Drilling and Blasting Technology
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Lecture – 05
Rock Formation (Contd.)

Let me welcome you to the 5th lecture of Drilling and Blasting Technology course, and we are in a position where we are discussing the Rock Formation of rock.

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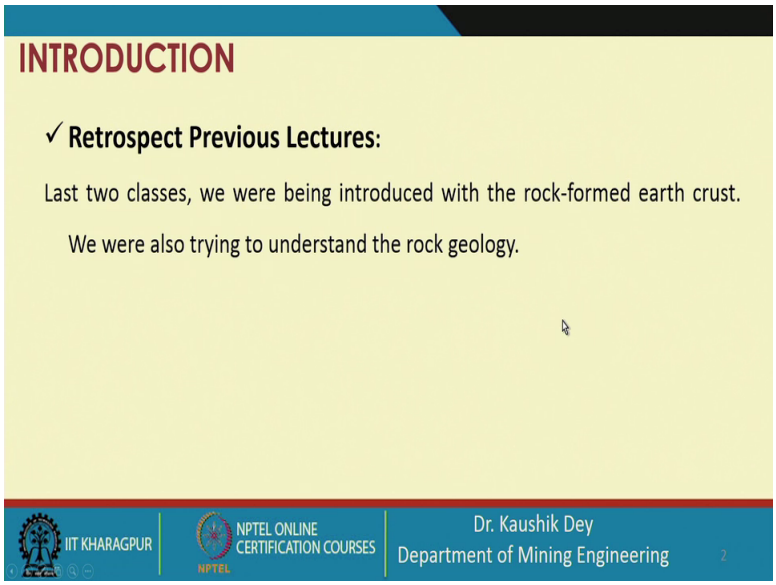

And in last two classes we are being introduced with the rock formed the earth crust and, we are also trying to understand the rock geology a little bit in the last class.

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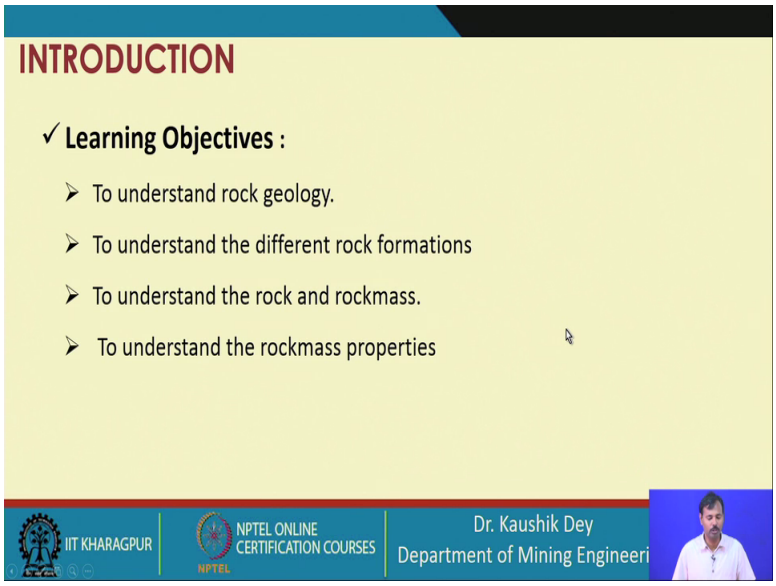

And our present objective is that to understand the rock geology, to understand the different rock formation, to understand the rock and rockmass and to understand the rockmass property. Last class we stopped where we are discussing about the different types of rocks which one, which we have discussed the main rock, which is forming our earth crust is the igneous rock.

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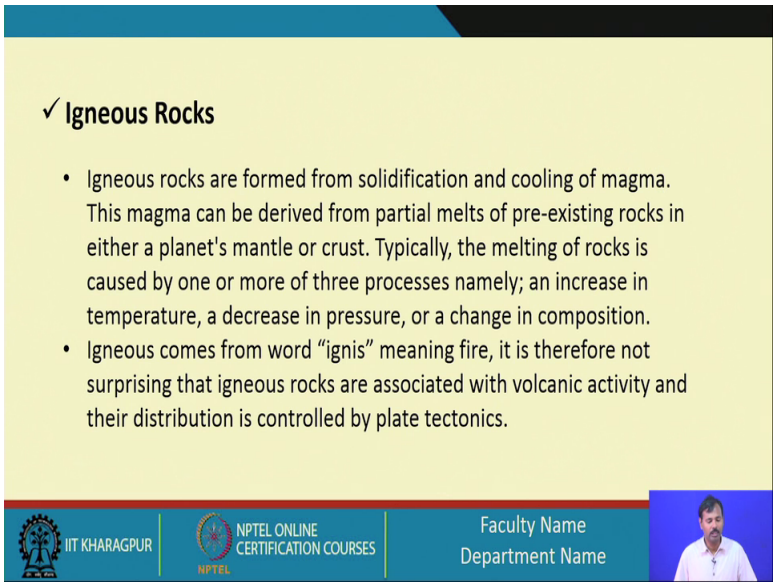

So, we have we know that igneous rocks are found from the solidification and cooling of magma and, this magma is medley coming out from the mantle part and, it is a basically

partial melt of the preexisting rocks, either in the mantle part or in the crust. And there coming out as the magma and this melting of rocks is cost by one or more three processes namely an increase in the temperature and, decrease in the pressure and a change in the composition.

