ENGINEERING GEOLOGY

PROF.DEBASIS ROY

DEPARTMENT OF CIVIL ENGINEERING

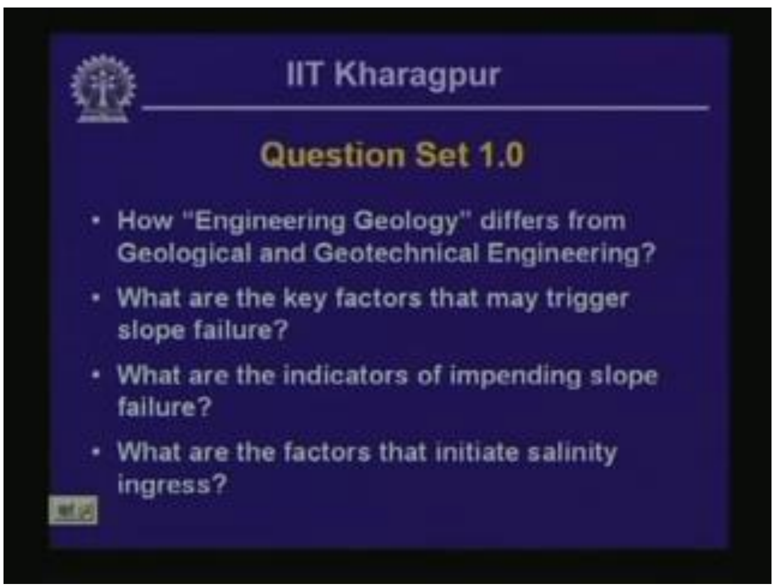
INDIAN INSTITUTE OF TECHNOLOGY IIT, Kharagpur

GEOLOGIC STRUCTURES

Lecture - 2

Hello everyone, welcome to session 2 of the series of presentations on engineering geology. In this session, we are going to talk about geologic structures; different types of land forms and will try to recognize what are the various land forms that one might have to encounter while working as an engineering geologist.

(Refer Slide time: 1:13)

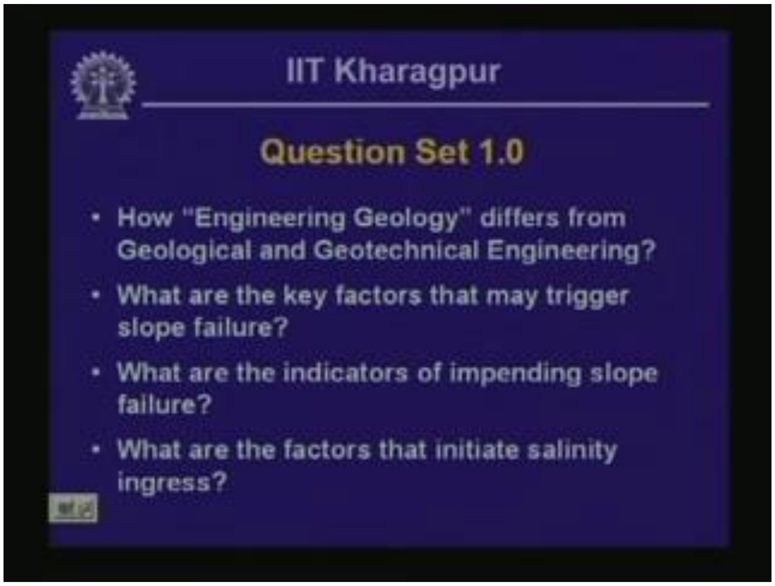


But before we get into the subject matter of today's presentation; I am going to take up the question set that I gave in the first of this series of lectures and I am going to try to provide you the answers of the question set.

The first question that we had in the last presentation was; how engineering geology differs from geotechnical and geological engineering? Now, the difference is essentially very tenuous. Only thing that I can think about is engineering geology is more inclined towards the geologic maters; while, geotechnical and geological engineering deals primarily with the mechanical aspects of the different problems that are encountered in engineering geology.

Then the second problem, the second question that I asked was that what are the key factors that may trigger slope failure? Two of the major factors that cause slope failure are loss of strength, loss of shear strength of the material of which this slope is comprised. The major reason for the loss of shear strength is basically rise of ground water table or it could be because of weathering effects and consequent deterioration of shear strength of material. Now, the other thing that often causes slope failure is human activity. For instance, as we talked about in the last presentation, if we over steepen a certain natural slope, sometimes that also may increase the likelihood of slope failure.

(Refer Slide time: 3:15)

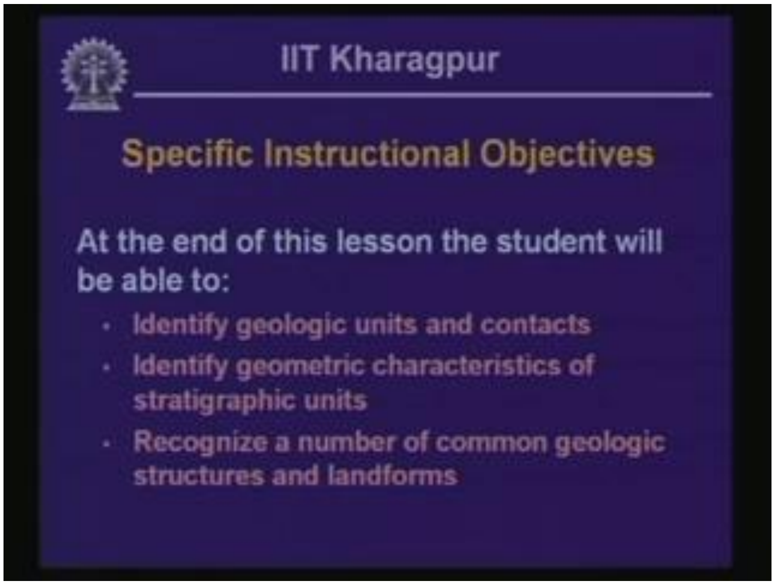


The third problem, third question that I asked was what are the indicators of impending slope failure? This I discussed in the passing when I was making the presentation the last time and one of the major indicators of impending slope failure is appearance of cracks near the top of the slope. If such cracks are detected while inspecting a slope, that is taken by engineering geologist as indicator of impending failure of the slope.

The fourth problem that I asked was what are the factors that initiate ingress of salinity? Now, the factors that initiate salinity ingress include the lowering of ground water table or rise of sea water level or both. Major contributor is really lowering of ground water table and the differential in head of the saline aquifer and the fresh water aquifer that actually is the driving force that causes salinity to enter the otherwise non-saline ground water condition. So, that actually in a nut shell is the solutions to the question that I asked in the last time around; you can elaborate on these ideas and now we begin with the subject matter of today's presentation

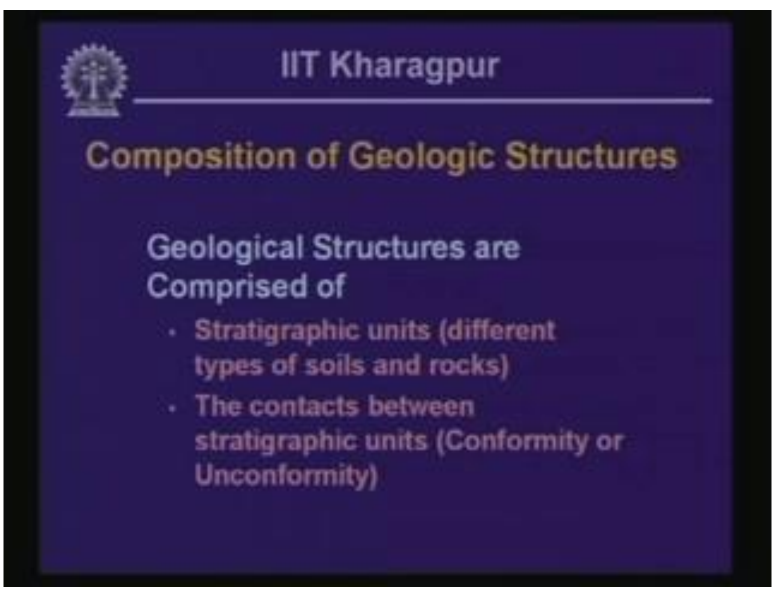
We begin with trying to summarize what is the, what are the objectives of the particular presentation? We want to learn what are the different types of landforms as I indicated earlier and how do you geometrically describe the different types of landforms, what are the different stratigraphic units, how they are related to each other or what are the characteristics of the context between different stratigraphic units and we want also recognize a number of common geological landforms that you might actually have to encounter if you decide to work as an engineering geologist. You need to understand; what are problems or what are the advantages that you might have to deal with when you try to handle a project in those kinds of land forms?

(Refer Slide time: 5:51)



So, these are objectives of this particular presentation. The objectives are listed on the slide that is up there now, which I just discussed. Now, we actually begin with the subject matter. What are the compositions of geologic structures? Now, you can imagine the geologic structures are comprised of different types of soils and rocks; these things we call as geologic units. So, geologic units mean different types of soils and rocks.

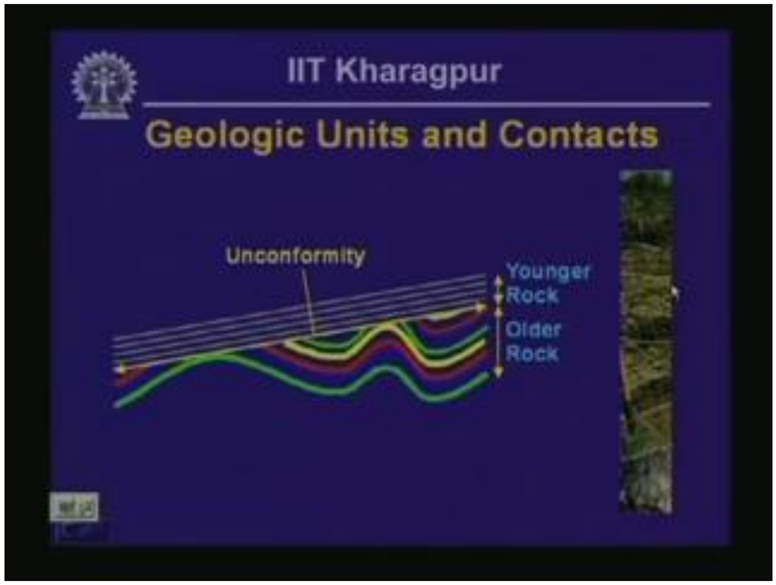
(Refer Slide time: 6:44)



Now, these different geologic units are going to be in contact with each other, these contacts also are an essential part of a geologic structure. So, we need to describe how the different geologic units are in contact with each other as well as what are the geometry of each of these different geologic units.

