Photogeology in Terrain Evaluation (Part – 2)
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Lecture – 07
Photo Interpretations: Demarcation of Faults and Related Landforms - 1

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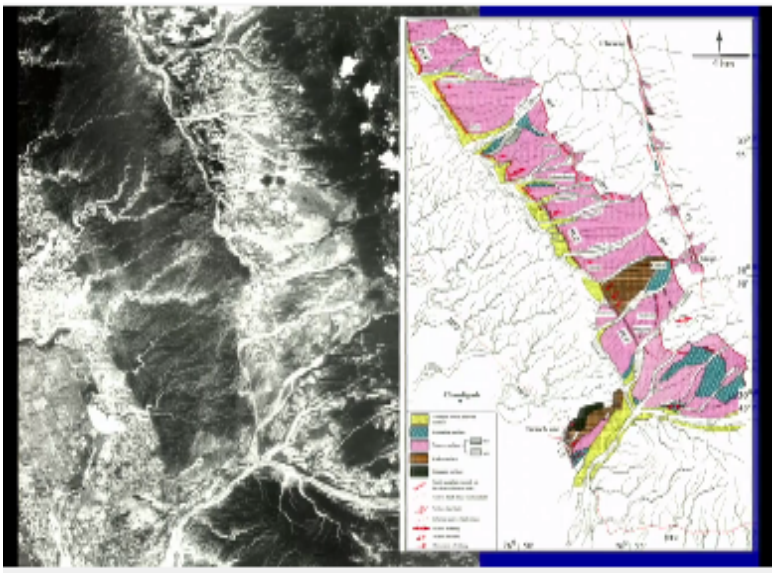

Welcome back, so this was the last slide from where we stopped and what I was trying to explain you that using the satellite data, we need to generate the landform map which is extremely important for the user, okay, so not only the geologists or geomorphologist will be using this information which has been put on the map here on your right hand side of the screen but at the same time, this is extremely important for the town planners.

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Because we have, we will put here the location or the traces of active fault in this area okay, so few more examples from this area. Now, this is what we see close to Chandigarh when we move to a Panchkula side and this is what we call the plate boundary between the Indian plate and the Eurasian plate, so you see a very small as compared to the Himalayas okay, a landform which has been raised or abutting against the Indo Gangetic plain.

So, the photograph is taken from the Indo Gangetic plain side, so this plain area what you see here is your Indo Gangetic plain and this is the boundary between the Indo Gangetic plain and the Himalayas and this raised part is of course what we call the uplifted terraces along active fault and as well I was showing in the previous slide and in one of my lecture I talked about that there are multiple terraces which were displaced in this region.

And this photograph in particular I will go back to the slide and show you where exactly the slides okay, so this photograph which you see is of this area, so we were viewing the false curve from this side that is from the Indo Gangetic plain viewing towards the Himalayas, okay so this is the boundary and the land form which has been marked here is; so this is the uplifted area.

So, what we see is; if I take the cross section here that is if I take the cross section on this side, then what I see is; the profile will be something like this okay, so this is your fault scarp and a fault in section is sitting somewhere over here okay, so this is a typical of thrust fault why we are saying that this is an thrust fault, I will come to the in the next slide, so the height of this is almost like 35 to 40 meters.

So, this itself, indicate that this is not a product of one single event, it was developed during or by different or multiple events and this height which we see of 35 to 40 meters or more is a cumulative height which this land form has required over the time. Now, the baguine as we discussed in one of the lecture that we should avoid putting structures right on the top of the fault scrap or on the hanging wall side.

So, if you see the location of one of the major building, I will mark that is sitting exactly on the top of the fault scrap and this building belongs to the Army headquarter. For me, this is not the good location, the building you can see here which I am marked with the arrow which is not exactly the good location to be put on because this is a hanging wall which will move during an

earthquake and we will have comparatively higher ground acceleration compared to what we see on the or observe in the Indo Gangetic plain that is your foot wall side, okay.

So, there are 2 scraps which we identified here and these 2 fault scrap again indicate that they were more events or the younger events which are reflected in form of the smaller scrap.

