Photogeology in Terrain Evaluation (Part -2)

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

Lecture - 06
Photogeology Interpretations of Tectonic Landforms

So in previous lecture we talked about the strike slip fault which we identified from close to Chandigarh area in Northwest Himalaya.

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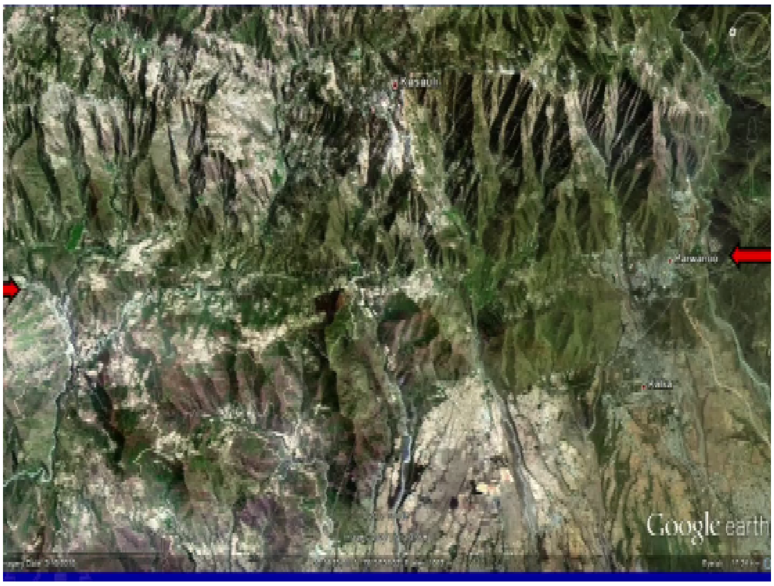

Now coming to this, this again is very well-known occasion and the picnic spot also you can say or the tourist spot hill stations one is the Parwanoo here and then you go to Kasauli. Now this is even to Shimla from here okay. So this is in Kalka town which is sitting in the Pinjore Dun area. And the fault which I was talking about the Taksal fault goes through here actually this location.

So some close up photograph and the points which we were talking in the last lecture that if this fault was not known then what the local people or the so called urban development people did without having this information because nowadays this is pretty much essential and slowly it is getting mandatory that any structure coming up in seismic zones should have the report that whether that structure is coming on the active fault or not.

So fault rays is here between those 2 arrows and if you see this Parwanoo is a town is very much close to the fault. We will have another close up of that the fault comes here and I will just put the offset here of this stream which is flowing stream comes like that and then take turns here.

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So let us see the close up of that. Faults turns here stream offset and you can see at the backdrop a lot of construction which is close to the fault line.

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Further ground photograph of that. Now this photograph has been taken from this hilltop viewing this side. So what you see here is the stream coming from here and taking turn that is okay. So this goes here so the fault runs somewhere over here and this portion of the cliff of the escarpment is your faults scarp. And you can see that lot of construction has been carried out on the top of this.

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Let us see close up of this area where you can see the tank here this is a water tank and then few houses are sitting exactly on the top of the fault. So this is a fault scrap on which this whole portion from here to this place is your fault scarp and faults runs somewhere over here. Now the point is whether this fault was known or not the answer is yes it was not known and without having any understanding that in future earthquake what will happen.

So you can just compare or think what we saw in couple of previous slides from Kobe or Awaji Island where the Kobe earthquake resulted into displacement. Now this scarp which is seen here are more than 15 meter and in some places we observed that it is almost like 50 meters. This did not develop in one single earthquake. So this itself indicate that there were multiple earthquakes which resulted into the formation of this high scarp.

Again this is not a very ideal condition to put a water tank on the top of the fault scarp. Second is this house which is sitting exactly on the top of the fault. So what will happen that when the earthquake will come this block will move as well as vertically that is moved laterally as well as it will uplift vertically. So both movements will be experienced here and you can think over that what will be the ground escalation in this area okay.

So this area for sure will observe total damage. So this is one example which I wanted to show you that what is the importance of delineating or identifying the fault lines from satellite photo interpretation.

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Another very good example from US. Now this fault is named as Denali fault. So what happen was when they were putting and this what you see here a white line is a crude oil pipeline. So they wanted to lay the crude oil pipeline. So all the transit and the orientation the alignment of the pipelines was decided, but they came across that or they came to know that this pipeline will cross the fault line.

So what is the best way to protect this pipeline from future earthquake. So they did the detail studies on Denali fault that is what we call the paleoseismic studies and they found that this fault will rupture in future. So the civil engineer and the structural engineer they asked that okay what will be the displacement which is expected and second is how much will be the amount of vertical movement in this area or along this fault.