Let us look at an example what I mean by different types of geologic structures.

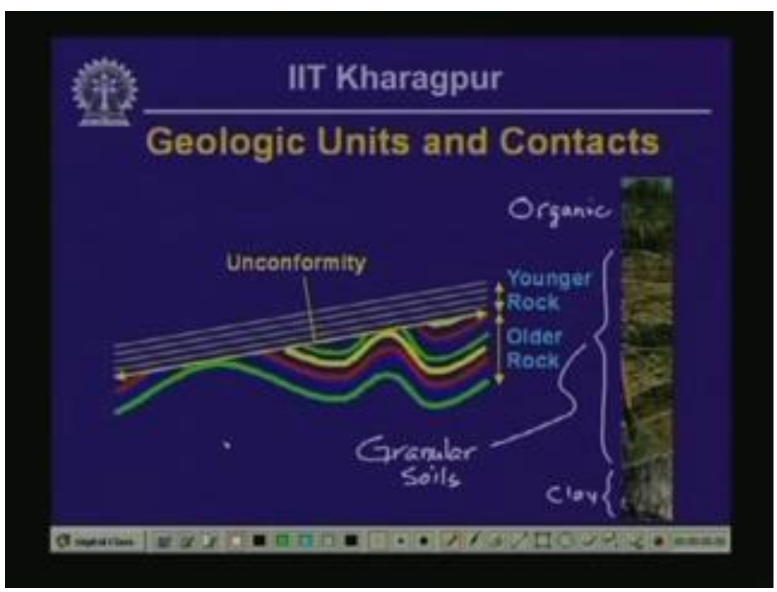
(Refer Slide time: 7:05)



Now the slide that is there now; to the right of it is a photograph of an excavation through a site underlain by different layers of soils. Now, you can see that near the top, near the top of this particular sequence of soils, you have got an organic or layer of soil which has got some organic content. So, this is the layer in which you have got some organics; the root of the overlying vegetation actually penetrates this layer and there are activities of different types of organisms.

Then underneath that layer is a sequence of primarily granular soils of brown color which extends upto the bottom where the shobble is kept. So, this is the layer of basically sands, cells and gravels.

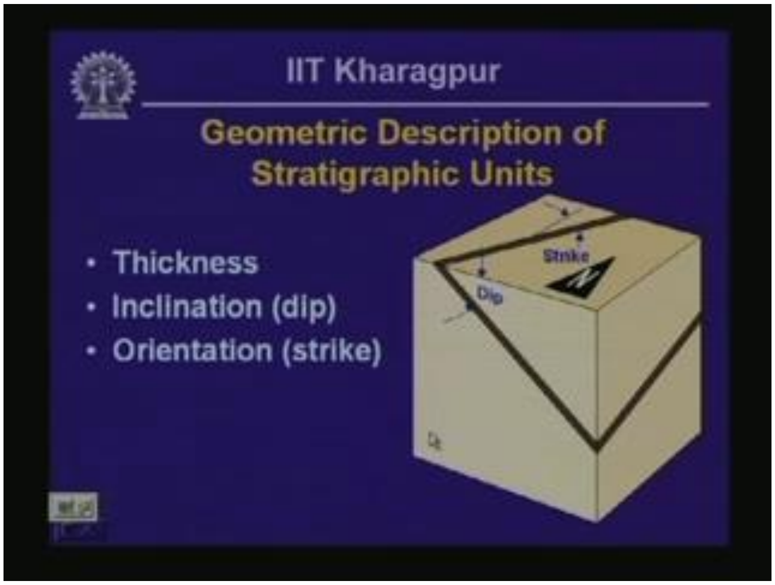
(Refer Slide Time: 8:33)



Underneath that sand silt and gravel sequence, is a layer of clay of grey color. So, this is the clay unit and this one here is the unit that comprises granular soils. So here, you have got several different geologic units then; basically, you have got an organic layer near the top and you have got a granular, a sequence of granular soils underlain by a layer of clay and you have to notice that the contact between each one of these layers are sometime near horizontal and sometimes they are deeping either to the left or to the right of this particular picture. The drawing to the left of the slide here actually shows a vertical slice through an older rock which is shown by a set of multi-colored folded lines and on top of it, there is another layer of younger rock which is comprised of not folded, relatively straight relatively flat layers of younger rock, relatively flat layers.

Now, this kind of, in this sequence, what you have got? The upper unit, you have got two geologic units there; the upper one comprised of younger rock and the lower one comprised of older rock. And, in between there is a contact which is called unconformal contact and we are going to discuss the details of this kind different types of contexts when we discuss the characteristics of contacts in the next little bit.

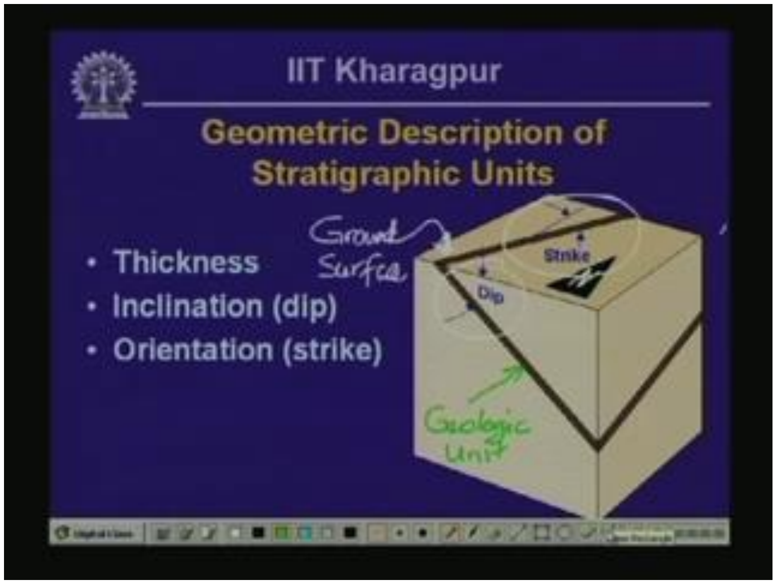
(Refer Slide time: 10:50)



First we try to understand, we try understand we try to look at the geometric properties; how to describe different geologic units in terms of their geometry. Now, what you need to describe? You need to describe the thickness of the layer and that thickness actually could increase or decrease as you proceed in a certain direction, then you have to talk about the inclination of a particular layer and that inclination is given the term dip.

And also, you have to talk about the orientation of the intersection of that particular geologic unit if actually there is one at the ground surface and that intersection of the geologic unit with the ground surface is given the name strike.

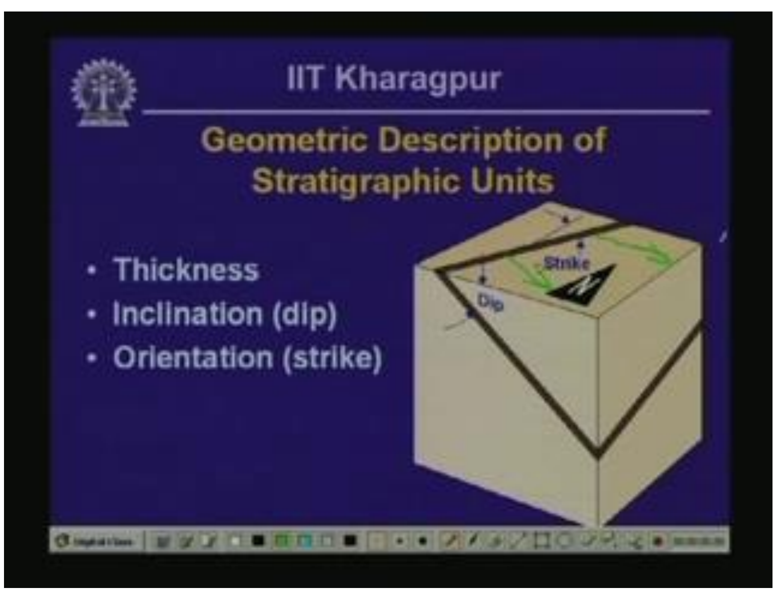
(Refer Slide time: 12:58)



This whole description is actually illustrated with the sketch to the right of the slide there. So, deep of the layer is shown here, then the strike of the layer is shown here. Now, this one, this one, this one here is the ground surface in this case and the dip and the strike shown on that sketch there, actually describes this geologic unit.

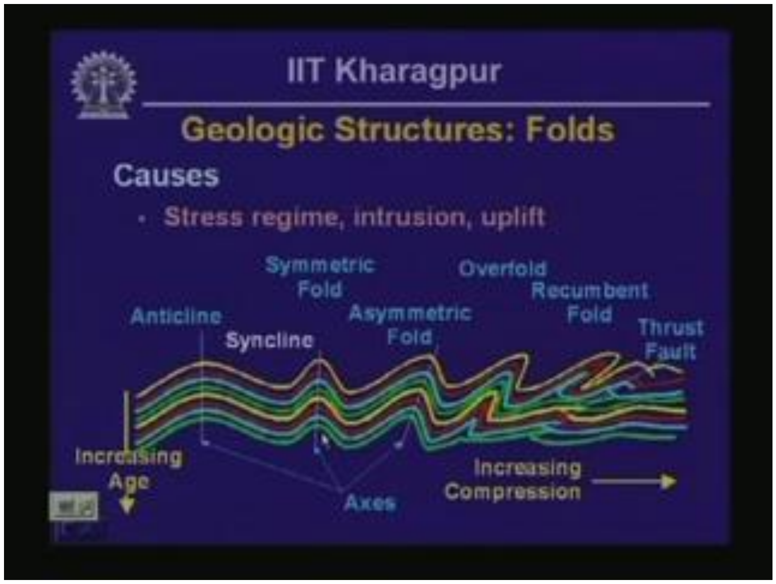
Now, there is another thing that one needs to know; what is a true dip and what is an apparent dip? Now, you can imagine that the slope of the layer that is shown on the picture there will depend on the direction in which the slope is given. Now, if for instance, in this case; we describe, we give the direction of the slope in this direction or we give the dip, we describe, we provide the, we provide the dip in this direction that is going to be different from the dip that is going to be obtained when one measures the dip in that direction.

