Photogeology in Terrain Evaluation (Part -2)
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Lecture - 03
Photo Interpretation/Identification of Landforms Associated with Folds - 2

Welcome back. So yesterday we left with this slide where we were talking about that if you see the section of the folding sequence or the strata.

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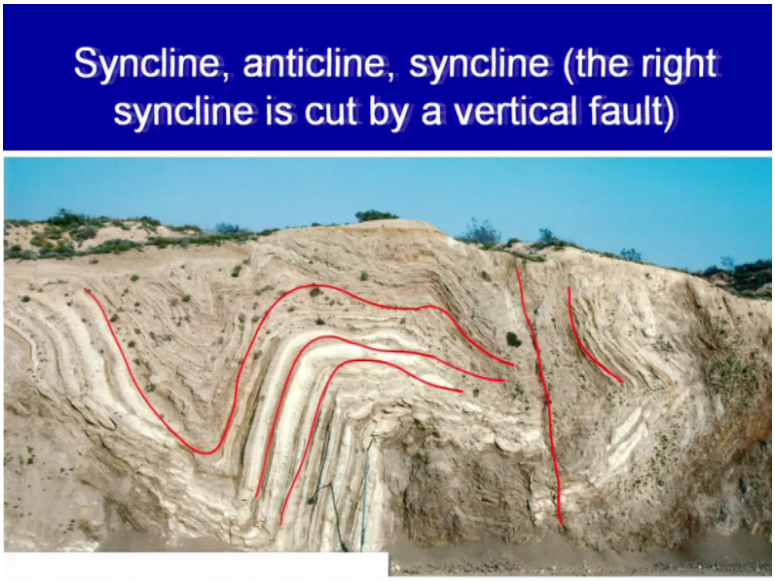

And then it looks something looks like that, okay. And then you have in combination as we were discussing yesterday that we will have anticlines and this inclines together, okay. However, along with this you will also see that there will be a brittle deformation which will be associated with such ongoing deformation. So what you see here is; this is a fault or the fracture along which the displacement has taken place.

And now onwards I will call this is an or use this terminology for the fault, because we see displacement along the fractures, okay. So this is a fault and if you see here then if you trace out the layers or the beds you will see that this is an overturn fold here, okay. So this is clear-cut example of ongoing deformation which is seen in the section, okay. However, the question always remains that how we will be able to identify the folds; and such the manifestation of

deformation or the displacement of the crust on the surface. That we will learn very soon in coming slides, okay.

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So moving ahead in this there is another deformational feature you will come across in fold it and fold a terrain where which is called as Monocline where only one side of the fold limb will get folded and another side remains almost horizontal. As you can see in this section here; so you have the horizontal on this side and then you are getting in slightly bend here, okay. Now this bend is because of the deformation or the displacement along this fault which has moved up.

So a monocline is a large step like fold okay because on the topography if you see you will find a very typical step, okay. So this is what you can you can call as a monocline, okay. So monocline is a large step like fold in otherwise horizontal sedimentary strata, okay. Monocline are associated with the reactivation of faults in the basement rocks below the sediments. So the displacement sometime does not come; reach right up to the surface and you see just warping.

So this warping will create a step like feature on the surface which is termed as Monocline. Now not all steps like features which you will come across could be a monocline, okay. So you have to be careful about on that part in interpreting the terrain. There is another very good example from US which shows a monocline; of course there is aerial photograph which has been which shows the deformation and the warping of the strata and but in the case the plane here again.

So you have a flat surface here then it goes up and there is an eroded one okay so you can see this part here over here. So this one side of the terrain is folded whereas another side is almost flat okay. So if you have to mark fault here or the; then this will be the trace of the fault here.

