Natural Hazards
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Lecture – 30
Type of Landslides Part III

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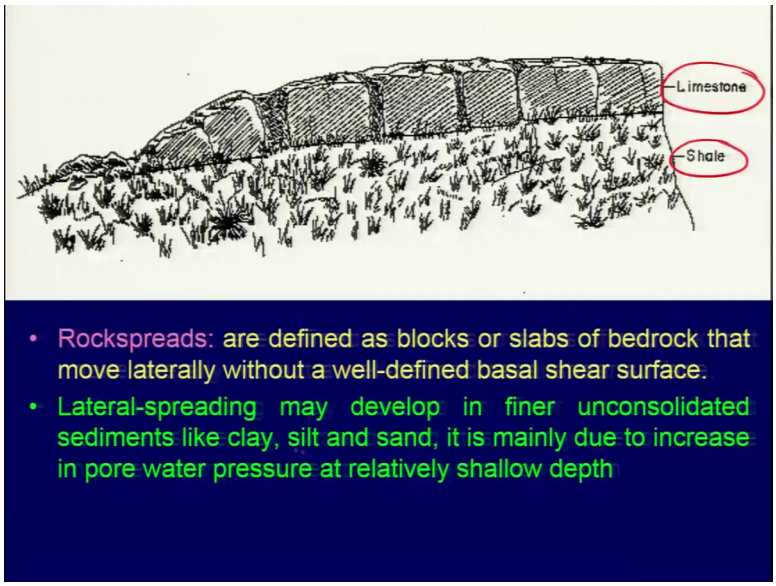

Welcome back. Another example is we usually we will not expect that any slip will take place because the slope is very gentle and the material, which is sitting on the surface is an hard rock. So, now, this is an example where you see that you are having a very fine grained rock and then you are having a limestone here. So, if you look at the top only and then you will say no only this area will never have a landslip. But the shale we discussed in one of the lecture that this will act as in a slippery surface or the plane of weakness which can result in to the landslip.

So, if this gets water saturated that is shale, it will allow the material to slip down and result into the formation of extensional crack in the hard rock, which is sitting or over lying this softer rock mass.

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So, rock spreads are defined as blocks or slabs of bedrock that moves laterally without a well defined basal shear plane or the shear surface. Lateral spreading has also been another term which has been given to this, which may develop in finer unconjugated sediments like clay, silt and sand.

Mainly the finer material it is mainly due to the increase in pore water pressure at a relative shallow depth. So, even if you are having near surface this material and a very gentle slope you can experience a lateral spreading. So, rock spread and lateral spread this is a typical example which we encountered during 2001 Bhuj earthquake and this is basically because of the lateral spreading.

Where along a very gentle slope if you will look at here what you can see is in very flat area, but overall a regionally if you take the profile we took the topographic profile, we found that this area is sloping towards south. So, this was north and this is south. So, it was sloping towards sorry it was sloping towards north this is your south and this side is north. So, this we encountered or observed the deformation which resulted with the lateral spread.

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There is another example of the same. We are having the photograph is taken looking towards south. So, this steps which you see is because of the extensional cracks which were developed and there is a typical example of lateral spreading and this was because of the increase in pore water pressure because of seismic shaking and this is an example of 2001 and Bhuj earthquake in epicentral area. Very important and of course, sometime beneficial and must have also have the disadvantages.

