Photogeology in Terrain Evaluation (Part - 2)

Prof. Javed N. Malik
Department of Earth Science
Indian Institute of Technology – Kanpur

Lecture - 01
Introduction to Geological Structures, Photo Interpretation and Terrain Evaluation

Welcome back all of you and; like this is the second part of Photogeology in Terrain Evaluation. And I hope there are few students or the participants from the previous course also who took the part one. And in particular this in a portion of Photogeology in Terrain we will emphasize more on the; how to identify the landforms mainly, and partly of course we have we did in the previous one; and we will emphasize more on the physical and structural geology part.

And then how to identify the let ethological variants on the surface based on photo geology interpretation. Okay or we can say the photo interpretations mainly. We will definitely use the high-resolution satellite data. And if possible we will use the color aerial photographs also to show you that how we can identify the different landforms; how to prepare the maps and why the understanding of the terrain is so important for all of us okay.

Now I would like before I get into the details I would also like to talk about that for the country like India okay which is now in a phase of infrastructure development okay. We need to have very detailed understanding of the terrain before we get into the construction, okay. So this is very much important and; so let me share with you that there are many projects which are coming up in Himalayas or in the hilly terrains and even in the Indo-Gangetic Plains.

Anywhere you go you need to have the complete full understanding of the geological structures okay, because without that you will not be able to go ahead with your project. We also have to look at that how the project will be cause as effective in terms of the time; in terms of the money which we will we are going to put there.

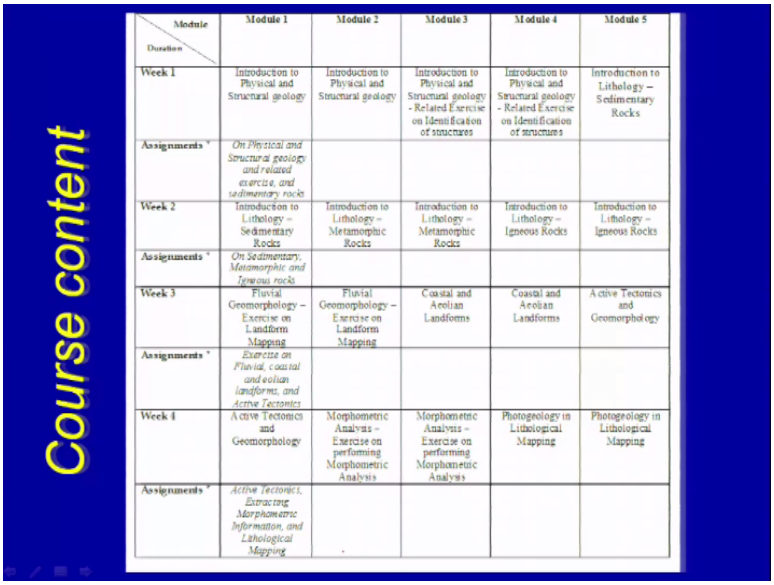
And of course the most important part is the safety part, okay. So those of all things like we have to take into consideration before going off for any major projects in Himalayas okay. Or in anywhere in the Indian part. So we will try to talk about of course the landforms will remain

more or less similar around the globe. If you take Fluvial; if you take an Aeolian that is the landforms form due to the wind action or the coastal landforms they will remain the same.

So we will be using some data from India as well as from other countries or the other part of the globe to make you feel comfortable and understand easily okay. So that is our aim. And we also will look at some exercises okay or the lab oriented which we did in the last time in the part one, so we will try to cover that also where you will learn that how to use the photographs or the satellite data to identify and delineate or demarcate the landforms okay.

