **waterfall**. Thus, when a river falls from a vertical escarpment it forms a waterfall. A fall that flows in a series of small jumps is called as a **Cascade**. Gerosoppa (Jog) water falls in the Swarvati River in Karnataka is the highest water fall in India.

3 RIVER VALLEYS

The channels carved out by the flow of running water are commonly known as river-valleys. These are negative land forms of varying size and shape. Three processes such as Valley- deepening, Valley-widening and Valley-lengthening are mainly responsible for development of valleys.

Gorge, (Fid.3.1j)

(a)Valley-deepening

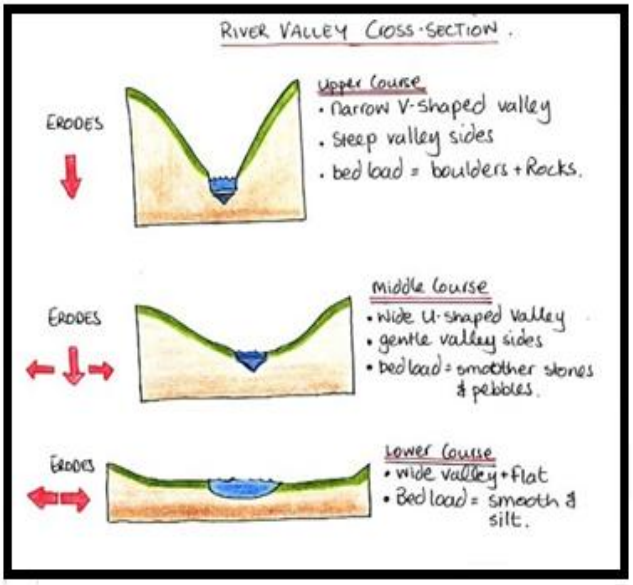
River erosion cause valley deepening in which the river bed undergoes down cutting giving rise to a narrow but deep valley. The down-cutting of valley floor take place in the youth stage of the river where velocity of river is high and slop is steep. This process gives rise to important geological features like gorges or canyons**.**

Gorges: A narrow valley between hills or mountains, typically with steep rocky walls and flat base with stream running through it**(Fig.3.1j).** It is formed by the excessive down cutting of the river. It is more narrow and much steeper than canyons.

Canyons, (Fig.3.1k)

Deep, wide gorges in which rock walls are not steeper as gorge

are called **Canyons (Fig.3.1k)**. These are found in mountainous areas and plateaus where the rocks constituting the river bed are chemically resistant and mechanically strong. These are called Canyans. The Grand Canyon of Colorado river is the greatest Canyon in the world. It is 900 to 1800 meters deep, 60 to 90 metres wide and extends for a length of 300 Kms.



Valley cross section, (Fig.3.1L)

The Base-level of erosion of a river is the level of the basin in to which it falls and at the level of which the river loses its kinetic energy and therefore a river cannot excavate its channel below this level. It should be noted that when a river falls into the sea or ocean the sea –level must be taken as the base –level; when it falls into a lake , the base-level is the level of the water in the lake. Base level of erosion is commonly defined as the mean-sea-level produced inland by river erosion. River valley cross section is shown in **Fig.3.1L)**

b) Valley – widening

Lower down the highland tract there is a gradual reduction in the channel gradient of a river and the erosive power of the river to cut downwards becomes less; but the river starts cutting sideways with wide swinging curves and meanders.

A number of processes may be attributed to the phenomenon of valley-widening which are lateral erosion, the processes of rain-wash, gullying, weathering and mass-wasting and incoming tributarie.

c) Valley - lengthening

Lengthening of river-valley is usually achieved by the process of headward erosion, where the long profile of the river develops from the base-level towards its sources. Apart from the above process of headward erosion, the other processes responsible for lengthening of river valley are as follows;

i) through increase in the size of their meanders;

ii) uplift of the land or lowering of the sea –level results in extension of the valley through the newly exposed land etc**.**

DEPOSITIONAL FEATURES

Deposition is a part of the process of erosion, without erosion deposition is not possible. The river carries the sediments that it erodes during the course of its journey and it enters in the plain areas the depositional process starts thus forming the various depositional features. The deposition is caused by decrease in velocity of river, increase in its load and gentle slope. The various depositional features of the river process are discussed as under;

1. Alluvial fans and Cones

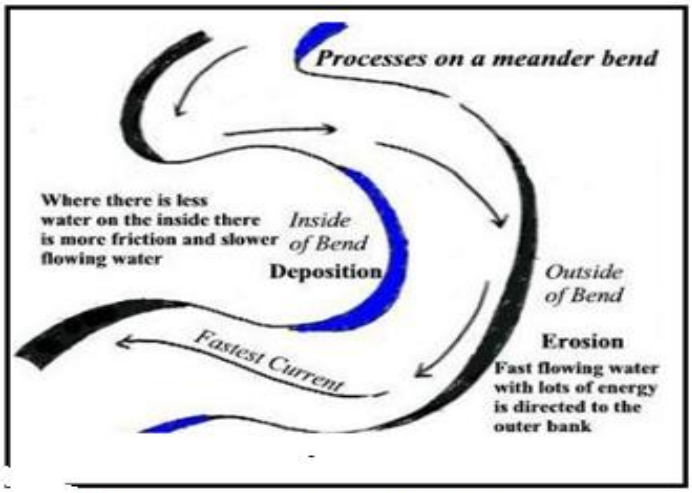
When streams flow abruptly from steeper to gentler gradients, at the base of a mountain or ridge, its velocity is checked and the huge quantities of material carried by the river are dropped their giving rise to a broad, low cone-shaped deposit called an alluvial fan **(Fig.3.1m).** Thus alluvial fans form where a stream leaves a confined valley and enters a flatter region. The material constituting a fan includes coarse boulders and pebbles at its head to finer material down its slope. The term alluvial fan is commonly used when the slope of the deposit is below 10 degrees and alluvial cone is from 10 to 50 degrees (**Fig.3.1n).** A series of adjacent fans may in time coalesce to form an extensive piedmont alluvial plain called "Bajada".

