Earthquake Geology: A Tool for Seismic Hazard Assessment
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Lecture - 22
Fundamentals Related to Active Faults (Part 1)

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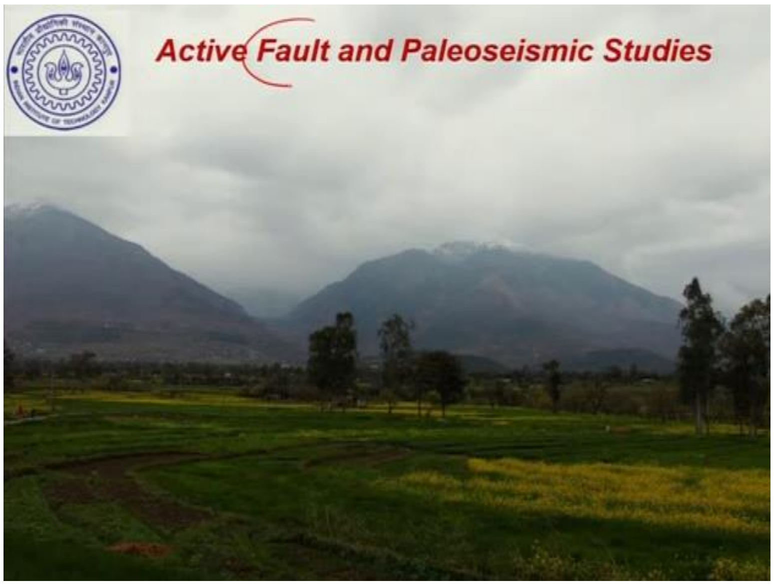

Welcome back in previous lectures we discussed about the primary and secondary features. Now in this lecture you will understand that the importance of what we have discussed in during that like that those particular lectures on primary and secondary features. Now this topic basically is on active force so initially we will I will try to understand the different type of faulting events how they occur and what are the different tectonic setting under which different type of faulting will take place and then I will get into the paleo seismic studies.

Paleo seismic studies I will talk later on in more detail, but we will just look at firstly the what are the active force and what are different type of faults and what are the surface manifestation of this type of faulting that is the strike-slip reverse or normal faulting.

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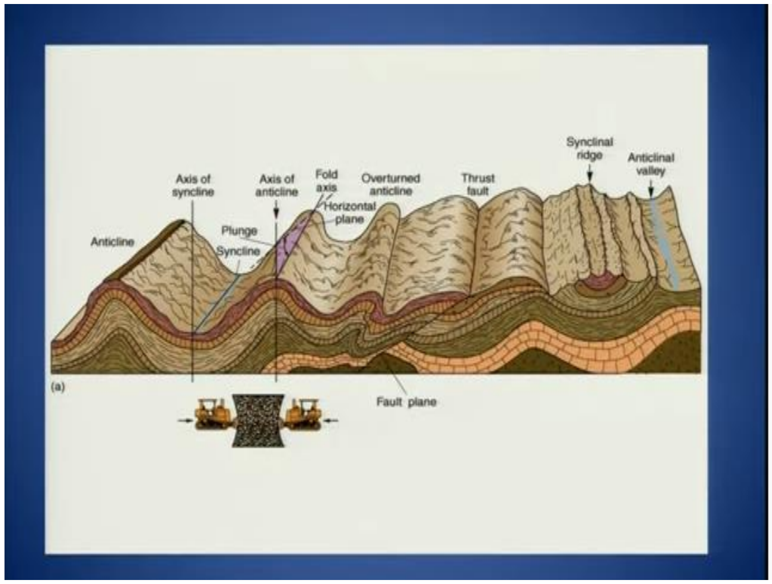

So in nature for example if you have the compression tectonic environment then what we see is not the combination of the formation of anticline and syncline and further if you keep on deforming further then you will get into having the overturned faults and finally what we see is the fracturing along the reverse fault or the thrust faults. So even this terminologies which we have been using about the reverse fault and thrust fault this will become clear and I hand this lecture. So we have usually what we see is the imported mountain chain and within the folded mountain chain we have the displacements which are along the respective faults.