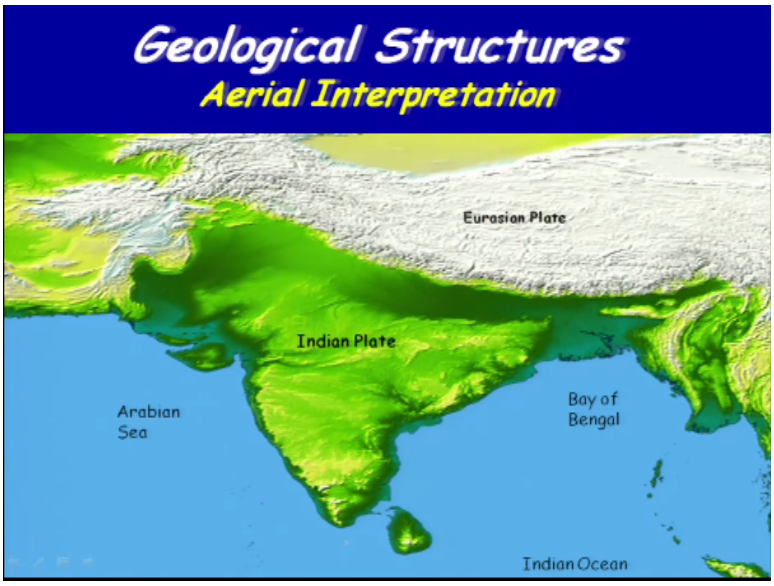
So with this short introduction let us move ahead and start this with this part of the course Photogeology in Terrain Evaluation.

(Refer Slide Time: 04:22)



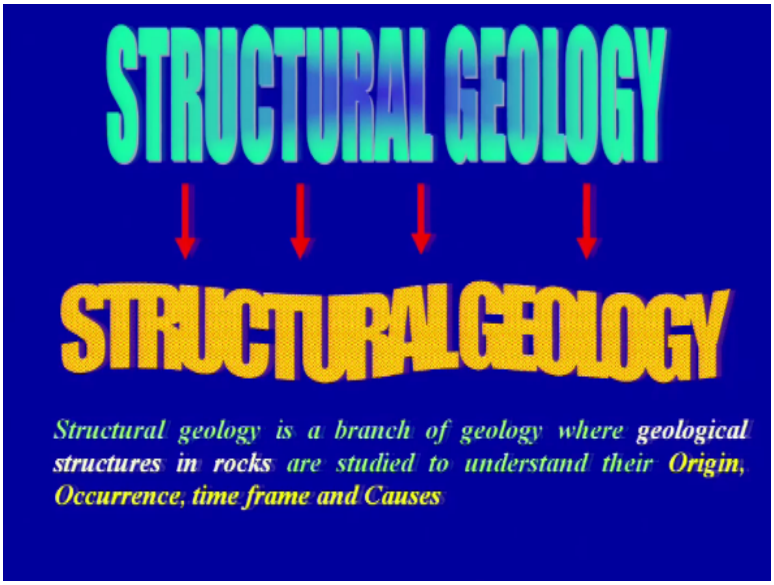
So this I as I discussed that this is a broad course content. But I would say that we will not restrict to the exactly what we are talking here like we will try to cover all but in some of the lectures you will find that you are having in the part which is (()) (04:45) or the coastal. So as and when we move in this course we will, that what I would like to say that we will try to cover most of the parts which are listed here okay.

(Refer Slide Time: 04:57)



So this is what we say that Geological Structure Aerial Interpretation, okay. So based on the high resolution satellite photos or satellite data, we will try to evaluate or we can say identify the landforms and evaluate the terrain, okay.

(Refer Slide Time: 05:21)



