Photogeology in Terrain Evaluation (Part – 2)
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Lecture – 09
Photo Interpretations

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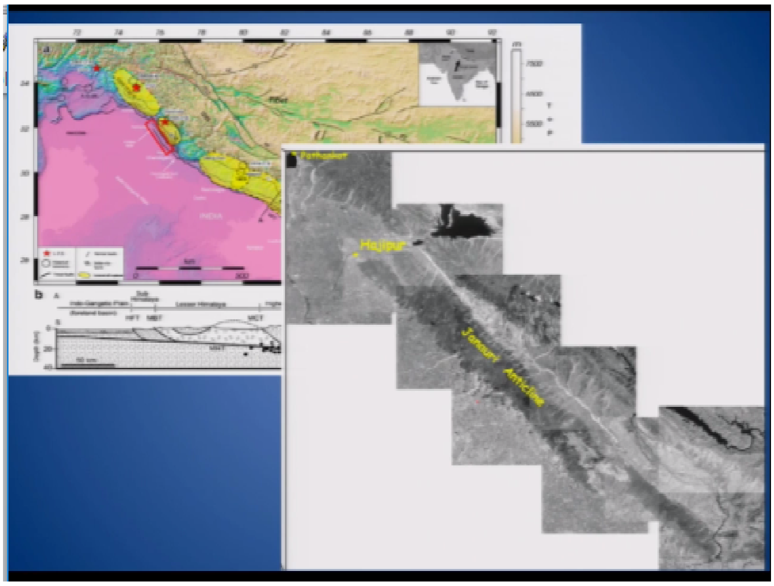

So, we discussed in previous lectures mostly about the geological structure and we stopped somewhere talking about the active fault races and how they are important in our day to day life and for the society as well as for the urban civilization or maybe we can say the infrastructure development. Now, this is the area where probably, I have shown a couple of slides but to get connected with, I will just quickly talk about this.

And how different the data, the same data can be used to generate different type of maps, okay now, this is the area which is around between Chandigarh and Pathankot, which is again marking in active tectonic zone and this anticline which was traversing almost along the frontal part for more than 100 kilometres in Northwest Himalaya is known as Janauri anticline.

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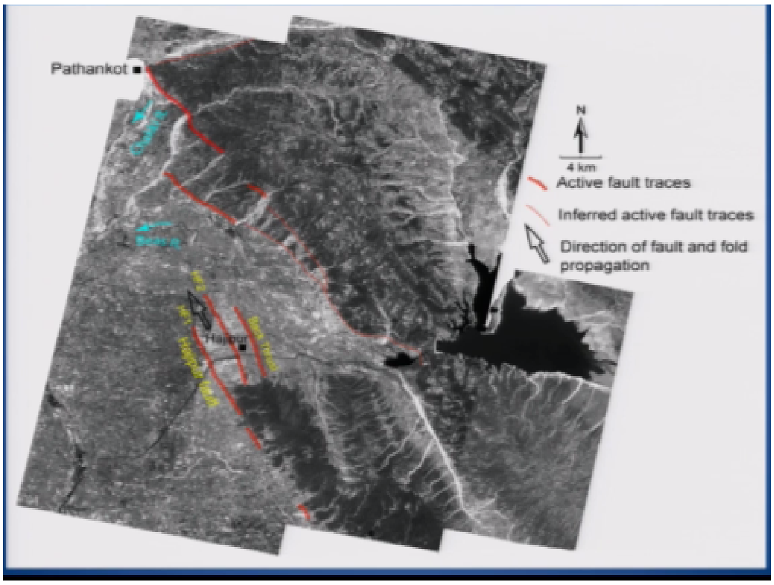

I have discussed this in the previous lectures also, okay now, based on the photo interpretations again we used high resolution satellite data which I have been telling you that we are using CARTOSAT data here but with the stereo vision capabilities ortho-rectified photographs we mark the active fault traces in this region okay. Now, in one of my slide probably, it is next in couple of slides it will come, I am just make a note that this data which we are showing right now is the recent data.

Recent data means are taken in last couple of years but the data which we took and used for our studies, okay which we have been collected by a US spy satellite long back in 60's okay and 70's that will not show you the existence of this Beas Dam because this Beas Dam came later on and then whatever the hydro power stations had been put on the low lying areas to generate the electricity as well as to facilitate the irrigation in the plains of Punjab that is Indo Gangetic plain.

The canal was been constructed and this I mentioned in the past also that this canal was been constructed without having understanding of where active faults are, okay and hence we have discussed in the past and what is the importance of active fault and why we need to identify that I think you understand that portion okay, so these are the fault traces and the bars which have been marked here or the COMS are indicative that this area is low, this is high and compared to this relatively, this is low and this is high and this side is low, this is high, okay.