So, basically this magmas are coming out from, because of this three problems and, as it is coming out from the volcanoes and etcetera it is called igneous rock, igneous means fire. So, basically what is happened whenever some increase in the temperature occurs, or decrease in the pressure occurs, then what will happen the magmas are coming out through the cracks in the earth crust, or by generating some cracks, because of the high temperature pressure on to the crust creating some cracks, it is coming out through that cracks.

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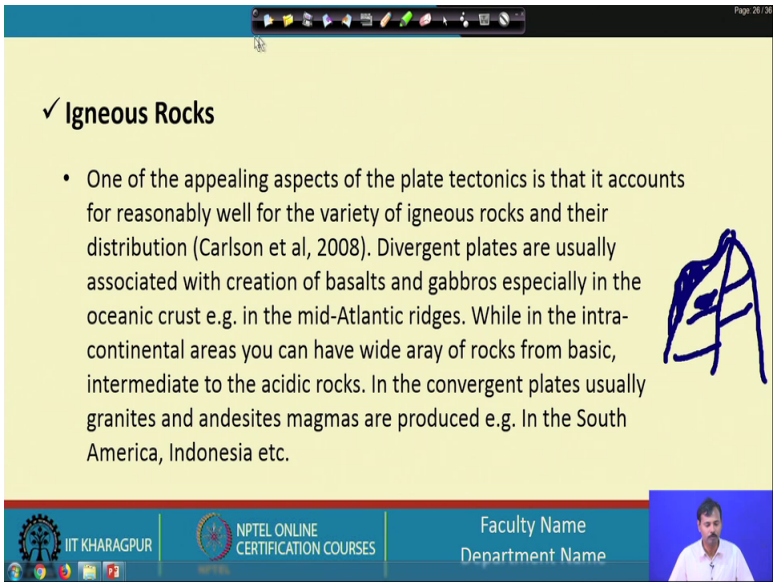

And then it is coming out and then it is coming out from the coming out from the earth crust to the surface. So, one of the appealing aspects of the plate tectonics is that, it accounts for reasonably well for the variety of igneous rocks and their distributions.

So, what is happened so, suppose because of the tectonic activities magmas are coming out, then it flows it flows and became solidified to became solidified to form the igneous rock. Simultaneously these magmas are moves through the cracks in the sides also and, by this movement and because of the high temperatures of the magmas, this also changes the properties of these rocks, or sometimes it also melt this rock.

So, basically these magmas are coming out which are basically the molten rocks, either from the mantle, or from the liquidification of the earth crust material only.

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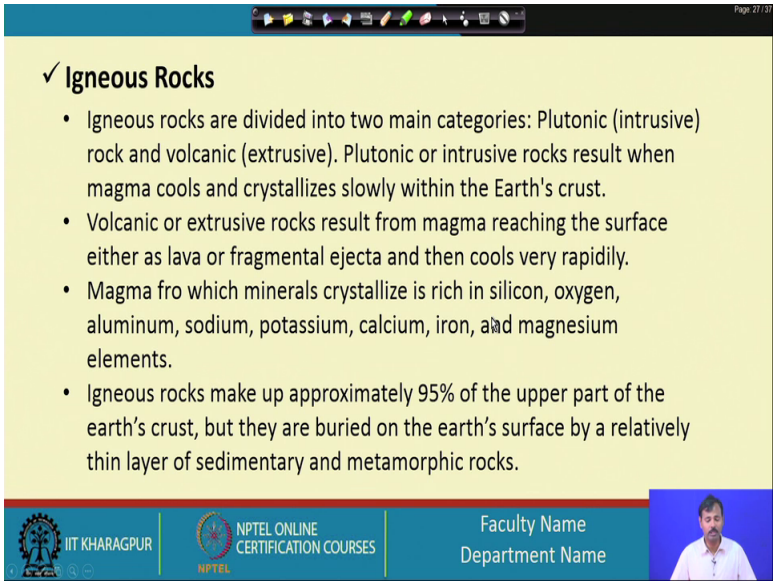

So, igneous rocks are divided into two main categories one is plutonic that is intrusive and second one is the volcanic. So, plutonic or intrusive rocks results when the magma cools and crystallizes slowly, within the earth crust; that means, in the earlier picture we have shown within the earth crust is gradually became cooled.

So, that is the plutonic one and the and the volcanic one, which is coming out reaches to the surface either as lava and, then it is cooled down rapidly because at it is in the atmospheric context. So, it is cooled down very rapidly so, that it is found the rock. So, basically igneous rock it may be plutonic igneous rock it may be volcanic and, as the temperature and pressure under which it is became cooled down. So, that is why their properties are also very very different. Magmas form from which mineral crystallize is rich in silicon, oxygen, aluminum, sodium, potassium, calcium, iron and magnesium elements.