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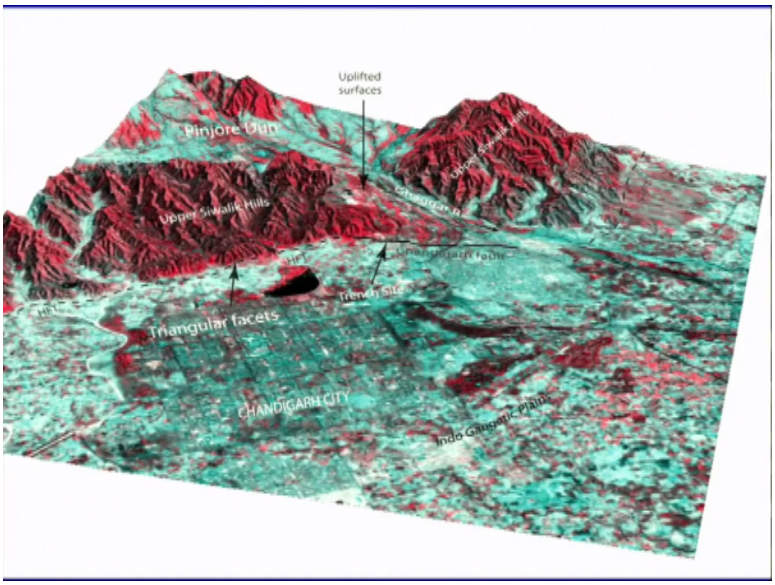

So, this is an another way of presentation where we have use SRTM data and landscape data is draped on the SRTM data and we prepared the 3d prospective view of the region, okay. So now, if you take into consideration, the well plants are sitting very close to an active fault which has a capability of triggering earthquake of magnitude > 7.5 and < 8, okay, so it is not very far from that okay.

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Further close up of that active fault trace which runs over here, I would like to show you few civil structures which are sitting exactly on the fault okay and that was done unknowingly because they were not aware of that the active fault is passing through this area and since we are looking at the youngest contact between the Indian plate and the Eurasian plate of the active fault which is; which we call as an Himalayan frontal thrust is the most active amongst the other thrust system exist in Himalaya.

This is going to move in near future, okay so if you look at this part we have been able to pick up the active fault scarp in the cantonment area so, this fault passes through the cantonment area and this is the view, a very small scrap, which you can see here, even you can make out with the help of the person standing here, so this is around 1.1 meter or 1.5-meter high, okay.

Further when we moved into the; along this scrap, okay and we tried to map, we found that this fault scrap; there are a few smaller buildings are sitting on the foot wall side but again now there is in water tank over here which is sitting on the hanging wall side because this side is your hanging wall and this is your foot wall side, okay. So, this I am talking; trying to explain you that after doing the photo interpretation this is what is required, okay.

So, the terrain evaluation can be done in a complete sense after you do the proper photo interpretation and do the fieldwork and mark your fault trace very precisely, the part of the tracing the structural features, okay.

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Or and this is a close up here which shows the fault trace in section, okay that is the fault plane further, we were able to trace the same feature in within the cantonment, which was when marked and again this area is now used for the race course okay, the horse riding, they have redeform or making, we can say that they have completely modified this area for the race course.

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Now, this was and quite worrisome part, seen last, say 10 years okay, a lot of construction has come up in this area and I would say that of course, the requirements in terms of the building codes and all that to provide an earthquake resistant building is taken into consideration but if not then is a very alarming situation that these buildings will definitely be affected by the earthquake, if it is triggered along HFT or the active fault which is very close to the Chandigarh area.

And this is not very far, hardly, it is about 2 kilometres from the active fault, okay and if you consider the severity often of for the earthquake, energy which has been released during an earthquake of 7.5, then it can affect the area covering more than 250 kilometres and less than around 300 kilometres.

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So, this is the photograph which I was showing that the previous one was close up but this photograph I have taken from the fault scrap, so this is the false scrap here and you can see that hardly the distance is around 2 kilometres, even < 2 kilometres at some point okay, so it is not very far and this a region will experience high ground acceleration, okay because it is sitting close to the fault.

And usually, in the seismic hazard assessment, we also consider that how far the site is located from the fault okay.

