Earthquake Geology: A tool for Seismic Hazard Assessment
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Lecture – 43
Strike Slip Tectonic Environments and Related Landforms (Part- II)

Welcome back, so in previous lecture we had a very detailed discussion on that how different type of structures will form if we are having, for example right lateral movement and you are having step overs, right lateral step over and left lateral step or what type of structures you will find either you will see the formation of pressure ridges or the formation of pull apart basins and we also had a brief discussion about the shear fractures, riddle shear fractures.

Which, how will they develop with respect to if you are having the right lateral movement? And we also talked about these synthetic faults and antithetic faults considering the ellipse.

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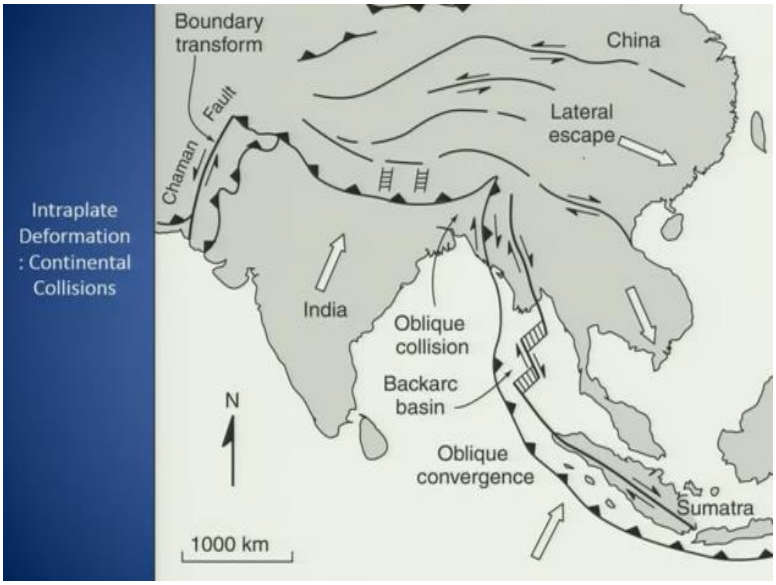

Now this was the last discussion that we had, and we had; in very detail discussion about the plate boundaries here, so we have due to the Oblique convergence along this side, that is the along the eastern portion of the Indian plate and along the western portion of the Indian plate. We have the transform fault system which is formed, so this side we are having the eastern side we are having sagaing fault system and on the western side we have Charman fault system.

So this sagaing is right lateral, whereas the charman fault system is left lateral and we also had brief discussion about the lateral escape theory. Now the hypothesis and we stop there.

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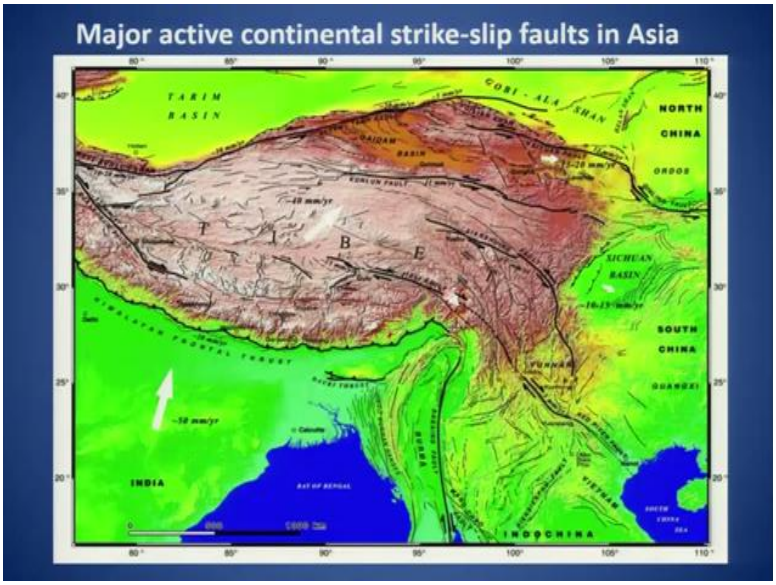

So let us move ahead. So what we see is basically we have like there are several number of faults which are showing a right lateral moment because of the process of lateral escape. So we have faults like Valley fault here, Kunlun fault, Altyn Tagh fault, these are very major faults in Tibetan side which shows the right lateral strike-slip. So if you see the arrow here you have right-lateral here, you have left-lateral here and left-lateral here.

And then we also had a brief discussion that we have and major fault system or here that is your Karakoram fault, which shows right lateral strike-slip and this one what I was mentioning is the sagaing fault system with right lateral moment.

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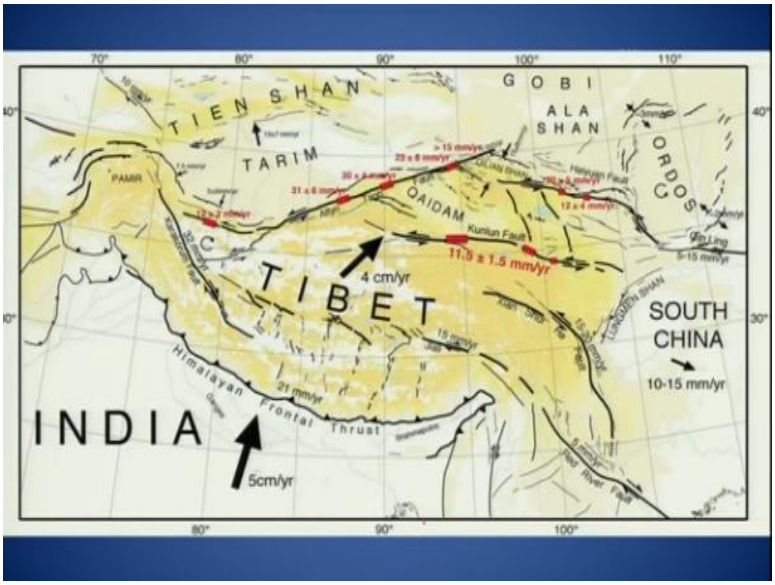