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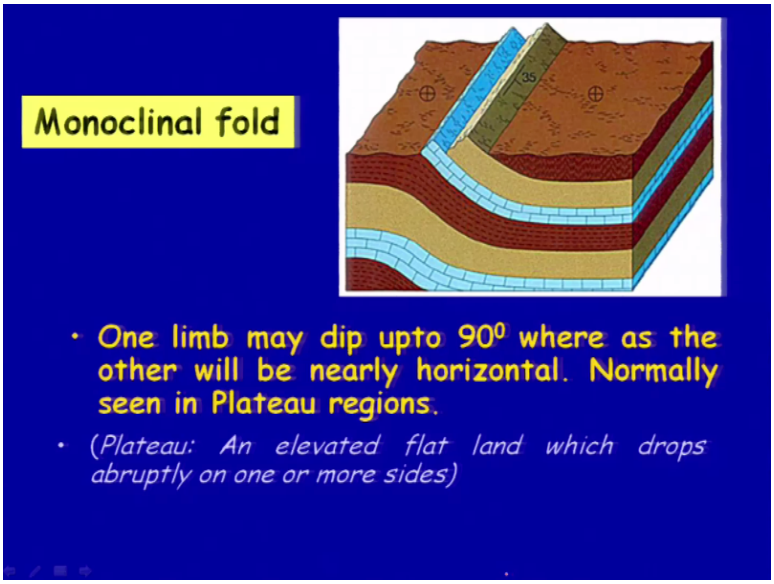

So Monocline fold as discussed, okay. You will be able to see something like this, okay. So one limb may dip up to 90 degree whereas the other will be nearly horizontal, and normally seen in a Plateau regions. So this is what you will be able to see in the section. And on the topography you will see a step like feature.

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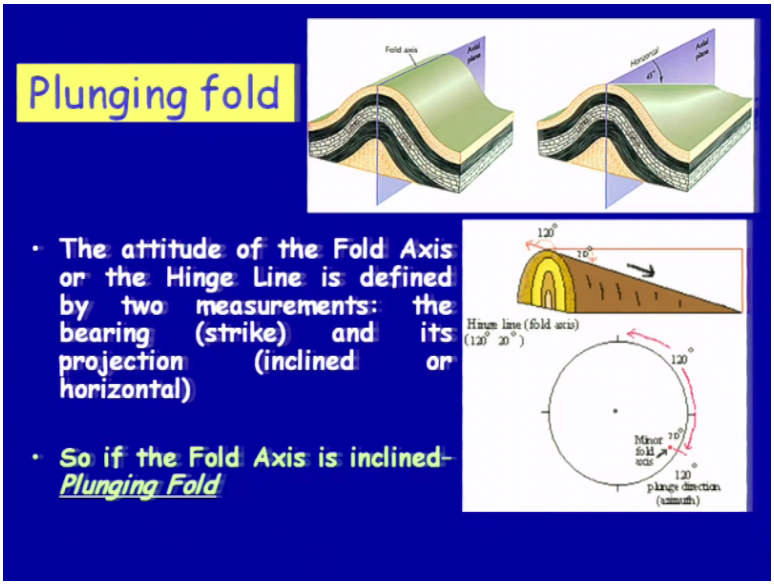

So this is another part of the fold and which is extremely important because in as we were talking about in nature that you will not be able to see incomplete straight line that is a hinge line or the axis; it will vary from place to place or it may change his orientation. Similarly, the axis may not travel or traverse through and through along its strike; but it may die out somewhere okay fine, and that is what we see in regions like a very young mountain building process like Himalayas, okay.

Where you see that the nose of the fold; for example, I am drawing a sketch here, so what you see in that the folding will start and a very small nucleation, okay and then it will keep growing, okay. So as it acquires the displacement more and more it also grows laterally. And this step is what we call the nose of the fold or the plunging; for this what we are looking at is in the plane view.

But if you look at in the sectional view or the side view then you will find something like this okay. So this is a normal anticline; this is also an anticline but the axial plane is having some attitude here, okay; hence we term this as a plunging in decline. So this amount which you will measure with respect to the horizontal for this axis is known as plunging sinking. So this is very important for Geologists also as well as worthy Civil engineers.

The reasons are I will discuss very quickly okay. The attitude of the fold axis or the hinge line is defined by two measurements. One is the bearing that is the strike and its projection. Either it is inclined or horizontal, okay. If it is inclined, then we classify that is in your plunging fold. So if the fold axis is inclined then we term that as a plunging fold. This we are not going to talk about the stereographic projections, but of course this is important for us, okay.

So this is our strike of the axis and this is the amount of plunging.