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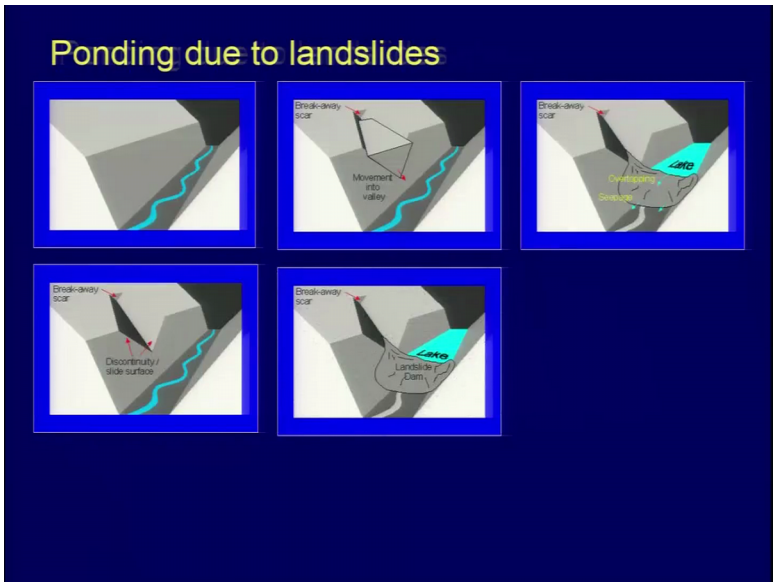

This pore you are having an very steep banks along a valley. If there is an movement of the material or the landslide and the material getting into the valley this will result into the formation of natural dam. So, what you see here is the formation of lake and this is a very common phenomena, which one can come across in the hilly terrain like Himalayas, where we see at some locations the lake deposits and those lakes are formed because of the massive landslide.

The material sliding into the river bed or a valley blocking the flow of the channel resulting into the formation of lake. But when this get preached, then you will have flooding events in the nearby area.

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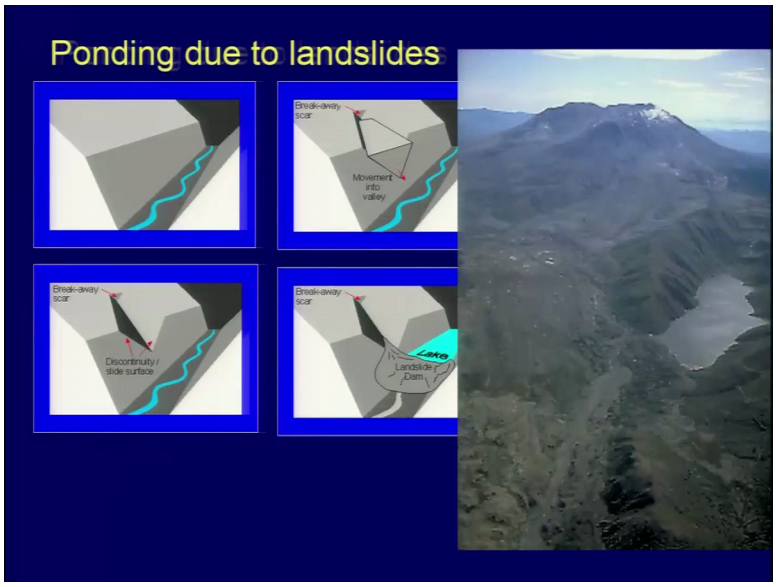

So, we also say landslide bank and this is an example of the typical lake formation along the valley, because of the landslide blocking the flow of the river.

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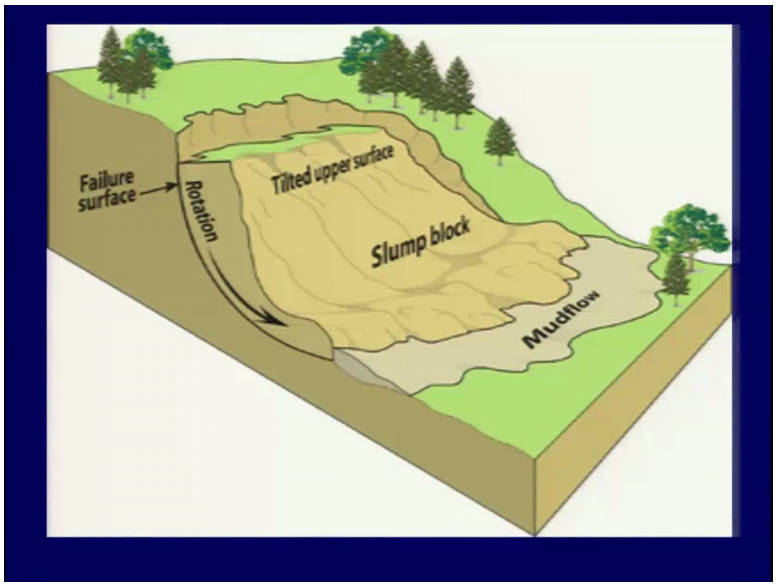