So the hypothesis which

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Which has been proposed here is

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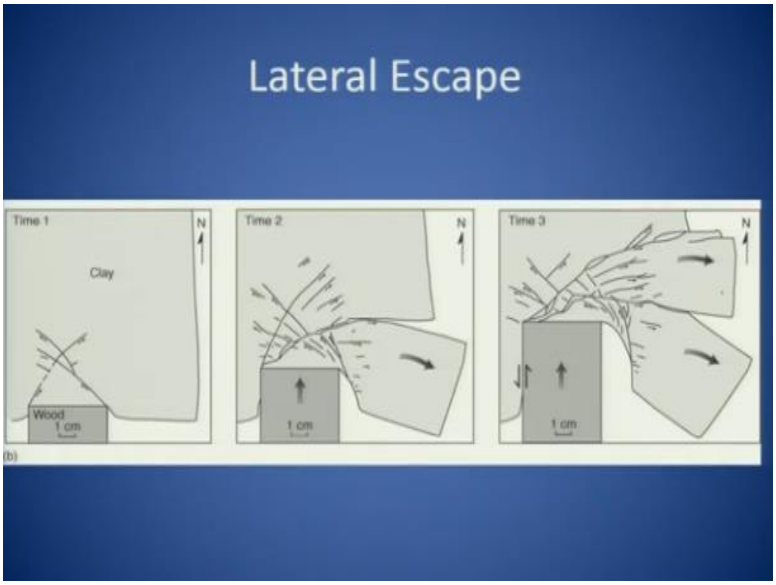

It shows that, if you have like an metal or a wooden plank is included in a clay then you will have formation of the conjugate fractures or the faults which will result into the displacement along the fractures, are the faults here and this is what is happening is related to your escape hypothesis. So this portion I was just showing the moment and this direction is because of your lateral escape.

So, this is what we have the escape portion or the portion of the Tibetan inside which is excluding towards south-east;

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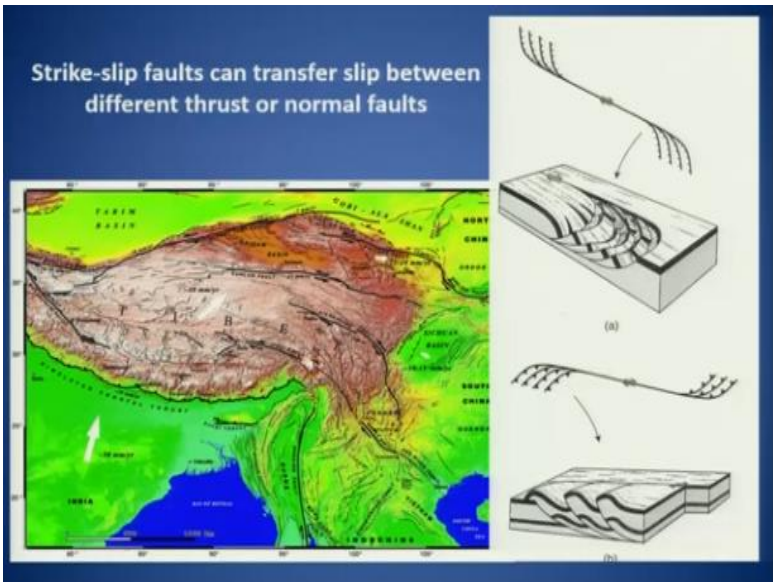

And associated structures basically what we were discussing about that you will find different type of structures along the strikes that depending on which side is whether you are having the releasing band or the restraining band. So we will see few more examples of this and then

we will go towards the detail of Paleoseismic studies that we did in one of the major active fault system in northwest Himalaya that is along Kangra valley fault.

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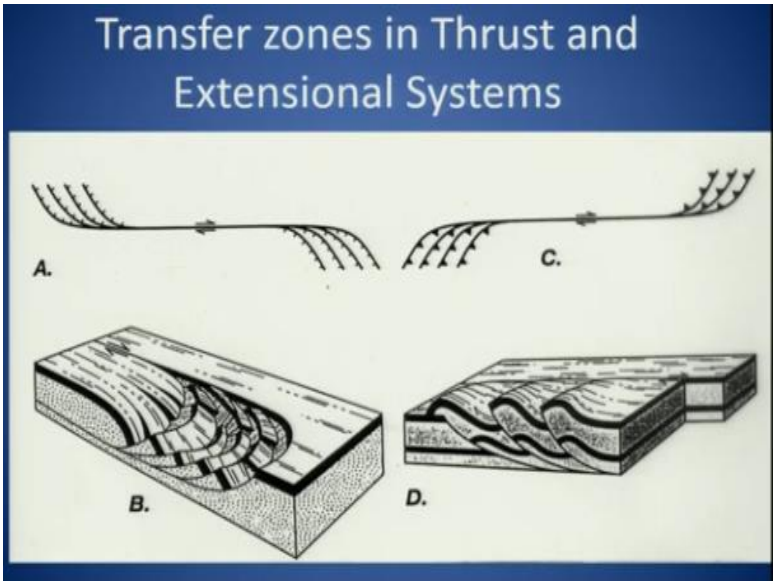

So if you have like for example transfer zones of in thrust and extensional system then you are going to see the formation of similar structures. So you will have, if you are having liked the thrust fault then you will see the folds are forming and it is as well as you will see NHL or folds or the faults which will result into the folding and in this case you will have extinction.