So, this COMS are indicative that which side is the down side okay, which is also again very important, so even I have shown in previous slides where we were talking about that we can;

you can generate the shaded relief map and that shaded relief map can give you the topography of this area, okay. So, this is important now, let us go into the detail of this one very quickly and then talk about okay at what exactly.

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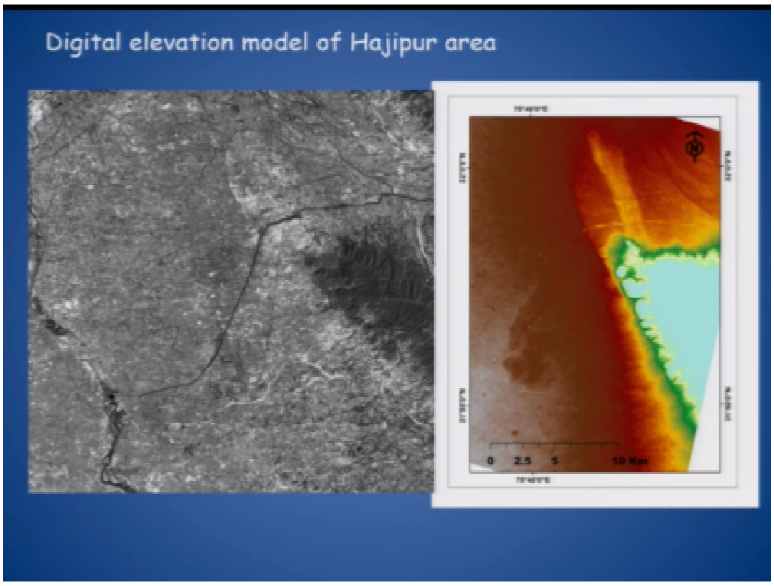

So, this is what I was talking about that you can use the data which is high resolution satellite data to generate different type of illustrations or maps okay, so this again it shows the different elevations and if you clearly look at this part which I was showing in the previous slide which we have marked the lines with COMS are the active faults which; that is the faults which I have displaced the young alluvial plains or flood plain of Beas River.

Because this is the outlet of the Beas which goes like this, okay and which is marked by here, so Beas flows right now like this and this portion is an uplifted portion, so this forms a part of the Beas floodplain.

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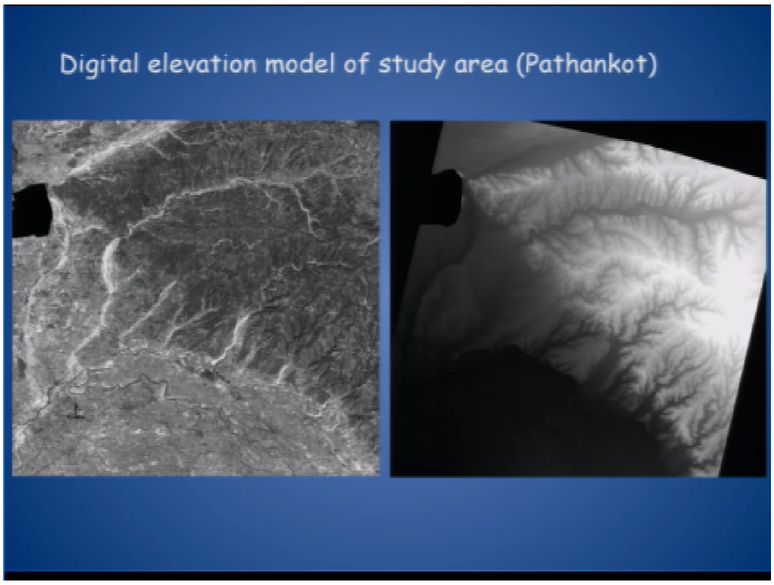

And another representations which you can do is; you can generate the DM from using the after and forward image of the given satellite data and this is the area of Pathankot, now what beautiful things we can extract out of this is that you can easily extract the drainage, okay so even a SRTM data you can use but SRTM data this having better resolution than these SRTM data. So, you can easily the market, the landforms as well as the drainage divides and the drainage network out of this okay.