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Another photograph of the fault scrap passing through the cantonment, this is the front gate of the cantonment area, Western Command and you can make out this is where we are standing is the bike, the person who is here on the bike is the Indo Gangetic plain and slightly elevated

portion which you can see here is your uplifted region, okay and the fault passes through this one, so this building which you can see here okay, a white building is the officer mess, where they have parties and all that.

But that this building is exactly sitting on the fault scrap, okay, so this will definitely break, so now you can recall the example which I was talking about of 1995, Kobe earthquake and the building or the house, it just was marginally close to the fault where the compound wall got displaced, so what will happen to this structure, if there is a displacement on this fault, okay.

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Another one, this is a Surat (()) (12:31) or Surat cinema hall which is also close by to that area, the fault trace exactly passed through this region or that is will recall underneath this okay, you are able to see that it is somewhere over here, okay goes like that so, this is again building which is not; should not have been constructed on the fault trace, okay.

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So, these are a few examples which worries us that the mistakes have been done in the past and that was because of the unawareness, okay and people were not knowing that where the exactly the active fault passes through. So, what we do further is that after identification of such landforms and the features using high resolution satellite photographs or high resolution data and even you can now use UAVs to map such features on much higher resolution.

And identify the location because this is another important exercise which we do to know the; what is the past history of the earthquake on that particular fault, okay.

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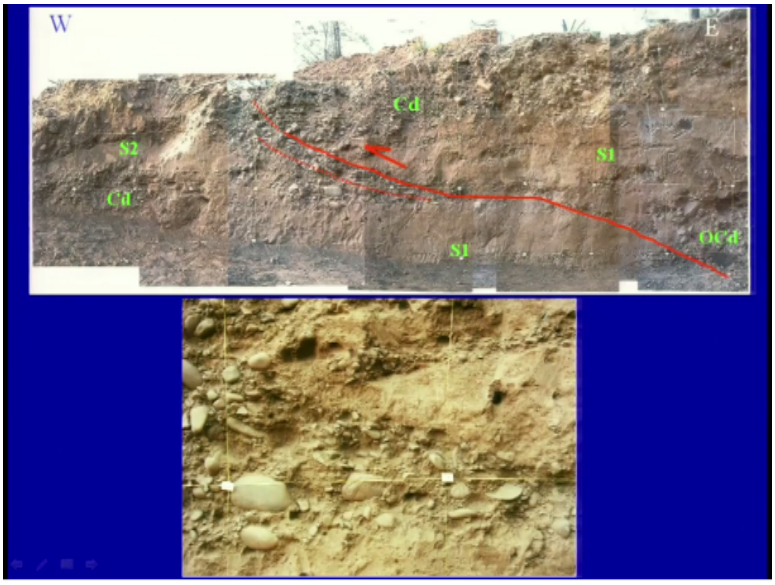

So, we open up sections, I am not going to go into the detail of this but this is a section which we see and this younger scarp okay, so you opened up the section, this section which I am showing here is from this location, so we opened up a trench and dug to trench here to see the

past signature of past earthquakes, okay or ancient earthquakes in this region and then what we found was that this fault was responsible for triggering a large magnitude earthquake in 1500 AD.

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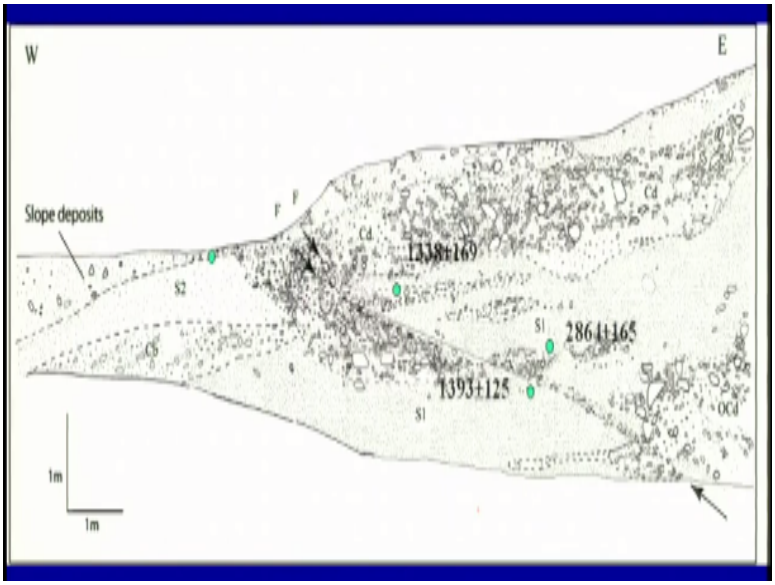

So, this is our finding, so this is what we do but I am not going to get into the detail maybe you can ask a TA to pass on if you require or if you are interested the publication on this part, okay.