Then we have this is an example we have already discussed, it is slumps and the rotational slide.

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Very good example another one from Himalayas. Now if you see here what this is an riverbed here and the road which has been constructed is on the top of the riverbed just. They have filled up this much a ocean here and constructed a concrete road. Now there is an undercutting or erosion which will keep on taking place because they if you are not having the overflow from the top, but the water will keep on seeping from below. Again

no foundation was been given here because the construction was been done putting the material or filling the material and putting the concrete road on the top.

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And most of the time what we find is that such roads, which are been constructed connecting the either banks will be eroded a very quickly. So, they may last for couple of seasons and then again you will have to do the reconstruction of such roads or transportation.

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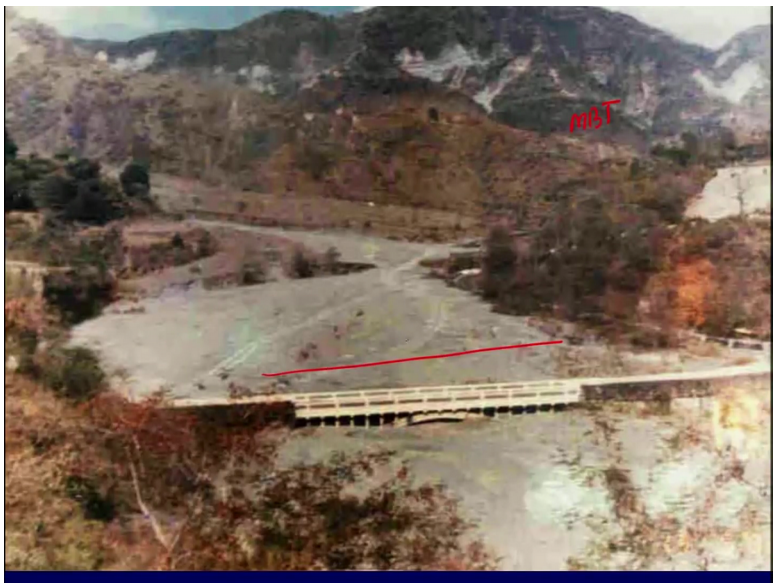

So, another good example from Dehradun region, what we see here is the channel which is flowing in this region and a bridge over here the problems which have been faced is that every time there is an excess amount of sediment bed load coming during the floods and covering this the bridge. It can damage this because this is the only connecting bridge, at that point of time this photograph was probably taken during 1970s which used to go to Missouri.

And the backdrop what you see is the lighter scars, these are all the landslide scars and there is an main boundary thrust the fall system major fall system which is active fall system in Himalaya is passing through this region. So, the ongoing deformation along this main boundary thrust is also responsible in churning the material here and acting as in source of the loose material for this channel, but load.

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So, every time what they do is they clean up this portion that is an arc area here to facilitate the water to flow through as early as possible. So, dredging has been done continuously before the rainy season. To protect this arc what they did was they constructed the retaining wall here which has been shown with this white patch I will show another photograph. To stop the material getting into this region and damaging because if you are having the material which gets filled up here the channel cross section area will decrease and the water will start flowing on top of this road.

So, this photograph has been taken looking downstream from the upstream part, the previous photograph is from the downstream looking the upstream. So, now, what we see is, that after few years with an understanding that this is getting filled up, they put a retaining wall somewhere over here which you see in the next photograph. But what happened again? Similar to what the road was been built on a riverbed connecting both the banks.