Alluvial fan, (Fig.3.1m)

Alluvial Cone, (Fig.3.1n)

2. Flood plain deposits:

When river is flooded its water overflows the banks and rises above the river channel. This water spread in the adjoining areas where it deposited its load thus forming the flood plain deposits. These flood plain areas are low and relatively flat land on the both side of the river banks.



River meander (Fig.3.1o)

3. Meanders and Oxbow lake

When river enter the plain area where slope is low, velocity of river is decreased and load carrying capacity of river becomes less. During this a slight obstacle or sudden irregularity in the path of river usually causes a deviation of the water current with the formation of a small bend in the river course. Once started the bends tend to grow and gradually become more pronounced and the rivers forms broad sweeping curved path in the flood plain known as river meanders**(Fig.3.1o)**. The river now moves in zig-zag form rather than following the straight path.

Oxbow lake (Fig.3.1q)

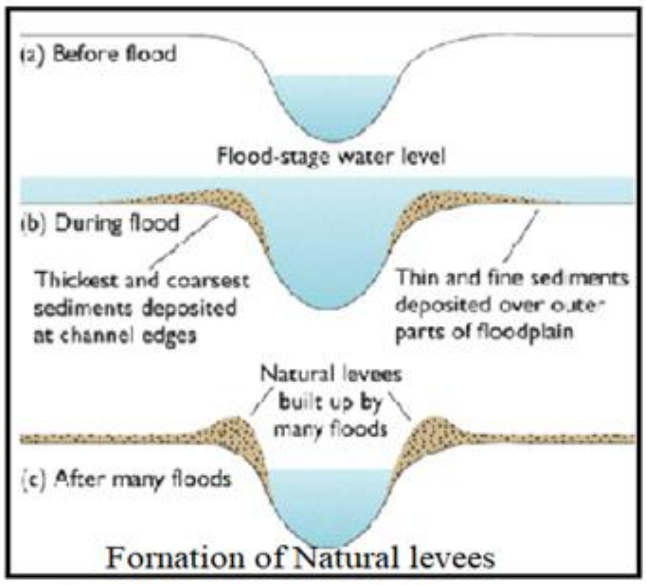
The water flows faster around the outer side of the bend and is slow on the inner curve therefore, erosion is more at outside of each bend and the channel deepens along the downstream part of the bend which is also termed as the under-cut side. The deposition towards the inner side of each bend forming what is known as the **slip-off slope**. Now the river shifts its channel towards the outer bank and leaves gently rounded slip-off slope on the inside of the growing curve. A meander grows until it becomes bulb-shaped with a narrow neck.

During floods, the increased power of the flow carry the stream across this neck cutting the loop which further get filled with water forming the OX-Bow lake **(Fig.3.1q).** These are shallow crescent shaped lakes formed when a meander is abandoned by a river. Sometimes a meander becomes so pronounced that only a narrow neck of land separates the two ends of it. When the river is in flood, this neck is broken and the river starts to flow a shorter, more direct route. Deposition takes place, sealing off the ends of the meander and creating an ox-bow lake. Take a look at the animation below which shows the formation of an ox bow lake

4. River cliffs and slip-off slopes:

When the river flows in zig zag form, the outside banks of the meander are undercut. This creates river cliffs. On the inside of the meander, where the water flows more slowly, deposition takes place. This give rise to a gentle slope known as a slip-off slope.

5. Natural levees



Natural Levees,(Fig.3.1r)

Natural Levees are broad, low-ridges formed along the bank of the river during river floods. During floods, when the entire flood plain is inundated, water spreads from the main channel over adjacent flood plain deposits. When the flood retreats sand and silt are deposited in a zone adjacent to the channel forming low ridges that parallel a river course **(Fig.3.1r)**. They are highest near the river bank and gradually slop away from it, because the deposits is more near to the channel and decreases away from it.

6. Delta

Deltas are important depositional features of river deposition. These are roughly triangular shaped rive deposits formed when a river enters a lake or sea its velocity is reduced rapidly and the process of deposition is accelerated. The coarser and heavier material is laid down first and the finer and lighter material

is carried further out. Thus the load brought by the river gets deposited at its mouth, which gives rise to what is known as a delta **(Fig.3.1s),** because these deposits are triangular in outline and resemble the Greek letter (delta).

Sometimes the tides and currents may be sufficiently strong to prevent enough deposition and the mouth of the river remains open forming what is called an estuary; – whereas deltas are formed when the deposits of a river are not removal by tidal or other currents. Thus the factors favourable to the formation of a delta are:

(a) Abundant supply of sediments;
(b) Absence of powerful waves or shore currents;
(c) A stable body of water,
(d) A shallow water offshore.

Small deltas may exhibit a characteristic pattern of stratification not present in many large deltas-built into the ocean. Thicker layers of coarser-grained sediments known as foreset beds pile up on the sloping bottom close to shore, whereas finer sediments deposited in thinner layers further out are known as bottom-set beds.
The bottom-set beds are actually the continuations of the forest beds. On top of forest beds, thin layers of sediments lie, which have a gentle seaward slope. These are known as top-set beds. Base on their shape deltas are of different types such as; i) Arcuate delta, ii) Bird-foot delta, iii) Cuspate delta etc.