And what is the best way then they started the thought process started was what is the best way to save this pipeline because whenever there will be an earthquake this area will break and then of course the damage will be experienced by the pipeline.

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So what they did was they decided that fine let us bring the pipeline on the surface rather than putting subsurface and since they knew that this fault is a strike-slip fault a right lateral strike slip faults which will definitely will have a movement where one block will move towards right and another towards left or maybe we can say that the block will move towards us. So they knew the sense of movement and then what will be the offset.

So and in later so the put this pipeline on a slider beam or we can say a very much similar to the roller coaster. And they took into consideration the amount of displacement which one will experience along this fault. So they kept that much of buffer that whenever they came up with a very flexible pipeline and they put this on the wheels okay. So when the earthquake came this just pipeline slide on the top of it and did not get did not damage.

And this is a very good example which we always talk about when we are talking about this one.

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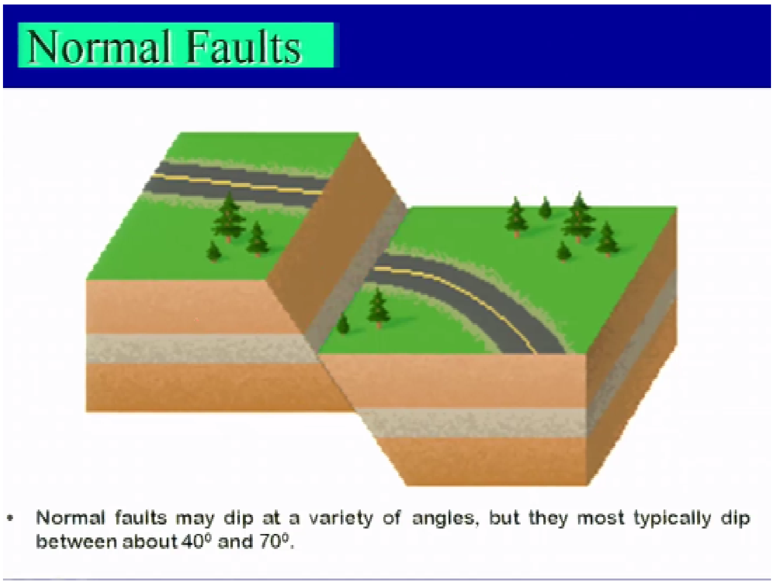

Now coming to the another type of fault that is a normal fault. So normal fault what will happen the hanging wall will move down whereas this wall that is the footwall will remain stationary. So we need to also understand and identify that what is the type of faulting and how it will move.

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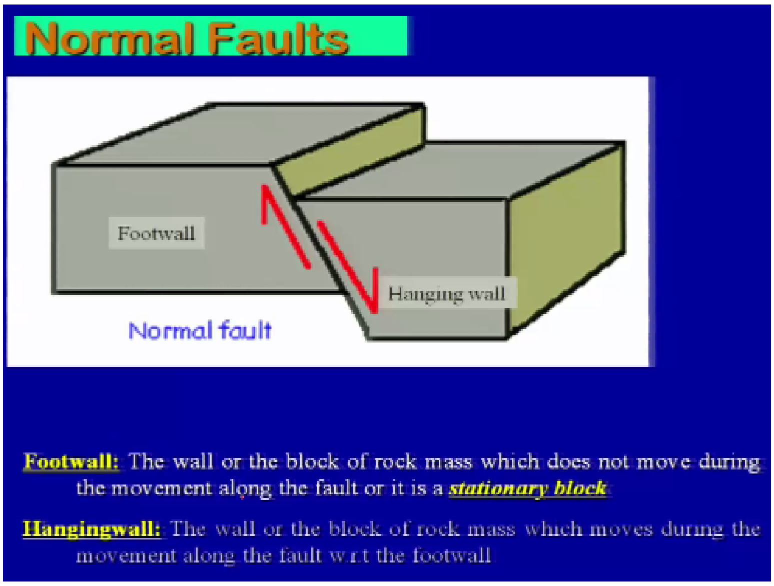

So normal faults we have the footwall, we have the hanging wall and the footwall block of the rock mass which does not move during the movement it will remain stationary whereas the hanging wall will move.