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So, this is a retaining wall and as I was talking about the road which was been constructed connecting the banks on either side, again the same in the similar way this retaining wall was been put on the riverbed without having proper foundation. So, to allow the water which has been seeped within the sediments here, there are some outlets which have been put here, but that way those were not enough.

So, this photograph we took when we took the 2001 2002 civil engineering batch to this area. The landslide which I was showing in the previous slide is a Kalagarh landslide. So, what happened after that? So, students are sitting on the retaining wall on Kalagarh Nala, Rajpur near Dehradun.

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After few years this what happened ok. So, this is an another example which we can say that this is because of the seepage, which broke the wall underneath the top wall remain as it is. So, this is an another example of the landslip or the erosion which take place within the river valley.

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So, the landslip took almost like a week and there is an movie from US which shows the mass moment and you can see the top scars which have been developing here the extensional cracks and the mass which are moving down here in the toe is under the formation.

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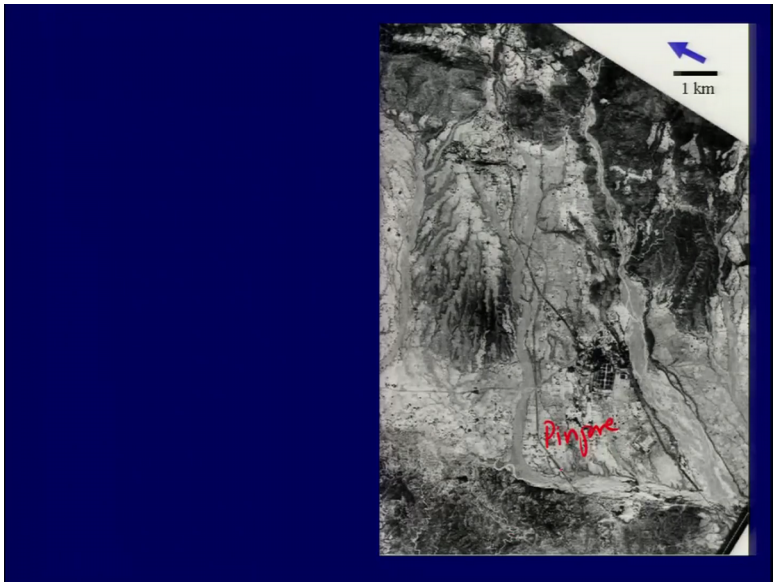

Very another good example from Pinjore area, this is around 25 kilometers from Chandigarh. So, this is on Pinjore Doon valley.

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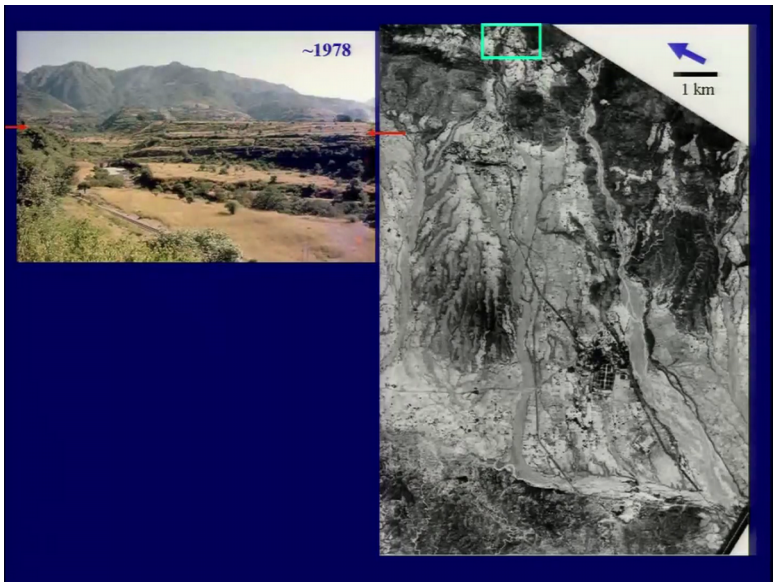

Example is from this region which is known as Kalka. This photograph was been taken long back in 1978 by Professor Nakata and what you see here is one is the rail track here which goes to Shimla, this is the same rail track which goes to Shimla here and then we are having as we took another photograph and there is an active fault here, but I am not going to talk about there active fault in this one.

