ENVIRONMENTAL GEOSCIENCES

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Lecture-25

Concept of Rocks

Welcome to the SWAYAM NPTEL course on Environmental Geosciences. Today we will learn the module 5. Module 5 consists of concepts of rocks, magma composition and constitution, description of common igneous rock, description of common sedimentary rock and description of common metamorphic rocks. Today we will start the first lecture that is the concepts of the rocks. So in this lecture we will learn about the concepts of rock, the classification of rock, the types of rocks, rock cycle, texture of rock and environmental significance of rocks.

So as we have discussed in the previous lectures, that earth's interior, we have seen that this is the earth's surface and this is the earth's interior. So these three important layers were there. First is the core, second the mantle and third the crust. So this we have seen in the previous lectures. This is the earth's surface and near about the earth's surface we are getting different types of rocks. So first of all we will understand what is rock.

A rock is a naturally occurring solid mass of minerals or mineraloid matter that makes up the earth's crust and most of its interior. So we have learnt that this crust layer, this is just the crust layer, it consists of some rocks and within the rocks the minerals or mineraloid metals remains in it. So minerals are remaining in the rocks and these rocks constituting the earth's crust. So, we know the rocks are necessarily the constituents of the earth's crust and it is composed of minerals. So, it may happen that sometimes some rocks have only one mineral, then it is called as monomineralic.

So, some rocks are monomineralic, composed of one mineral only, while most of the rocks are multi mineralic means if there is a rock and in it we are getting several types of minerals so this is multi mineralic rock. So one we have learned that if the rock consists of only one mineral then the rock is mono mineralic rock and if the rocks are having several minerals then it is multi mineralic rock. Generally Igneous and meta-igneous rock constitute 95 % of the rocks of the earth crust. Sedimentary and meta-sedimentary rocks

constitute near about 5 % of the rocks of the earth crust. Now some important definition related to this is, Petrology, it is a branch of geology which deals with the study of rocks. So petrology defines about the study of the rocks whereas petrogenesis it deals with the study of origin and mode of occurrence as well as natural history of the rocks how the rocks have evolved how it has formed through the geological ages these are coming under the purview of the petrogenesis.

And petrography generally it deals with the study of classification and description of the rocks. So these are some of the important terminology related to the rock. Now the classification of rock, rocks are classified according to characteristics such as mineral composition, chemical composition, texture of the constituent particles and the particle size. So, on these few bases, different rocks are classified, having different types of minerals, having different chemical composition, texture of the mineral constituents or the particle size. So, all defines the different different types of rocks. The types and abundance of minerals in a rock are determined by manner in which it was formed.

So most rocks are generally made of silicate minerals. These minerals have a structure that includes tiny building blocks called silicate tetrahedra, which we have learned in the previous lecture also. So Si tetrahedra. Si tetrahedra. Now,

This is the Si tetrahedra. So, most silicate minerals make up of one third of all known minerals and about 95 % of the earth's crust. Now, these minerals have a structure that includes the silicate tetrahedra. So, this tetrahedra, it includes and silicate minerals make up of about one third of all known minerals and about 95 % of the earth's crust. The proportion of silica in rocks and minerals is a major factor in determining their names and their properties.

So it is very important factor about the proportion of the silica percentage in the rocks. Now types of the rocks. According to the mode of origin, all rocks are categorized into three important types, three major types, that is igneous rocks or primary rocks, sedimentary rocks or secondary rocks, and third one is the metamorphic rocks. So in nature, within the earth crust, we get only three important types of rocks, that is igneous rocks, sedimentary rocks, and metamorphic rocks. Now one by one we will discuss the three important types of rocks.

So first is the igneous rocks. These are the rocks formed by the solidification of magma either underneath the surface of the earth or above the surface of the earth. So when the rocks are forming just by the solidification of the molten magma underneath the earth's

surface or the solidification of the molten lava above the earth's surface, then such type of rocks are called as igneous rocks. Some of the examples are granite, cyanite, rhyolite, basalt, andesite etc. So what happened?

Inside the earth surface generally we are getting the magma near the core. So this is the core where we are getting the magma. This magma through the mantle and the crust generally erupts out and then it becomes the lava. So both this magma or lava will then solidify and make rocks, then this is also called as igneous rock. But the difference is, this is the plutonic igneous rocks and this is the volcanic igneous rock.