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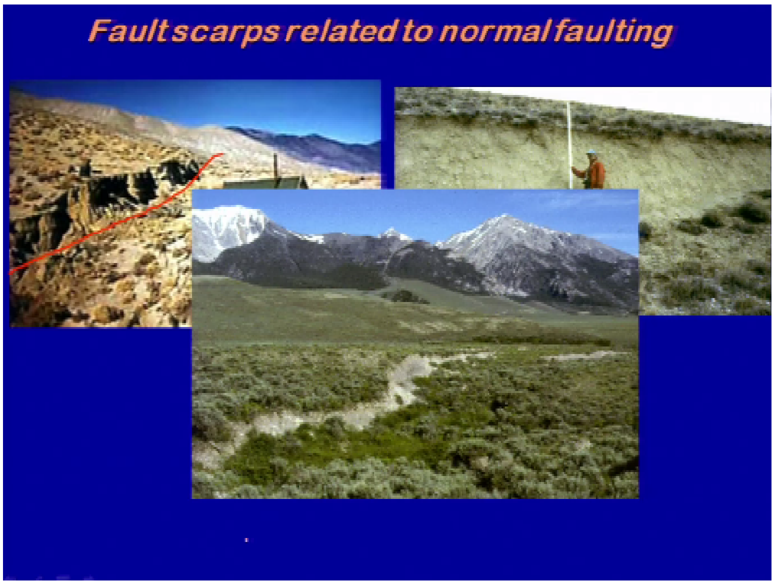

Examples again from US normal fault scarps how it looks like in the field and the fault line has been shown by the red line. The amount of displacement which will result into the formation of the fault scarp and this is how it looks like and this was a young displacement like 2 or 3 decades back. So normal fault after the earthquake or for example the erosion it takes place this is an example from Bulgaria.

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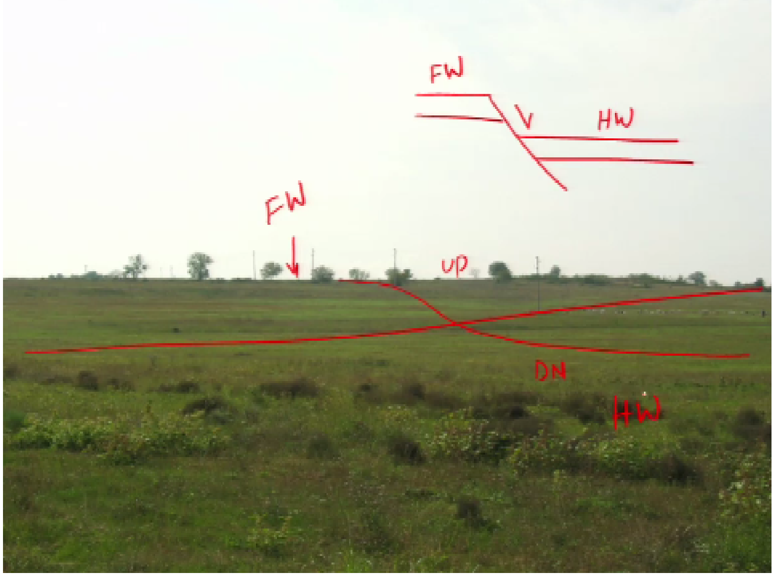

So what you see here is that there is a ground here slowly getting elevated. So you have a very gentle slope which is coming up here. So fault run somewhere here and this is an example of a normal fault scarp where this side is up this is down. So in normal fault what we were learning is that one block will move down another will remain stationary. So this block has moved down.

And this will be your hanging wall and this will be your footwall. So here this is your hanging wall sorry this is your footwall this is stationary and this is your hanging wall which moved another photograph of same area.

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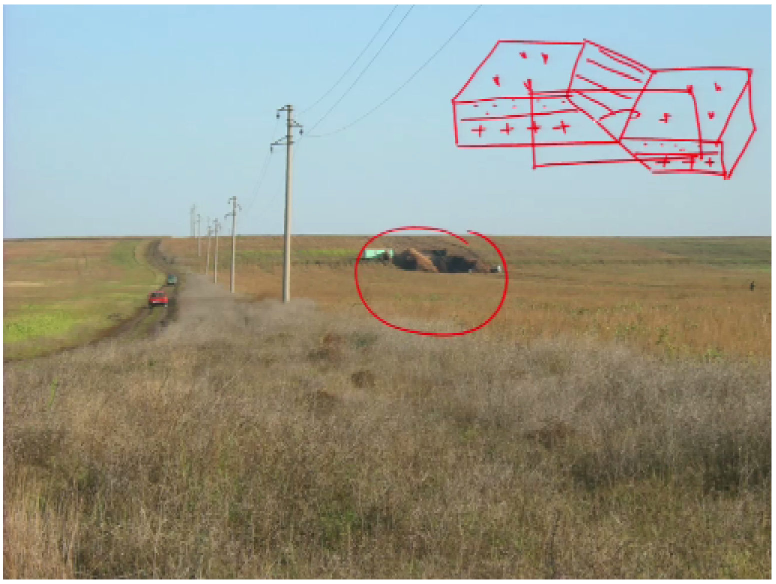

So for this what they did was the best way is to identify that the displacement how many earthquakes took place on this fault. So they opened a section because that is what we were looking at when we were talking about the folds, when we are talking about the faults that we should see the section. For example, if we have a block movement. So on this surface you will be able to see this scarp, but in section you will be able to see the net displacement.