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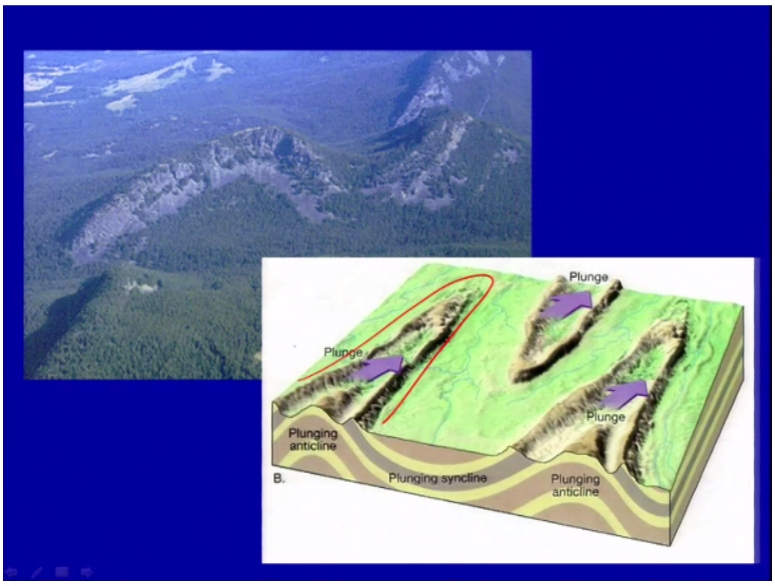

Now if you see this from the around the aerial view then in the front you may come across and see a very beautiful anticline here, okay and associated syncline also. But if you try to map further along the axial plane or the fold axis then you will find that the fold does not continue for the longer distance, okay. And that is what is the plunging fold you see, okay. So, either is a plunging anticline or plunging syncline.

Now the point is yesterday we were talking about that if you are having if you select to put the tunnel here, okay then what you will do okay. You will extend your tunnel up to this only and even then you are out. You do not have to go for a tunnel here, okay; you are getting into the syncline here. So this is one important part that you need to understand that whether this is an anticline, a complete anticline or you are looking at the plunging folds or plunging anticline.

So this is what will happen, okay. So in the front; this axial view you may see that there is a fold but on the top view you will be or the plane view you will not be able to see that the fold is extending okay and it dies out somewhere over here. Similarly, this folds dies out here and this out here okay, fine. So this is important again to understand that whether the fold is plunging or not. And we will see some examples from Himalaya also of the plunging folds.

Or you can say the growing folds, okay because this fold will keep on growing. So next time when there will be movement or the displacement then this fold will further grow like this, okay, and then further it goes like that. So this is how it will develop.

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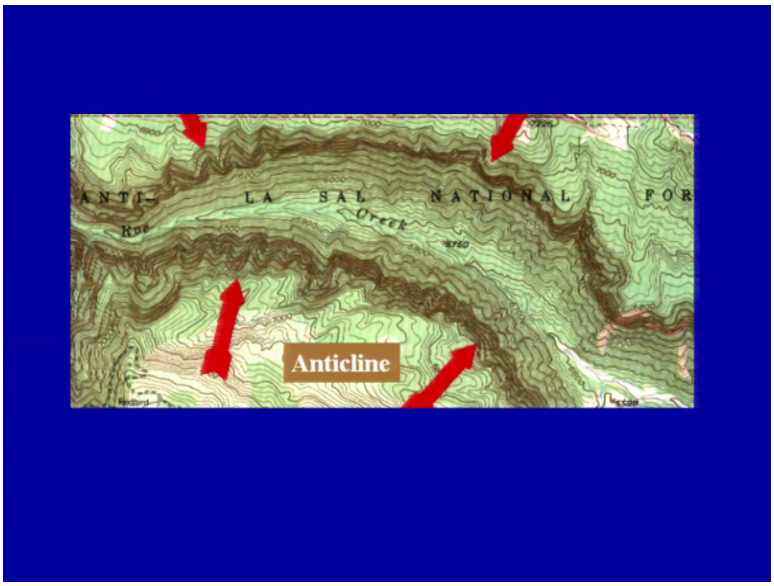

Now this is just; if you have the topographic maps, okay Topographic map are giving an information of the elevation and the terrain, okay. It can also try to find out the morphology of the surfaces okay or the earth surface. So this is; this has been given in terms of; I am not going into the detail that what other information are available in topographic maps. But most important for us because we are looking at the terrain is your contours, okay.