(Refer Slide time: 13:28)



Now, the maximum slope of the different, among the different directions in which the dip can be provided is called the true dip and all other dips, I mean the dips in any other direction is called, are called the apparent dips of that particular layer.

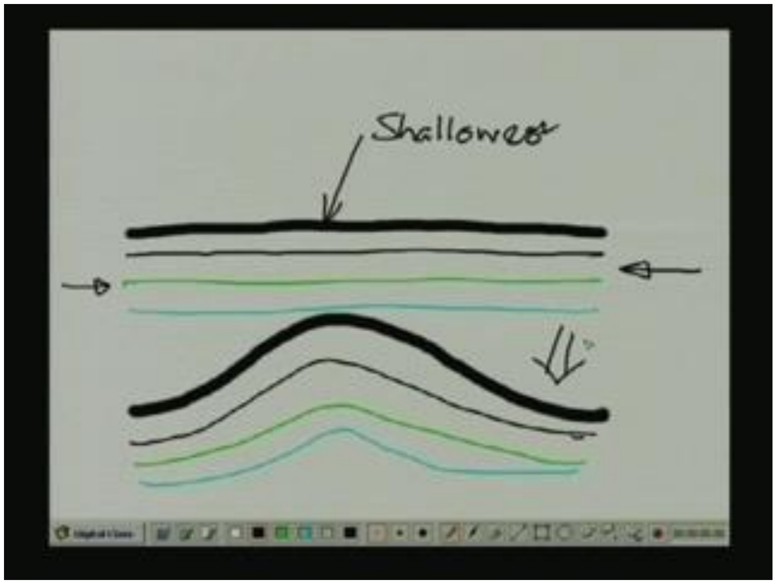
(Refer Slide time: 14:21)



Now, we can describe different types of geometry of the geologic units. We now want to get into different types of geologic structures that you are likely to encounter if you work as an engineering geologist. The first type of geologic structure that we consider here is called folds. Now, the sketch that is shown there, actually schematically presents a series of folds. In this case, we are actually looking at a vertical slice through a bed rock and you can imagine that generally what happens; as we go deeper, the age of the bed rock actually is increased.

Now, what are the causes of development of this kind of folding? Folding develops because of changes in stress regime or it could develop because of intrusion into the bed rock of another type of rock. For instance, there could be an intrusion by volcanic rock through an overlying bed rock, that could also cause a fold to develop or folding can develop because of tectonic activities and uplift. Now, we illustrate each one of these things in the next little bit.

(Refer Slide time: 16:34)



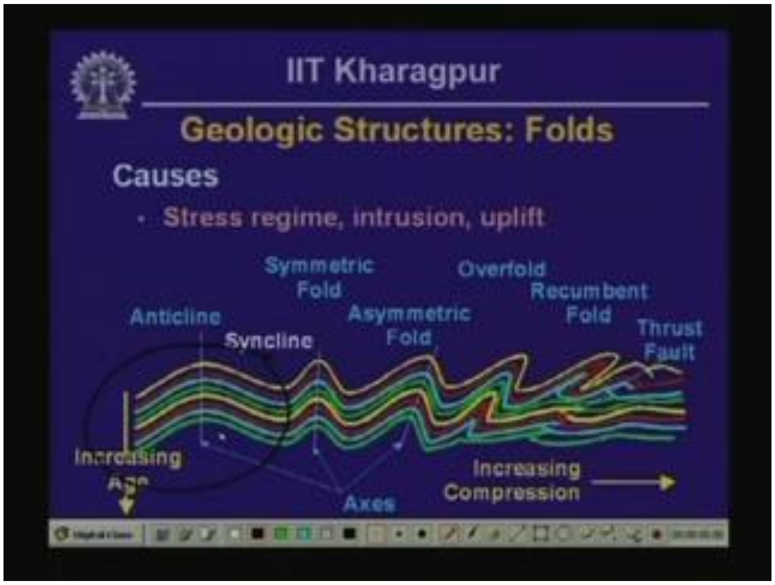
Let us consider how folds develop when the regime, the stress regime actually changes. Let us consider a bed rock sequence comprised of different bed rock layers that are shown in this sketch. Let us consider this sequence of bed rock and this one here actually shows the shallowest layer and as we go down deeper, we get into green and cyan colored layers.

Now say, we want to apply a compression in that direction. Then what we are going to end up with is a bed rock that is going to look like this eventually. So, that is how actually folds develop; that is how folds develop when a sequence of bed rock is subjected to an increase in the regime of stress in a given direction.

Now, as this stress regime increases, then this particular fold is going to become steeper and steeper and eventually it is going to actually fold over onto itself and finally if the stress regime is increased even further, then this different layers of rocks will be torn apart and that kind of a situation is called faulting.

So, what I explained in the sketch in the previous page actually is illustrated in the series of folds here. So, as we go to the right of this particular sketch, then the compression is actually increasing in that direction. So, when we are on the left, to the left, the folds are gentler that is to the left, the folds are gentler as you can see here in this area, the folds are gentler; and as we go the right, then the folds are becoming steeper and steeper. Actually, the limbs of the folds are coming closer together and eventually to the extreme right, the layers are torn apart from each other and that is called the thrust faulting.

(Refer Slide time: 20:02)

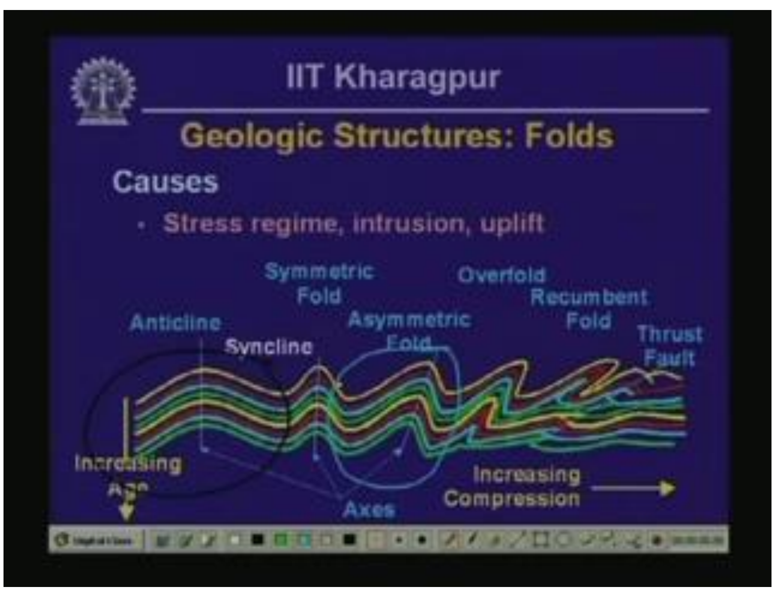


Now, there are different definitions in this connection we have to consider. One is the definition of anticline; anticline is actually a hump like body, the central part of it is a little bit at a higher elevation then the right and left lank. So, this kind of a situation is called anticline and the reverse of an anticline is syncline which is shown just to the right of anticline here.

Now, a symmetric fold is a fold which is actually has got or for which the two arms are actually symmetric. So both the folds, the two folds to the left of the sketch here actually are symmetric folds and asymmetric fold is the one on the other hand for which the two limbs, the characteristics, the geometric characteristics of the two limbs are not identical.

For instance, the fold shown here is an asymmetric fold.

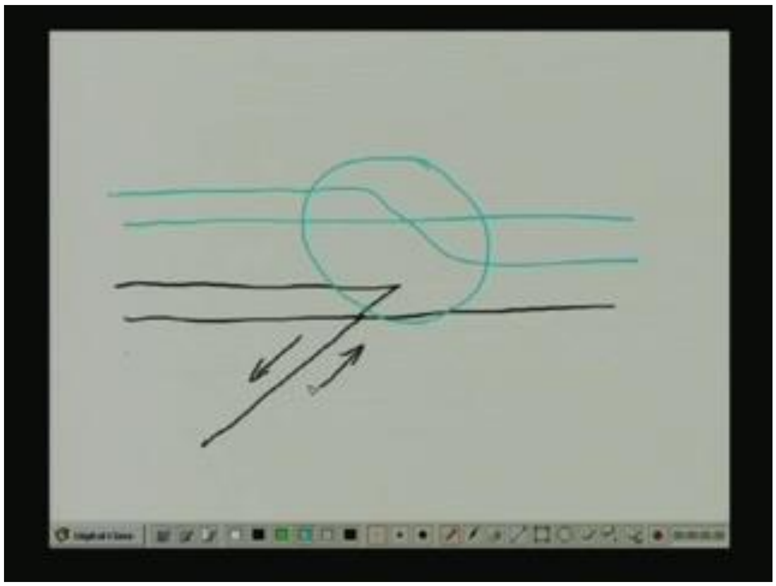
(Refer Slide time: 21:13)



You can see that the dip of the left limb of the fold is much gentler compared to the right limb of the fold and when the compression increases further, then the folds the different units actually they come even closer together and we get an over fold which is further to the right and finally, the fold completely closes and that situation is given the name recumbent fold. So, this is actually an example of how folds develop because of the change of stress regime.

Now, let us consider how folds could develop because of tectonism.