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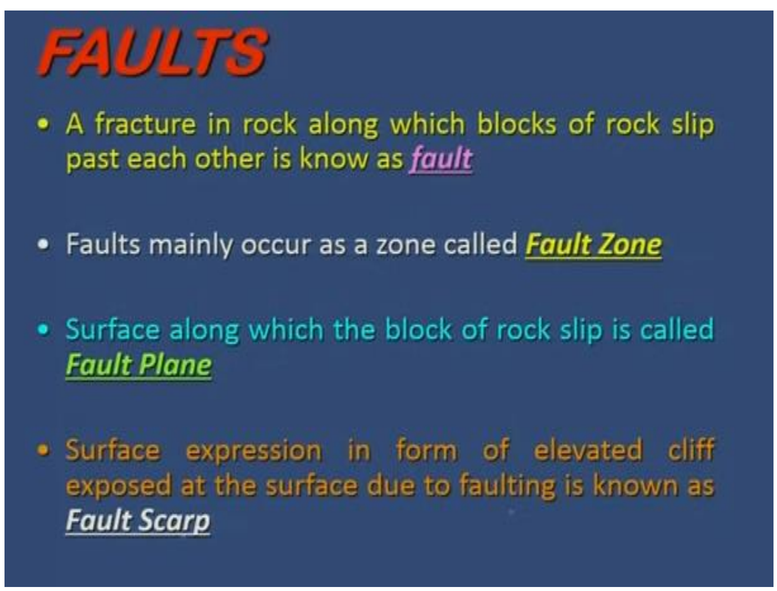

So fault if we take as an definition then fault is a fracture in rock along which block of rock slip past each other and those fractures are termed as faults and faults mainly occurs as an zone called fault zone and the surface along which the default block moves or slips are termed as fault plane and the surface expression that is the manifestation of the how the deformation on the surface which is in the form of elevated cliff exposed at the surface do revolting is termed as fault scarp.

So these are the few terminologies which you will remember because when we are going to talk more on details about the different type of faulting then the surface manifestation will differ from one faulting environment to another faulting environment.

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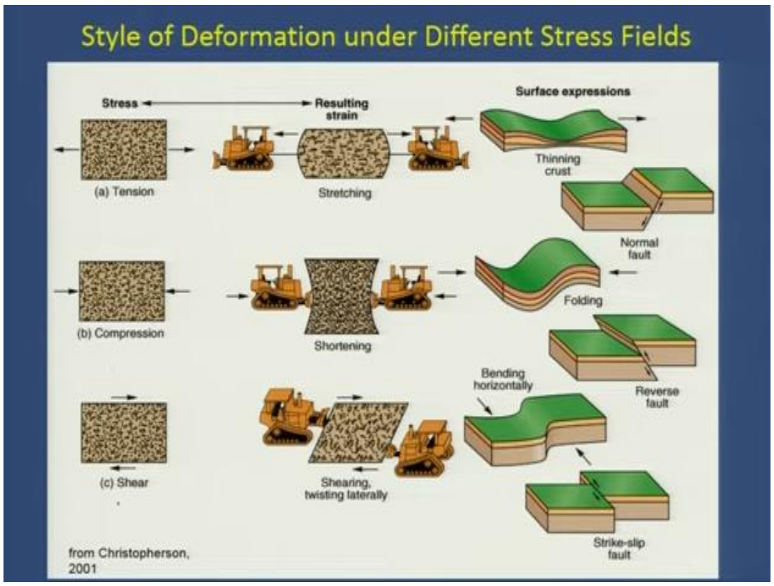

So style of deformation under different stress what you will see is basically if you are having extension tectonic environments and then you are stretching the crust. So you are thinning across in practically you are thinning the thrust and one block will with respect to another one will move down. So this is the hanging wall this is the foot wall that is what we call the stationery wall and average is lying on the inclined fault plane.

And similarly if you are having the compression tectonic environment then you are doing the shortening of the plates or the crust and your resulting the deformation pattern will be folding and mostly you see formation or in the development of the reverse fault and in case of twisting or shearing as a pure shear then you are going to result into the bending movement and along the horizontal plane you will have what we call the strikes defaulting.