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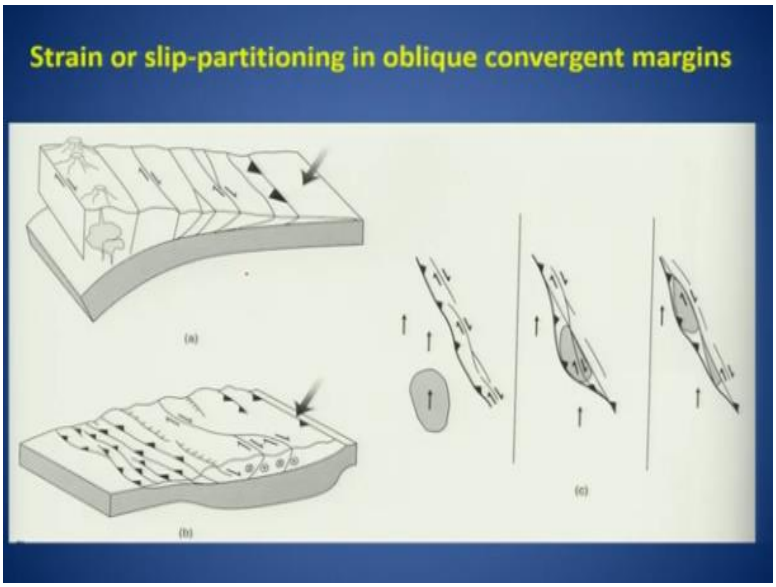

Similarly here also this has been shown and the most of the literature you will find this symbol that is here the circle and the dot inside. Usually this is to represent that which block is moving towards your side. So in this case this power portion of the block is moving

towards your side and this is away from you and this is showing towards your side and away from you. So this is the case of where you are having an oblique convergence.

Then you are bound to see the thrust here for example, and towards the hinterland side you will find that formation of the strike with faults. So basically if you have such situations or the configuration of the fault distribution then what you find is mainly the slip partitioning in the oblique convergence margin. So you will have this slip which is distributed remain slip which is occurring along this is getting distributed long thrust faults, as well as straight faults.

So this type of pattern is very common even in the Himalayas where I was showing one of the major faults, Karakoram fault and then you are having a thrust fault system. So we will talk about this and we have the example of the strain or slip partitioning due to oblique convergence in North West India.

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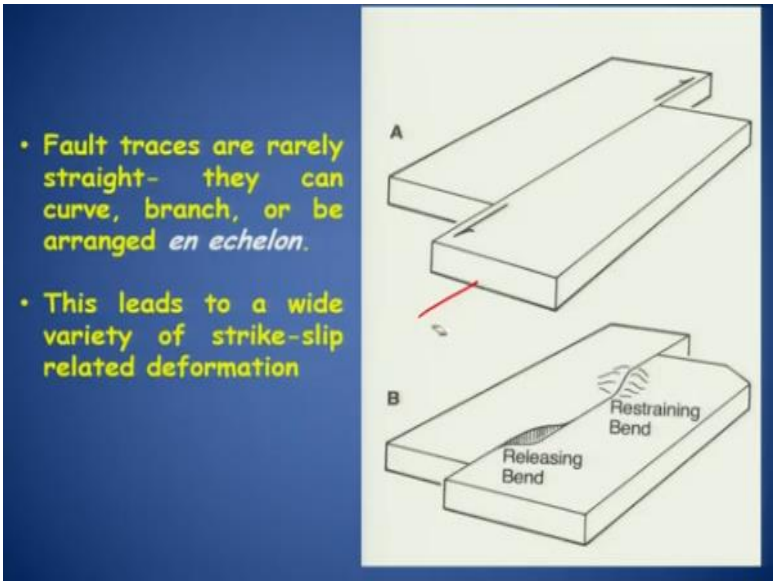

So normally what we learn in structural geology and will try to put in very straight line for any fault but in nature it is not like not because of the hetero-genetic change in the strike of the structure you will not be able to see a very straight line and so usually the faults are not straight they are curved and they branch also. That what we are talking about that if you are having a fault draining like that and then step overs and then this step over will result into the formation of different features.

So that what we call the en-echelon faults and here it has been shown for example, if you take this one here and then another one is going over here, then you have this one here. So now if

you are standing here and if you are taking the motion which is your right lateral again what we have already discussed. So I will quickly move to ahead, so again we are having right lateral here and this is also, you have the right lateral at this point here.

So you have this portion getting deformed, so this portion you will see, what you call the restraining bend and whereas here you have the bend which goes over this side and you will have the extension here. So restraining you will see mostly the formation of the faults or the ridges and various in the releasing band you will see the formation of pull apart basins.