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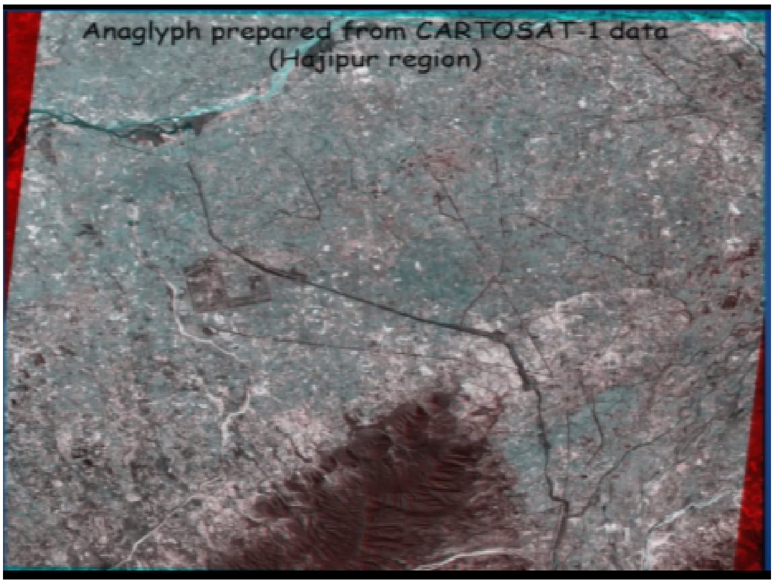

This is an anaglyph which I have; we will try to provide you if possible because these are all restricted photographs, so we will see if we can share with you this anaglyph, where you can see all this area in three dimension okay, so this whole area you will be able to understand and see that how we have picked up the different landforms and all that but one thing again clearly it shows here the path of the your canal which was been constructed without knowing that the fault passes through here, okay.

So, fault passes here like this, another fault is over here and third is over here, okay, so we are relatively this side is down and here this side is down here and then you have this side, sorry this is the opposite, so you have this side down now, this without knowing because that this area is the topography, which they see in this area is because of the active fault or the displacement along the active fault unknowingly, they have put this hydro power station.

And this comparison I did in my previous lectures with the old structure, okay, ancient structure which was been constructed on Pinjore Garden Fault by Mughals in 17th century, okay.

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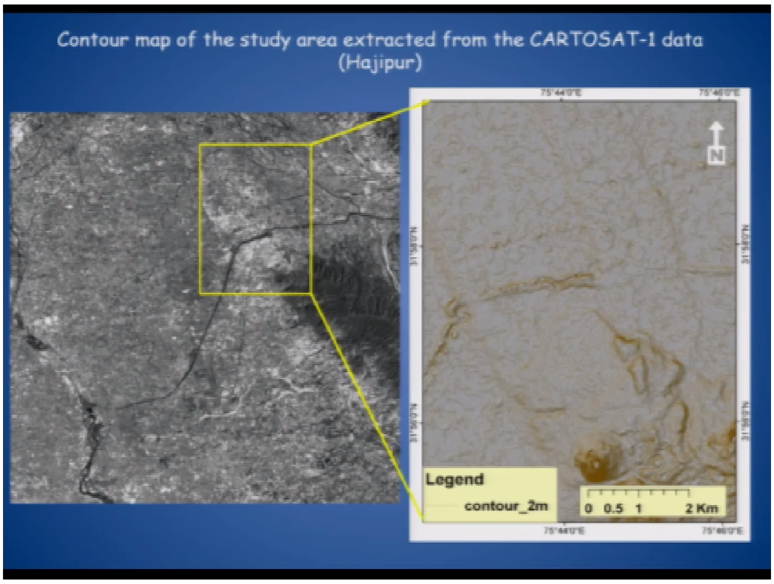

Now, if you look at like; this is another way of generating the contour map you can use, okay the same data was being used to generate the control maps also.

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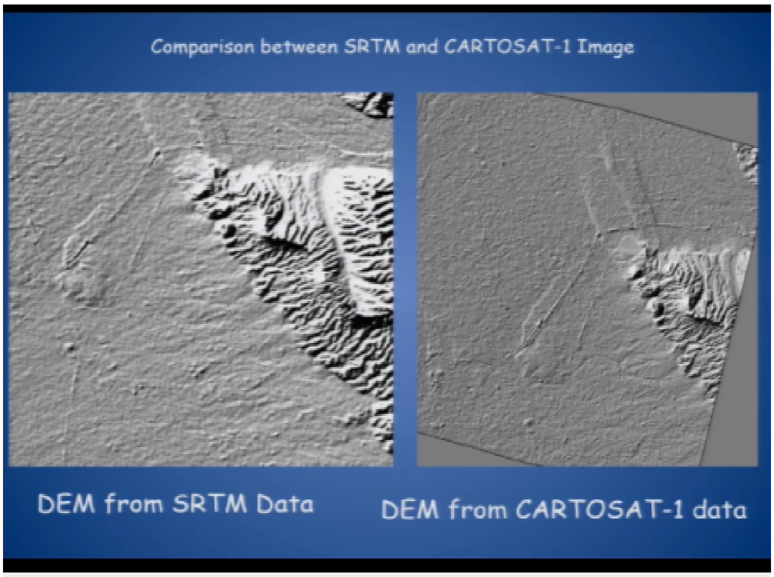

And then also the shaded relief map.