So contours depending on the scale you will find the contours intervals are different okay. Some places in high resolution maps you will find two meters also contour interval; you may also generate the contours of 20 centimeter interval; 50 centimeter interval or you may have the contour interval of 20 meters and so on, okay. Now wherever the topographic will change, okay the contour spacing will also change, okay that is what has been shown here, okay.

So here we have very closely spaced contours. Here also we are having very close the spaced contours in some places and then it becomes wider her and then it become wider here. So if you have to draw a cross-section here what you will find is something like this, okay. You have a

steep and then the broader shallower here and then becoming broader shallower here. So this is like an; the valley, okay.

Similarly, if you suppose you try to look at the contours of your having the anticline here, okay then this is if you draw a cross-section then you what you will find that the contour is steeper here and then become gentler this side, okay. So this is again you can interpret the terrain if you are having the topographic sheets also. So this is this sketch topo map is showing that this is steeper and it is what is being shown here is a flat area slightly; or a wider area is been covered because the contours are widely spaced and then slowly get into the steeper part, okay.

So this is a creek. So this side is an anticline; this is your syncline or a valley; so this you will be able to judge very properly.

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Now if you I ask that how you are going to interpret this aerial photograph based on the dip and Strike, okay as we were talking about that if you are having an anticline, okay. Now for example if you put an anticline here and then if we ask you to put the strike and dip, okay; so on the plane view what you will put is that this will be your fold axis and the beds are dipping; this is a strike and the beds are dipping in this direction here; And this is the strike here and beds are dipping in this direction, okay.

So you have the other clear-cut fold; this indicates here that the terrain is folded, okay. Now with this understanding look at this photograph and try to visualize it that what exactly has happened here okay. So we have a very typical in like the elliptical landform here okay and then if you see the beds here at please tweak and make out that these beds are dipping in this direction and this beds are also dipping in this direction, okay.

Whereas if you come this side this bed is dipping in this direction and even here also you can see this bed is dipping here; this bed is dipping this side again, okay. And further to be very clear here, this is your; what you click in the hinge line, okay. And this is eroded here; you can extend like this; and this portion is having slope in this direction and this portion is toping in this direction.

So again what we are able to see here is that it is an example of an eroded anticline, okay where you have this beds which are going here; this also you can see the folds here, okay folding. So if I connect this bed here this goes something like that, okay. And if you extrapolate this, this will definitely come like this, okay. So this is an example of a typical anticline, okay. So based on the topography you will be able to mark or identify that what type of landform you are looking at it.

So the importance here is that you need to understand properly the structurally geology part, so that when you are interpreting the satellite photos you can clearly make out that what type of landform you are looking at.

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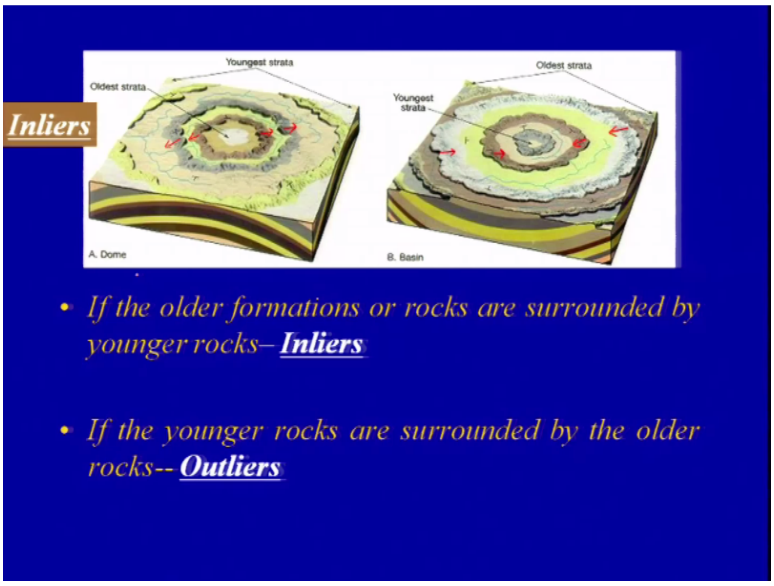