This is your surface. So to see this part here they opened up a trench somewhere at the base of the scarp and this is what has been shown here.

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And this is what they got. So this is the scarp here this is a footwall and this side is the hanging wall fault run somewhere here.

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Another close up of that. So we have a fault rays so this block move down from this fault. Now what we see here is very quickly I will just explain that why we say that this will move in future and there are chances of this fault to move in future. Now what will happen is this is a present day ground surface here. So when the second the next earthquake will come this will rupture.

So this will move further down and this remains stationary here. So to avoid this we need to identify the topographic expressions of such deformation.

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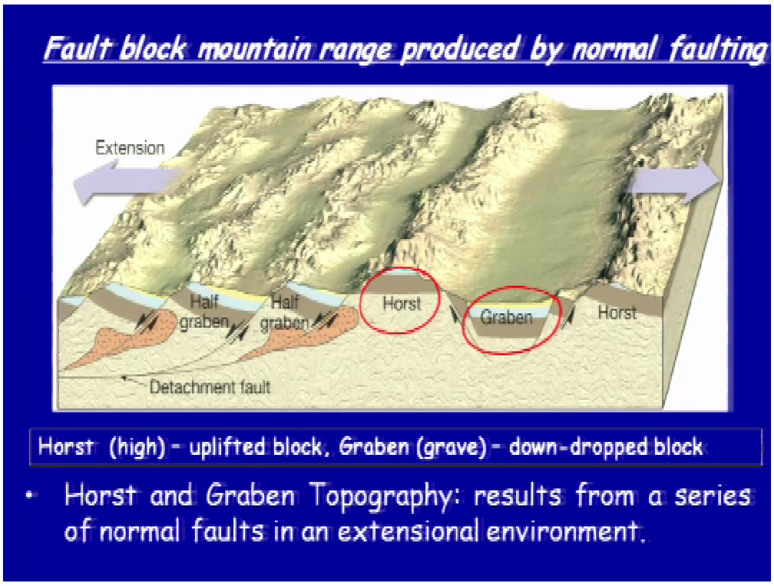

So fault block movement mountain range produced by normal. So this is in combination usually been seen on the larger scale if you look at you will find something like this. Now topography if you see will be slightly similar to topography which you will find in folded mountain chains, but here what we consider that the horst is stationary one whereas this block will move down. So normal faulting usually you will find the combination of horst and Graben.

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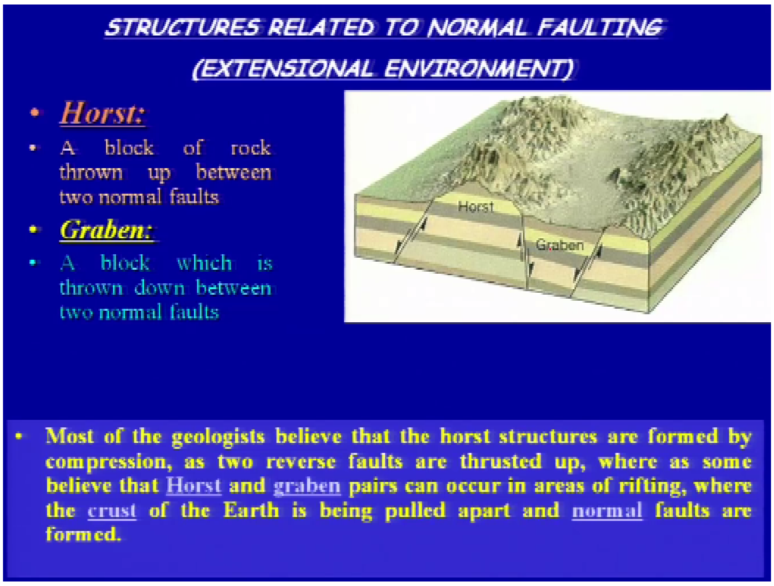

So topography you will see something like that. So horst a block because if you take in a strict sense then you will find that this block has moved up with respect to the Graben here or the block which is sitting adjacent to it. So the block of rocks thrown up between the 2 normal faults. Graben is termed as blocks which is thrown down between the 2 normal faults. Now most of the geologists believe that horst structures are formed by compression as two reverse faults are thrusted up.

Whereas some believe that horst and Graben pairs can occur in an area of rifting or in extensional environment where the crust of the earth is being pulled apart and normal faults are formed. So this is in the extensional tectonic environment.