Volcanic igneous rock. So in this way the igneous rocks we are getting in the nature. What we have discussed just now. Accordingly, they are divided into two groups. First is the intrusive bodies which are formed underneath the surface of the earth.

That is, on the basis of the depth of formation, generally intrusive rocks we are getting. And these intrusive rocks are remaining of two types. When we are getting, suppose this is the earth's surface and here we are getting the magma. Magma, and when this magma will come through and erupts out in the form of lava, then this is forming the plutonic igneous rock. And near the shallower depth is the hypabyssal igneous rock.

And just above it is the volcanic rocks. So this generally happens as per the their mode of formation at different depths. So, platonic rocks are formed at very great depths. We have seen here. Whereas, hypabyssal rocks are forming at the shallower depth.

Here we are seeing. And the extrusive rocks are nothing but these are the volcanic rocks, which are consolidating when the magma becomes lava after the coming out from the earth's surface then this rocks is volcanic rocks is also called as exclusive bodies that is a exclusive igneous rock. So this is about the different types of classification of the igneous rocks on the basis of the depth of their formation. Now, some of the important features of igneous rocks. Generally, igneous rocks are remaining hard, massive, compact with interlocking grains.

The reason is that it is consolidating all of a sudden. So, it becomes hard and massive. It is very compact with the interlocking grains. Hence, entirely absence of fossils remains in igneous rock. Also, absence of bedding planes, this is very important property of the igneous rock.

No bedding plane we are getting in the case of igneous rocks. Enclosing rocks are baked. Whatever rocks we are getting in enclosed pattern, they are remaining in baked condition.

Usually, igneous rocks contain much of feldspar type of minerals. So this minerals we are getting, feldspar minerals generally we are getting in abundance in the igneous rocks.

Now second category of the rock is called as sedimentary rocks. So sedimentary rocks are those rocks which have been derived from the pre-existing rocks through the process of erosion, transportation and deposition. We have discussed this thing in the lecture, about the weathering and erosion by various natural agencies like wind, water, glacier etc. So this thing we have discussed in the previous module about the weathering and erosion because of the natural agencies. So the loose sediments which are deposited undergo the process of compaction and the resulting products are known as sedimentary rocks.

So what we have seen in the previous lecture also that suppose this is the earth's surface and some rocks, some rocks are there. So this top portion of the rocks will first disintegrate. Then with the movement of wind, water, whatever the natural agencies are acting there, it will transport to certain distance, then it will deposit at a certain place. So after depositing at a certain place, if the process of compaction takes place, and then it is making some different type of rocks. So this type of rocks are known as sedimentary rocks. So this is the sedimentary rocks.

So here what we have seen that igneous rocks were just forming by the consolidation of the molten magma. It was hard and massive, but sedimentary rocks are depositing at a certain place. After weathering and transportation, it is depositing at a certain place and there the process of compaction takes place and then the resulting products are formed and these resulting products are known as the sedimentary rocks. So some of the examples of the sedimentary rocks are sandstone, limestone, shale, conglomerate, coal, etc., So this is about the sedimentary rocks.

Now again on the basis of place of formation sedimentary rocks are of two types. So this sedimentary rocks suppose suppose this is the rock and the weathering erosion has take place means these are the disintegrated product because of the weathering. It transport to a certain distance then it deposit. These products deposit at a certain place. Compaction takes place so here what we are seeing that this disintegrated products are transporting to a certain distance. But sometimes what happened, the, this is the rock, this is the rock in which the weathering takes place means the top portions are being disintegrated, disintegrated and it is not transporting neither depositing but these products remain at their own place of the formation or disintegration and then the compaction take place. So

two different cases we are seeing here. When the disintegrated products remains at the same place.

Means no transportation, only deposition takes place and then deposition, after deposition compaction takes place and the resulting products are forming. Then such type of rocks are called as sedimentary rocks. So this is the case of the sedimentary rocks. This is the case of the sedimentary rocks. Whereas, in this case, the disintegrated product is transporting to certain place, then depositing at some place, and then the compaction takes place and the resulting products are forming, means resulting rocks are forming. Then such type of sedimentary rocks are known as transported sedimentary rocks. So this is the basic difference between these two. So sedimentary rocks are also known as residual deposits.