So, if it is coming out from the mantle part of the magnesium elements are becoming more, igneous rocks makes up approximately 95 percent of the upper part of the crust earth crust and, but they are surface occurrences are limited mostly it is found in the deeper part of the earth crust, but 95 percent of the material is igneous rocks. In fact, metamorphic rock is also very very similar to the igneous rock, we will discuss about

that in the later part of this lecture, but igneous rock is very very different one it is mostly hard.

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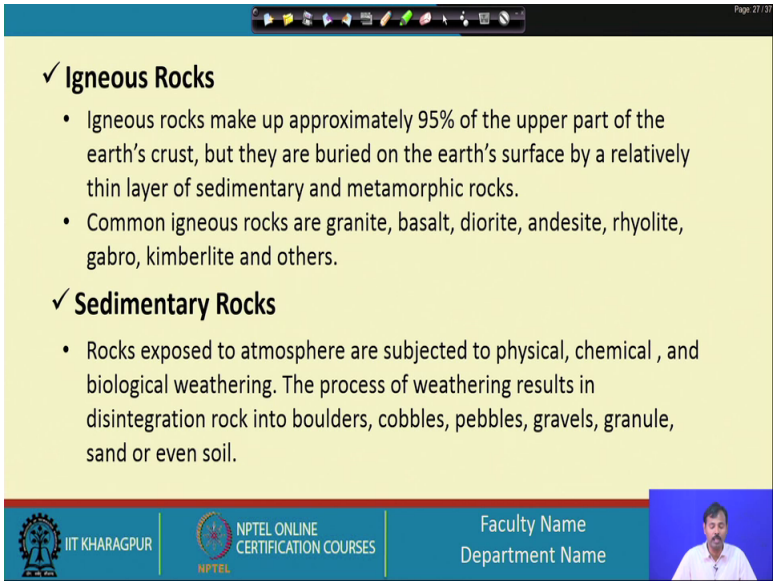

And its excavation is little bit different igneous rocks are more most of the times having less number of fractures, less number of less number of folds etcetera. But igneous rocks are giving some somewhat less heterogeneity than the other type of rocks. So, igneous rock makes up 95 percent and, common igneous rocks are granite basalt diorite and andesite, rhyolite, kimberlite like, this gabro these are the igneous rocks. And, in general the density of the igneous rocks is generally little bit higher than the other rocks.

Sedimentary rock is the next type of rock, when the igneous rocks are export exposed to the earth exposed to the atmosphere and subjected to the atmospheric, as atmospheric deterioration like physical, chemical, biological weathering in those cases those rocks are changed in the property little bit. Either these rocks are weathered, then removed from that place to the, another place and deposited there that may be a sedimentary rock, or it may be weathered of the same place to form a sedimentary rock.

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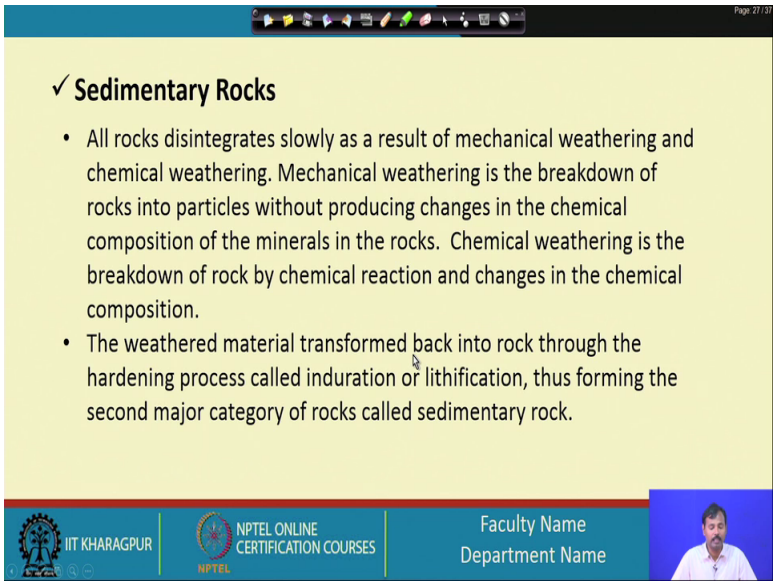

So, this igneous rock disintegrated into boulders, cobbles, pebbles, gravels sand even soil. And then they are formed another type of rock that is called sedimentary rock. So, mechanical and chemical weathering, breaks downs the igneous rocks in a smaller size particle and, often this smaller size particles are subjected to the subject to the pressure, bed pressure, or some subject to some bonded by some chemical reactions, that that way also they can form another type of rock which is also called sedimentary rock.

