# ENVIRONMENTAL GEOSCIENCES

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**Lecture-10**

## Geological Work of River

Welcome to the SWAYAM NPTEL course on environmental geosciences. We are discussing module two, and within module two, today we will discuss lecture four, which is the geological work of rivers. We have already discussed the geological work of wind. Today we will discuss the geological work of rivers. In this lecture, the three important concepts will again come up, as we have seen in the geological work of wind: erosion, transportation, and deposition. In this lecture, we will cover the erosion part, which is fluvial erosion. This fluvial erosion is divided into two different parts: mechanical erosion and chemical erosion, and then transportation and deposition.

The geological work of rivers. This phenomenon, which is associated with the geological action of rivers, is generally known as the fluvial cycle of erosion or the normal cycle of erosion. Now, what are the methods? By erosion, we mean the disintegration and decomposition of rocks and soil material by a natural agent through mechanical, chemical, and other physicochemical processes, accompanied by the removal of the disintegrated or decomposed product to far-off places by the same agent. So, rivers are the most powerful sub-aerial agents of erosion. This erosion caused by river water or running water is generally of two types: mechanical erosion and chemical erosion.

Now, one by one, we will discuss them. First, the mechanical erosion. It is due to the physical forces associated with the running water. It takes place in four different ways. Hydraulic action is the first one. Forces that are inherent in the flow of running water.

They also disintegrate the product. It can cause a great deal of erosion of the bank and the bedrock. It is mostly due to the surface relief, that is, the gradient. The second is abrasion. The materials that are being carried away by the running water, the loose materials, the disintegrated materials that are being carried away by the running water act as tools of destruction. During their transportation, because of their rubbing action against the

surface of the bedrock, they bring about a scraping action of the surface. This process is generally known as corrasion. So, this is about abrasion.

Now, third is the attrition. So, materials during their transit often collide with each other and in turn get stirred, and this is the process through which big boulders are gradually reduced to a finer size, that is the size upgrade of sand and silt. This term is used for the wear and tear of the load sediments being transported by a moving natural agency through the process of mutual impacts and collisions which they suffer during their transport. Next is the cavitation. This is because of the presence of air bubbles which create a whirling action at the time of penetration of water through the existing pores and fissures.

And the small sand particles along with the air bubbles play a major role in widening the cavities. In the figure, also, you can see just small pore water entering, and they are creating the whirling action. It is particularly observed when running water suddenly falls with high velocity, such as at a location from a high level to a low level. It is known that when stream velocity exceeds twelve meters per second, the water pressure developed results in the vertical sucking out of the material and thereby creating holes and depressions that continue deepening with the passage of time, and such types of holes are called potholes. So, potholes are because of the cavitation process.

The next type of erosion is chemical erosion. It is also called corrosion. This is a process in which the material gets dissolved in the water of the river and is transported in solution. Chemical weathering involves the breakdown of rocks through chemical reactions, altering their mineral composition. Key processes include hydrolysis, where water reacts with minerals to form clays; oxidation, which leads to the formation of rust-like iron oxides; and carbonation, where carbonic acid dissolves rocks like limestone. Additionally, dissolution occurs when soluble minerals such as halite dissolve in water, while acids from organic matter or pollution further accelerate the weathering.

The factors generally responsible are the dissolving action of water due to the presence of $CO_2$ and the solubility of the riverbed. Now, second, after erosion, the second process is transportation in the geological work of a river. Here again, two different methods of transportation: mechanical transportation and chemical transportation. Mechanical transportation takes place by three different means: suspension, which is floating; traction by creeping and rolling; and saltation through lifts and falls of materials. So, this is about mechanical transportation.

Now, chemical transportation occurs through the process of solution, usually in the form of carbonates and sulfates of sodium, potassium, and magnesium. So, in the figure, you can see both mechanical erosion and chemical erosion. Next, every river receives an enormous amount of material during its flow from head to mouth. This material includes rock and soil particles that the river acquires through its own work of erosion along the channel. Heterogeneous types of materials, comprising branches and trunks of trees washed down by the rills, and material contributed from processes of mass wasting, such as rock falls, soil creep, rainwash, and landslides, form another distinct category of materials that are transported by the river.

So, this is about the transportation of sand by a river current. The load, as all the material being transported in the running water of a stream or river, may be distinguished into different categories, like suspended load, which is made up of fine sand, silt, and clay sediments that are light enough to be transported in the stream water in a state of suspension. Bed load, this fraction of river load comprises the heavier particles of sand, pebbles, gravel, cobbles, and other types of materials which are moved along the bed of the river. The dissolved load, this fraction includes particles of material soluble in water, which the river may gain due to its solvent action on the rocks of the channel. Numerous rivers from the land part carry calcium carbonate, calcium sulfate, sodium chloride, and other soluble salts from limestone, gypsum, anhydrite, and rock salts.

So, this is about the different types of load that the river or running water generally carries with it. Now, the third is deposition. It is the last geological action by the river whereby the materials transported get accumulated in an appropriate site where the following factors generally play major roles. First is the decrease in the velocity of the transporting medium. Second is the decrease in slope.

Third is the decrease in volume. Next is the change in channels. And next is chemical precipitation. So, the entire load of a stream or a river will normally remain in transport unless there is a change in one or other factor responsible for its transport. The process of dropping down its load by any moving natural agent is technically called deposition.

Wind, rivers, glaciers, and marine deposits are important natural agents that create typical types of deposits. The types of deposits. First are the alluvial fans and cones. These are cone-shaped accumulations of stream deposits that are commonly found at places where small intermediate streamlets coming down from hill slopes enter the lowlands. In the

figure, the left side is showing the alluvial cones, whereas the right side is the alluvial fans.