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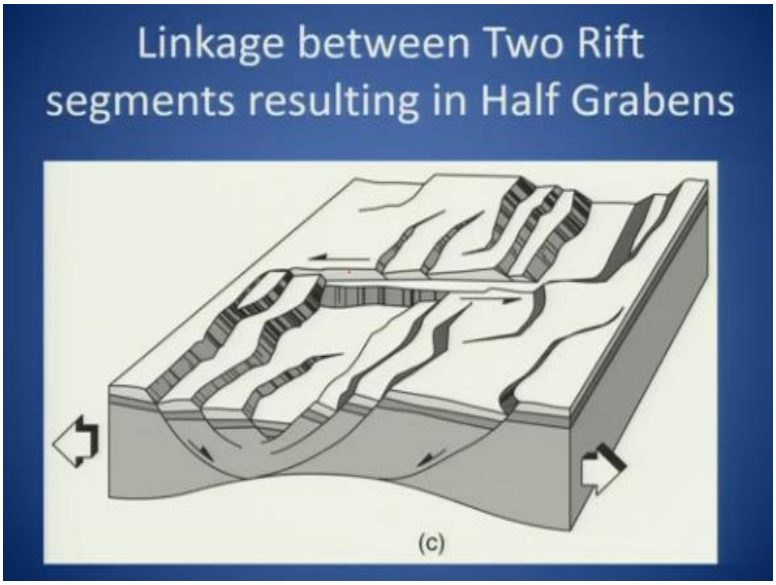

So similarly you will be also able to see in multiple linkages of fault segments, in case if you are having the rift valleys and all that. So you will also come across in such a tectonic environment even if it is an extensional part, we will be able to see some linkage or between the two grabens or the rift portion which will show these strike-slip motion.

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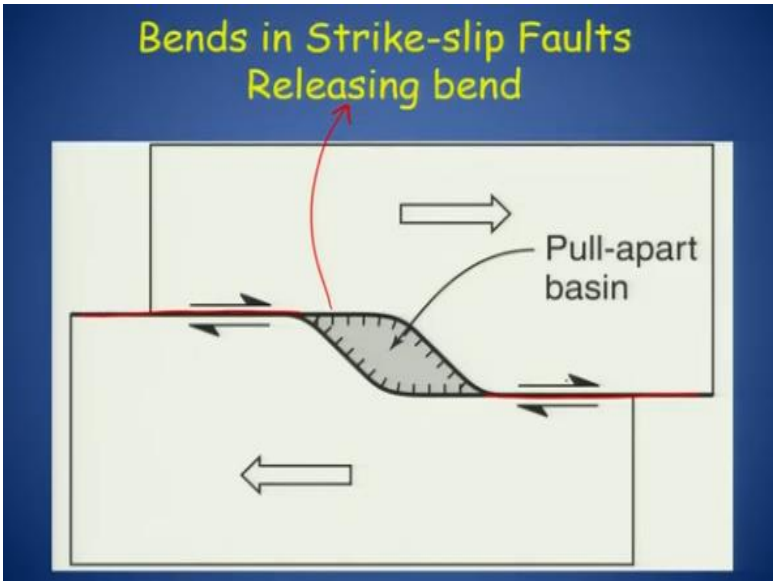

So again the same one which we are talking about, so you will have the pull apart when you are having the main fault here and then another one is over here. So the step over is this one here and this portion is your extension portion. So this is your, what you call the releasing bend. So if you are having releasing bend then you will be able to see this one, so from here if you see then what you are having is your right step over you are having in case of your right lateral moment.

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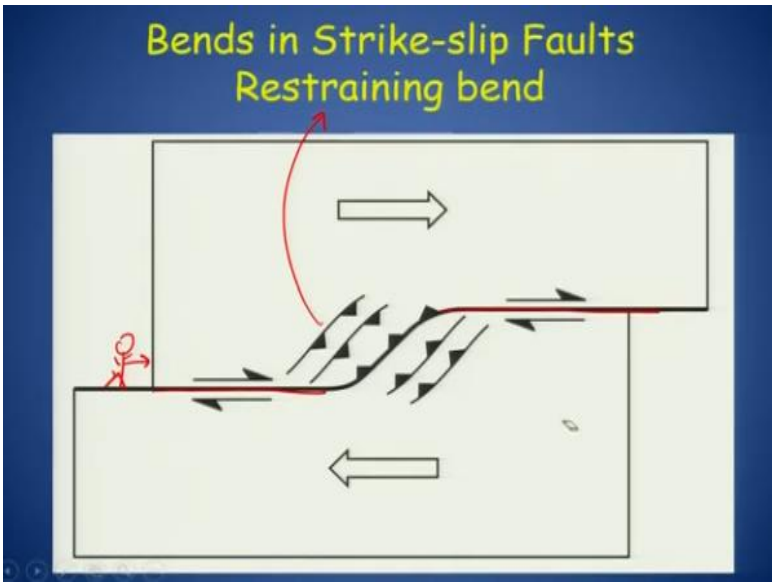

Similarly if you are having the left step over, so if you are standing here and viewing this side then you will see that this is your left step over. Hence you will see this portion is your restraining bend, so you will see folds and thrust faults which will be seen along this one. So if you are having a very straight fault then you will be looking at and simple features which we have discussed like linear formation of the valleys and offset of streams and all that.

But if you are having bend and if you are having in step over then depending on which step over you are looking at and we find the field or along the fault that is either left step over a right step who are depending on that we will see either the deformation of thrust faults or the folds in restraining bend and extensional basins in releasing bend.

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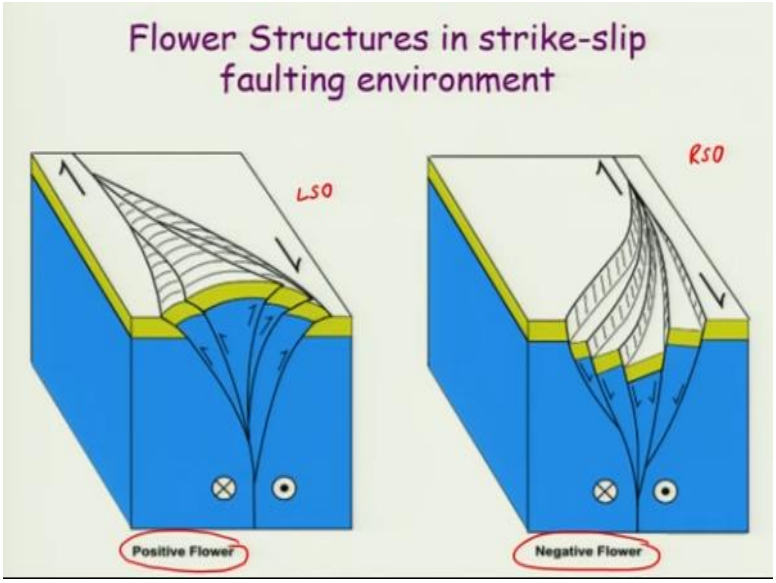

So now moving further this is again and very important aspect which usually we try to talk in terms of the strikes-slip faulting environment, which we called as an flower structure and so if you again this portion the dot one is moving towards your side and here also you are having this one, but again here what you see is one that you will be able to see the positive structures and so in positive structures, so please recall the bends which we are talking about.