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Now, coming to the further few kilometres north, if you move we hand another fault; Pinjore Garden Fault, so in this lecture, from the Indian side I was talking about; one is Taksal fault which was strike slip, Himalayan frontal thrust; thrust fault, another fault which we identified in that domain is Pinjore Garden Fault.

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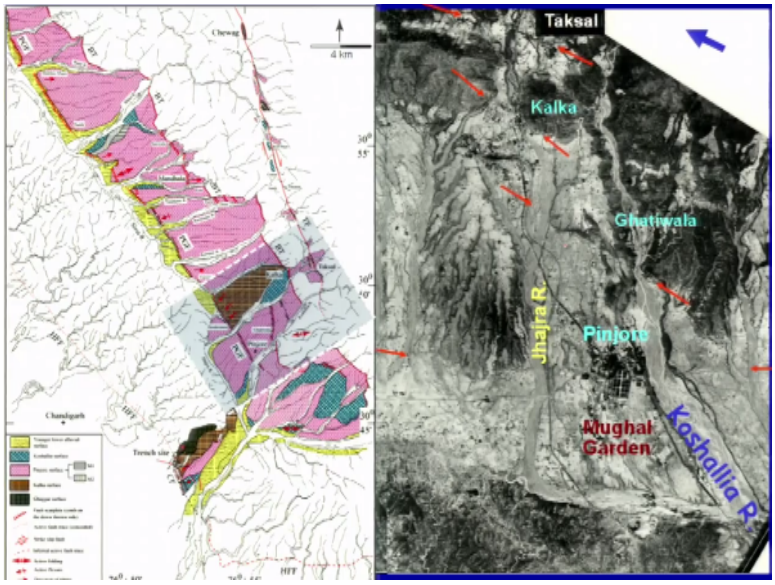

So, Pinjore Garden Fault; the previous fault which we were discussing was here, a Pinjore Garden Fault is running here okay, again this fault was picked up for 45 kilometres along the strike and the features which we identified again was bothering us, okay, the features as well as the structures which were been constructed, okay. So, I will give you like very good, the recent construction which we did was a mistake because we were not aware.

But the historical construction; the ancient archaeological sites or maybe the Indian structures which we were constructed in 17 or 16 centuries, they also did not realize about the fault trace, okay. So, if you take this portion, it has been shown this portion of the figure has been shown here of the corona photograph and what we have is these are the locations, so we have a Mughal garden here which is very famous.

And most of the; there is a lot of tourists which; they visit this, whenever they visit Chandigarh that is in the Pinjore valley and we have like traces which are been marked by this arrows okay, so fault runs here one, another smaller fault and third over here and fourth, this is a Taksal fault okay, which I was talking and if you go further this side, then you will come across the Chandigarh fault or Himalayan frontal thrust.

So, as I have shown that we have 1, 2, 3 major and 4; 4 major faults along with the smaller faults in between okay.

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So, let us see what we have fixed up again, we did the similar studies, we did trenching, we opened up the section to see the past earthquake but i will not go into the detail of that so, this is how it looks from the space, this is an Google earth image, okay where you can see a very well structured garden, okay and this portion here usually, this is a typical of Mughal architecture, where you will find that in between in the centre of the any such garden, you will have a stream or the water pathway which will flow through and through okay.

So, they will; the Mughals were very much keen or fascinated with this type of structures, so even if you go in Kashmir or in Delhi, you will find that this Mughal Gardens are of typical a very similar pattern, okay. So, what they need is that they need a big gradient from somewhere over here and they try to flow through the water, okay, so that they have the beautiful canal, small canal or the waterway in the centre of the garden, okay.