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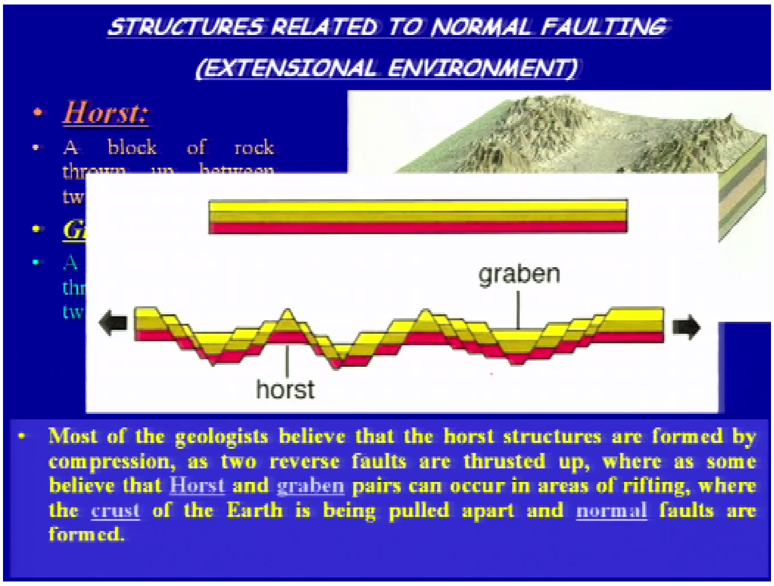

So if you look at this what has been shown here that this level has remained as it is whereas this block moves down. So if you stretch something what you will have you will have the breaking and the blocks moving down and that is your combination of horst and graben structure.

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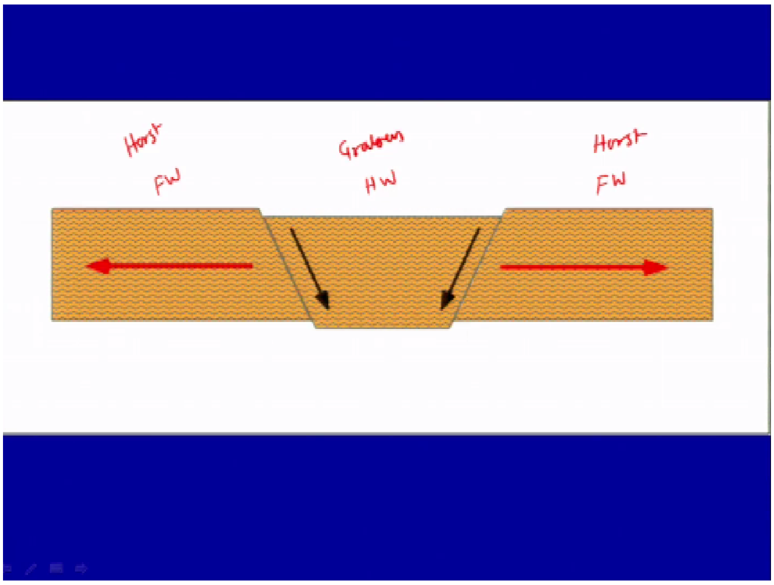

So this cartoon explains that you are stretching the plate or the crust and the block in the center along 2 normal faults is moving down. So this is your footwall this is also your footwall and this is your hanging wall and in terms of the structure this will form your horst this is also your host and this is your graben.

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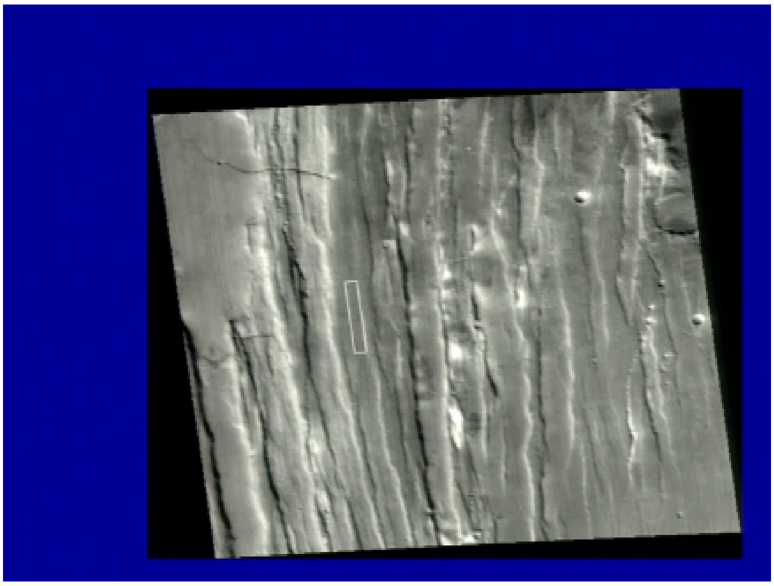

So from aerial view or from the satellite data how it looks like you will have a very linear ridges and associated valley.