Now these are further terminologies which are commonly used, okay. And even you can also make out this interpretation. You can interpret if you are coming across such signatures okay. Like for example is very common like seen in; you must be knowing about the Domes and the Basins, okay. Now when we sort say Dome immediately we say that okay fine it is something like this, okay fine. And if we say Basin, then it will be like this.

Now this is a sectional view we e have drawn. But if you see the top view or the plane view then what you find is that there is a slope; if in terms of the basin which is like this and; so any streams which will develop on this slope will converge towards the center and that is what we call the basin. Another part is that the; if you are having Dome then the slope is on the side. So what will happen is exactly the opposite okay.

The streams which will develop over the slope will flow away from the hinge part. So now what we have done here is that we are using drainage pattern and trying to identify the landform. But at the same time if you have very clear information available on the satellite data you can also pick up at the dip of the beds or the strata. These are dipping in this direction here; this is also away; this is also like this; this is also like this, okay.

So they are dipping away from one another, okay whereas here they are dipping here and this one is dipping this side; this one is dipping this side; this one is towards each other, okay. Hence,

this is an syncline and this is an anticline, okay. And if you see there is a symbols which have been given here of dip and strike. So everywhere it is been marked that what is the dip and the strike of the units. So this is a typical example you will come across of the dome.

So if you put this okay then you will find that if you; drainages are flowing in all direction away from the center okay whereas in the in the case of the Basin you will find that they are flowing inside. So this part you will have to remember. And very commonly you will be able to see this type of features on the Earth Surface. It is the Dome and the Basin.

Now another term which is been used in geology along with this is here Inlier and Outlier. So Inlier what you see is; if the older formation or rocks are surrounded by a younger rock, okay. So older rocks are surrounded by younger rocks, so where is the older rock? In the core here, surrounded by younger rocks, so you will call that as an Inlier, okay. And exactly opposite if the younger rocks are surrounded by the older rocks, okay.

So what you are having here is that you have younger rocks surrounded by older rocks, okay. So you have younger rock in the center and then older rocks at the periphery, okay. So that is termed as Outliers, okay. So this is another term which you may come across in the literature and which can be associated with the Basins and Domes in the region. So this is an Inlier. This is your Outlier.

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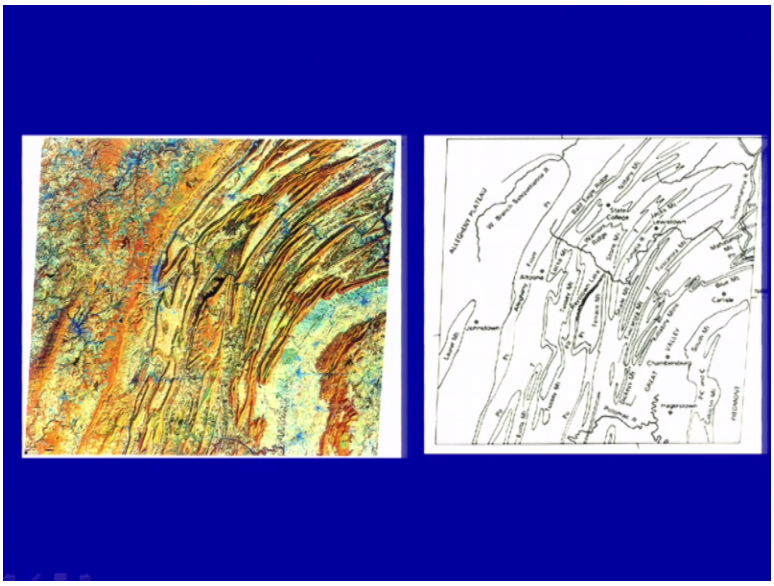

This is a satellite image which gives a complete idea about that how folds will look like in a deformation; because of the ongoing deformation in the region, okay. So you have a very typical linear features which have been seen here which people may call as lineaments but these are all folded ranges, okay. So you demarcate very clearly two regions over here. So this is the boundary between the folded areas and this is the terrain which is not experienced much of deformation.