So, the weathered material transformed back into rock through the hardening process called induration, or lithification thus forming the second major category of rock called sedimentary rock. So, the sedimentary rock is basically formed from the igneous rocks. or maybe two three types of igneous rocks, which are chemically jointed, or jointed under pressure to form the sedimentary rock. Often it may be jointed on the temperature also, but this jointing process must be carried out for the formation of the sedimentary rock.

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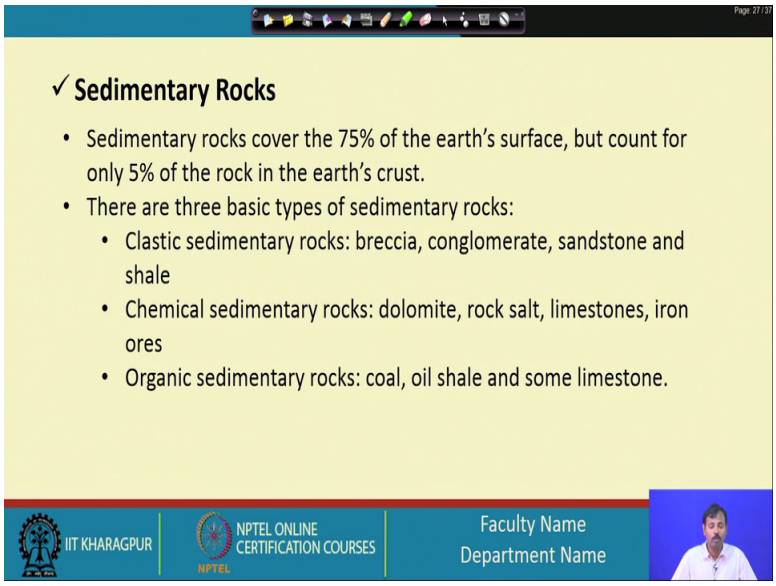

So, basically sedimentary rock is formed under a low temperature and that is why these are and these are found from the atmospheric weathering. So, that is why you will find out the 75 percent of the earth surface is comprises of the sedimentary rock; however, it comprise very little of the earth crust. So, the deep earth crust the occurrence of the sedimentary rock is not that much significant, but in the earth crust most of the rocks are sedimentary rocks.

Sedimentary rocks are having some particular properties most of the time, they are occurred as a bedded from, their variations are limited not like igneous rock, variations are high a great variations. So, like that a sedimentary rocks are little bit weaker rock, their excavation is of little bit easier energy requirements are fragmenting those are very little bit easier.

And basically often the sedimentary rock comprises silica also it may be abrasive also. So, the properties of sedimentary rocks are different, it is very easy to understand the sedimentary rock, it is very easy to determine the sedimentary rock, it is very easy to handle the sedimentary rock. So, sedimentary rock there can be classified in three group, this is clastic where breccia conglomerate sandstone shale etcetera are there, this is chemical sedimentary rocks, dolomite rock, salt, limestone, iron, ores these are the chemical sedimentary.

And organic sedimentary rock is coal oil shale these are some of the limestone are also, there which are coming out from the animals those are also organics. So, basically sedimentary rock are the three types of rock and, most of the times these rock are increases with some minerals and often we go for excavating the sedimentary rock for our upper requirements.

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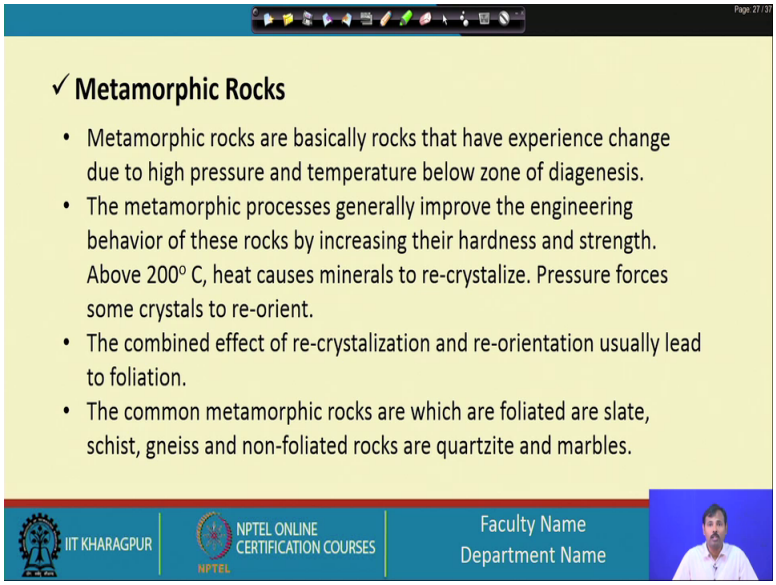

Metamorphic rock is more or less similar to the igneous rock, where the where the igneous rock is or sedimentary rock is changed under high pressure and temperature. So, basically when the igneous and say, or sedimentary rock, subjected to a another volcanic activities, or it may be the bedders are subjected to under high pressure, because of the huge deposition of the rock above that, in those cases those igneous, or sedimentary rocks are converted to the another type of rock which is called metamorphic rock.