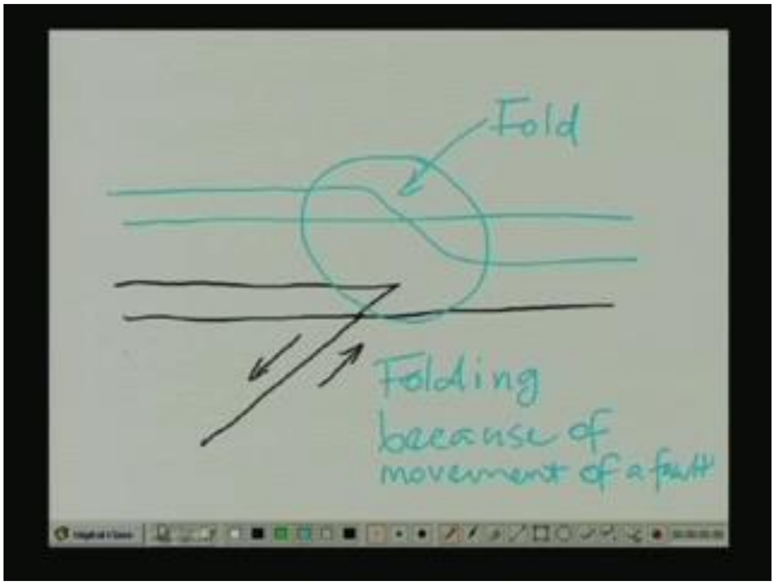
(Refer Slide time: 22:13)



Now say, you have got a bed rock that is underlain by two blocks of another unit of bed rock and these two blocks, they try to move relative to each other. So, let us consider that this block goes up and this block goes down. So, what could happen actually, that you get a configuration which looks like this once the movement is over?

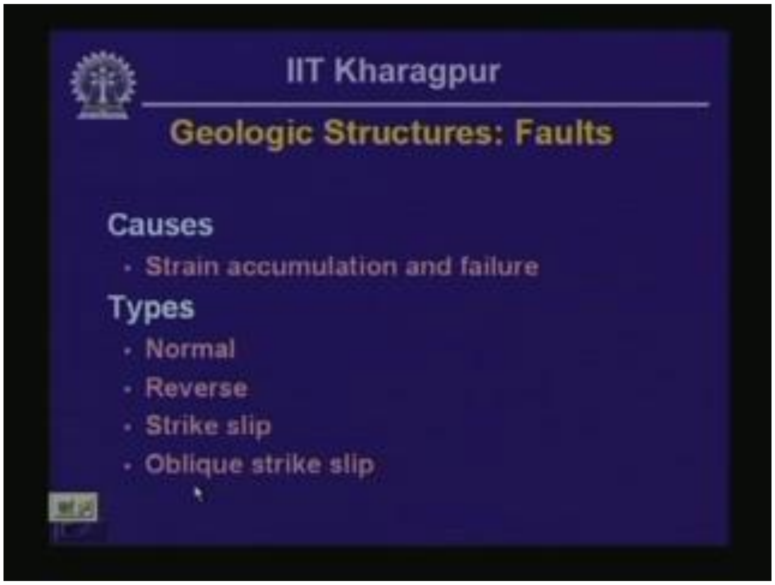
So, if there is that kind of configuration, then the overlying layer is going to take a final configuration that might look like that. So in this area, because of the movement of the underlying bed rock, a fold is developing.

(Refer Slide time: 23:13)



So, this is folding because of of movement of an underlying of a fault. We are going to actually learn more about fault in the next little bit.

(Refer Slide time: 23:49)



What do you mean by fault? As illustrated, in the last sketch, when actually rock masses are crisscrossed by join, I mean, there are different block of rocks that are actually underneath a particular site. Now, these blocks sometimes try to move relative each other that could be because of several different things again because of stress regime change or because of intrusion or because of seismic activity in the nearby location.

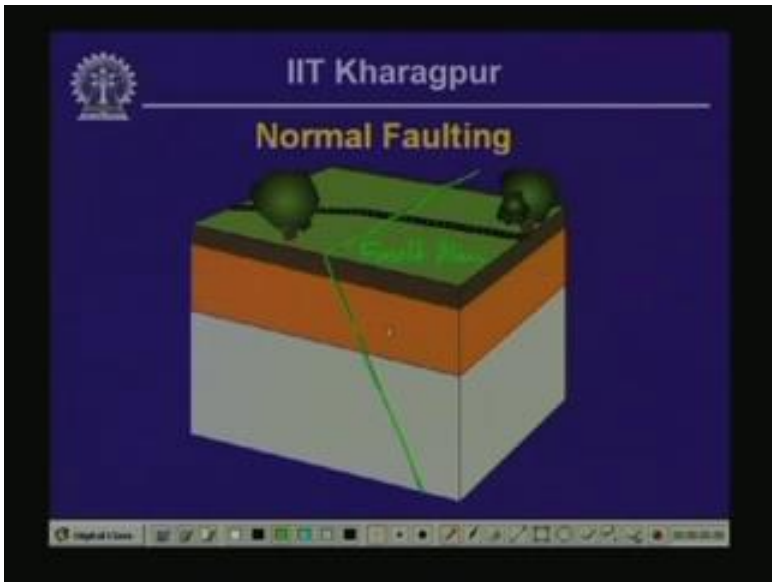
Now, basically the movement is initiated by accumulation of strain at the interface between two blocks of rock and if that leads to a failure, that actually causes different blocks to move relative to each other and that is from the mechanical point of view, that is the cause of movement of fault.

Now, the two blocks can move relative to each other in several different ways. Now, depending on which way the faults in which way the blocks move with respect to each other, that causes different types of faults to develop. Now, we have to consider different types of faults then and the types of faults that are encountered usually are normal fault, reverse fault, strike slip fault and oblique strike slip fault.

Now, what is meant by each one of these faults is going to be explained in the next few slides and you have you have to understand that basically the classification of the fault means that the relative movement between the two blocks that are on either side of the fault are of different types.

Let us first consider, what we made by normal faulting.

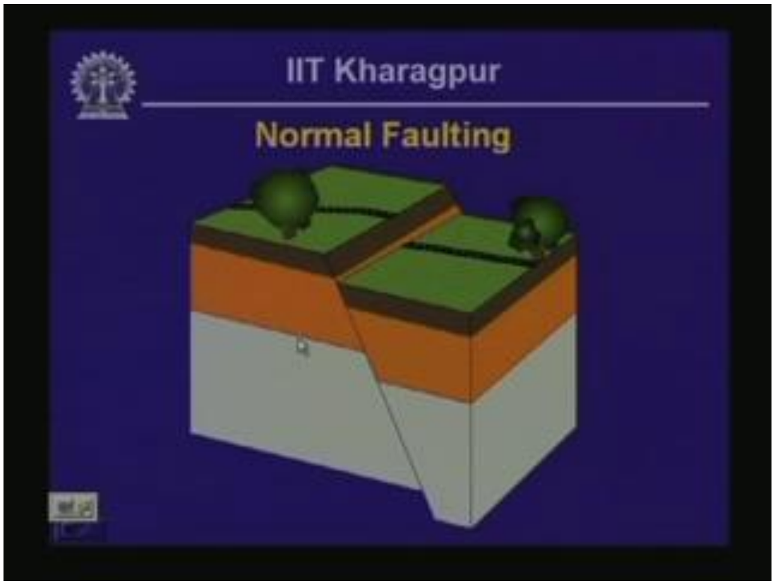
(Refer Slide time: 25:53)



The sketch that is shown on the slide there, it actually shows, it actually shows two blocks separated by a plain. The plain that separates the two blocks is shown there, that is the plain I am talking about. This plain is called the fault plain fault plain. Now, fault plain essentially separates two blocks on either side then and the two blocks are going to try to move with respect to each other.

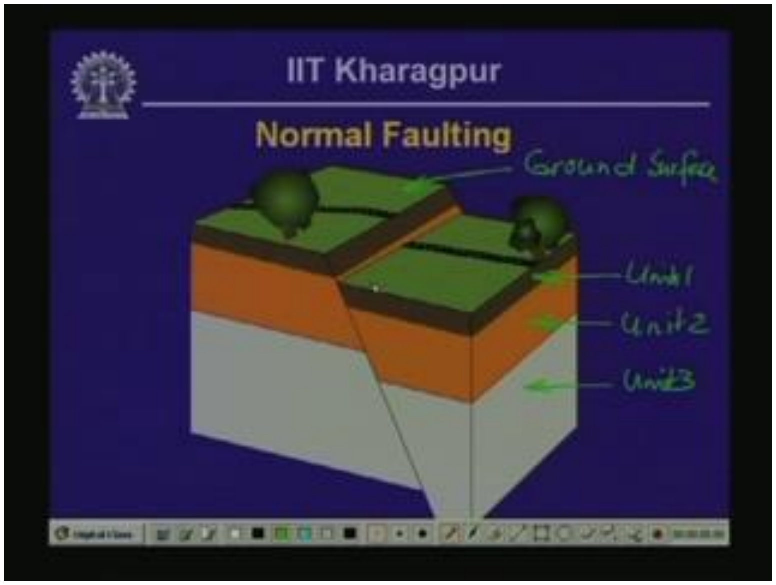
Now, let us see what kind of movement we are going to get in normal faulting. Watch the animation here.

(Refer Slide time: 27:28)



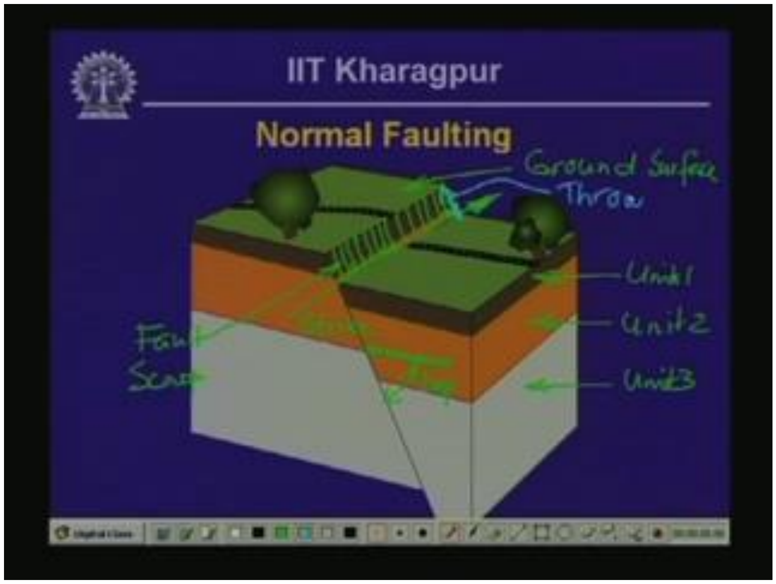
So, that is how normal faulting is going to develop.