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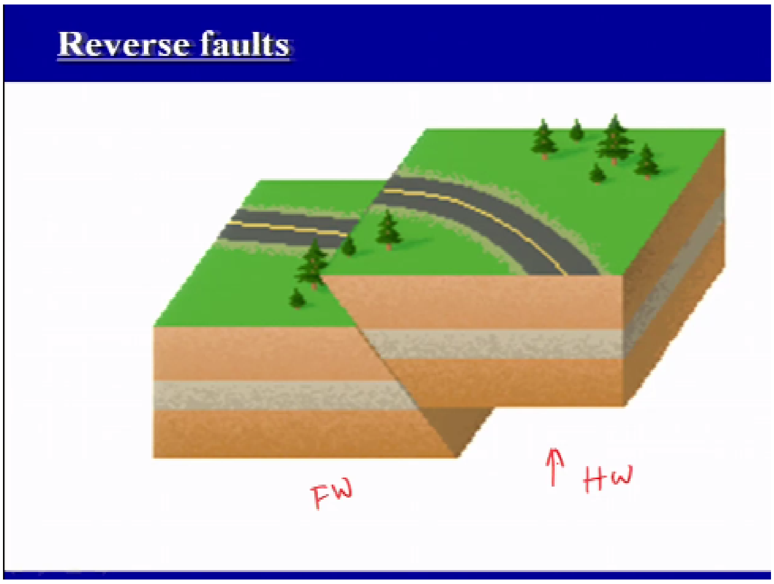

Now coming to the reverse fault. So as we were talking about that in strike slip fault one block will move towards us or away from us along the strike and in combination you will have the movement taking place up along the dip. So here it is reversed what we see in the normal fault. So this is your hanging wall and this is your footwall. So this block has moved up along the fault plane.

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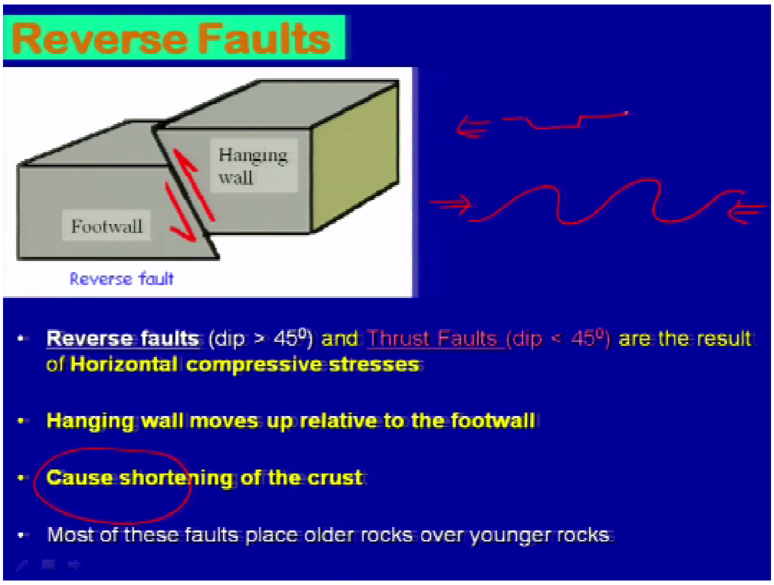

So reverse faults, hanging wall, footwall and this we have already discussed so I will just move ahead, but this is important that when we are talking about the reverse fault thing then what we see is that we have the shortening of the earth crust, but when we are having extension then we are stretching the earth surface.

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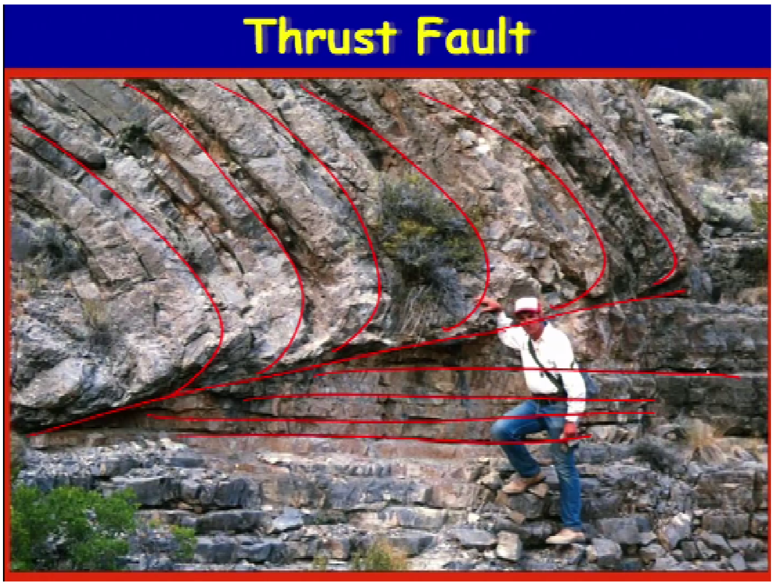