So, basically metamorphic rocks are the rocks where the rocks are changed it is property, because of the high temperature and pressure and most of the time these high temperature and pressures are applied to those rocks to the volcanic activities. So, these metamorphic rocks are having some different types of behavior and, generally it is a it has been found that their hardness and strengths are more, above 200 degrees centigrade heat causes minerals to recrystallization. And, thus the recrystallization of the mineral occurs from its earlier rock to the metamorphic rock

So, this in combined effect the recrystallization and re orientation occurs in these metamorphic rocks and, which lead to the foliation of the rocks. The common metamorphic rock which are foliated or slate schit, gneiss the non-foliated rocks are like quartzite, marble. So, basically sand stone is the sedimentary rock which become metamorphosed and become the marble.

Similarly granite is the igneous rock which is metamorphosed and become schist, a shale is the sedimentary rock which is metamorphosed and become slate. So, basically a some sedimentary rock became metamorphic rock and, some igneous rock became metamorphic rock. So, their properties are changes, because of the recrystallization, because of the re orientation.

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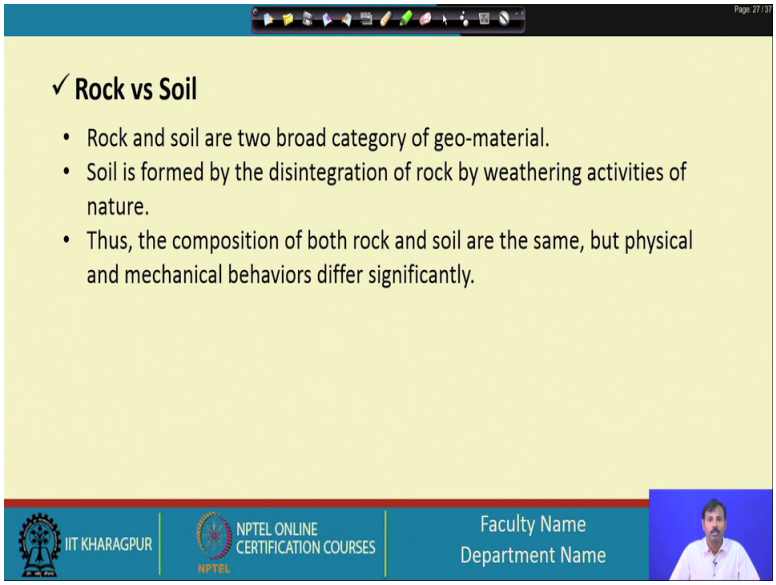

So, these are basically changes of the restructuring of the compositions of the material. Now, let us understand little bit about what is the difference between the rock and soil, because the excavation activities are entirely different for the case of rock and for the soil. So, basically soil is basically the wave that rock, when the rock is wave that, and it is disintegrated into the finer particle. Then in those finer particle again combined to each other, often with the inclusion of the biomass, then result and resulted into the soil.

So, soil is basically formed from the disintegrated rock. So, the basic chemical composition or more or less similar in the rock and the soil, but often soil is added with the organic material, because of the plantent animals, residuals are coming into that. So,

that is why soil is having little bit different property, then the rock and, it is as it is a finer is the mixture of the finer particle its properties are different.

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So, in a nut shell if you (Refer Time: 14:15) into the metal that will find so, the igneous rock, this igneous rock, that is formed from the metamorphic rock, igneous rock became melting they, then magma is first the magma is coming, it is cooling and hardening, then it is forming igneous rock. Then weathering occurs in to igneous rock, then it is became soil and sediment, then sedimentation occurs sedimentary rock form, but sedimentary rock may lead to the high temperature and pressure, became the metamorphic rock.

Again metamorphic rock may melt, because of the volcanic activities and for magma. So, basically the transition from the igneous rock to the magma, igneous rock under high pressure temperature to metamorphic rock, again metamorphic rock through the melting magma became igneous rock. Similarly some sedimentary rock may melt and became magma to from igneous rock; again sedimentary rock can convert into the metamorphic rock. So, like that a different inter, rearrange reorientation of the structures reorientation of the chemical composition occurred, because of the different activities and the inter changing amongs the rocks, or often occurred into the earth crust.

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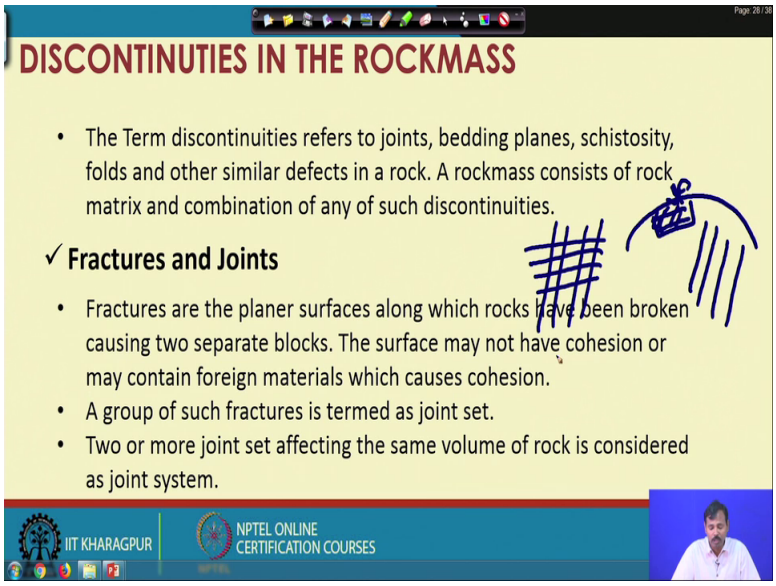