So if you are in this case what we have is the left step over, so you have left step over and then previous one was your right step over because you are standing here and viewing in this direction. So this is your right step over and this one is here left, so if you are having the right step over then you will be able to see the extension going on and then so most of the faults which are forming and this is related to again you are releasing bend.

And this is related to your restraining bend, so you will have different type of flower structure which are termed as positive flower structures. When you are having the reverse faulting taking place and we are having the normal faulting taking place then you are talking about the negative flower structure.

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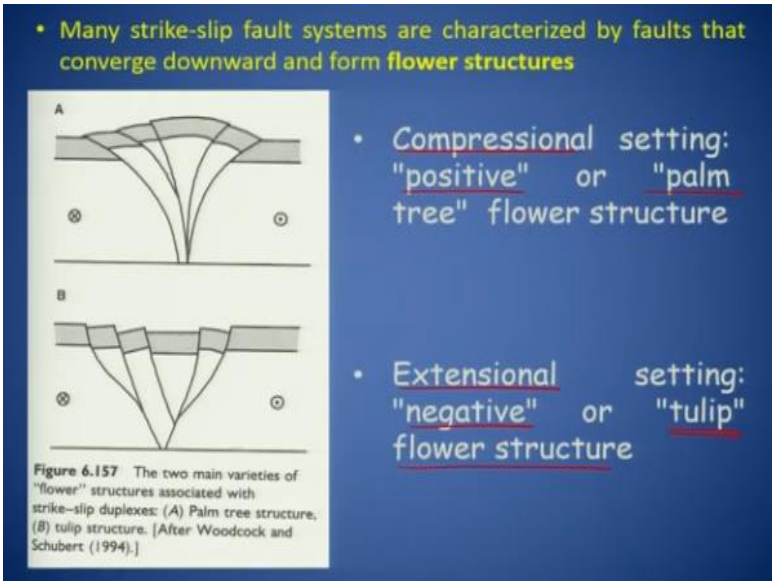

So again about the same, many strikes-slip fault system are characterized by faults that converge downward and form a flower structure. So in compressional setting positive or you also term this is an palm tree flower structure, so we have positive flower structure in case of the extensional setting negative flower or we also termed as tulip flower structure so in this case if you are having positive, compressional.

Then you have palm, extensional, negative and you have tulip flower structure. So what it says that we have the small faults which merges at the deeper path with the main fault.

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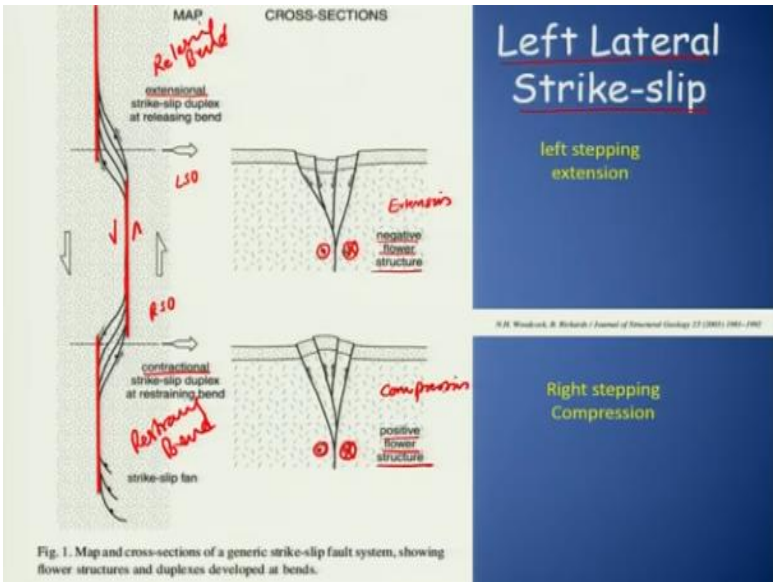

Similarly again if you look at and this is in the case of your left lateral strike-slip faulting, so you have the, this block is moving towards us. So this is your left block and this is your right block this is moving towards us and in this case where you see the negative one, so negative

you are having the negative flower structures you are having the extension. So you see this one here so you have the fault which runs here and then step to the left.

So you have the left step over here and if you see this one then you have the right step over, this one. So if you see, this is your right step over and you will see in the left step over you are having extension so for example, this block is moving like that and this is coming towards you this is moving in this direction and this is coming towards you and this is moving away from you.

So this will be an extension going on, where it is, in this case, in so you this block is moving towards you left one and this block is moving away from you this is towards you. So this portion will be you are contractional. So again very much similarly what we are talking about, so this will be your releasing band and this will be your restraining band. So in this case you will see in this block is coming towards you, this is away from you, you will see positive flower structure.