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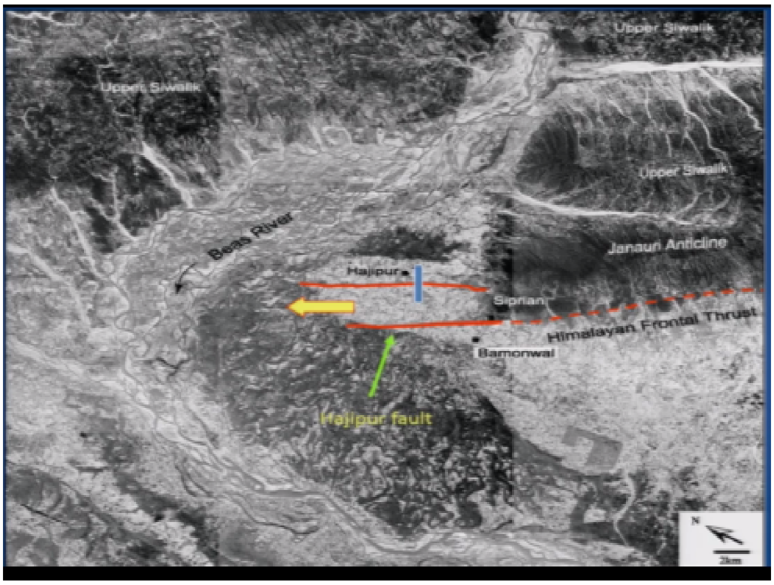

So, this is what we have talking about, this is an old photograph which was collected by US spy satellite in 60's and 70's and this does not show the existence of the canal as well as the dam here, okay. The Beas dam came after this but this fault existed before that okay, so there was an oversight or maybe the people or the scientists were not able to pick up those faults, okay.

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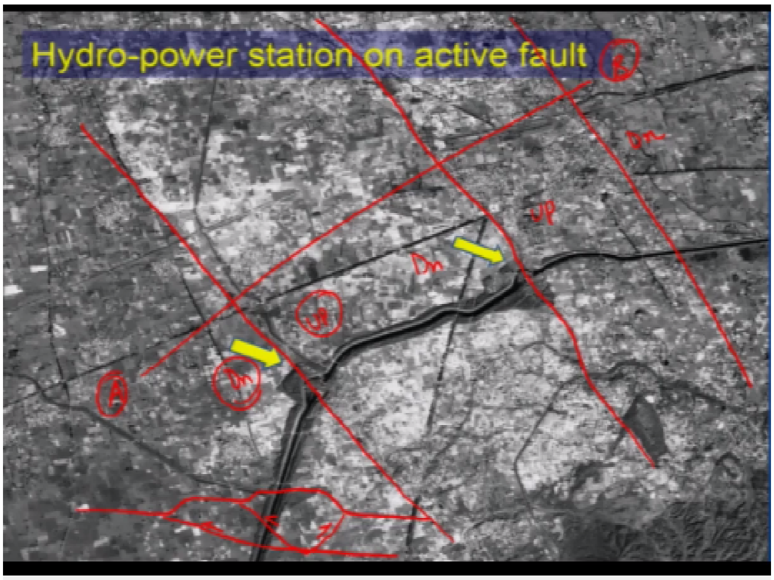

So, these are the two hydro power stations which are been put on exactly on the active fault, the active fault runs here and this is the trace of the active fault and the another traces over here which goes, so you have a very clear boundary because this side is up, this is all I am talking over relative and this side is down and this is down, okay. So, relative to this, this is up actually.

So, if you take in profile like this and this side is another fault, which goes like this here, very clearly and so this side is down, okay. So, what; if you take the topographic, the cross section here between for example, A to B, then what you will be able to see is something like this, so Indo Gangetic plains comes like that then this goes up, then there is another up here and then this goes down here like this, okay.

So, subsurface what we do is; we understand the deformation pattern and we also understood this our establish this based on the trenching which we crossed; like did across this area, like at this location and then we did 2 trenches upon this location as well as one we did here somewhere, so that shows us that the fault is dipping like this okay and this goes, this is opposite dipping and this connect like that okay, fine.