So these are the major three type of different faulting normal reverse and strike-slip in different tectonic environment or different stress pattern you are having tension here your extensional then you are having compression and you have shear.

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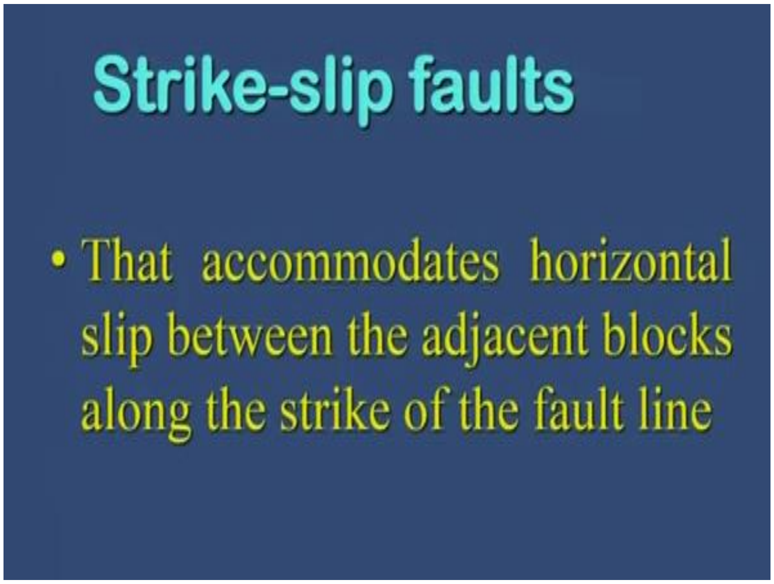

So strikes slip faults mainly are those faults which accommodates horizontal slip between the adjacent blocks along the strike of the fault line.

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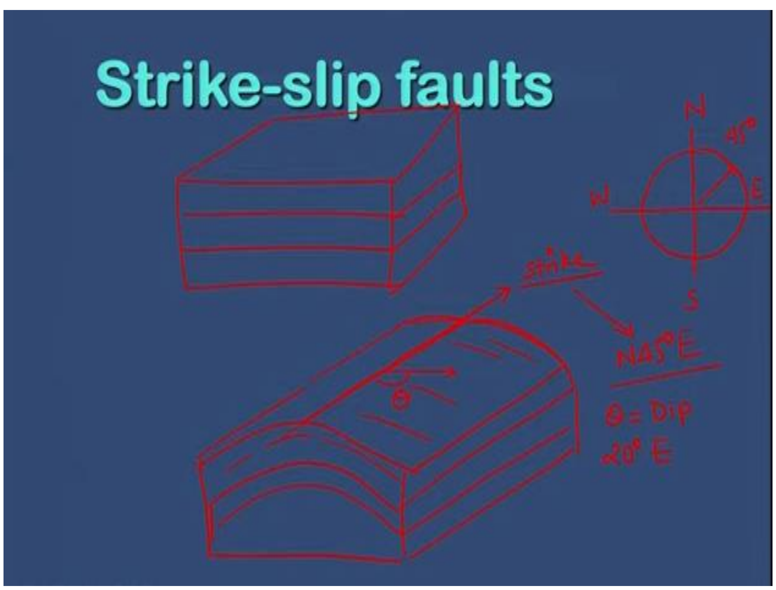

So I will just give briefly the idea about what we are talking about this strike and dip. So suppose you have horizontally stratified succession so this unit will not have any strike or dip so you will not be able to measure the strike and dip off of such layers because they will be exposed horizontally but if you will deform this okay. So for example if you are deforming the others layers then they are like this.

So you have the folded layers so this imaginary line if you take okay that is the contact between the two limbs which are dipping away from one another. So you are having the fold here like this so this will be your strike. So basically, we are taking orientation with respect to north. So if you if you take the north, south, east, west then you are measuring the strike suppose the strike is with the help of compass you come across that this is the orientation and for example this is around of 45 degrees then you can say that north 45 degree east.