This is an example of the thrust fault where this is in footwall and the overriding rock block is folded. So thrust goes here because thrust we will classify as a low angle a reverse fault and we see the folding taking place over here. So this you will be able to see in the section rather is on the footwall side you see all data are horizontal.

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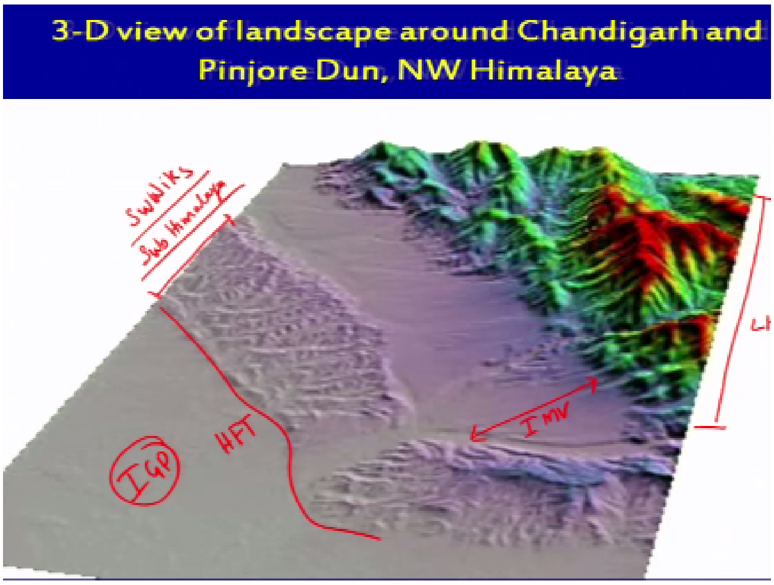

Now this is the part again coming back to India close to the Chandigarh area. So what we see here is in this we prepare using SRTM data and using the software NV which you will also learn in some of the labs okay. So we see a very clear cut topography which has been marked by different colors here and this region what you see here is your lesser Himalayas and this portion is your inter mountain valley between the 2 ranges.

And this is your youngest mountain change which we say sub Himalayas or Swalik. So the contact here as we were talking about this is the contact which is marked by Himalayan frontal thrust. So this side is your Indo-Gangetic Plain and from here you start having the Himalayas. So this one is another example of the Taksal fault. I will just check whether we have the video of this so that we can play for you if we remove this.

You see this so this part also you can do on NV you can fly through the terrain and then look at different example. So here which you see is your Taksal fault. Another close up of that Taksal fault here where we can see a very straight valley and then offset of streams also and another fault which is lying here this is your Barsar thrust close to the Pinjore Dun and how it looks like when you look at the 3D.

Now you can clearly see this line come here. This is your Taksal fault which is a right lateral fault and here is the Barsar thrust. So what we basically found here was that in this area in a very short distance we looked at 1, 2, 3, 4 faults and all 4 faults are active faults. So this is extremely important for us to understand.

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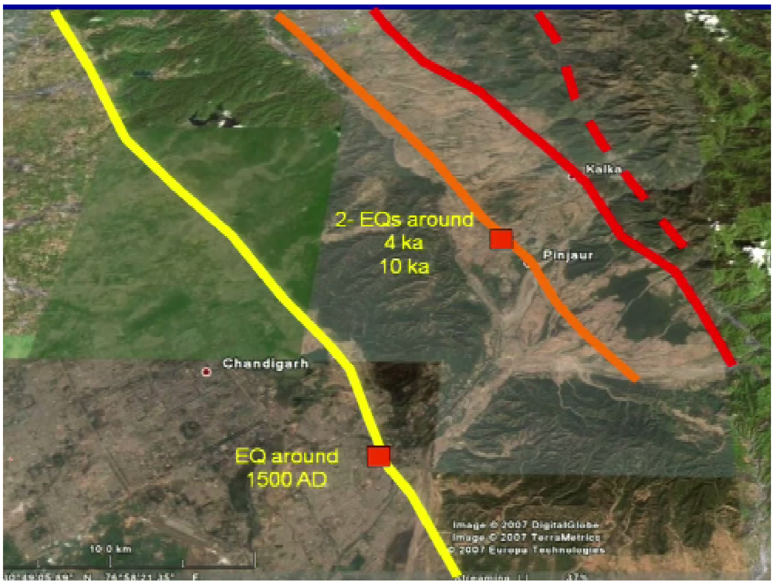

So if you look at 4 faults and what is the history on this until now we have identified that this fault ruptured or triggered the earthquake in 1500 AD and Pinjore fault or Pinjore garden fault I will come to that is an another interesting story here. It triggered the 2 earthquake in last 10,000 years. One was around 4000 years and one around 10,000 years. Still we have been trying to identify on what happened on the Taksal fault and Barsar fault.