So, these are all thrust faults and what we see on the surface is your faults scraps, okay so, these are two hydro power stations which are put exactly on that okay and this again is not a good selection of site okay, so terrain evolution is extremely important when you are going ahead with such projects okay.

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So, these are the photographs of; ground photographs of hydro power stations, which I have been put on the active fault and one of the hydro power stations, if you see on high resolution Google Earth image has been shown here and this is the same hydro power station.

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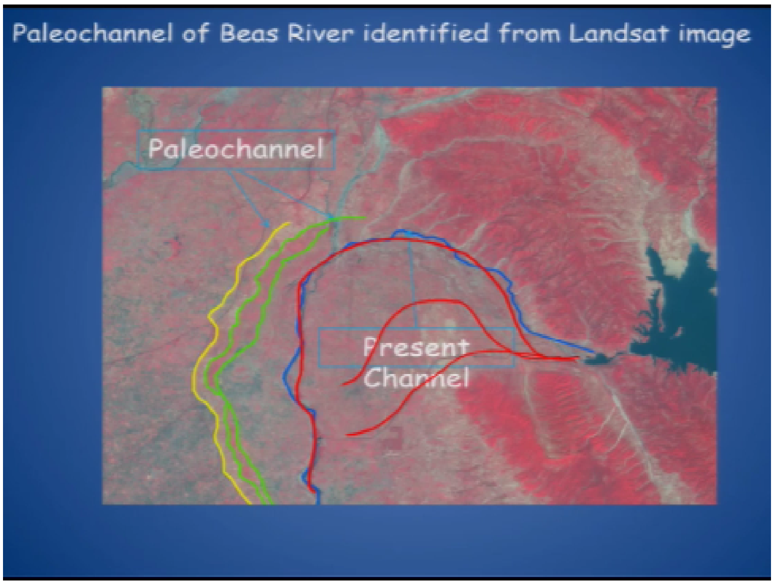

Now, we also picked up some very interesting information using Landsat data, okay so this resolution is around almost like 28 to 29 meters but then also the tonal variations, this image is your fault scrap composite, so you can play with different bands and try to enhance the features okay as per your requirement okay but for us this was the best and which gave us an indication that this a present channel here okay.

But this present channel this is again, very not very old data because you see the Beas Dam here and the canal here okay, so this is a present channel but what we found was the channel which is coming from here, this is in Pathankot area has almost like swinged couple of time, okay. So, one is; this is one trace which goes another trace here and third trace here.

So, this also indicate that the drainages or the drainage in Himalayas all flowing on the floodplains are having tendency to shift okay that is one now, this shift is a natural shift because of the fluctuation in the velocity or the bed load supply or what we can say the water carrying capacity is less or maybe because of several reasons okay or it is purely because of the tectonic moment okay.

But since we have a very good example here of Beas being getting shifted to its present path okay, where earlier it flowed through this okay and then slowly it got shifted over here and then finally, you are having what do you see flowing here okay fine, so this shift we understand that this is a major factor which affected this was your tectonic deformation, okay. So, structural elements, geological structures played an important role for this shift okay, might be some climatic fluctuations.

Because you can ask the question that this is one of the mighty river which was flowing on the Indo Gangetic plain, why it was unable to cross hardly 10 to 15-meter-high warp, which was developed by the on-going deformation okay so, of course that is a big question, it can erode and it can flow through but the carrying capacity or the river was not capable enough to cross this 10 to 15-meter-high landform okay which was eventually developed by the tectonic movement.

So, the climate was the main factor for not leaving the river to erode this feature and moving ahead okay and finally, it got deflected so there are the interpretations which one can make in a different way also, okay.

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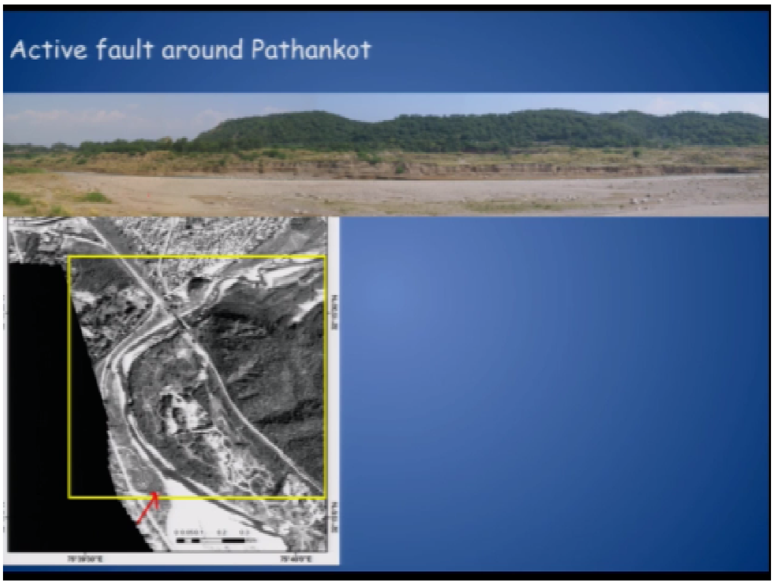