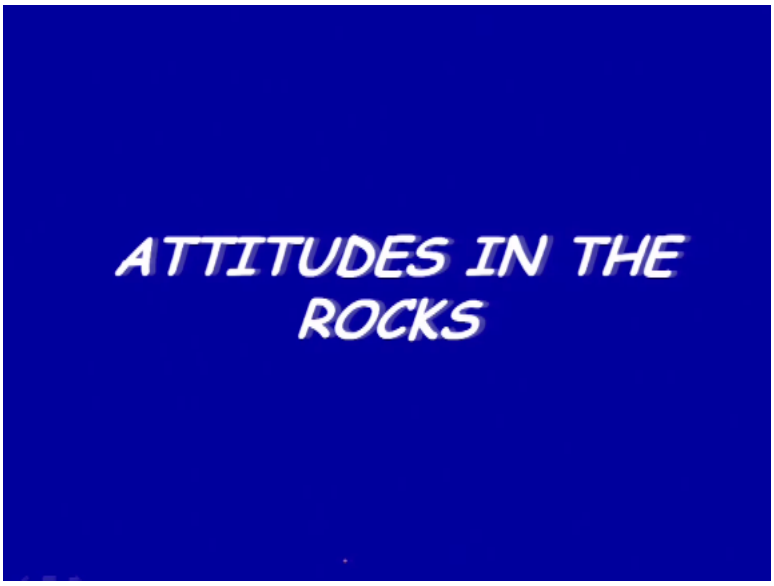
So what is; this is the basic; some of you must be aware of what is the structural geology mainly because this deals with these structures which are created by ongoing deformation or by erosion, okay. But then we will be looking at one in this part will be looking at the deformational structures, okay like folds for joints briefly I covered in one of my course which was offered long back that is our Sciences for civil engineering.

But I would like that for the new candidates; or the students who have joined this course, it is important for them also to have a link between what we are going to use as an photo interpretation and then the evaluation of the deterrent okay. Now the structural geology is a branch of geology where geological structure in rocks are studied to understand; one is their Origin, Occurrence, time frame and Causes, okay.

So how they were formed and what was the timing of their forming and how active they are. Because we as I told that we will be more interested in understand then how vulnerable these structures are to the society okay or the people who are living there or if you are going to have some transportation links like roads or maybe you can say and highways or tunnels or bridges, so this is extremely important.

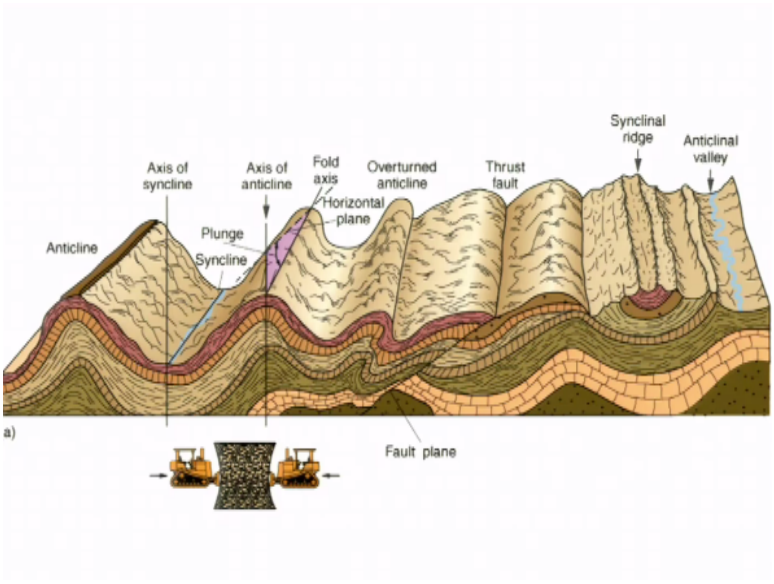
And let me tell you that this basic information will be required by each and every project which is coming up in India in such terrains, okay. So this is very important in from that point of view.

(Refer Slide Time: 07:19)



So any deformation if you take a and consider on the earth surface will result into the attitudes in the rocks, okay. And this is not exactly the attitudes which we are talking; of course we have attitudes in our lives but this is; and almost most of the people will show the attitudes but these are the attitudes of the rock okay. So as soon as you deform the rocks they will lead into folding okay and fracturing.

(Refer Slide Time: 07:48)



So if you keep on deforming the earth surface or the crust okay. And this is already linked with which we talked in the previous course and all that; this is linked with the or you can connect this with the plate motion okay. So the plate tectonics plays an important role where two plates either collide or passed each other or move away from one another; they will result in two such deformational features, okay.