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So, they used the elevated part, which existed naturally during that time without knowing that this is a fault scrap okay so, what they did was, let us see further here, so this is an again which we see from the corona satellite photo and the fault passes through this part here okay exactly, so there is a beautiful fault scrap, which exists here, okay. So, we have of course, there is an old structure here, at the same time we also have few constructions which have been done here, they are also exactly sitting on the fault scrap, okay.

So, you have a combination of the ancient structure and the new structures or the recent structures which people have made or constructed exactly doing the same mistake, okay but again we can say that this was because of unawareness okay but let us see what we identified in the field, this is a very beautiful hotel, which is now it was in the part of the Mughal garden but now it has been taken over by sort of an Heritage Hotel here, which is exactly sitting on the fault scrap.

So, very low fault scrap you can see here and this fault runs through this area over here okay, this is one. Second is; you can see that this this whole mean step okay, what we call as a big step and this is exactly over here actually, so I have taken the photograph looking from this side, okay, so this is one point. This is outside the; so this is like if I say out this is one, the left hand side which we see this 2 photographs here.

And on the right hand side what we found was a very beautiful scrap, okay so this is a wall and this wall is here, this is the wall of the garden here and then we have taken the photograph looking at here, okay, so there is a typical fault scrap, which runs or here okay. Now, fortunately

this fault did not move after the construction of the Mughal garden, okay, so indirectly we are able to obtain a date that since the construction of this Mughal garden, there was no movement on this fault.

And this increases the likelihood of having the earthquake in near future okay, there is again the same area of the photograph but this photograph was taken almost 15 to 20 years back, okay and this photograph was taken in 2001, okay again almost like more than 10 years back okay. Now, people have a tendency to pass through because there is a pathway which has been constructed here by the local administration.

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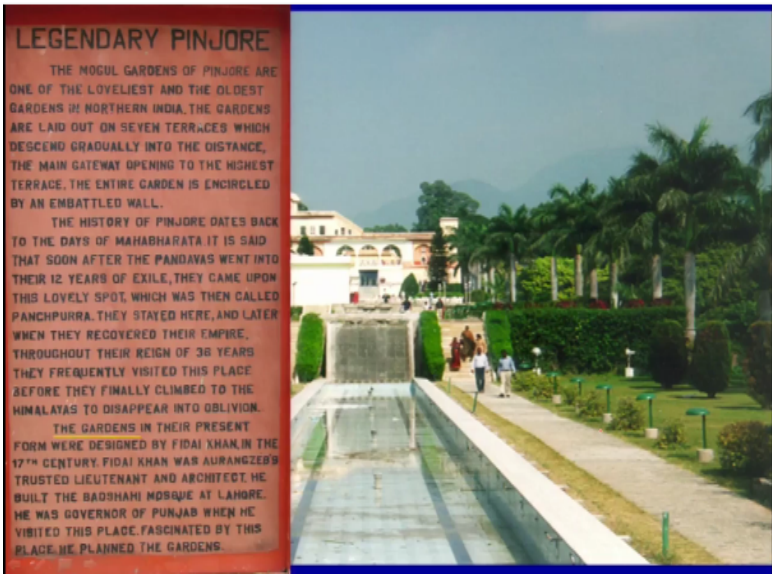

But they are not know; they do not know about that this is the feature which is going to trigger an earthquake in near future, okay. So, this Mughal garden detail if you take, it was constructed in17th century and after that there is no earthquake because there is no damage to this particular structure, okay.

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So, this is a big scrap here, which you can see and they have used this big fault scrap, which is and fault scrap for providing gradient to the water pathway in the center, okay similar feature we will also see in Taj Mahal in Humayun tomb or the garden in sunder nursery in Delhi yeah, so typical features or the architect you will see in most of the Mughal Gardens, so this was done by mistake, they were not aware of that this fault, this is a fault scrap, the elevation which they see which was naturally occurring elevation is a fault scrap okay.