So, this is the close up of that notch which I have like this place and the next photograph; field photograph is from here, the Pathankot where there is a very sharp turn of the channel, the river comes and flows, this is a Chakki River, it takes a very sharp turn here okay, so this is again because of the tectonic moment. So, this you can see in this photograph is taken from this side here viewing this area, which shows the very sharp turn from here and flowing in this direction, okay.

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There is again close up of that so, you have the exit so, river comes flows through here and then take almost 90 degree turn here and this is because of the fault Himalayan frontal thrust moment okay.

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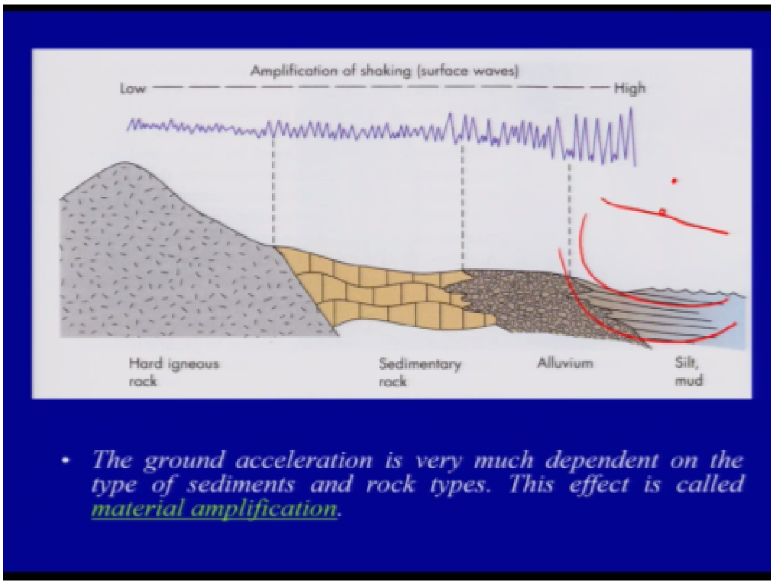

Now, overall whatever we have discussed until now about active faults, folds and all that okay where exactly, we can put the; that what is the implication of that how we can use this data and why we are so much keen in understanding all this okay or knowing having awareness about this okay, we cannot stop the deformation; on-going deformation cannot minimize that okay but what best we cannot even stop it, okay.

But what best we can do it, we can minimize the hazard level okay, so what happens during such like events okay because any movement which is taking place on this faults okay or the structures will result into the ground acceleration I think that is what we call earthquakes, okay. So, sudden release of energy which is stored, okay so, when we understand we have been talking about that the Himalaya is getting folded or and day by day.

Because of the tectonic movements or the collision between the Indian plate and the Eurasian plate stores; these energy is getting stored okay. But at some point of time, it will be released and those will be released along the active fault lines okay, so the point is that how far we are sitting from those sources okay, so earthquake sources that is very important and that what we have been identifying in Himalayas and in other seismically active regions in India like in Cochin, Andaman okay.

So, the amplification of the seismic waves will vary from place to place depending on the subsurface geology, okay. And that is what we call lithology, so the lithological variation will be again an important factor for site evaluation, okay because you cannot have the same style, type of buildings or design on; for example, the hard rocks or the softer rocks or the soft material that is what we call alluvium or the finer materials which we can say that it is comprising of silt and mud.

So the amplification will vary from place to place depending on the site and depending on the lithology. So, the next topic which we are going to talk about that how best we can identify the lithological variation using this satellite data that we are going to talk about and where we will talk about the igneous metamorphic sedimentary terrains how we can see and how what landforms we can look at which will help us in identifying the subsurface geology.

Now, here if you see carefully this figure, it shows the ground acceleration varies from left to right. And that is because of the change in the lithology, so in hard rock the ground acceleration triggered by the same magnitude earthquake will be very less but as you move into the softer rocks, there are sedimentary rocks you will have slightly higher but if you get into the alluvium again, the lose material you will be having much higher and in the finer material, you will have much higher, okay.