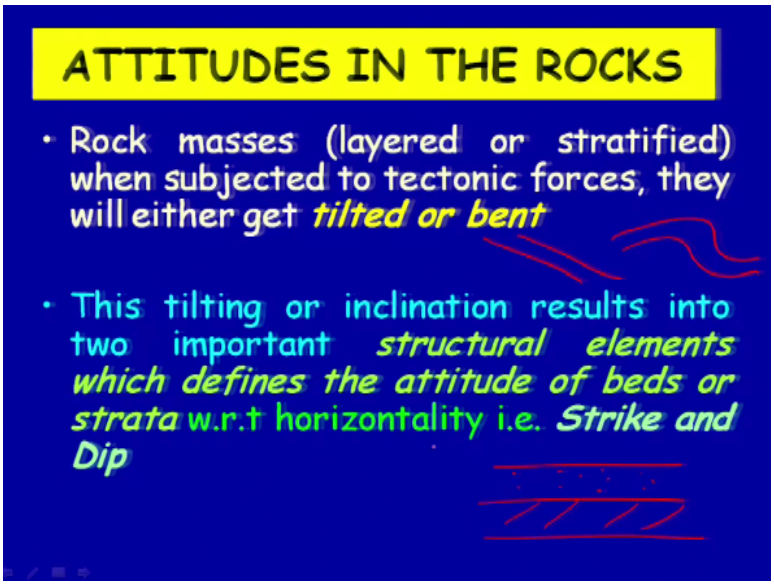
And we have to live with these features like for example we have Himalayas, okay. So Himalayas were formed because and still there they are developing, okay they are growing because of the ongoing deformation. So we need to understand that process and to some extent we have; will established research outputs which talks about that how Himalayas were formed; but still we are unable to pinpoint that exactly where are the fractures;

Or the fault lines which we need to avoid okay we cannot put the structures on those geological features, okay. We have to avoid those. So if you look at in this broader picture what you see is that there is the base if you see there is an - like tractors or maybe the bulldozers are deforming the material; and as a result of that what we see is the complete folding okay. So we have the folds and at some point we have the plane along which the deformational features will move okay. And this is what we call as in faults okay.

And in general if you look at this feature written this as an Anticline and associated depression along with this is written as Syncline, okay. So we will have; if you are having compressional tectonic regime or the area in compression then you will be able to see the features like folds and folds will be always having associated with Anticlines and Synclines as well as Faults, okay because there is a displacement along these fractures.

I will briefly talk about that what is thrust and all that but if more details are required you may please refer our previous lectures to make yourself comfortable in terms of the terminologies okay.

(Refer Slide Time: 10:33)



So Attitudes in the Rocks as soon as you like the form any rocks here like the because usually it is in thumb rule which has been taken that all the position of the material will take place in a horizontal fashion okay. So you will have for example, you have these layers deposited and when you when you deform those okay then you will see that they are folded. So this is what you see in the upper sketch which has been shown in the top okay.

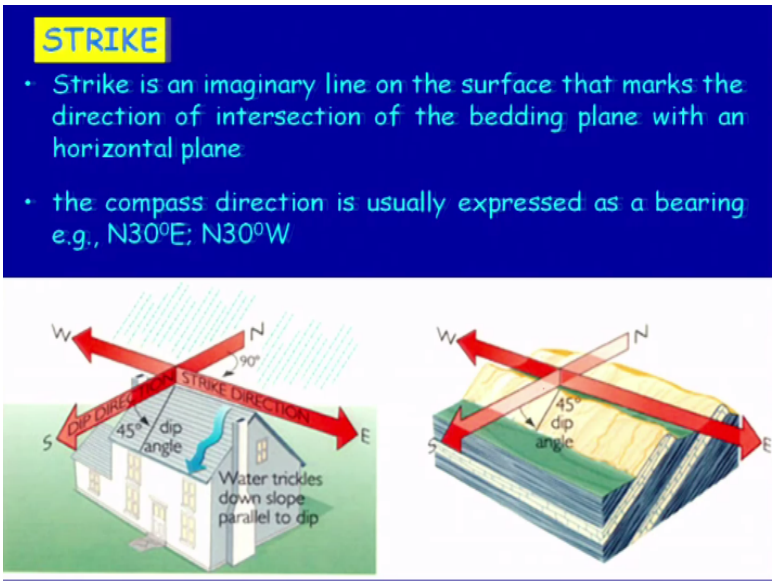
So now there is the formation when it has taken place what has happened; these all layers were horizontal, okay. But now this layers when they are folded or deformed they are having some attitudes okay, so that what we call; so they will have some attitudes in terms of the strike and the

dip, okay. The layers got inclined, so that is extremely important for us when we talk about the attitudes in the rocks, okay.