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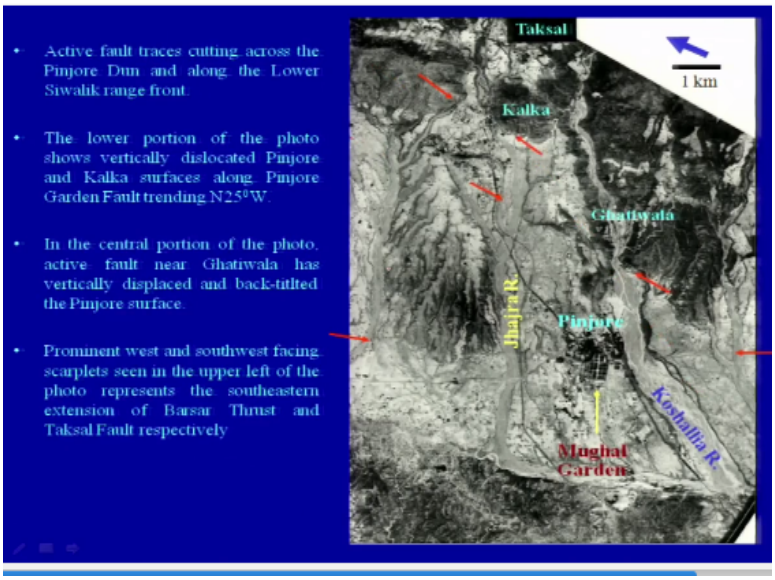

So, whenever there is a next earthquake coming on this fault will completely destroy in the structure okay, so this were the details which we gather from this fault, okay so I will just move ahead and come and stop wherever it is more important, okay. So, this is the same area which I have shown in the past in the few couple of slides.

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Yeah coming to this, this is what we did okay now, this is important, there was no other way of crossing this rail track and this rail track is one of the major rail track which takes you to Kalka and from further there, you will take the smaller or the meter gauge rail for Shimla, okay. Now, if you look at the; what would we have been discussing about the fault scrap then, you will be easily able to make out that there is a false trace over here.

And the elevated portion which you see here is the fault scrap, so this train; the trail track okay is exactly crossing the fault scrap and this is again I am pretty sure that this was done without having any awareness or they were not knowing about this fault scrap okay, and they have constructed the fault or the rail track on the top across it, okay. So, the question is whether we can avoid; the answer is may not be, we will not be able to avoid this.

But then what measures we have taken to protect this rail track, okay that question remains always, okay. So, again similar type of studies we did, we open up the trench and then we found that this fault triggered earthquake, one in 4000 years before present and one is 10,000 years before presented.

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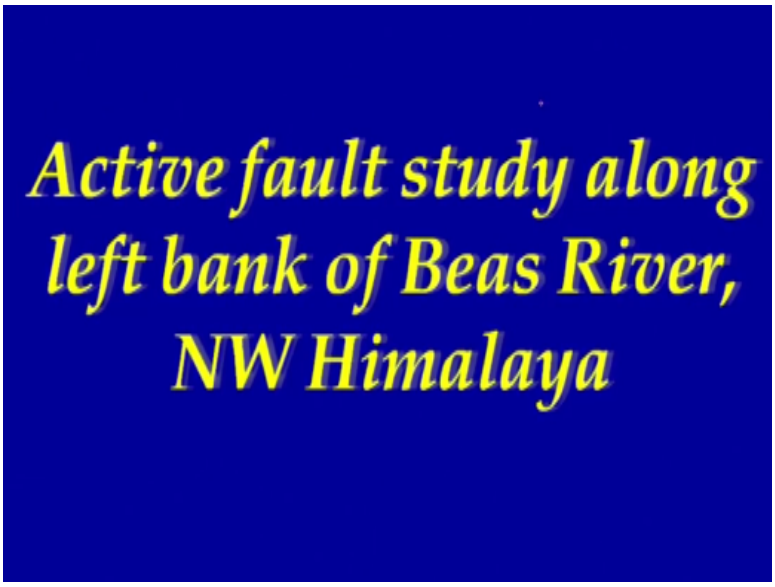

Now, another mistake but this is a very interesting area okay, this is on the left bank of Beas River, so I will continue this part in the next class okay, we will show you that how the hydro power station is sitting right on the top of the active fault scrap and that is again has been done because of the unawareness, okay, thank you so much.