So, this will affect the buildings okay, so even if you are; if you say that okay I am sitting away from the fault line of course, the fault line should not be used to; for the construction but if you are sitting away on different material okay, then you will have to take care of that how best you can construct the houses or the buildings or the structures to withstand that amount of shaking, okay.

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So, this is the main important point of overall what we were talking about the site evolution is very much important okay, so this is what we were discussing that if we are having the houses sitting right on the faults scrap and away from the faults scrap, what will happen, so please recall this figure again, so for example if you are having the hot rocks, we consider this the topography is your Himalaya.

And then, we have the alluvium coming in which we talk about like we consider the Indo Gangetic plain, so what exactly will happen in the Indo Gangetic, you can imagine considering the amplification factor here okay, fine. So, even if you are sitting maybe an almost like 250 kilometres from the fault line and depending on the magnitude if you are having larger magnitude above 7, 7.5 or around 8 where we have been talking about that the Himalaya can produce or capable in producing the magnitude of 8.1, 8.2.

Then, the effect will be seen or experienced then covering a larger area okay, so depending on that sometime we feel that no, no we are sitting away from the active fault and in previous slides, we have seen that active faults are of course which we need to avoid those locations but sometimes we say that no, we are sitting away from the active fault but then also if that active fault is capable or triggering, the sourcing the large magnitude earthquake > 7.5 or so, okay.

And then the larger area may be up to 350 kilometres and that circumference will get affected okay, so we will; and most populated okay as compared to the hilly terrains like, if you take a Himalayas and all that more population is in the Indo Gangetic plain okay and we keep on having more buildings and structures coming up in the last couple of years okay, as I was talking about that we are having an infrastructure boom, so right and left we are having the constructions.

Now, whether those sources have been taken into consideration okay, this is extremely important and then you may say that okay, 2015 earthquake in Nepal that is Gorkha earthquake did not result in too much damage in the Indo Gangetic plain but if you think so that okay, let us consider that the earthquake which was triggered like Gorkha earthquake was almost like 50, 100 kilometres south of or north of the Himalayan front okay.

So, I will just put in sketch, okay this is a Himalayan front here, so earthquake epicentre was somewhere here but now, if I move the earthquake epicentre here, then the affect in this area will be different okay, so that is an Indo Gangetic plain region, okay. So that point is extremely important to be kept while going for the site selection and all that okay and there is no option because we are sitting in alluvial plains, okay.

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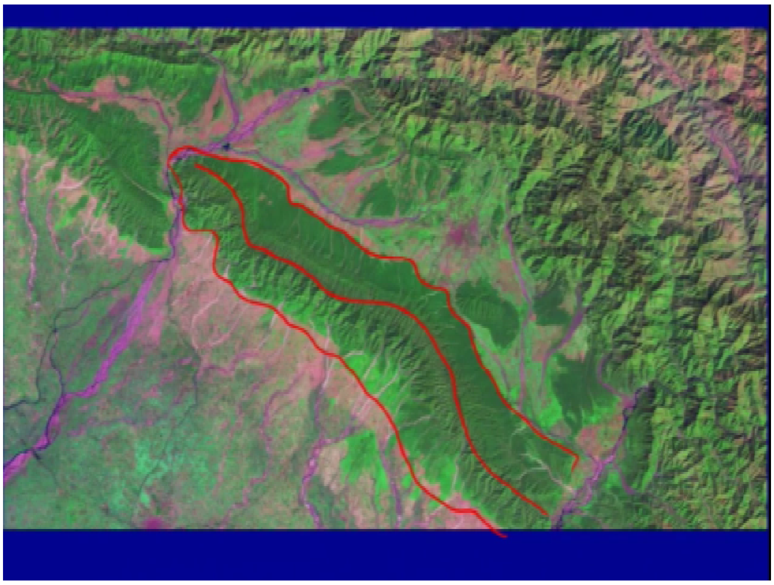

So, we need to consider those parameters while coming up with the construction, okay, so I hope this lecture helped you a lot okay and the last slide which I have is just to explain you that this is another data set, which you can use to identify the major landforms okay because for identifying the precise active faults and all that you need in very high resolution data but on a regional scale, you can pick up easily the folds.

And I can quickly draw the ridge line here or the hinge line, okay which we can pick up from here and this is then and then the outer part of the fault you can quickly pick up like this okay, so these are the data's which are available and or you can buy from NRSC, which can help you in identifying different landforms.