So rock masses or layered or stratified okay when subjected to tectonic forces, they will either get tilted or bent okay. So they will either get tilted or you can say they will be a short off bending effect okay. So this is one thing which we have to keep in mind. And this tilting or inclination results in two important structural elements which defines the attitude of beds, okay. So beds what a means is that these are they were deposited in horizontal fashion.

So these are all horizontal bed or strata you can take, okay. And then they got deform. So the deformation will with respect to horizontal will result into the two attitudes that are your Strike and Dip, okay. So we will quickly look then what is Strike and what is Dip and we will move ahead in course, okay.

(Refer Slide Time: 12:54)



Now this you will be able to see only if you are looking at the section; but on based on the photographic interpretation you can also judge that what type of feature or the landform you are looking at okay. So that is the part the important part. But without having this understanding what I am talking about the attitude of rocks and all that you will not be able to go ahead, because final interpretation of the map which you are going to prepare will require this information, okay.

So after doing your satellite data interpretation or photo interpretation of course you will have to go for field check to do few locations, okay not the complete area and that is the advantage of this course okay or maybe the aspect which we are talking about the photo interpretation. Because otherwise in the earlier days where we were not having very high resolution satellite data, everyone has to go in field and do the mapping okay.

That is what typical structural geological mapping we have to do okay and prepare the detailed map. But now on the based on the high resolution satellite photos at least you can prepare the preliminary map; of course you can also finalize it but field check is required to some locations okay. Another part is that why this is advantageous because you will not be able to move or approach or reach each and every location because of some reasons, okay.

Either the roads are not there; no connectivity or maybe it is under thick forests okay. So you may not be able to approach those areas, okay. So satellite data will give you an idea and over bird eye view or you can say in the synoptic view where you can look at the terrain and identify the locations of the landforms, okay. Now coming to the strike, Strike is an imaginary line on the surface that marks the direction of intersection of bedding plane with a horizontal plane.

So I will come to that picture but I will just draw here so that you are able to understand. As I told that we have horizontal beds and within that they are folded, okay. Now when this inclination of the beds is there, so with respect to this okay; this is the line here and plane which will be joining here will be this one okay. So this is an imaginary plane which you will draw or will make it as a horizontal plane okay, so that will give you the strike of the inclined beds, okay.

So this is what you can see in a simple example if you take in top of the hut or a roof of any house where you are having two inclined surfaces. So the horizontal plane which connects this line okay with respect to the inclined one. So for example what you are taking is that you are having an inclined plane here okay and you are having; this is your imaginary horizontal plane. So the direction of the strike will be this okay of this inclined.

And perpendicular to that okay will be your dip direction okay. So one this is very important that how the structure is oriented, okay; it is one and how this; what is the amount of dip of the plane okay. So this is very important for us to identify. So even from the satellite photographs you will be able to identify that how steep the surface is dipping okay, so that is very important for all of us, because nowadays you might be watching in the news that there is a lot of landslides and there is a lot of rock falls in many countries mainly in the hilly terrains, okay

And this is because you have the steeply inclined beds and fractured rocks, okay or maybe you can say the fault at rocks, okay. So this is; I hope this is very clear. So there is an example which is been given up of a housetop okay where you can draw in line with respect to the horizontal plane intersecting at the top which will be a strike direction. Now the strike direction can be given like it is traversing for example east-west okay.

But the direction of the dip will be in one direction only okay, because you cannot have any direction you can say the strike is east-west and perpendicular to that will be your dip, okay. So that is your Dip direction. So you can say that the beds are dipping towards south and the strike of the beds are; that is inclined beds are east-west, okay.