Now, let us understand about the properties of the rockmass, the rockmass property which is basically very very important for our drilling and blasting, purpose those are the property is called discontinuity properties of the of the rockmass. This term discontinuity refers to the joints bedding, planes, schistosity, joints bedding, planes, schistosity folds faults. So, these are the basically discontinuities, which are considered the dictating the properties of the rockmass.

So, fracture or joints this are the main parameter, which is basically the properties of the discontinuities. What is happen if the rock is in the in suit, then it is subjected to the differential pressure, differential temperature load and, because of this differential pressure and temperature the inherent fractures are occurred there. So, suppose this suppose this is a earth crust, a rock is at this position and this rock is subjected to the temperature from the sun.

Then temperature seasonal temperature in the summer winter then, the pressures differential pressures of the rock layers and other movement on this. So, like that way on different activities the rock is subjected to different temperature pressure and which may generate cracks tension cracks in the rockmass. Often this tension cracks may filled with some other material also. So, basically this fracture joint this may be formation joints also this may be the induce joints also, this may be the induced fractures also. So, because of this existence of this discontinuities rockmass behave differently.

So, fractures are the planers surfaces along the along which rocks has been broken causing two separate blocks, a group of such fractures is terms as joint set, if the fractures occurs in a similar manner like this all the fractures are like this, this is called joint set. There may be different number of joint sets one may be like this, another may be like this. So, there may be different number of joint sets two three four number of joint sets are also, very common this in case of discontinuities of the rock.

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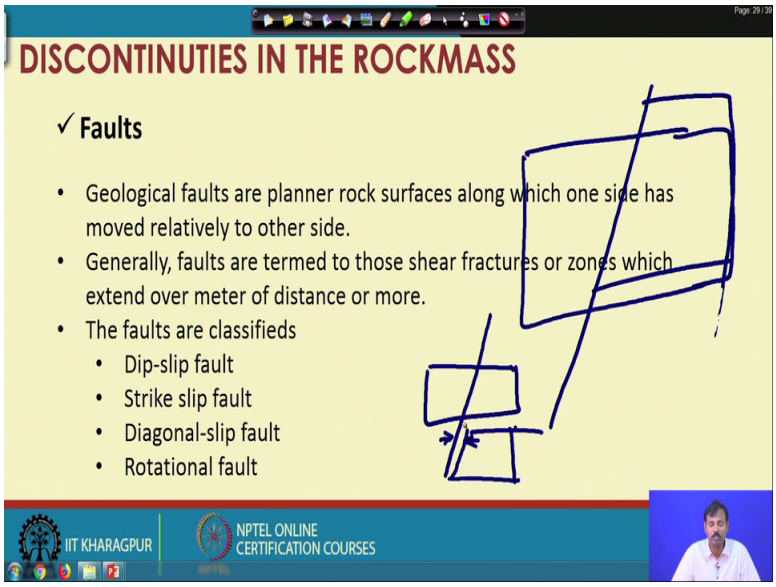

Fault is basically occur in the rockmass as a major discontinuity, this is for what is happened a long crack, a long crack may occur in a rockmass, a long crack may occur into the rockmass and that may subject to the displacement of the that may subject to the displacement of the block. So, this block earlier this block may displace like this, this block may also this block may also displace laterally also, this block may laterally displace also. So, there may be gap some gap may occur in the continuation of the rock.

So, faults are basically the planner rock surfaces, along which one side has moved relative to the other side. And this amount of movement is called throw. So, faults are termed to those shear fractures, or zones which extend over few meters of distance, or more than that is often there may not be throw also, but fault may exist as a discontinuity plane. So, faults are classified as the dip slip fault, strike slip fault, diagonal slip fault, rotational fault. So, faults are also another very very important geological feature to be

considered in the rockmass however, most of the case cases if we are interested in the drilling and blasting.