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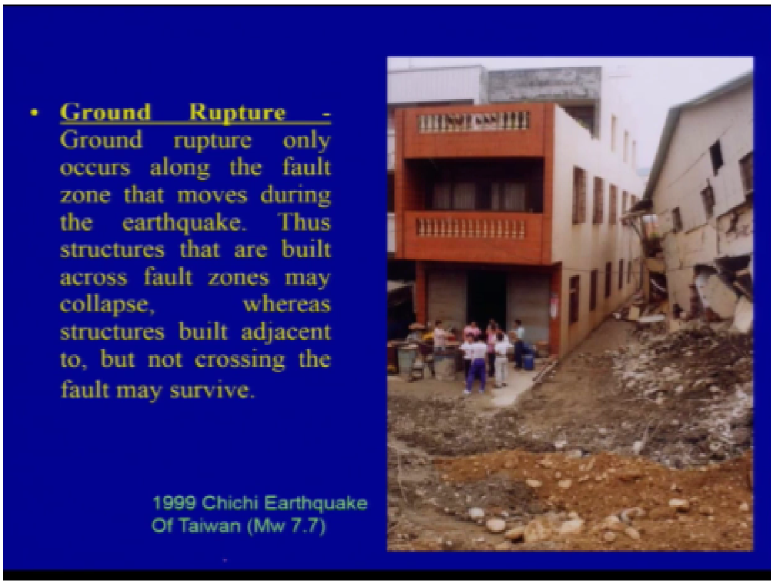

So and this is a very good example which has been given okay that the house which was sitting close to the rupture, okay that is the fault line, got damaged here but the other house just escaped the damage, okay so this is the another important part okay, fine and this is from Taiwan, during the the chichi earthquake, 1999, magnitude was 7.7.

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This is another one from 2005, Muzaffarabad earthquake or Kashmir earthquake where this is the fault scrap here, okay, this is the fault scrap and the fault runs somewhere over here, okay at the base here. Now, the houses and this faults scrap is a thrust fault scarp okay, so this is your foot wall and this is your hanging wall, so hanging wall moved and the foot wall remains stationary, the house sitting here was safe.

But what you see on the top of the scrap, okay, all this whitish block is the roof of those houses which were completely raised to ground okay fine, so this is what the difference you can identify, so you cannot have much of construction on the active fault scarp, okay, you need to be away from that and then you need to understand that what is the lithology of that area and how far the houses which we are going to construct will withstand the ground shaking, okay.

So, ground shaking on the hanging wall close to the fault will be much higher, okay as compared to the foot wall, I do not say that there would be any ground acceleration but of course, comparatively or you can say relatively less acceleration will be on the foot wall side okay, so this is another example which we based in short of a lesson which we learned from 2005, Muzaffarabad earthquake close up of that.

All the houses sitting in the foot wall were okay, nothing happened to that those houses but all the houses which was constructed on the top of the active fault scrap where raised to ground, okay. Again, you can use a different type of data to identify the landforms and this is one of the data which we have taken again, this is Landsat data, which shows the area around the foot hill zone of Dehradun and now, okay.

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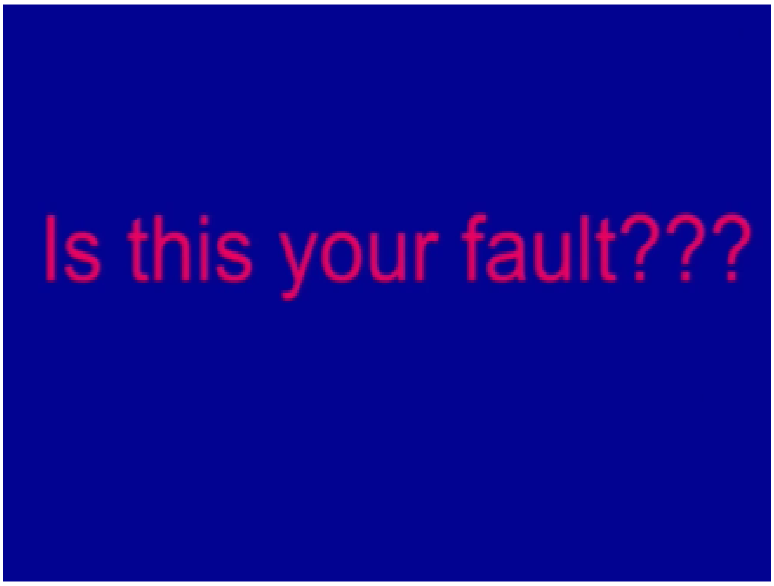

So, finally I would say, is this your fault or not and with that I will end this part of our lecture series and then we will move to the next topic in coming lectures okay, thank you so much.