Natural levees, these are essentially riverbank deposits made by a river along its bank during floods. The natural levees are sometimes helpful in preventing further flooding in a river, provided the volume of water for a new prospective flood is not much higher than that of a previous flood. Deltas are defined as alluvial deposits of roughly triangular shape that are deposited by major rivers at their mouths, that is where they enter a sea. In the figure, you can also see the delta; generally, these are the alluvial deposits of roughly triangular shape. Next are the channel deposits.

Many streams are formed by some natural causes to deposit some of their loads along the riverbed. These are also called the channel deposits. They are of great economic use, being the source of sand and gravel, quite suitable for use as construction materials. Now we have seen the erosion, transportation, and deposition through the geological work of rivers. Now, the different landforms being created because of this action are very important.

Because prolonged erosion by a river and associated streams produces many interesting and important surface features like potholes, river valleys, gorges and canyons, waterfalls, river terraces, river meandering, and oxbow lakes. Now, one by one, we will understand potholes. These are variously shaped depressions of different dimensions that are developed in the riverbed by excessive localized erosion by the streams. The potholes are generally cylindrical or bubble-shaped in outline. These are created in the softer rocks occurring at critical locations in the bedrock of a stream.

The formation process for a pothole may be initiated by a simple plucking out of a protruding or outstanding rock projection at the riverbed by hydraulic action. In the figure, you can see the potholes formed in the riverbed by hydraulic action. Next are the river valleys. A valley may be defined as a lowland surrounded on the sides by inclined hill slopes and mountains. Every major river is associated with a valley of its own.

In fact, rivers are responsible for the origin, development, and modification of their valleys through the well-understood process of river erosion. Now, the origin of a river valley may have a modest beginning when traced backward in the geological history of the area. On a gently sloping surface, river water gets collected at a lower level and flows as small streamlets. In a short time, small gullies are produced where rainwater gets

naturally collected from adjoining slopes. Further erosion deepens and widens an originally small gully that can accommodate bigger volumes of water.

So you can see in the figure a river valley with small gullies. Valley deepening is achieved by the cooperative action of the processes involved in erosion. Deepening is obviously caused by the cutting down of the riverbed. Lengthening of a river valley, a peculiar type of process called headward erosion, is generally held responsible for the lengthening of river valleys. River capture, or river piracy, is a peculiar phenomenon of the capture of the drainage basin of one river by another river rapidly eroding its channel in a headward direction.

Third are the gorges and canyons; the process of valley deepening often gives rise to a magnificent surface feature known as gorges and canyons. Gorges are very deep and narrow valleys with very steep and high walls on either side. In the figure, you can also see. A canyon is a specific type of gorge where the layers cut down by a river are essentially stratified and horizontal in attitude. So this is about the gorges and canyons, the third type of landforms.

Fourth are the waterfalls. These are defined as magnificent jumps made by a stream or river water at certain specific parts of their course, where there is a sudden and considerable drop in the gradient of the channel. Many falls are easily attributed to unequal erosion of the channel rocks within a short distance due to the inherent nature of the rocks. Next are the river terraces. These are the bench-like ledges or flat surfaces that occur on the sides of many river valleys.

From a distance, they may appear as a succession of several steps of a big natural staircase rising up the riverbed. Next is the river meandering. When a stream flows along a curved zigzag path, acquiring a loop-shaped course, it is called a meander. Meanders are developed mostly in the middle and lower reaches of major streams where lateral erosion and deposition along opposite banks become almost concurrent geological activities of the stream. When a stream is flowing through such a channel, it cannot be assumed to have absolutely uniform velocities all across its width.

The same river is eroding its channel on the concave side and making its progress further inland, whereas on the convex side, it is depositing. A loop-shaped outline for the channel is a natural outcome when a stream is seen from a distance. Next are the Oxbow Lakes. In the advanced stages of a meandering stream, only relatively narrow strips of land separate the individual loops from each other. During high water times, such as

during small floods, when the stream acquires a good volume of water, it has a tendency to flow straight, and some of the intervening strips of land between the loops get eroded.

The stream starts flowing straight in those limited stretches, thereby leaving the loops on the sides either completely detached or only slightly connected. These isolated curved or loop-shaped areas of the river, which often contain some water, are generally called Oxbow lakes. So, this is about the Oxbow lakes. Now, we will discuss the drainage pattern. The joining of the tributaries with the master stream produces a pattern, which is termed the drainage pattern.

The common drainage patterns are dendritic patterns, which are also shown in the figure below, characterized by irregular branching of tributary streams in a pattern similar to that of a tree's branches. Parallel patterns develop on steep slopes where the tributaries and the master stream flow parallel to each other. Trellis patterns develop in topography created on a folded structure of synclines, anticlines, faults, or joints, etc. We will discuss these terms in the coming lectures. Radial patterns consist of drainage lines radiating from a central point, as on a dome. So, this is about the different types of drainage patterns generally resulting from the geological work of rivers. Now, just concluding this lecture.

We have started with river erosion. We have seen that rivers erode through mechanical and chemical means. Features of river erosion include potholes, river valleys, etc. Then, after erosion comes transportation. River transport sediment includes suspended load, fine particles like sand and silt; bed load, heavier particles like gravel and cobbles; and dissolved load, generally soluble materials like salts.

Sources of sediment include erosion, mass wasting, and organic materials carried from land to rivers. Third is deposition by rivers. Rivers deposit sediments when transport conditions change. Forming features like alluvial fans, natural levees, deltas, and channel deposits. Deposition processes are significant for creating fertile soils and resources like construction materials.

The different landforms made by the geological work of rivers are potholes, river valleys, gorges and canyons, waterfalls, river terraces, river meandering, and oxbow lakes. Thank you very much to all.