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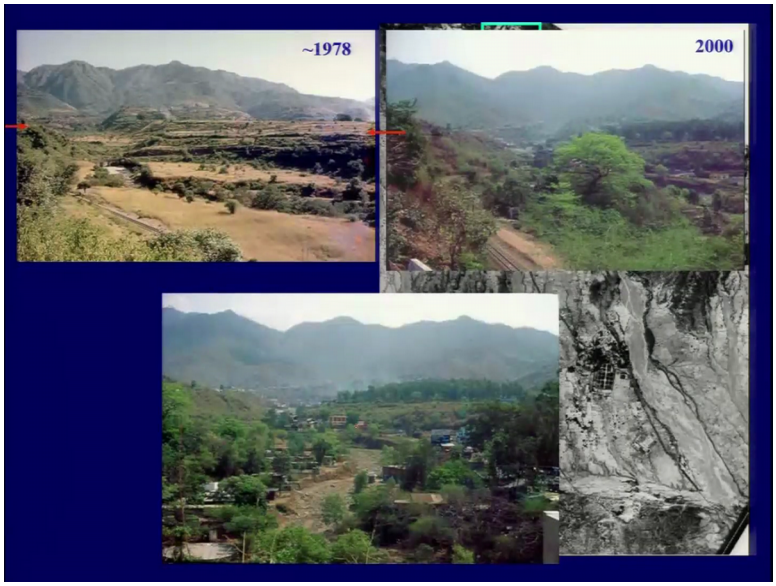

There is another photograph which I took in 2000. So, if you want to have a similarity this peak and this peak is the same, the rail track of course, the angle is different, but the

real track you can see here a lot many big trees have come up, but what we are able to see is that no population here no population here and slowly if you carefully see there are lot of houses which has come up. So, close up of that ok. So, this portion which you see here the hope all terraces have been occupied by supplement. Now, whenever there is an peak flood in this region this whole area will get affected.

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So, river bank erosion undercutting of the banks definitely this fellow will be drowned very soon and this must have happened up by now because those photographs would not be taken almost 7 to 8 years back.

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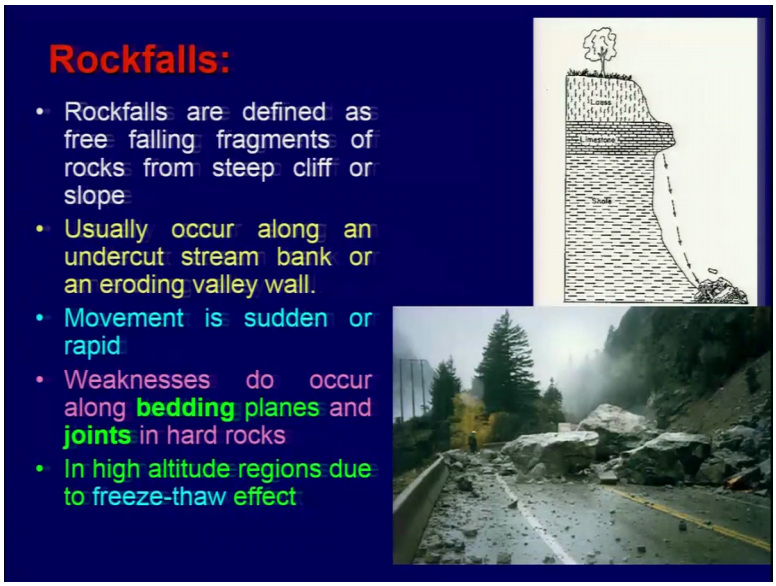

Coming to fall, the rock fall are defined as free falling fragments of rocks earth blocks from the steep cliff or slope usually occur along an undercut stream bank or an eroding valley walls. Movement is sudden or rapid weakness to occur along the bedding planes or joints in the hard rocks in high altitude regions this will take place because of freezing and thaw effect.