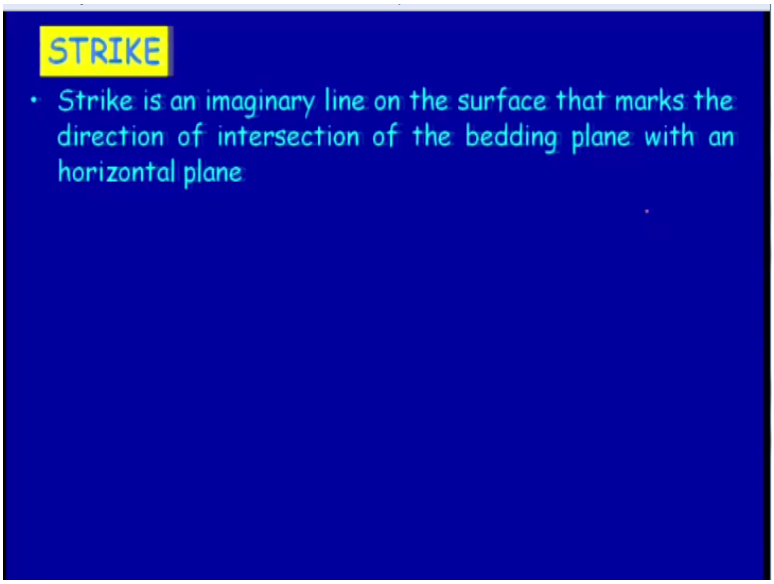
Another example which is been given here is the; the section is been shown and the top view is there where you see the inclined beds and or beds or the succession of a rock succession which again is showing the, this strike that is east-west and the direction of the dip is here. Another part which is important is your; amount of dip, okay. And amount of dip will be always taken with respect to again horizontal, okay.

So what is the angle of that, you can see here what I am showing is okay fine. So you are having an inclined bed. So you have; there is an inclined bed and then you are having the dip direct as strike direction is this one, okay. And amount of dip is what you will say first the direction; this is the direction here. So this direction and then amount of dip is this one, okay. So you will measure the angle with respect to horizontal, okay.

Now to some extent you will be able to cater this information on from the satellite data provided your photographs are ortho-rectified okay, and that you; we did in the previous part okay part-1. So if they are ortho-rectified exactly the camera is looking perpendicular to the surface then you will be able to do something related to the strike; dip at least okay.

But dip, you will have to check at least in some locations in the field okay. So the compass direction is usually expressed as a bearing that is North 30 degree East; this is just an example which will tell you the strike of the or maybe you can say North 30 degree West, okay, so this is a strike directions you can put.

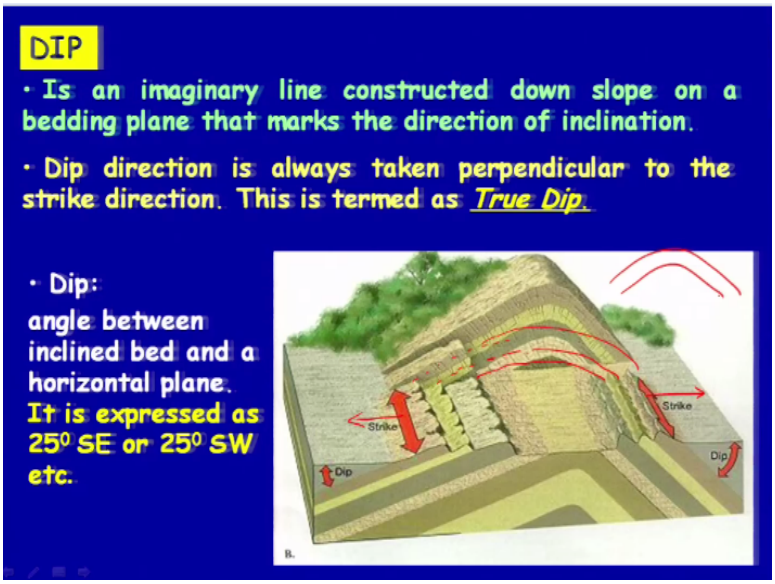
(Refer Slide Time: 20:02)



So everything you will talk about with respect to north, okay. So one thing which I would like to explain here is that suppose you take this for example this is your north, south and then you are having the east and west, okay. So you can either use this to quadrant on the top and then say okay fine. This is your strike direction, okay. So say; like so you can say North 45 degrees East or you are having somewhere here, so you can say for example North 20 degrees West okay.