But recent studies which is still we are preparing the research article there was an earthquake in 1400 AD on this actually.

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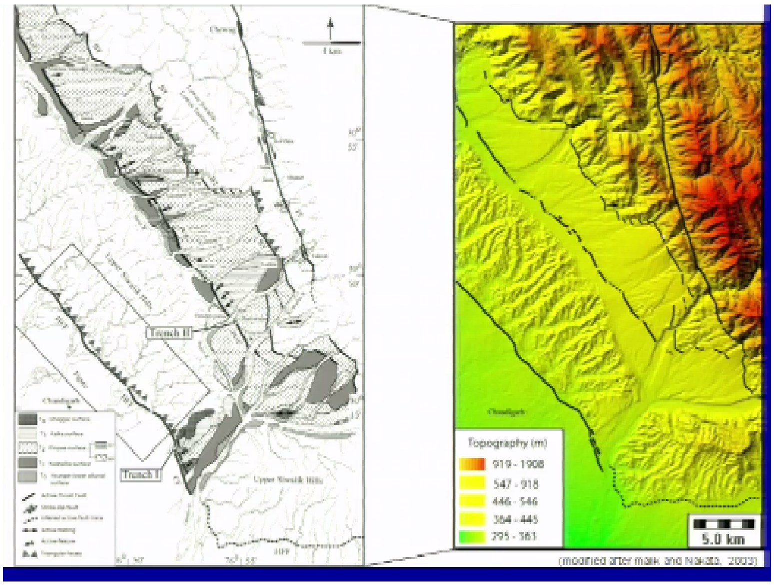

So coming to this part that we can prepare a very detail map after doing a proper interpretation.

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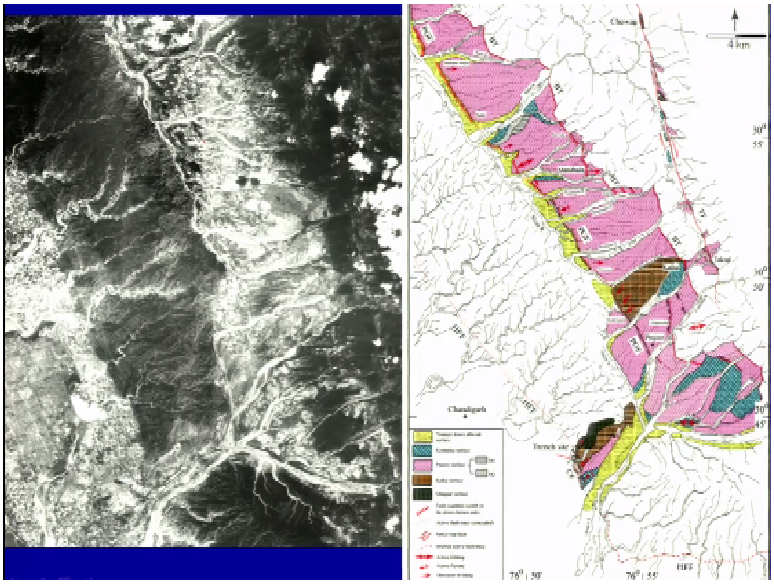

Let us some more information on the fault lines close to Chandigarh area. Now before going to that let me just quickly explain you that what exactly you see here there is a again corona satellite photograph, high resolution and we have tried to merge 2 photographs over here. So this line is not in fault line, but it is just an emerging of 2 photographs. You can see the construction pattern here well planned city of Chandigarh.

And this is one fault line here which you can identify that is the geomorphic contact between the hilly terrain and the flat area. Another contact very sharp contact is here. This is again in flat area which is in Pinjore Dun or in Pinjore valley and further getting into the lesser Himalayas here. This is same map which you are seeing on the right colored map of geomorphic map which I was showing earlier.

So you can compare the photograph on the left and the geomorphic map along with the surfaces as well as the fault line to understand that how we have extracted the information using the satellite data and prepare our fault map or morphotectonic map of that particular region. I will continue this in greater detail in the next lecture until then bye and see you in the next lecture. Thank you so much.