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In movement of rock falls. Land slip again and this was in Bangladesh which was triggered because of torrential rain.

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Landslides in Uttarakhand again because of the undercutting of the riverbank.

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So, this is an animation which was been given for Uttarakhand which blocked the channel because of the landslide.

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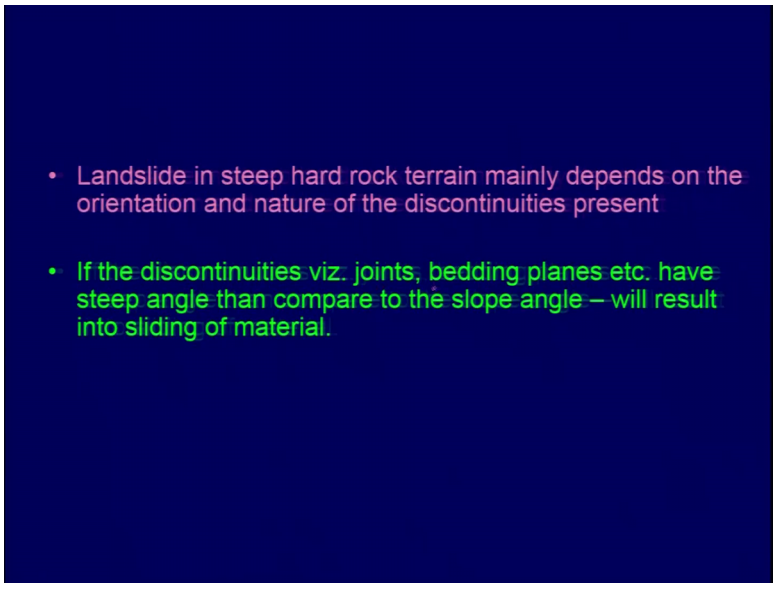

So, landslide in steep hard rock terrain mainly depends on the orientation and nature of discontinuities present and this discontinuities viz could be either joints bedding planes etcetera.

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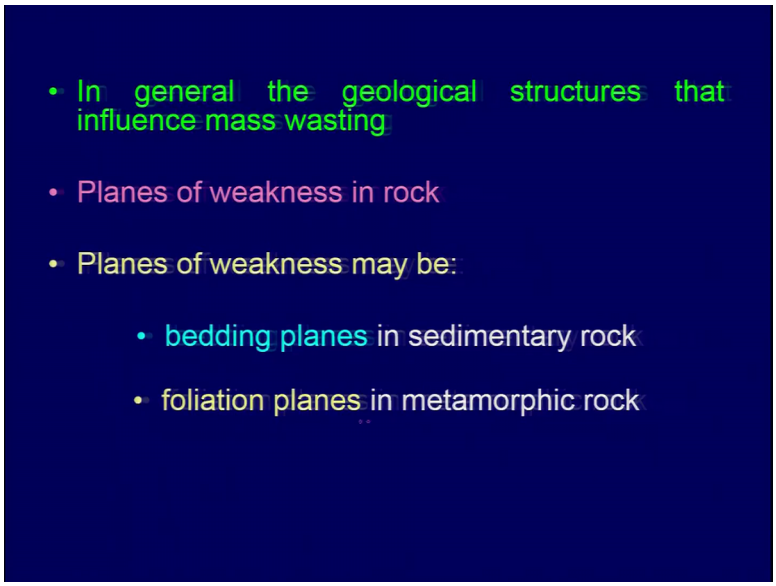

Now, in general the geological structures that can influence the mass wasting is what we have discussed in part, there is weakness plane of weakness and rocks either or plane of weakness maybe one is bedding plane in the sedimentary rocks or the foliation for example in the metamorphic rocks.