So one will be easily; will can make out and you can add one here and then you can have this direction also okay fine there is absolutely no problem. So if you write in your report or mark on your map; this two information that will suffice your case okay, so this is one. So let us move ahead and see what is the dip; how we will talk about the dip.

(Refer Slide Time: 21:17)



So Dip again is an imaginary line constructed down slope on a bedding plane that marks the direction of inclination, okay. So as I told the direction of inclination; so here you will only be able to give one direction, okay. So Dip direction is always taken perpendicular to the strike direction and this is termed as the True Dip, okay. So if you have the strike direction here, okay say North-South then perpendicular to this will be your Dip direction, okay.

So this is termed as True Dip, okay. So Dip angle between inclined bed and a horizontal plane. It is expressed as been there is 25 degrees southeast or 25 degrees southwest whatever you get okay fine. So what we are doing is that we are giving only one direction that is either if it is for example it is dipping in this side okay in the quadrant then we will say southeast okay, and then amount of dip.

And amount of dip as I told that if you take the with respect to the horizontal plane and you are having the inclined up in here, okay then this will be your amount of dip, okay. So for example if you say 25 degrees and dipping towards whatever the quadrant you are coming across okay, so that will be; this will be your strike, okay. So the dip direction will be this; amount of dip will be this one; amount of dip will be this one and remain whatever quadrants you are having, okay.

Now if you measure the dip which is in any other direction then the perpendicular, okay to the strike then we call that as an Apparent Dip, okay. So this you will have to take into consideration. And in most of the locations which face you are observing it will be very important, because that will lead to the measurements of the apparent dips, okay. So this is for example on ground surface or the earth surface.

You will not be able to see the complete structure because there is a process; there are process going on which will keep eroding and there are all features and keep modifying the landscape, okay. So over the time you will be left out with some features on the surface which will not exactly give you the idea of the complete fold. For example, in this sketch both the actual landform as well as the eroded features are been shown okay, or the left out features are been shown here.

So based on that you will have to identify what structure it is okay. Either it is unfolded or a syncline or; so what is happening here is very carefully you should and try to look. You are having the beds here 1, 2, 3 and then we are having a very broad flat area and then again we are having the beds 1, 2 and 3 here, okay.

Now both are dipping in different direction; both are dipping in different direction. Of course you will be able to make out the strike because as I told that the if you put an imaginary play plane here, okay. And then you put a line here connecting the bed then you will be able to identify this strike, okay. But with respect to what is the amount of dip here you will have to look at, because both the sides we are having different dip directions, okay.

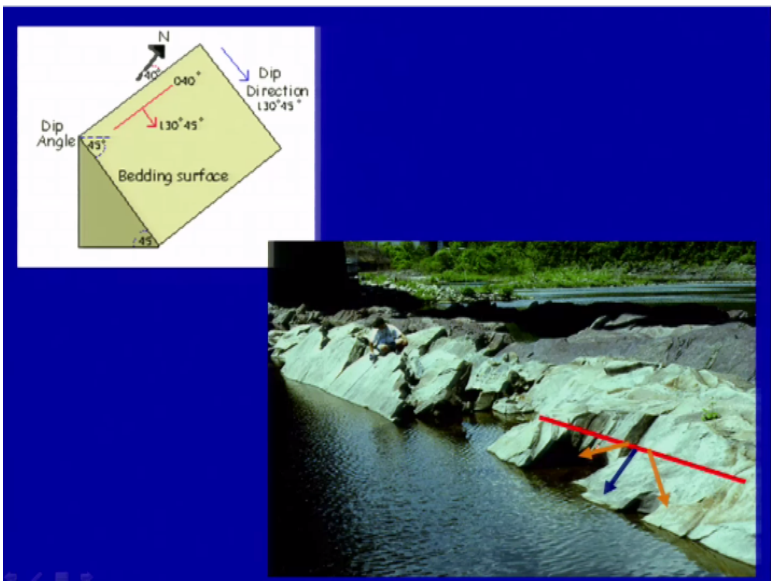
So one side the dip is in this direction and other side dip is in direction, okay. So this is what we call the reconstruction of the landforms, okay. So you will have to reconstruct the landform and give your interpretation, okay. So what we can do is suppose the geologists coming going into the field and based on the change in the dip direction, okay. And here what we are able to see that the dip are the; or the beds are dipping in different direction away from each other, okay.