So you have right stepping here, so you see compression and this one you see left stepping. So you will see extension, so this part you can recall the previous examples which we have discussed and that will help you in understanding that if the fault is not straight if it is curved and if you see the step overs then you will be able to see the different type of pattern of deformation that is related to extension and compaction or compression.

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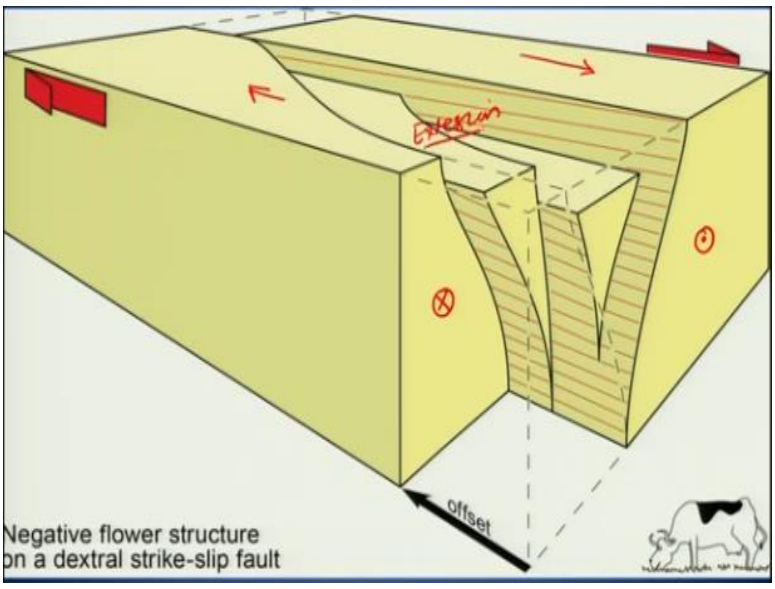

Similarly this is what we see the negative flower structure, in case of dextral strike-slip so you have the right lateral strike-slip that this log has moved in this direction. So this is away from us, so this is your one and this is away from you. You will see the negative flower structure where we are seeing extension basically, so you are able to see here extension.

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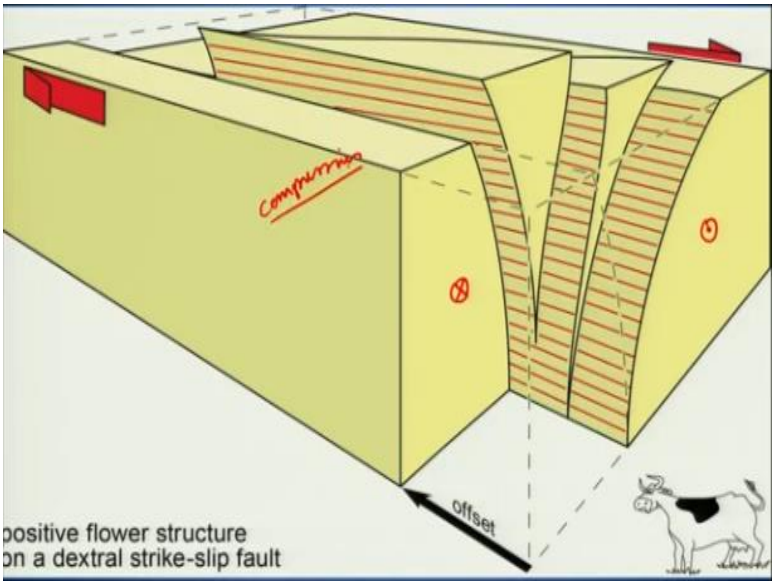

Again, similar one but here this block is moving towards you, this is away from you but you see as your the positive flower structure that is your compression.

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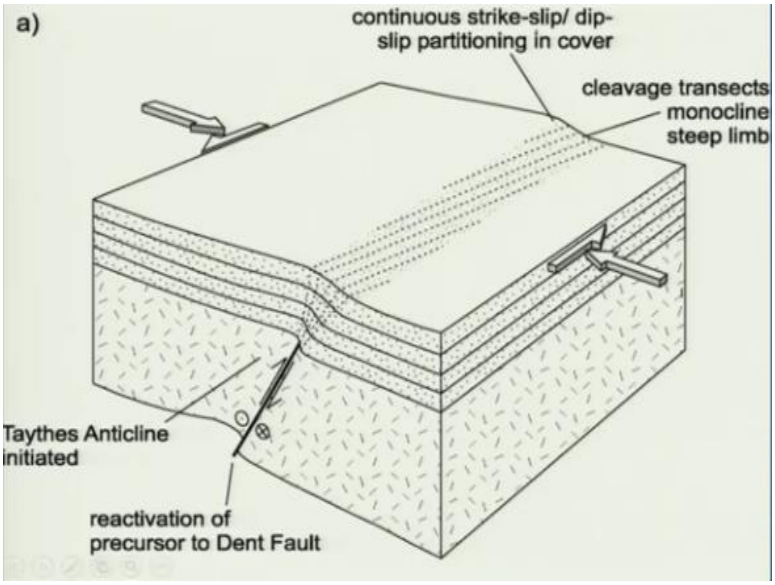

So you may also come across that if you are having like some oblique slip is there along with the thrust then on surface you may see the formation of monocline and also this monocline will show or along the fault you will be able to see strike slip motion.