(Refer Slide time: 27:18)



This is the ground surface, you might have understood that already that is the ground surface and different layers of rocks and soils are shown using different colors. So, this one is essentially is unit one that is the surface layer, then you have got unit 2 that could be another soil layer and this one here is unit 3 which could be a rock layer. Now, we have to describe the geometry of normal faulting.

(Refer Slide time: 27:59)

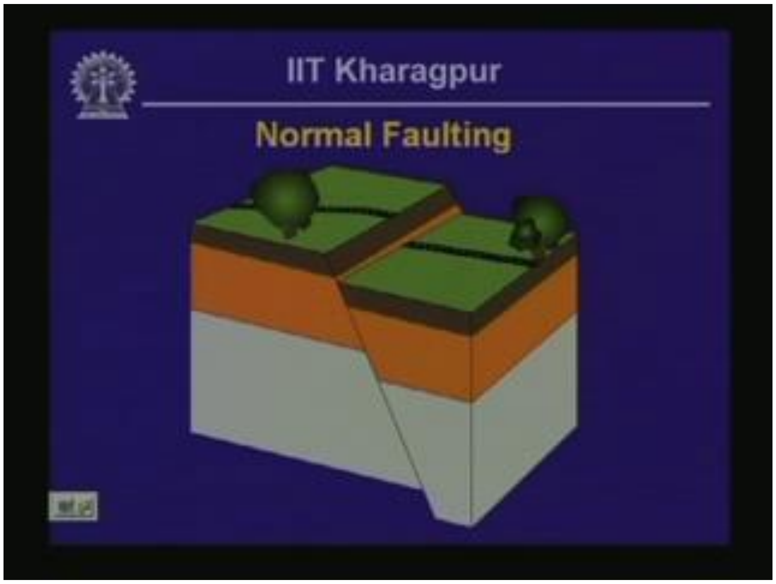


This particular slope, this portion of the slope is called the fault scalp. So, that steep portion of the slope is called the fault scalp. Now, the direction in which the fault intersects the ground surface is called the strike of the fault. So, that is the strike of this fault and the dip of the fault plain from horizontal is called the dip of the fault; in this case, this is the dip of the fault.

Now again, as we discussed earlier, the dip of the fault could be an apparent dip or a true dip. So, the Azimuth of the strike has to be provided for a given fault, one has to also provide the dip of the fault along an Azimuth and also may be true dip of the fault and the Azimuth in which the true dip occurs. So, this is how a fault is described.

We also have to define another term here and that is called the throw of the fault. A throw of the fault is actually measured along the fault plain that actually gives, that actually gives the maximum movement of the fault which is shown there. So, this one here is the throw of the fault plain, throw of this particular fault. So, we need to then describe throw of the fault, we have to describe the strike of the fault and we have to describe the dip of the fault. So, that is normal faulting; let us watch it again.

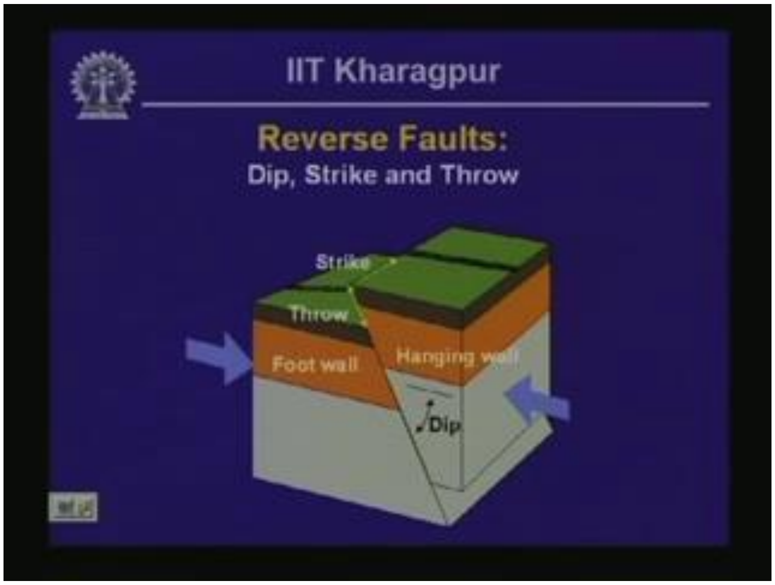
(Refer Slide time: 30:29)



This is how normal faulting develops, you can understand that normal faulting develops when a tensile regime; actually when we try to pull the two blocks on either side of the fault plain apart from each, then we develop a normal fault.

Now, let us go to next type of fault and that is called reverse fault.

(Refer Slide time: 30:51)

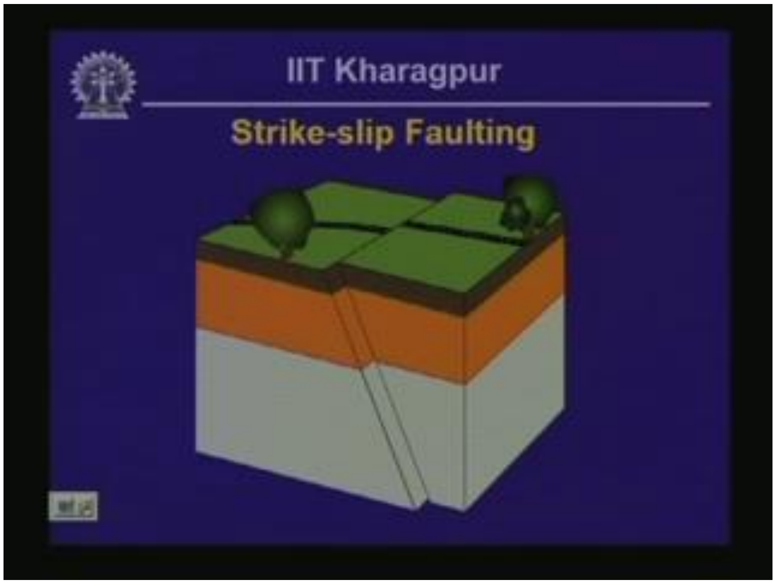


Reverse fault it exactly opposite to normal fault and the different features of reverse faulting is explained on the slide there and you can see that reverse faulting arises because of a compressive regime shown using the bold arrows on either side of the of the two blocks and in this case because of the compression, one of the blocks, the block to the right in this case actually tries to climb on top of the block to the left. So, the block on the right is called the hanging wall and the block on the left is called the foot valve of a reverse fault.

Now, the throw of the fault and the strike of the fault are also indicated on the figure and so is the dip of this particular fault. If a reverse fault becomes a very shallow angle fault; in that case, the fault is called a thrust fault. So, thrust fault is a type of reverse fault in which the dip is very small.

Now, we go and try to understand how the other type of faulting develops. This animation actually is going to show you how strike slip faulting develops.

(Refer Slide time: 33:03)



In this case, what we are trying do? We are trying to apply a shearing across the fault plain. So, we are trying to or in this case, we are going to, we will try to push the block that is on the right of the fault plain further away while keeping the portion that is on the left on the fault plain at the same location. So, what is going to happen if we try to move these two blocks related to each other as we described? The animation actually shows the result of such a movement, such a deformation process.

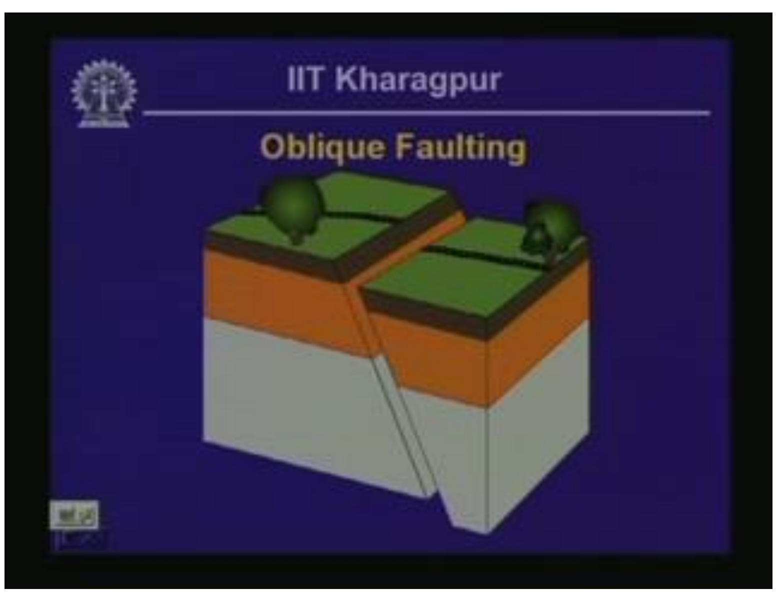
(Refer Slide Time: 33:15)

So, in this case again, dip of the fault is going to be given by this angle. So, that is the dip. The throw of this particular fault is going to be this much; so, that is the throw and this particular movement as is evident occurred because we want to apply a stress state as shown by these two arrows. So, we wanted to push the block that is on the right further away, while to we wanted to keep the block that is on the left side of fault plain at the original position. This kind of faulting is also called a left lateral fault.

So, if you are facing the fault plain, the block that is ahead of you is trying to move to the left, to your left; then it is called left lateral fault movement, left later strike slip fault, while if a reverse fault moment takes place, then that kind of fault the is given the name right lateral strike slip fault.

Then we could also have oblique faulting which is a mixture really between the normal faulting or reverse faulting and strike slip faulting.