So this will be your strike and the amount of dip is the inclination which is measured exactly perpendicular. So the inclination of this that is your angle between the strike line and the inclines plane which is measured perpendicular to that will be your dip. So this angle will give you the dip amount of dip and the direction is the in dip direction. So for example here if this is if we take this strike of this bed this one is north 45 then the amount of dip is going to be for example you are having say 10 degrees or 20 degrees then we will say 20 degrees dipping due east.

So this will be the amount of dip so any displacement which is taking place along the strike then those we faults have been termed as strikes slip faults. So strike slip faults mainly you will find that if you are having the horizontal or the strike of any fault then a block which are moved for example this is I will draw in block diagram here then this block has moved towards us and this has moved away from us.

So this will be termed as the movement has taken place or occurred along the strike where two blocks are just passing along this with respect to one another along this fault line. So this is termed as right lateral and if the it is on the other another direction opposite to this then we termed that as in left-lateral strike-slip we will come to these examples in coming slides let us move ahead.

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So again strike is an imaginary line which is torn with respect to the inclined plane and so we have you have this one then this will be you can have the imaginary plane here for example and again. So if you are having the this is your imaginary plane and the intersection of this will be your strike direction and the dip goes will be this one. So in nature what we see the dip now the movement has taken place along the strike and along the dip plane. So based on this the faults are been classified one as in strikes default that accommodates horizontal slip between the adjacent block along the strike of the fault line.

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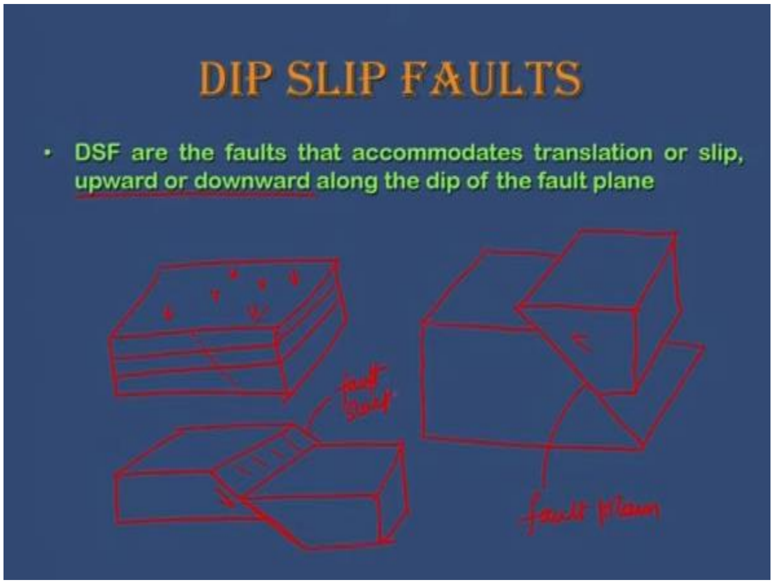

Then comes the dip slip faults. So dip slip faults are the faults that accommodates translation or slip upward or downward along the dip of the fault plane. So you have like here if you are having undisturbed unit or the layers and this is your surface and if you are having for example upward movement. So if you take this fault here and then if you are talking about the upward movement and what usually we will be able to see is so you have this block has moved up with respect to this one so there is an upward movement and similarly you will have the downward movement also.

So where you are having the blocks which is for example if you have the block which has moved down. So here the block has moved down with respect to and this is along the slip plane and this is the slip plane which has been here again. So this portion is what we call as an fault plane, and this is your surface expression fault scarp and if the movement is along the strike. So this will be the strike of the fault here this will be the strike of the fault. So on surface it will be somewhere all here.

So if you are having dip slip movement then the mostly the movement has been seen along the dip plane either it is the block has moved up or block has moved down but you will be classifying whether it is a normal fault or a reverse fault. So in normal fault the block usually moves down and reverse fault the block moves up. So upward and downward movement along the dip of the fault plane.