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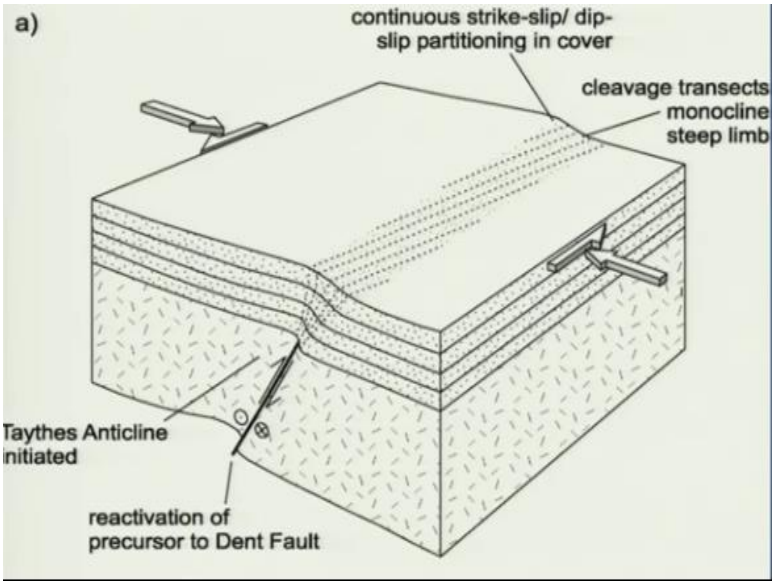

This is what it is been shown here, so initially you develop a folding along very like almost right, high angle fault where you have this block is moving up, so you see folding here and if this is having an oblique slip along with that

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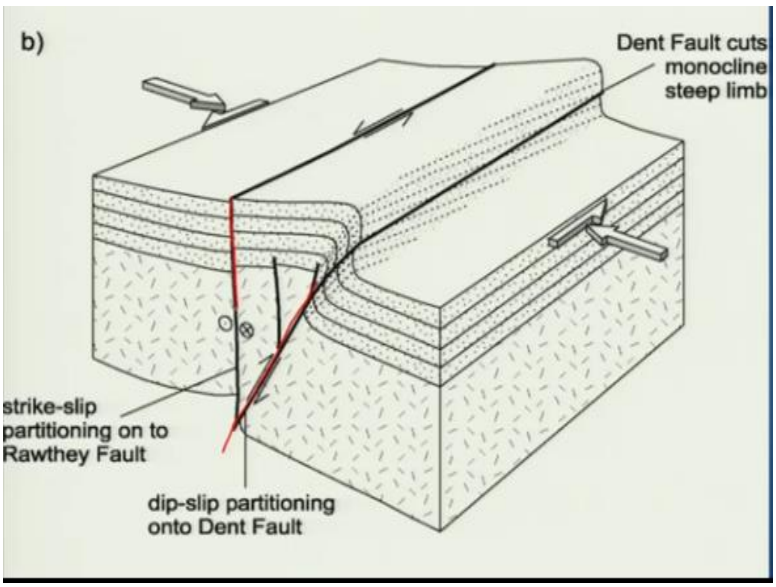

Then you will see the formation of it and strike-slip fault in the hinterland side. So this is typical of what we were talking about but we will have the slip partitioning because this is the main fault is like that. And then one is taken up while this slip has been taken up by this fault another one is along this one. So this is a resulting into the left lateral but the moment will depend on what type of deformation is taking place or with respect to the strike.

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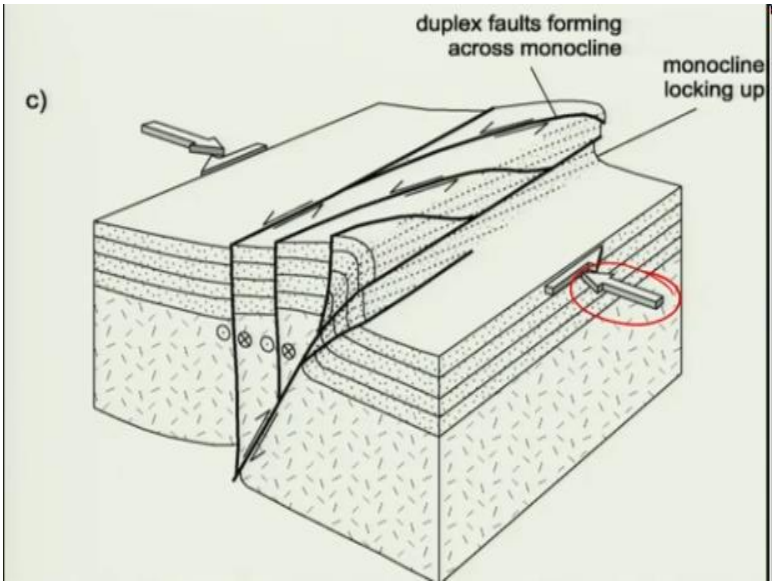

So that will result into the formation of multiple strikes-slip fault branching out from the main fault here. So what we have the main formation is compressional but it is like oblique movement you will find the combination of thrust faults or reverse faults and strikes-slip fault.

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So Transtension in releasing bend may lead to newly development of sag ponds and there is an example of the pull apart basin along the San Andreas fault system. So in releasing bend we will see the extension and formation of the sag ponds and pull apart basins.

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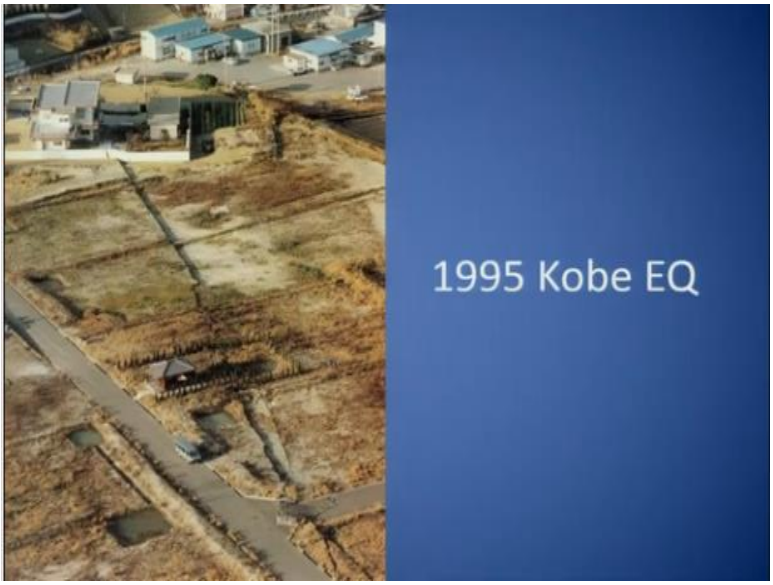

Now this part I have already discussed, I will just skip this one maybe you can.