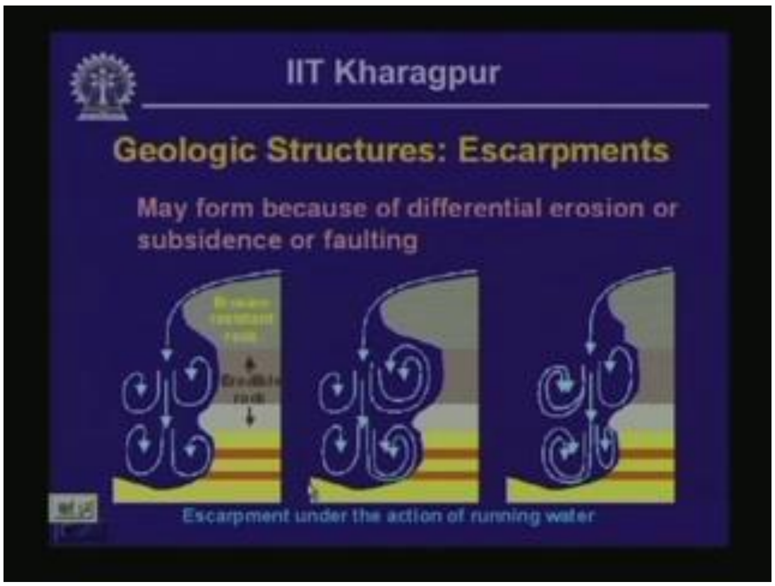
(Refer Slide time: 34:50)



So in this case again, you have to describe the dip of the fault that is shown here that is the dip and you also have to show the throw of the fault; throw of the fault is that much, so that is the throw and as usual, strike of the fault is in that direction and the first scalp is that steep portion of the slope.

So, we now get into the get into other type of geologic structures, other type of important geologic structures. One of those structures we consider is an escarpment. Escarpment is essentially a steep bluff that separates two relatively flat areas of land. Now, an escarpment can develop because of erosional activity of the water or air or of because of faulting or subsidence. We actually illustrate an escarpment, an evaluation of escarpment using a set of sketches on the slide that is being show now.

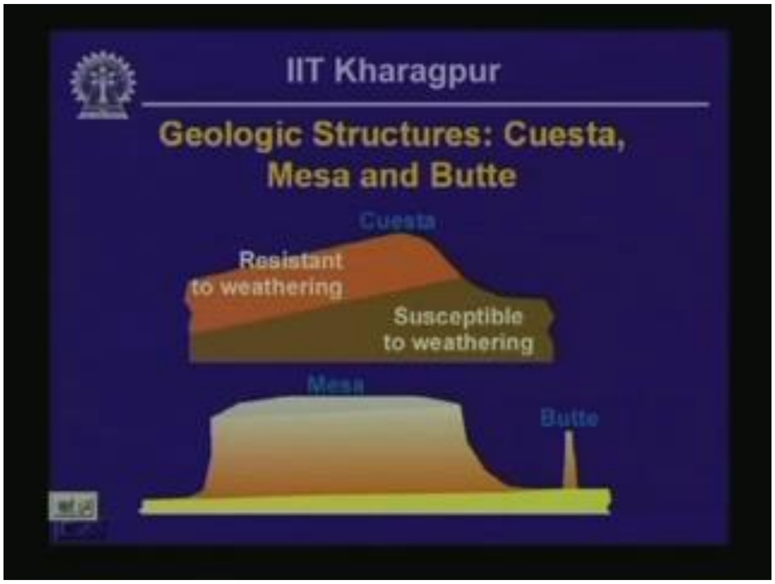
(Refer Slide time: 35:35)



Here, we have got an erosional resistant rock near the surface and on top of it flows a river and that river, that erosion resistant rock underlain by relatively softer erodible rocks. So, what happens actually? The splash, the water that splashes while falling like that, actually causes the layer underlying the erosion resistant rock to erode and resist and because of the recession of the erosion resistant rock, the block overlying or because of the recession of the erodible rock, the erosion resistant rock actually, an overhang actually is generated in the erosion resistant rock and that overhang eventually gives way. So, that is shown on the right most sketch and gradually the bluff actually works its way to your right.

So, this is an evaluation actually or this is an illustration of how an escarpment evolves because of erosional activity of water flowing at the surface. Two other types of landforms are cuesta, mesa and butte; those are illustrated with the sketches on this slide.

(Refer Slide time: 38:26)

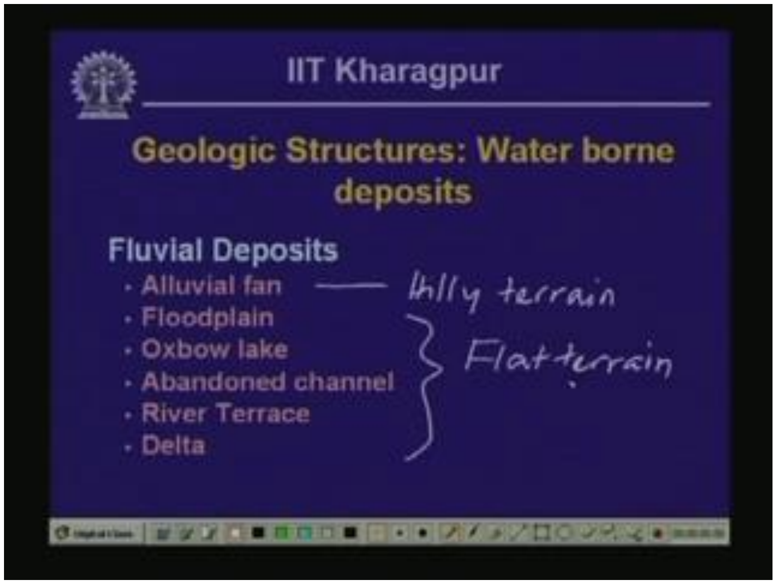


Cuesta is essentially a long hill one side of which is much steeper than the other side. So, it is very similar to an escarpment. But in escarpment, the bluff is more or less vertical and the two sides of the bluff are quite flat; in case of cuesta, they are all gentle slopes on one side and the other side as shown here is usually flat. This is also, cuesta is also developed because of difference in erosion resistance and particularly near the top, we have got erosion resistant rock that juts out after erosional activity due to the erosional activity and a cuesta develops a shown in the sketch on the top.

The bottom sketch illustrates mesa and butte; these are essentially flat topped hills that generally develop in dry areas because of erosional activity once again. The essential difference between a mesa and butte is that mesa covers a much larger aerial extent than the butte. If the area on the underneath the top of the, underneath the flat top of the hill is approximately 10 hectare or more, that is called a mesa; otherwise if it is smaller, the hill is called a butte.

We now try to understand, try to get an idea about different types of landforms that one might have to have encounter in a fluvial environment; in an environment where there is water flowing through the round surface like a river.

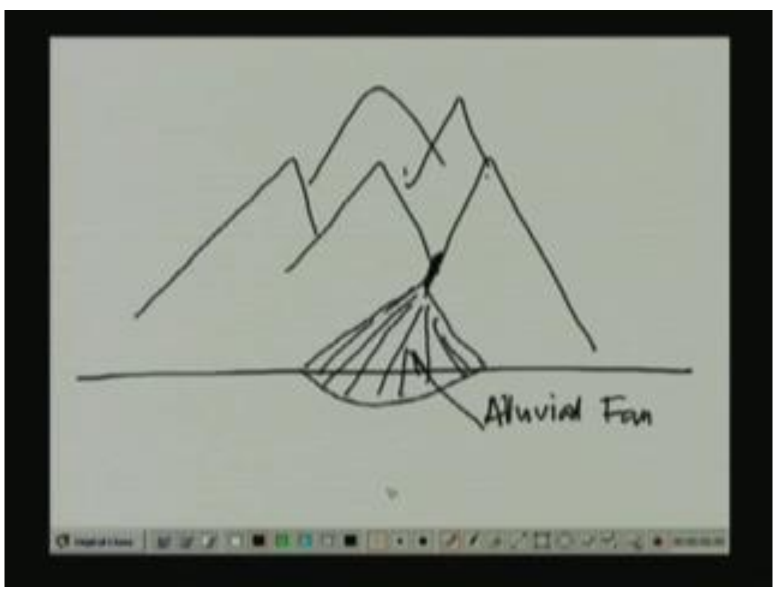
(Refer Slide time: 10:32)



So, river related land form include alluvial fan, it also includes flood plain, oxbow lake, abandoned channel, river terrace and delta. We will actually explain these each of this individual terms in the next little bit. Now, this one here, this one here, occurs in a hilly terrain while all the other ones are typical of flat terrains. Mind you, all these different types of landforms or because of flowing water.

Now, let us see what we mean by each one of those things; each one of the terms that I listed there.

(Refer Slide time: 41:49)

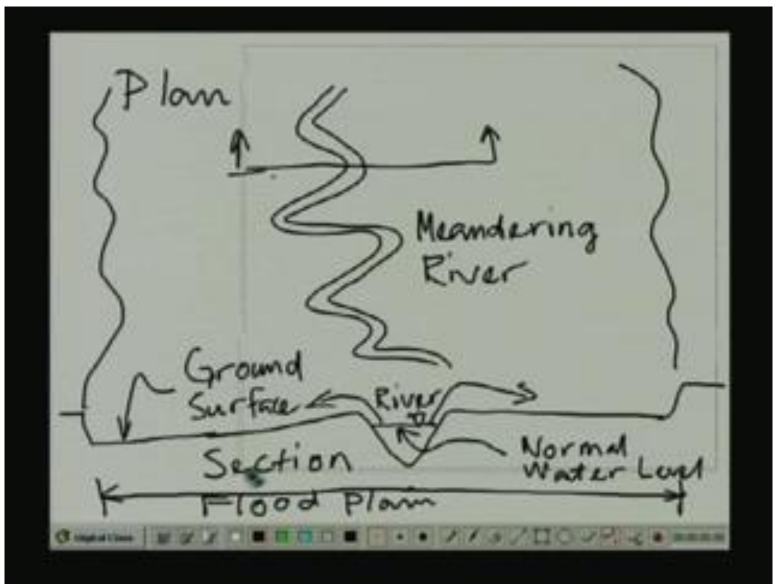


Imagine a river flowing out of a mountain range and it is hitting a relatively flat area once it exits the mountains. So, in that case what happens? There will be a lot of sediment load that it carries when the slope that it is passing through is relatively steep and then once it hits a shallow slope, then river actually tends to deposit sediment load in the form of a fan and this particular type, this type of a structure is called alluvial fan.

Alluvial fan is characterized by heterogeneous mixtures of sand, silt and gravel. And, because of the heterogeneous nature of alluvial fan, it has got some advantages like; it actually is more resistant to failure during, for instance, an earthquake. So, these are the typical properties of alluvial fan.

Now, let us see, what we mean by a flood plain. If there is a river flowing through a relatively flat terrain, then what you might have, what you might what you might have seen already is that the river generally tends to meander. So, this kind of geometry of a river when it is flowing through the flat terrain, we are looking at a top down view here, bud side eye view; this kind of a geometry of a river is called meandering river.