Residual deposits, why? Because it is forming at the site of the pre-existing rocks from which they have been derived. So these are not formed by the process of transportation. Whereas transported sedimentary rocks are the disintegrated and decomposed rock materials which are transported to a certain place from their origin and get deposited at a suitable site. So this is the transported sedimentary rocks. According to the mode of transportation of the deposits, these rocks are subdivided into three different types.

When mechanically deposited, it is known as clastic sedimentary rocks. When chemically deposited, it is known as chemical deposits or chemically deposited sedimentary rocks. When it is organically deposited it is known as organic deposits or organically deposited sedimentary rocks. So this is the difference among three important types of rocks that is clastic rocks, chemical deposits and organic deposits. Now important features of sedimentary rocks:

Generally sedimentary rocks remain soft, stratified that is characteristically bedded so in the igneous rocks we have seen that it was hard and compact. Whereas sedimentary rock is soft in the igneous rock we have seen no bedding plane but here we are getting the bedding plane because it is stratified, in the igneous rock we have seen no fossils but here fossils are very common. Stratification, lamination, cross-bedding, ripple marks, mud cracks, etc. are the usual structures of the sedimentary rocks. No effect on the enclosing or the top and bottom rocks. So here we are getting no effects. There we have seen in the case of igneous rocks, it was just baked. Now quartz, clay minerals, calcite, dolomite, hematite, these are the common minerals of the sedimentary rocks.

In the case of igneous rock, we have seen feldspar were the common minerals of the igneous rock. So this is the difference between igneous and sedimentary rocks also. Now, third category of the rocks we will learn, which is metamorphic rocks. So it is very interesting because these are formed, means these metamorphic rocks are forming by the alteration of the pre-existing rocks. Pre-existing rocks means we are having two pre-existing rocks.

One is the igneous rock, second is the sedimentary rocks. By the action of temperature, pressure, aided by sub-terranean fluids. And these fluids are nothing but these are the magnetic or non-magnetic fluids inside the earth's surface. So, just in the case of metamorphic rocks, we are seeing that it is alterating the pre-existing rocks. Now some of the examples of the metamorphic rocks are slate, marble, schist, gneiss, quartzite, etc.

So this is the example of your metamorphic rocks. Now important features of the metamorphic rocks we will see here. It is hard also just like the igneous rock. Interlocking grains are there and bedded also if derived from the sedimentary rocks that is the stratified rocks. Fossils are rarely preserved in rocks of sedimentary origin, except slates.

So sometimes we are getting fossil, but definitely the pre-existing rocks should be of sedimentary origin. Foliated, gneissose, schistose, granulose, slaty, etc. are the common structures of the metamorphic rocks. And the common minerals are andalusite, sillimanite, kyanite, cordierite, wollastonite, garnet, graphite, etc. So in this case, we are getting these type of minerals. That is, in the igneous rock, we have seen the feldspar were the common mineral, where in the metamorphic rocks, we have seen andalusite, sillimanite, kyanite, cordierite, wollastonite, garnet, graphite, etc. So these are the common minerals of the metamorphic rocks.

Now in the nature we are getting the rock cycle. Rock cycle means over the course of time the rocks can be transformed from one type into another as described by a geological model that is known as rock cycle. The rock cycle is a continuous process which describes how rocks form, break down, and reform over the time. The three main types of rocks we have seen igneous, metamorphic and sedimentary and the rock cycle explains how heat and pressure change in these rocks into one another. Now, the stages in the rock cycle, we will know this.

We have seen in the previous model also that weathering and erosion chapter, we have seen that the rocks undergo the disintegration because of the natural agents. So, erosion

produce the sediments and these sediments are transporting and depositing at a certain place. Then it hardens to form sedimentary rocks. Main compaction process takes place and then sedimentary rocks are forming. If these rocks are deeply buried, then what will happen?

The temperature and pressure turn them into the metamorphic rocks because they are three important agents play that is temperature, second is pressure and third is the chemically active fluids. So these are just transforming the sedimentary rocks into the metamorphic rocks. Intense heat at great depths melts metamorphic rocks and it produces the magma. This magma will again reach near to the earth's surface where it cools to form the igneous rock. So what we are seeing, that at the surface, igneous rocks are exposed again to the weathering and erosion, and then the rock cycle will move.