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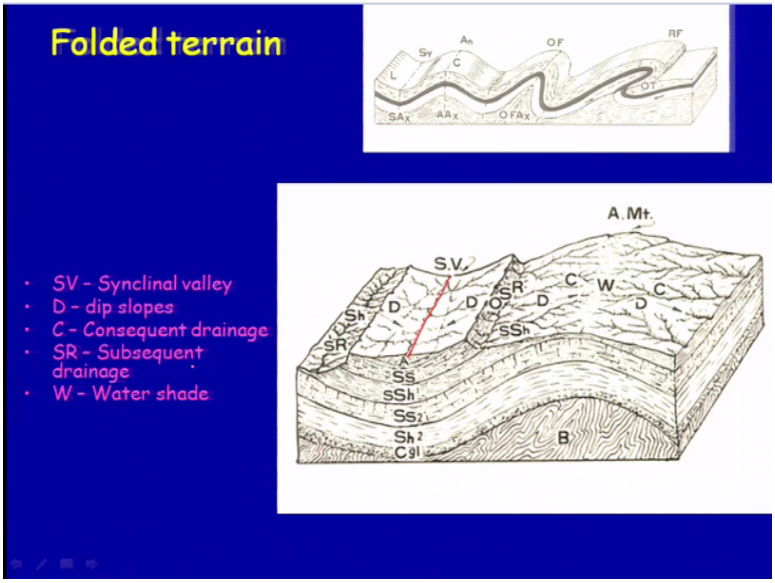

These are few more terminologies which you will be using when you are going to interpret your satellite data, okay. This we have we talked about that this is a syncline, anticline and then if you are having an overturn fold this is a typical of asymmetrical fold; this is a symmetrical fold here.

And if you are having the eroded portion here mostly what you will see is that the drainages, okay. So this will flow along the dip slope here.

And again this will; these are the drainages where you are having the axis here; so I will put here this is an axis here and this is syncline axis here, okay fine. So if you put it in the cross-section you will find over here, okay. But we will not be able to see quite often the sectional view, okay So we will be relying on the plane view also mostly plane view. So you will be able to identify very easily that this is an anticline or syncline.

So either you call this as a drainage divide or you can say the water shade, okay, so water shade area. And then we are having some with this; I believe that we have already covered in the last part, part-1 consequent stream, subsequent streams and all, that okay. So please read out those and refer to those slides and; which can be used for the; this course.

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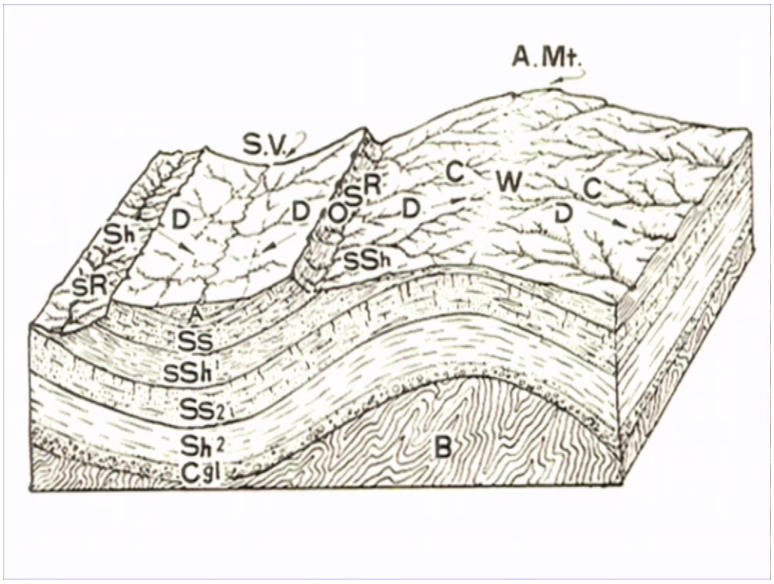

This just to show the; are in the broader view.