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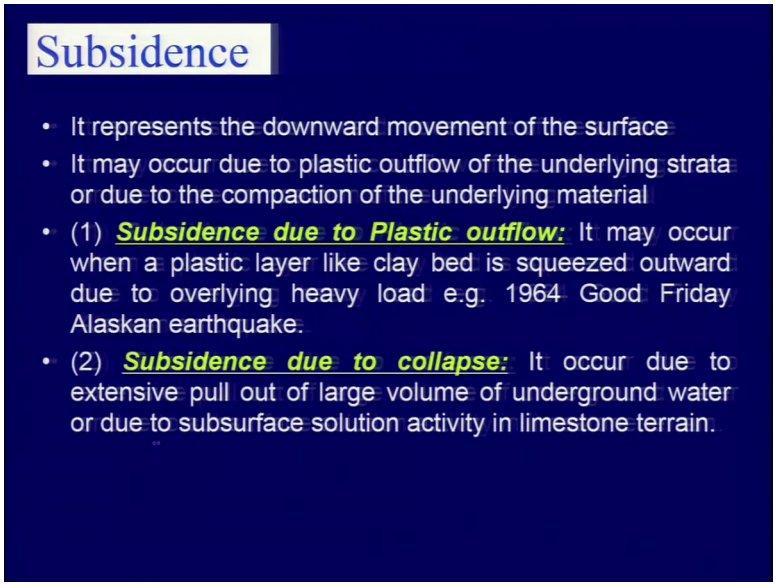

It is another example of subsidence it represent the downward movement of the surface, it may occur because of the plastic outflow of very fine material most possibly the clay or silt and so, it occurs when a plastic layer that is mainly the clay bed is squeezed

outward due to the overlying heavy load. The example of 1964 this was been triggered because of the Alaskan earthquake where the clay bed which was sitting in the deeper portion cab by gravel succession squeezed because of the strong ground shaking.

Subsidence can also occur due to collapse and it occurs due to the extensive pull pulling out of a large volume of underground water or due to subsurface solution activity is mainly in the limestone terrains, where we see a typical formation of potholes.

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So, typical of the limestone terrain and subdued topography, but in between what you see here is the depressions and these depressions are because of the dissolution activity taking place subsurface.

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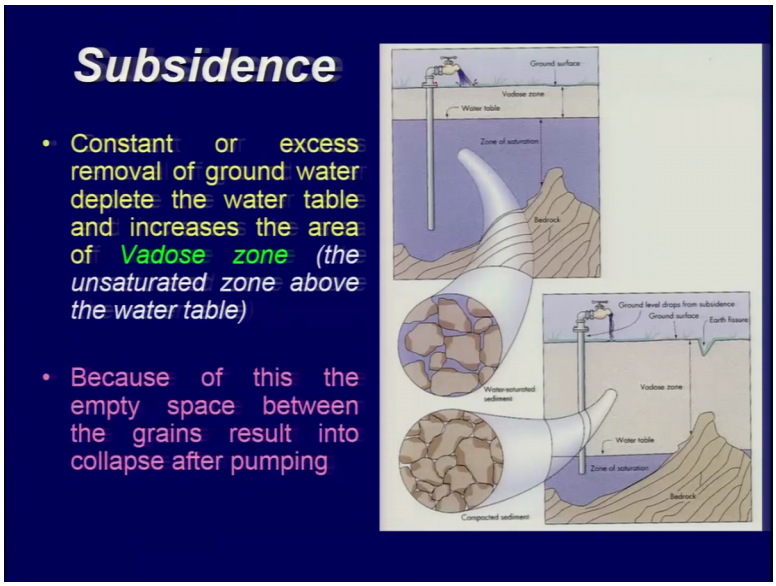

Another example is your excess removal of groundwater can also result into the subsidence. Now this example what has been shown here so, we have an round surface here vadose zone and in zone of saturation and then bedrock. So, if you keep on a removing excess water from this region which has been pumped out here, then the pore space which were relieved and filled by how this zone of saturation the pore space filled by water will go into compaction.