So the cycle begins again with these continuous processes. Here in the diagram, we can see that the top parts undergo the disintegration because of the natural agents. These natural agents, these are just weathering an erosion process taking place. These are just transporting and depositing, and then sedimentation takes place, and these sediments are again undergoing compaction and cementation, and then the sedimentary rocks are forming. Sedimentary rocks are forming.

These sedimentary rocks are now exposed to high temperature and pressure at deep seated position. Then it is just transforming to the metamorphic rock. This metamorphic rock since it is at great depth so because of the temperature high temperature it melts so it is forming the magma it is just forming the magma and this magma is crystallizing and then forming the igneous rocks. So what we are seeing, this is a continuous cycle and this cycle is known as the rock cycle, this cycle is known as the rock cycle. Now, the texture of a rock is a very very important constituents of the rock. So the texture of a rock is the size, shape and arrangement of the grains or crystals.

So in the case of sedimentary rocks, it is the arrangement of the grains, whereas in the case of igneous and metamorphic rocks, it is the arrangement of the crystals. So accordingly the texture of the rocks are being defined. It also includes how uniforms the rock composition i.e. whether the materials that make up the rock are the same throughout or if there are noticeable differences in parts of the rock. Analysis of texture can give us information about the rock source material, conditions and environment of deposition, for sedimentary rock, or crystallization and recrystallization, for igneous and metamorphic rock, and subsequent geological history and change. So this is about the

important features of the rock that is texture rocks have many different textures. For example, layered sandstone produces a gritty texture, whereas coquina may be rough with cemented shells, occasionally producing a sharp edge.

Likewise, breccia, which contains pieces of other rocks that have been cemented together, and porphyry, which contains interlocking mineral crystals, tend to be rough. In contrast, obsidian tends to have a smooth, glassy feel, whereas serpentine may feel platy of fibrous, and talc, schist often feels greasy. So, on the other hand, the texture of gneiss is often described by its distinct banding. The point is that each type of rocks, sedimentary, metamorphic, igneous rocks are having the different different textures and these textures are defining the characteristics or the importance of the type of the rocks also. Now environmental significance of rocks.

Rocks from the earth crust shaping landscape and ecosystems. So whatever rocks we are getting on the earth crust, it is just defining about the types of the ecosystems. Weathering of rocks creates soils essential for agriculture and plant growth. So we are getting different color of the soil because we are getting the different mineral constituents in the bedrock of that place, and this bedrock is undergoing weathering processes and again creating the soil. So that's why we are getting the different color of the soil at different different places of our surface.

Now rocks provide valuable minerals, metals, gemstones, fossil fuels. For example, coal, oil and natural gas. Sedimentary rocks like sandstone act as reservoirs for groundwater, storing water for drinking, agriculture and industry. Rocks like granite and marble are used in construction, while crushed rocks are used for concrete, roads making, and infrastructure. Rocks preserve fossils and geological evidence, helping us to understand the Earth's history, plate tectonics, past climates, and significant events like volcanic eruptions, while also holding cultural and symbolic importance.

Rocks like quartz and marble are used in jewellery, home decor, and art, etc. So this is about the environmental significance of rocks. Now, just summarizing the lecture one, what we have discussed about the rocks. We have seen that three important rocks are there. First is the igneous rocks.

These are the rocks forming by the solidification of the molten magma either underneath the earth's surface or above it when the lava is just consolidating. Some of the examples of igneous rocks are granite, cyanite, rhyolite, basalt, andesite, etc. Second type of rocks we have learned that is sedimentary rocks. These rocks have been derived from the pre-

existing rocks through the processes of erosion, transportation, and deposition by various natural agencies like wind, water, glacier, etc. The loose sediments which are deposited undergo the process of compaction and the resulting products are known as the sedimentary rocks.

The good examples of sedimentary rocks are sandstone, limestone, shale, conglomerate, etc. Third category of the rocks, we have seen that the metamorphic rocks, these are forming by the alteration of pre-existing rocks, pre-existing rock means the igneous sedimentary rocks by the action of temperature pressure aided by subterranean fluids. The example of metamorphic rocks are slate, marble, schist, gneiss, quartzite, etc. So, we have seen in the nature three important types of rocks we are getting, igneous, sedimentary and metamorphic rocks. In the next lecture, we will learn in detail about these rocks.

Thank you very much to all.