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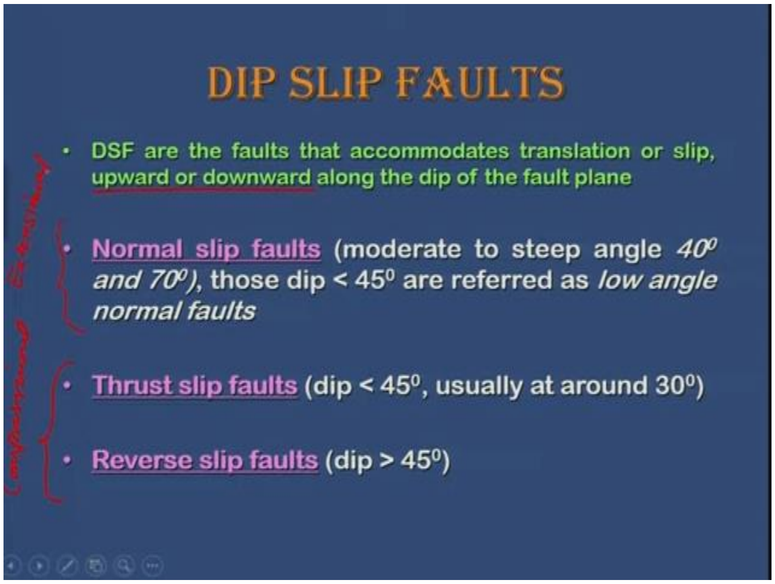

So normal faults that usually has been seen but if you are having steep angle moderate to steep angle usually which ranges from 40 to 70 degrees and those dip with less than 45 degrees are referred as low angle normal faults. Thrust faults if the tip of the fault plane is less than 45 degrees so if you are having for example you have the reverse fault. So this block has moved up so if this angle of the fault is less than 45 degrees then they are termed as thrust faults.

So if an if greater than 45 degrees then they are termed as the reverse faults. So here this 2 faults that is your normal sorry thrust and the reverse fault they will fall under the category of compressional tectonic environment and this will go as an extensional tectonic environment, so this is the major difference here.

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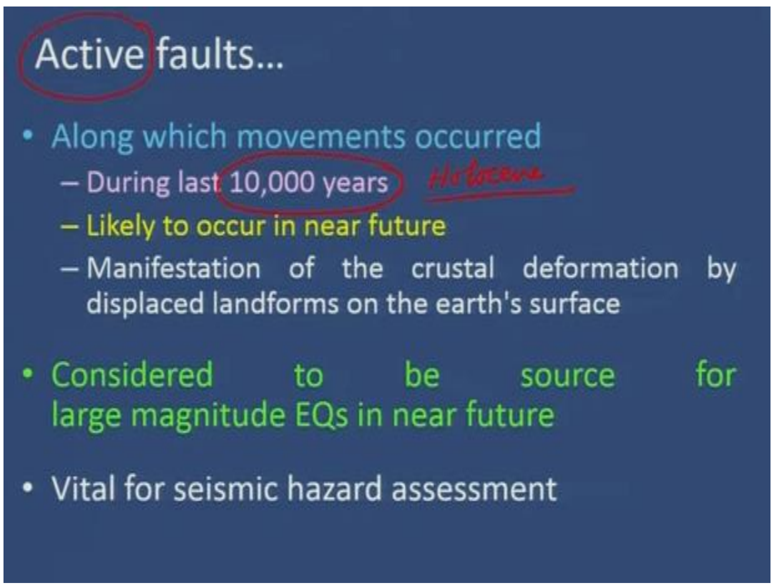

And the active fault so what we are using is the term active for the faults then it itself suggests that this fault is having the potential to move in near future. So as an broad definition what we take is that the active faults are those faults along which the movement has occurred during last 10000 years and if you remember that we have been emphasizing this 10000 years when we have the Holocene epoch likely to occur in near future.

So earthquake is likely to occur on a particular fault in near future then we will classify that as an active fault and manifestation of the ongoing deformation or the crustal deformation by the displaced landforms on the surface is observed. Active faults are considered to be the source for large magnitude earthquakes in near future and it provides extremely vital information for seismic hazard assessment.

So that is one of the most important parameter which we require for the seismic hazard assessment of any given region. Now globally this has been done in most of the countries which are sized which have the region's seismically active regions and depending on the user one can classify this active force. So either you want to restrict yourself to last 10000 years that is in Holocene or you want to classify the active faults or if there is a movement during the older time also.