So, this is in compacted sediments and that will result in to the increase of this vadose ozone and the decrease of the saturation zone. Here this compaction and the increase in the vadose zone because of the excess removal of the water from this unit will result into subsidence.

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There is an example from the because of the subsidence in the limestone terrain, where you can see the potholes because of the dissolution activity.

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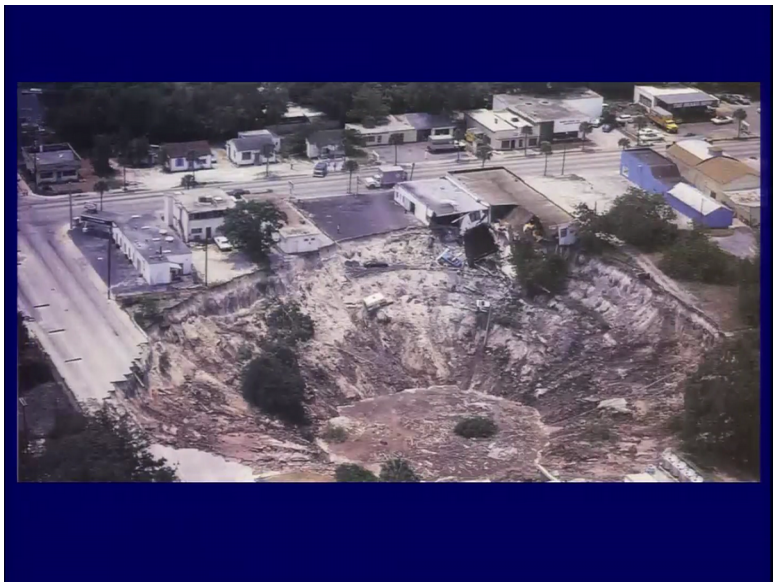

Its another example from the same, you can see the size of the pot holes where you can compare with the a big dimension of the scars here, you can understand the what is the magnitude of that.

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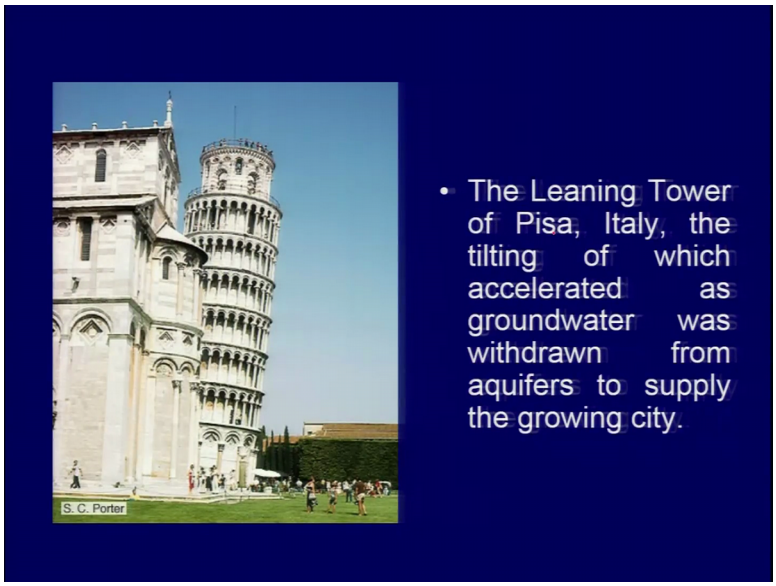

So, this is because of the dissolution activity, the another one is excess removal of water the best example is leaning tower of Pisa in Italy. So, we will discuss this control and stabilization portion in the next class.

Thank you so much.