(Refer Slide time: 43:30)

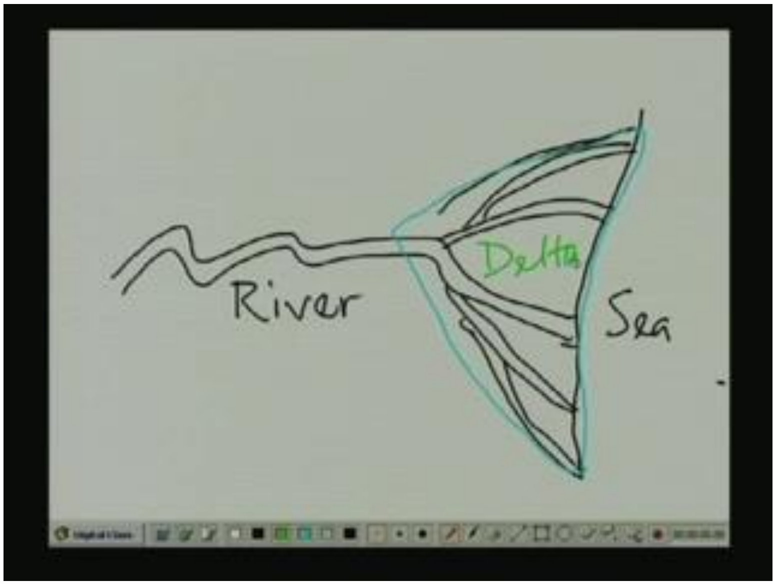


When we take a section of a meandering river, then what we see normally is that the river bed is shown here and on both side of river bed is relatively a flat land. This flat land is sometimes flooded when the river water level, this is water level, normal water level; when the normal water level is surpassed and the water tries to overflow the banks, then the area that actually is folded is called the flood plain. So, the flood plain actually could extend several kilometers on either side of a river until one gets an even higher, one enters an even higher ground.

For some rivers, the flood plain is very extensive and from some other rivers, smaller streams, the flood plain is relatively of narrower extent. So, this is a section that we have drawn here and that is the plan of this particular area and here we show the ground surface like that. So, this area essential is the flood plain. So, that illustrates what we mean by a flood plain.

Now, let us see what we mean by a delta.

(Refer Slide time: 46:52)

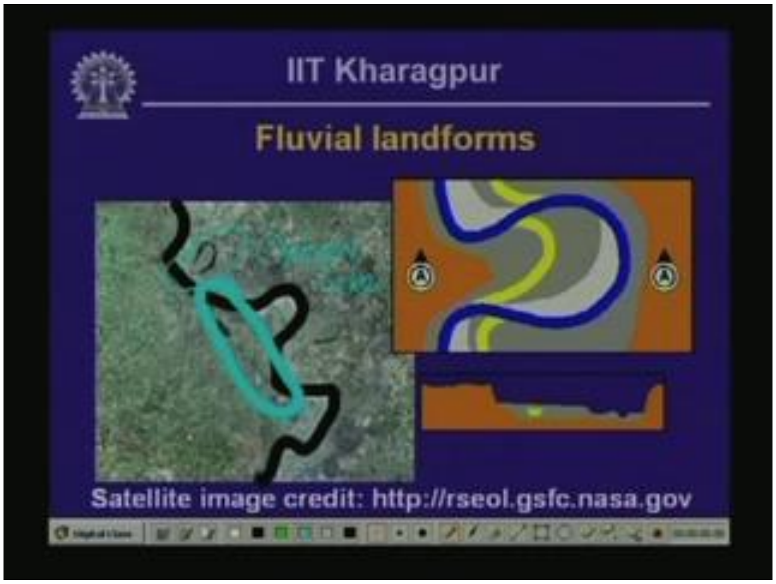


When a river enters the sea, then it actually bifurcates in several different smaller streams before entering the river (sea); this particular type of triangular area through which those smaller streams actually crisscross before entering the sea that is called the delta. So, this is a delta.

The size of the delta also depends on the size of the river and it could be actually several hundred kilometers across as is the case of the Ganges River; on the other hand, for smaller streams, there could be only a very small delta. Now, delta is typically crisscrossed by different channels and these channels sometimes take a different course and so a delta is actually crisscrossed by abundant channels and there could be saturated areas, saturated patches inside the delta which is used to be a water course earlier and it is no longer active.

Delta is typically underlained by sands and silts and gravel whereas, flood plain that we saw earlier is typically underlained by extensive deposits of silts.

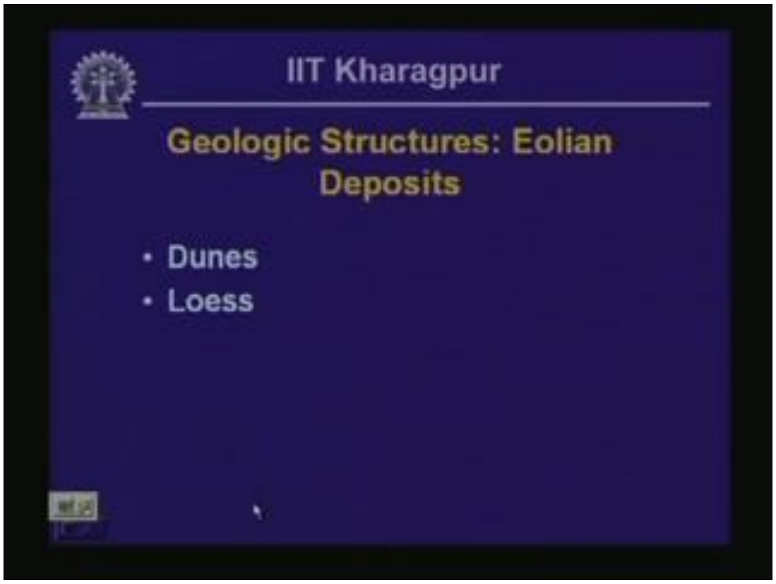
(Refer Slide time: 49:12)



The other features, the other features are illustrated in this satellite image that is shown on the left of figure. It is taken from the NASA satellite actually this shows the river Ganges; a little bit north of Kolkata. The river that is shown there is the river Ganges as I mentioned and here, this is the water course, this one is the water course, this one is the water course and you can also see in this drawing that there used to be an abundant channel in this area and then there are other features like an oxbow lake. So, this is an oxbow lake which is used to be water course earlier but the water course is no longer active.

So, this entire area is characteristics of flood plain and is typically underlained by silt or finer grain deposits unless one is in the actual water course that is active right now or it is presently inactive. So, the sketch on the right shows what I mean by that; so the blue line is basically the existing water course and the grey shading is shown to indicate the flood plain under lain by silts, the yellow line indicates river channels that are no longer active and these yellow channels are actually under lain by sands, sandy soils and the area that is on either side of the grey shaded area actually indicates the terrace or uplands that is the extent, lateral extent that actually is the lateral extent of the flood plain.

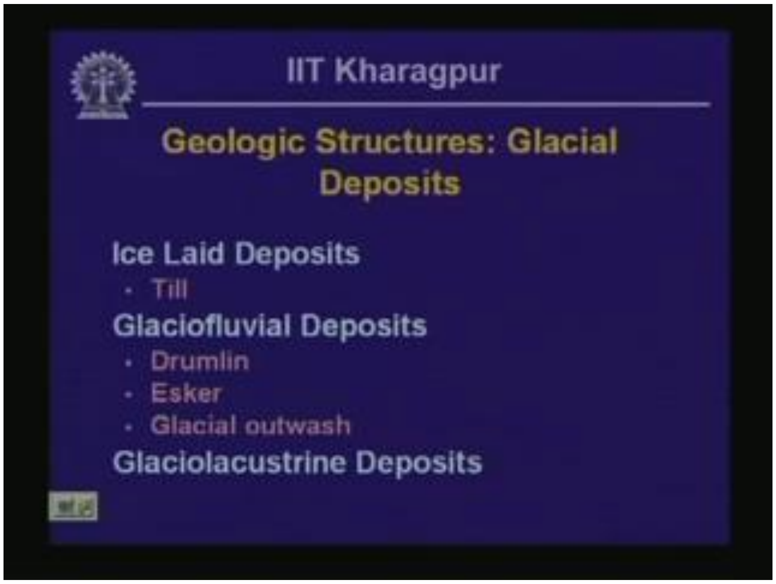
(Refer Slide time: 51:52)



Now, we have to consider there are geologic landforms that are due to activity of wind and we normally get dunes and loess, loess is essentially fine grained silt size particles blown by wind and these are characterized by steep slope and they are very susceptible to failure. If water, is water they become saturated, they become prone to failure whereas dunes are generally underlained by sand grain deposits.

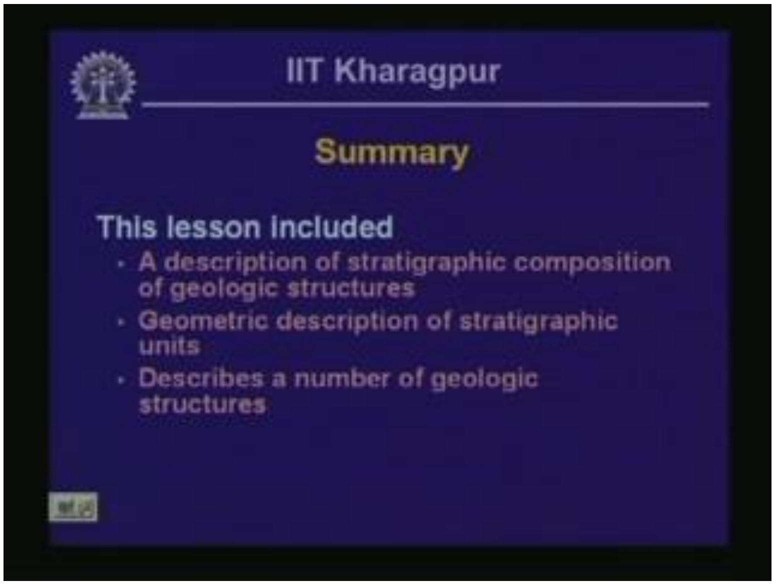
We could also have glacial deposits. Glacial deposits or listed here and they are generally laid by ice. So, if there directly laid underneath ice, they are called till. They could be glacial fluvial deposits; melt water that originates from melting of glaciers like drumlin, esker or glacial out wash.