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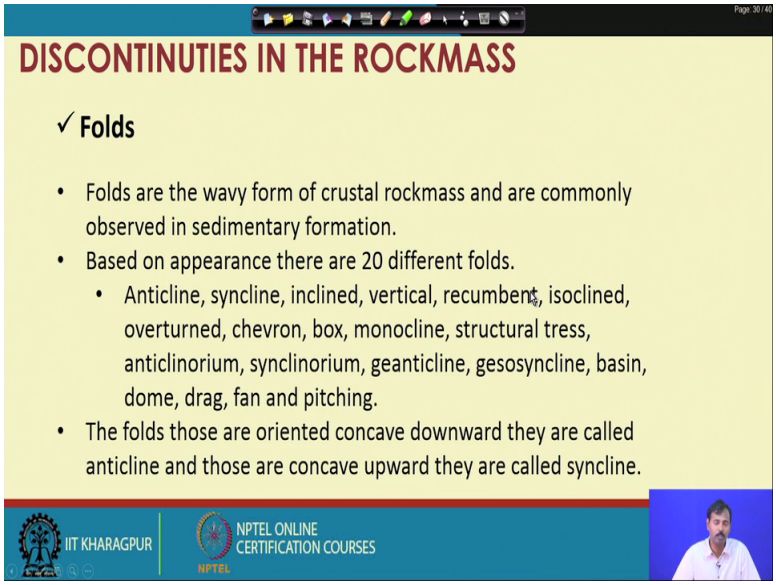

The major property which needs to be considered is the joint set not the fault. Similarly, faults are also there which is basically; wavy form of crustal rockmass and are commonly observed in sedimentary formation and, based on their appearance, it can be divided into anticline syncline like different types of classification.

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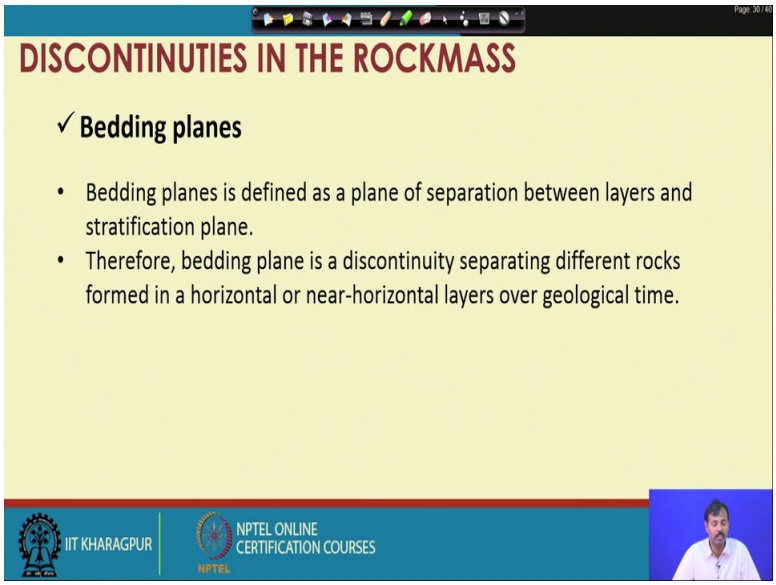

But the important is that the joint and bedding planes, these are commonly observed and that need to be taken care bedding plane is defined as the plane of separation, between two layers of different material and also the static considered as the stratification plane.

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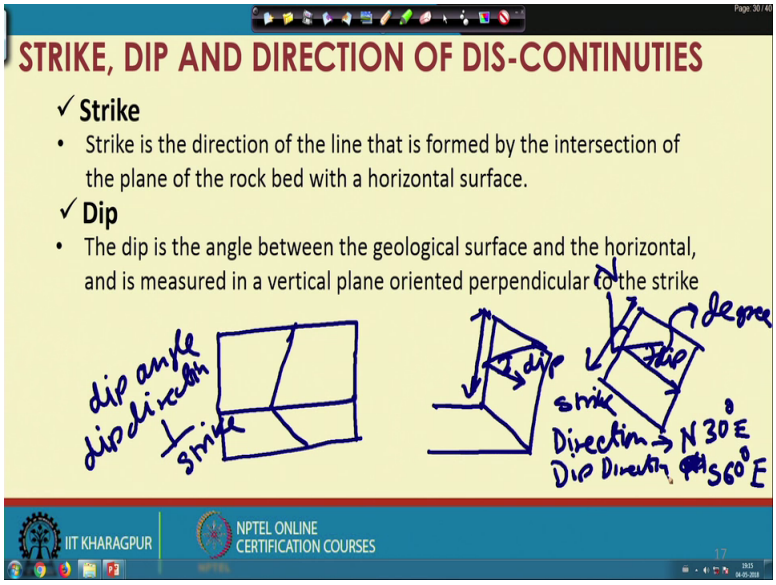

The important part of understanding of this discontinuity is the strike dip and direction of the dip. Basically strike is the direction of the line that is formed by the intersection of the plane of the rock bed with horizontal surface. Dip is the angle between the geological surface and, the horizontal and is measured in a vertical plane orientation perpendicular to the strike. So, let us have some more understanding on this. So, suppose this is the planned view, where a discontinuity plane existing like this if we like to make it a 3D one; say the discontinuity is existing like this.