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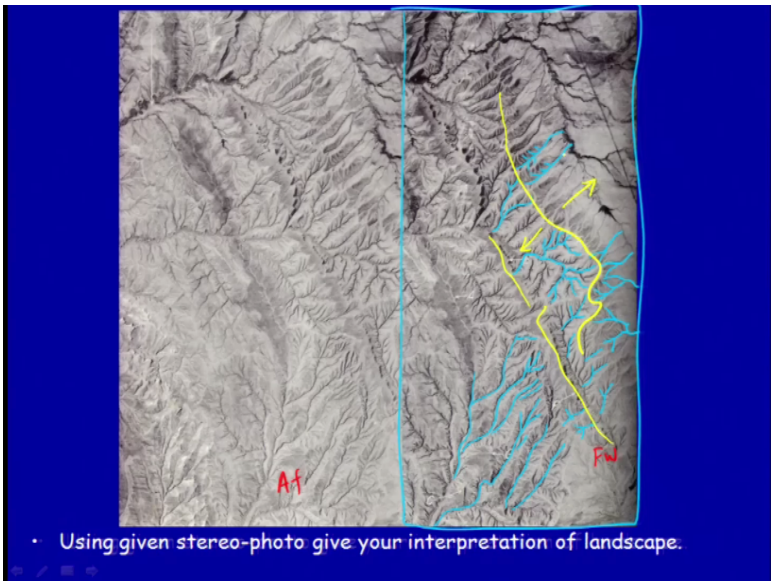

Now this is the stereo photograph of the terrain. So this is not the same like continuously one photograph but this is an overlap of the same area, so some features you will just find where I am putting the pointer; his is the divide of; between the one photograph and the another one. So this is the left photograph or right photograph and this is the left one, okay. So either you can say forward and after. So you have one is the forward image and one is your after image, okay.

This is what you are having here. Now if I ask you whatever we have discussed in previous slides, okay either it is an anticline or in syncline or asymmetrical anticline or overturn folds or maybe you can say plunging fold and water shade or the tenet divide; I believe that you will be able to demarcate that, okay. But then also let us just look at okay that what we see here; I will start putting some areas.

I am just taking because if you when you view this and stereo; stereo scope under the stereo scope you will be able to see three dimension, okay. So you will have a 3D view of this. Even if you are having in good practice looking to your with using your eyes you can generate 3D looking to at least merging 2 points okay that is what we were talking in the last part the previous one and you can like you can generate the stereo vision or the; of the terrain, okay.

So now if you trace out just on the; I am taking this image that is a forward one, only this one this okay, this part if you take. And immediate interpretation if I have to do and if I put the

streams here and I will put here and; I will pick up few streams only not all. And then we have few flowering here and then I can see this are going like this. We are getting in meeting the major one. This you will be doing in the lab also, so do not worry about that.

But let us let us say that if we put the; identify these streams unbiasedly then what we are able to get, okay. Now again if you carefully look at while tracing this the drainage pattern is also changing; it is not the same everywhere; and that also indicates that the subsurface lithology is different. So I have picked up many here now. Now we can talk about that what we are able to see here, okay fine.

So if you can broadly see this there is a divide here okay. And even there is something; I will take in different pen okay and then you can draw, fine. And then put somewhere and see this, okay. This goes like this and then this, okay fine. And here if you take this is what I am getting somewhere, something. And then even here some location that you see this, so what you are able to pick up is; there is our drainage divide and probably we are able to see;

Because these are the drainages which are flowing in different direction, okay. This flows in this direction; this flows in this direction; so this unfold here; and even here also you are moving away from one another, okay. There is a stream which flows like this and so on, okay. So there is a clear cut indication of unfolded terrain here. But at the same time what you will be able to observe that pattern of drainage is different here and pattern of drainage is different here.

And also here we are having, very sparse drainages. So this portion we will cover later on. But at least at this stage you will be able to talk about and there is some sort of an; hilly terrain which you can see based on the drainage each pattern, okay. And you will be able to pick up at the divide that is in the water shade or you can say if this is fold then you are able to see the, the hinge line of the fold, okay.

So I will stop here and we will continue in the next lecture with further details, okay. Thank you so much.