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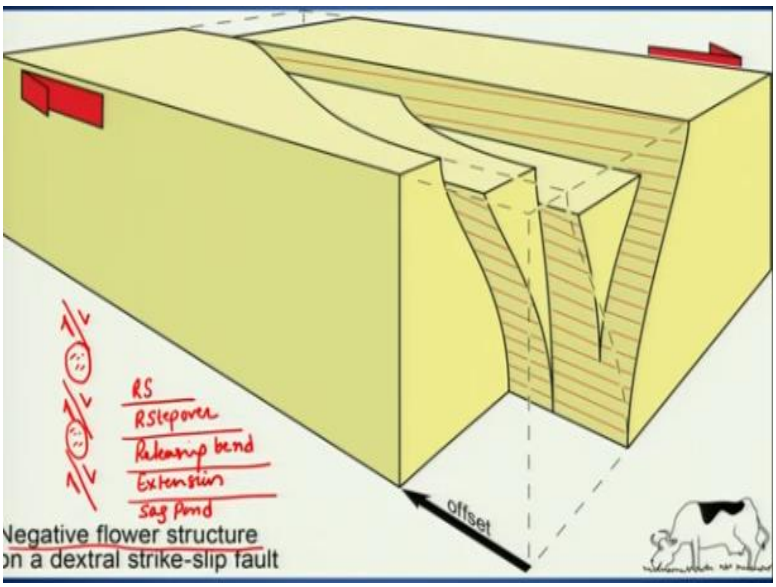

So as we were discussing about the positive and negative flower structure in different movement like right lateral and left lateral and this what we saw I just now, is your right-lateral strike-slip movement and what we see is the negative flower structure. So if you look at the step overs here, so if we combine everything that what I just wanted to end this lecture with that, if you are having the, suppose you are having the right stepping of the fault.

And you have a right lateral movement, so what you will see here is your extension, so you have a right lateral strike-slip and in right-lateral strike-slip you have a right step over, so you will see the releasing bend or releasing extension or you can also say the formation of your sag ponds. So this you should keep in mind, when we are talking about so this we are having

basin, here extension. When we have and that will be related to your negative flower structure.

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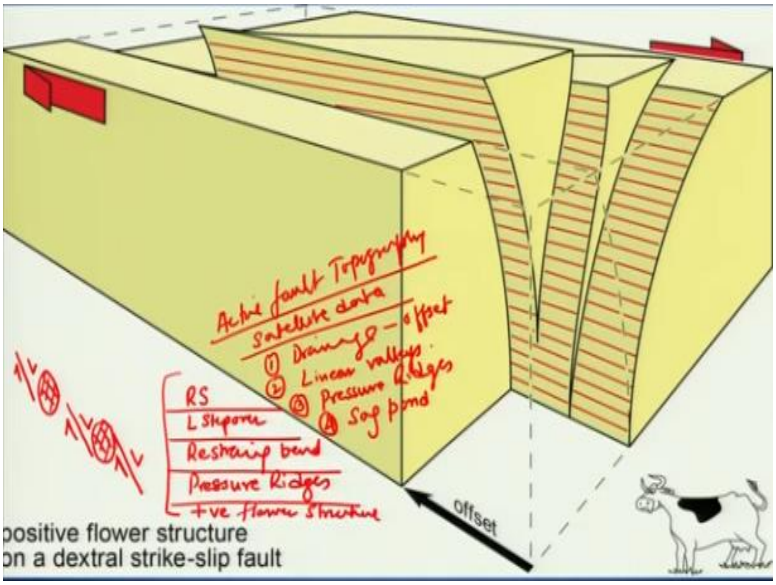

So similarly if we look at the formation of the positive flower structure then again what we see is you have the, let us see that if we have the left step over, so you have strike-slip here, I have right-lateral strike-slip here, you have right lateral strike slip. This portion we will see compression. So this we are having again right lateral strike-slip and we have what we see is the left step over and we see a restraining bend or we can say formation of pressure ridges.

So this you will see and what we look at is the positive flower structure. So this if you keep in mind whenever you are talking about or the strike-slip left lateral moment, either if it is left lateral then this will change but in case of rule right lateral, what we have seen and we just explained. So you can keep this in mind and this will help you in identifying the landforms that is your active fault topography using satellite data.

So main features again I will just quickly go through that we have one is your drainage you will take it, that is your offset with respect to what type of moment you will come across then prominent one will be your formation of linear valleys, then 3rd you will see the formation of pressure ridges and 4th; sag ponds or you can say pull apart basins. So just while interpreting the satellite data and in identifying the active fault topography you will have to keep in mind.

That this step over which is simple way of the reconstruction and justifying that what landforms you have identified is either pressure ridge or sag point you will have to look for

the signatures of the step over. So with this I will stop here and now we will continue with the same topic like strike-slip fault but we will look at the case study from northwest Himalaya that we did Paleoseismic studies around Kangra valley fault. Thank you so much.