So, the movement we take this out and only look into the discontinuity plane, we will see the discontinuity plane looks like this. And, it is understood that this discontinuity plane, if we are looking at the horizontally this is the horizontal direction and, here it is dipping towards this so, this is the dip direction. And the angle which it is dipping is called dip angle. So, basically if some plane if some plane, this is the plane is dipping in these direction, this is the strike direction, this is the strike direction and angle with the horizontal is the dip angle and, this direction is the dip direction.

So, this is very important in the rock excavation point of view, where we need to carry out our blasting, we need to carry out our drilling. So, in those cases these directions are

important. Generally, we use commonly brunton compose, or clinometer for measuring, this a strike is always express by it is direction, by it is direction. And that may be N 30 degree east may be like this, or may be 30 degree east means, it is always from north 230 degree is means, it is 230 degree means, it is from the north 230 degree so; that means, it may be in the south west direction.

And this may be the way we can express as strike. Similarly the dip angle is also dip angle is also mentioned as the degree and, dip direction dip direction is always perpendicular to dip direction is always perpendicular to the strike direction. So, if the strike direction is strike direction is N 30 degree east, then the dip direction. If these directions say if this is the north we are considering this is 30 degree, then this is of this direction.

So, this may be then this may be 30 degree plus 90 degree 120 degree. So, this may be N 120 degree east. So, as it convert be the N 120 degree it is south 60 degree east will be the dip direction. So, this is the most common way we express our strike dip and dip direction.

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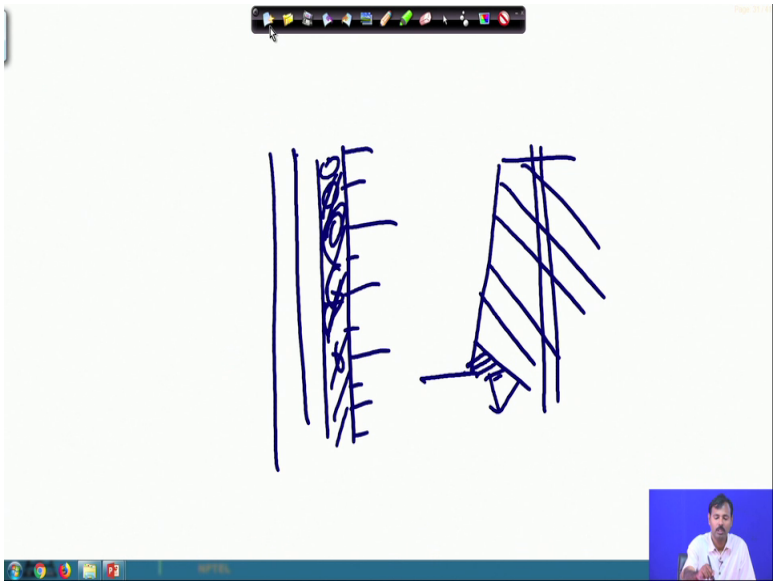

And accordingly and accordingly we need to orient our blasting free phase based on the direction of the dip and dip direction. So, most commonly if you are having some strike direction like this and, dip direction in this, in those cases if you are carrying out blasting, then it is easier for us to explored this materials and, we can observe a good

blasting in this. However if the joint orientations are different, then this is very difficult condition to blast this one, as the chances of this portion of rock may not be blasted.

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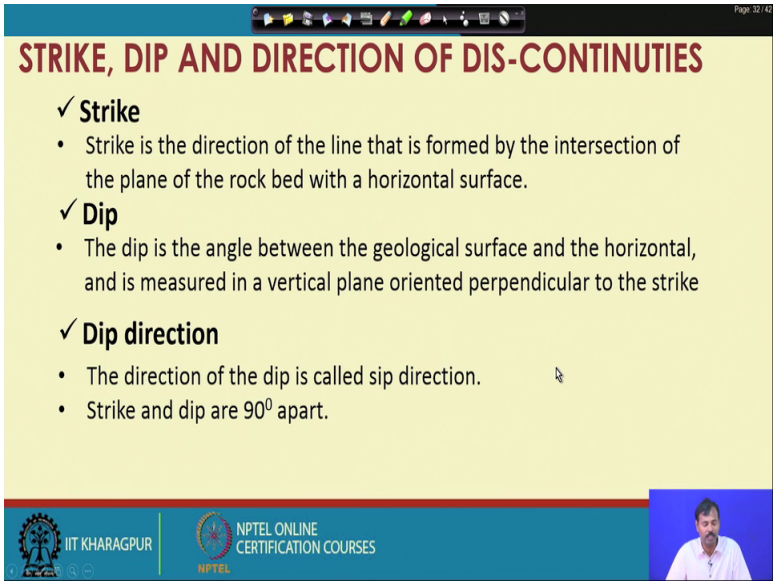

So, that is why the direction of dip directions are also very very important for our as the rockmass property in rock excavation part, specially in this course where we are dealing with the drilling and blasting. Dip direction is the direction of the dip is called dip direction a strike and dip are 90 degree apart.

So, in next class we will start the drilling technology part, before that the understanding. I hope the understanding of the rock, as a medium of excavation is now clear to you.

Thank you.