So when we say away from each other then, if when you reconstruct this for example, this is one bed here; I am very crudely drawing it; there is another sorry. So if you put this; this will go here another one if you put this; this will go here and third one is here, okay. So this is what you see at the backdrop is your fold; and this is what we call a declined, this we can see. Now if you come across the section so well and good.

And most of the time what we do is that if when we go in feel the best areas to look at such sections are your either the river outlets, okay where river has cut across the folds or the structures or you may see in some areas where the road construction is going on, okay that also helps us in evaluating the landscape, okay. So this is the part which we can do one is that the True Dip and the Apparent Dip part.

And then if you are having the beds dipping in different direction you can identify that what shot of deformational feature it will be.

(Refer Slide Time: 26:52)

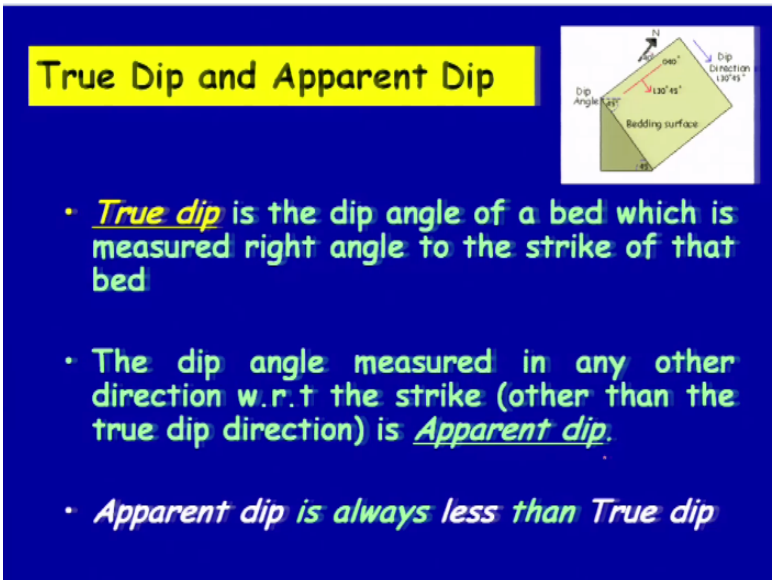


So this is the part of the Apparent Dip. So suppose you are having the inclined plane and you have you know the; in that there is the strike which can be easily done, and when you are measuring the dip amount okay, so you will be putting your compass in a particular direction to take the dip amount. So if you take exactly perpendicular which you can try okay then it will be included.

But any other directions if you are coming across then that may be your Apparent dip, okay. And that you can easily get it; you can know based on your strike, okay. So for example you are having a strike here on 40 degrees okay then the dip direction will be you can take as in perpendicular to that okay. So you add 90 here; so you are having 130 and this will be amount of dip here, okay that is for 45 degrees.

So if you are measuring the dip exactly perpendicular 90 degree to the strike then you will; whatever you measured will be your True dip, okay. But if you are measuring any other direction okay; suppose your site is this and then you are putting your compass something like this because you whatever the face you are; is exposed you will you will try to measure it, okay. Then you will, you will get the apparent dip, okay.

(Refer Slide Time: 28:15)



So True dip and Apparent dip if you take; the True dip is the dip angle of a bed which is measured right angle to the strike of the bed and the dip angle measured in any other direction; with respect to the strike, okay. Other than the True dip direction is termed as Apparent dip, okay. And this is one very important point is that Apparent dip is always less than the True dip, okay. So we will stop here and we will continue in the next lecture and see more on the photo interpretation part. Thank you so much.