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Figure 4.2-1: Fault scarp near Crowley Lake, California.

So this is an example of an fault scrap here where you can see because we the displacement is the manifestation of the ongoing displacement or the deformation has been seen on the surface. So this surface has been displaced along the default line here. So if I have to draw the fault line it will go something like this and this portion which you see is your cliff or the elevated portion and this is termed as fault scrap.

So if you take a section along this line say A and B then you will find that you will have you have an infestation like this. So this is an elevation you have so this displacement is long an active fault because young surface has been displaced. Now this part we will discuss later with the default is dipping in this direction as a fault is either like this or the fault is like this okay if this is there then this block has moved down and this is stationary whereas in case of this fault this block has moved up.

This part we will discuss when we are talking about the different type of faults that is an active fault, thrust fault or reverse fault or normal faults. So in this case if this block has moved down and default is dipping like this then this becomes normal fault and in this case that is if I say at one case 1 is your normal fault and case 2 is your reverse fault. So as I told that depending on the users one can classify the faults.

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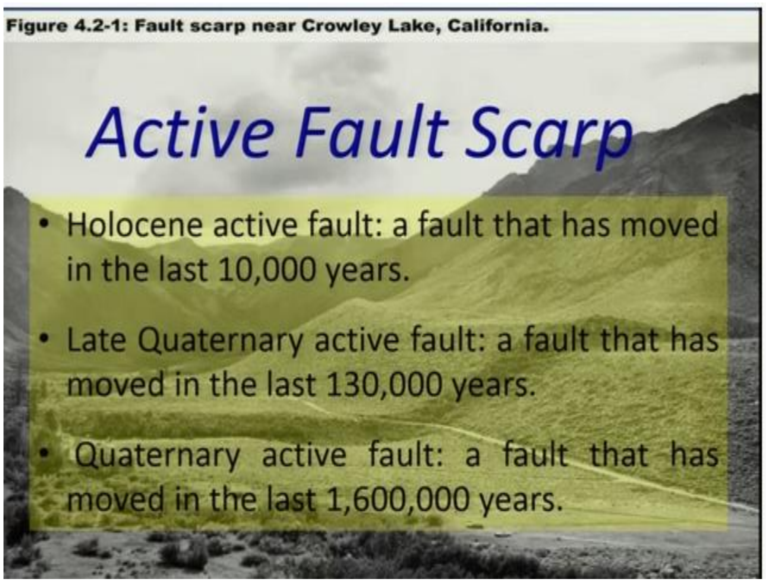

So active fault scarps Holocene active faults, a fault that has moved in last 10000 years late quaternary active fault a fault that has moved in last 130000 lakh years and quaternary active fault a fault not has moved in last 16 lakh years. So this one can classify based on the tectonic activity observed on the respective fault so the this is a broad classification of the active force but the what we are interested in is we are interested in mostly in 10000 years what has happened along that particular fault in last 10000 years.

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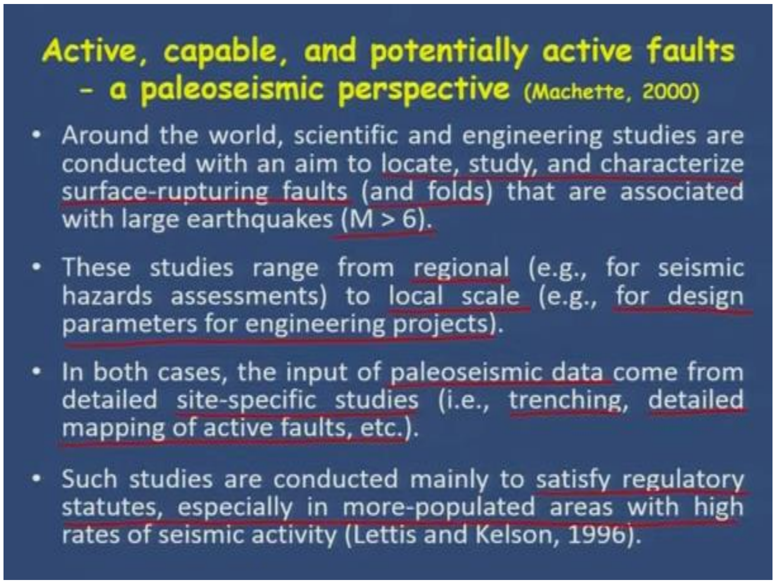