(Refer Slide time: 52:39)



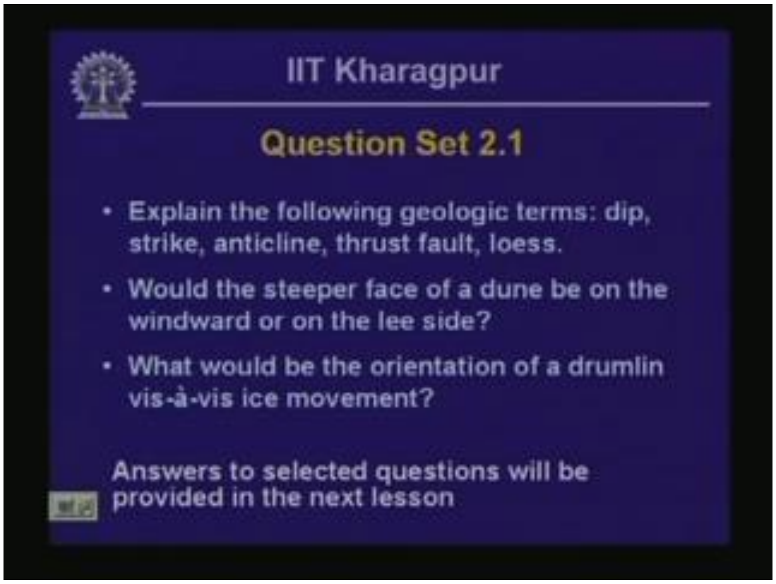
Now, these things typically are elongated in the direction of the ice flow with their slope in the direction of ice flow, in the up ice direction is generally gentler compared to generally steeper in comparison with the down ice direction, there could be glacial outwash deposit that are comprised of basically sand and gravel deposits or there could be glaciolacustrine deposits that are find grained deposits underneath glacial lakes.

(Refer Slide time: 53:52)



That in a nut shell summarizes different types of landforms. We looked at descriptions of different stratigraphic units, we looked at how to define them geometrically and we looked at we tried to list a number of landforms that are encountered often in the branch of engineering geology.

(Refer Slide time: 54:18)



We finally end the session with the set of questions that you should try in your leisure and again as we did in the last presentation, I am going to provide brief answers when we meet for the next lesson. You should try to explain the dip, strike, anticline, thrust fault and loess and you should explain the slope on the windward or on the lee side whether the slope of the dune is likely to be steep on the windward or on the downwind directions that is the lee side and you should also try to say, try to answer whether a drumlin, what is going to be an orientation of a drumlin vis-à-vis ice movement.

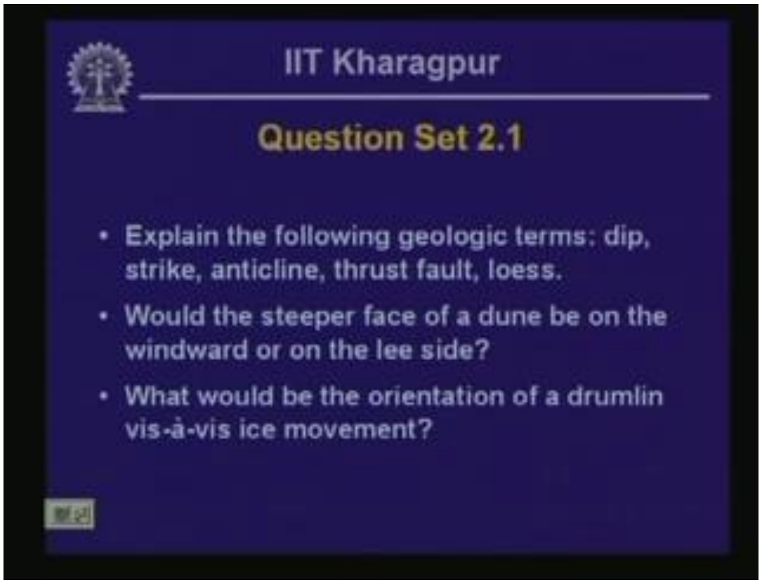
So, you try to answer those questions and I am going to provide the solutions when I meet you again for the third of the series of presentations.

Thank you very much.

(Refer Slide Time: 55:36)

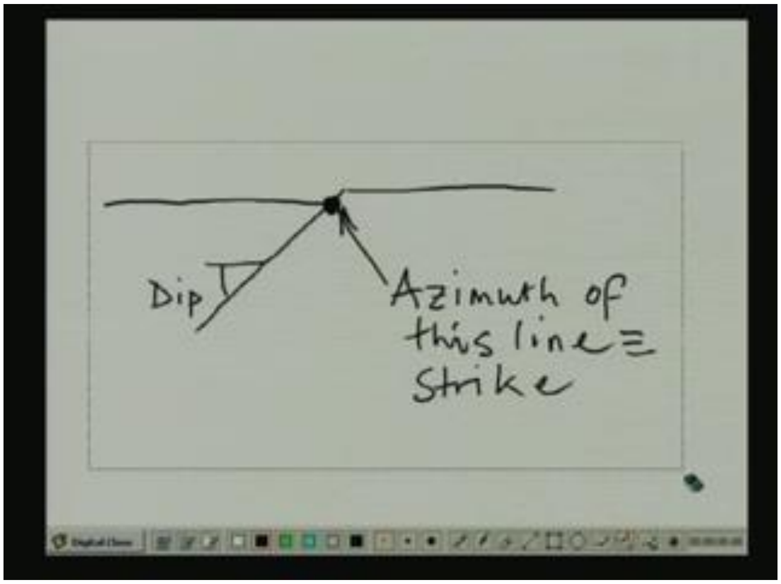
Hello, everyone and welcome to session three of the video course on engineering geology. In this session, we are going to talk about geologic maps and stratigraphic sections. But as is the practice; before going into the subject matter of this presentation, I am going to first discuss the answers of the questions that were asked in the previous presentation.

(Refer Slide Time: 56:06)



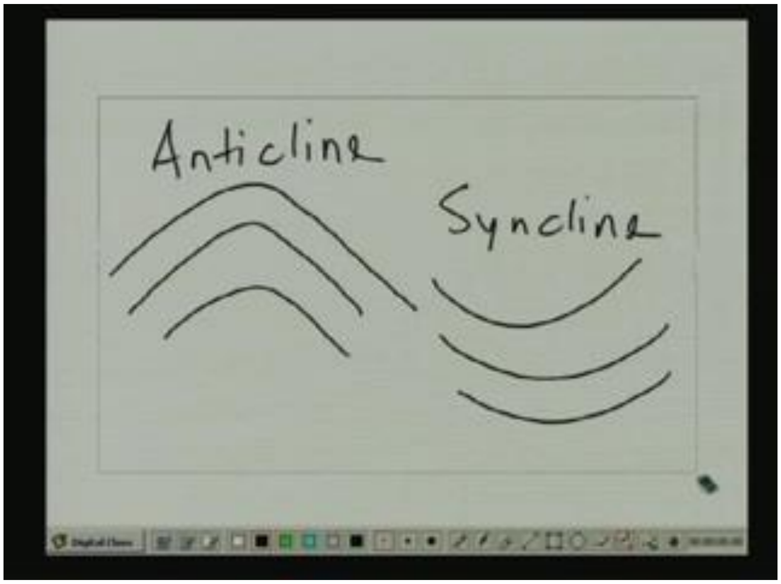
The first question that we were trying to answer was the explanation of the following terms; dip, strike, anticline, thrust fault and loess. Now, the meaning of these terms was clear from the presentation of the last lecture. To restate what I did in the last lecture time; for example, let us take an example of a fault and the fault looks like this.

(Refer Slide Time: 56:53)



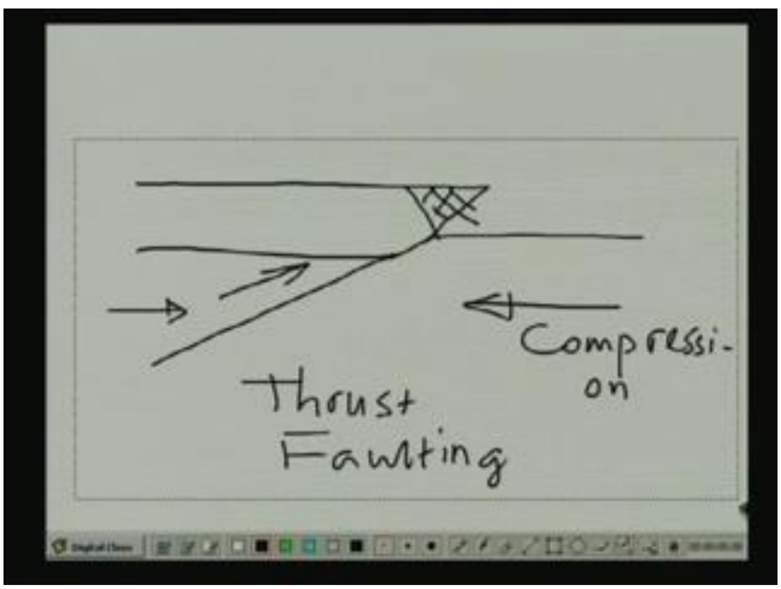
So in this case, deep of the fault is that angle there, strike of the fault is the orientation of this line perpendicular to the plain of this paper; I mean the Azimuth of that line is going to be giving the strike, Azimuth of this line is equivalent to the strike of the fault. So, that is what we mean by the terms deep and strike.

(Refer Slide Time: 57:56)



Then by syncline and anticline, what we mean is if you have got a fold like this, then that one is called an anticline and the reverse is a syncline.

(Refer Slide Time: 58:32)



Getting back again; thrust fault, what we mean by thrust fault is say, you have got a fault which is essentially a shallow angle fault and we subject this one, these two blocks actually to a compressive load like that, then this block is going to try to ride on top of the other block and eventually take a shape like this and this block is going to get eroded out and this kind of faulting is called a thrust faulting.