Further we can also classify the faults as active capable and potential active faults within prospective of paleo seismic investigations. So around the world scientific and engineering studies are conducted with an aim to locate study and characterize surface rupturing faults. So this is what is the required data so to locate, study and characterize what type of faulting has been taking place and another associated landforms are the faults.

So such surface faulting 's are mainly seen it or associated with earthquake having magnitude greater than six this studies range from regional example for seismic hazard assessment to local the local scale and this is mainly than keeping in a background of the design parameters for engineering projects. In both cases the input of paleo seismic data comes from detail site-specific studies that is what we are going to learn about trenching detailed mapping of active fault etc.

Such studies are conducted mainly to satisfy a regulatory statues especially in more populated areas with high rate of seismic activity and in case of India we are overpopulated and in case if we take of the Indian subcontinent then we are having 3 zones one is Andaman Nicobar another one is that is Sumatra, Andaman Trench region then Himalayan collision zone and Kutch.

And as we have discussed in previous lectures that the earlier the area which were been considered as in stable continental regions have also triggered or experienced earthquake in recent past that is in year 1993 Lathore earthquake and 2001 Gujarat earthquake. So this is mainly is conducted with an aim to satisfy the regulatory status for the seismic hazard assessment.

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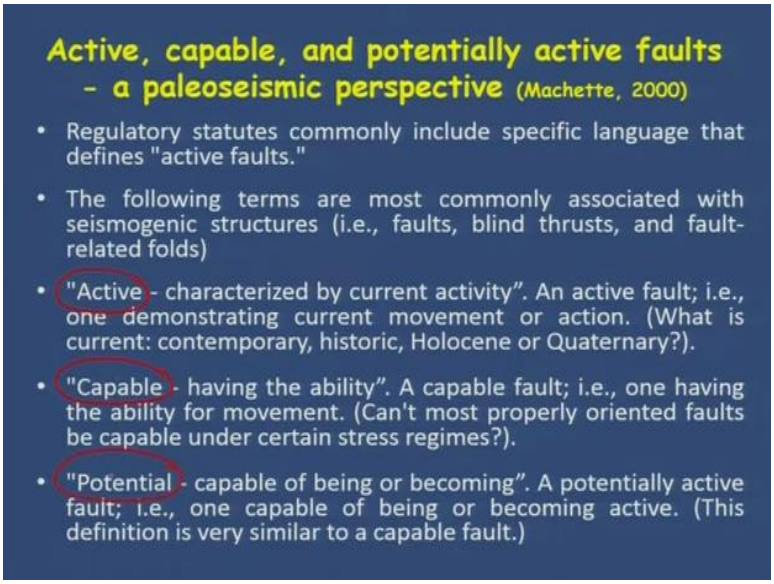

So further regulatory statues commonly include specific language that defines active fault. So that this will depend on region to region and countries to countries. So regulatory statues of different countries will have different a specific language in which they can define their active faults. The following terms are commonly associated with seismogenic structures faults, blind thrust and fault related folds, strike-slip faults and normal faults etc.

Now term active characterized by current activity so if you have active then an active fault that is one demonstrating current movement or action what is current contemporary, historic, Holocene and quaternary this is one another one is capable having the ability a capable fault that is one having the ability for movement in near future and third is your potential capable of being or becoming a potential fault.

So a potential active fault that is one capable of being or becoming active in near future this definition is very much similar to the capable fault. So you can have different categorization of the faults whether it is you want to categorize an active fault or whether you can you want to categorize in an capable fault, or you want to categorize that as in your potential fault. So you can have this categories on the active fault map depending on your studies and that is paleo seismic studies.

So paleo seismic studies will be extremely important in characterizing the faults. So I will end up with this and continue in the next lecture we will talk more about the active faults in coming lectures. Thank you so much.