Earthquake Geology: A tool for seismic Hazard Assessment
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Lecture – 52
Earthquake Geology: A tool for seismic Hazard Assessment

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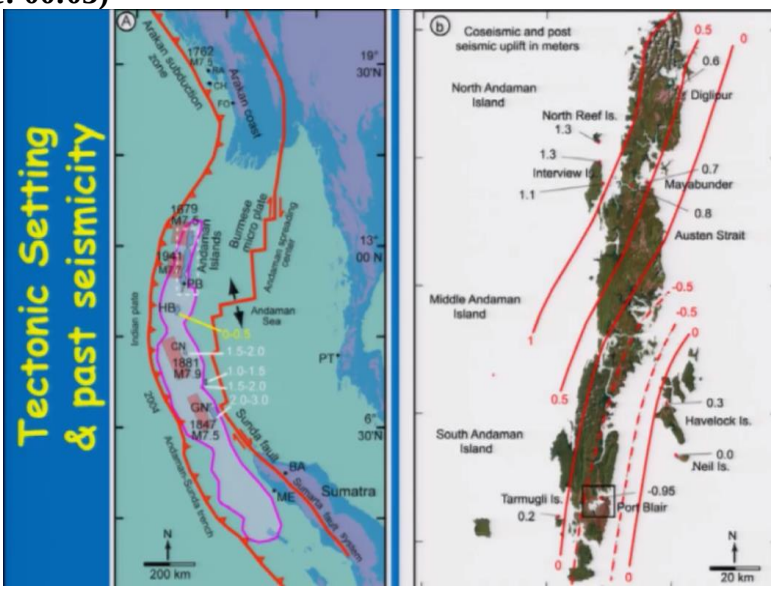

Welcome back. So, as I was talking about that, about this part in the last lecture, so I will just explain here that what happened was because if you take this consider this as an Andaman Island, there was not a push here. So, this portion of the Andaman that is your west coast got uplifted pushed up and the east coast subsided. So, we were able to see this clearly because of the low lying area where under the water and the tidal water because of earlier.

It was like this so tidal water coming here and going back, but because of the tilt, the tidal water started coming to like, inundating more areas. Whereas this portion, earlier, it was like this was coming, but now the most of the part remain exposed. So we will quickly look at the different landforms from 1 Andaman.

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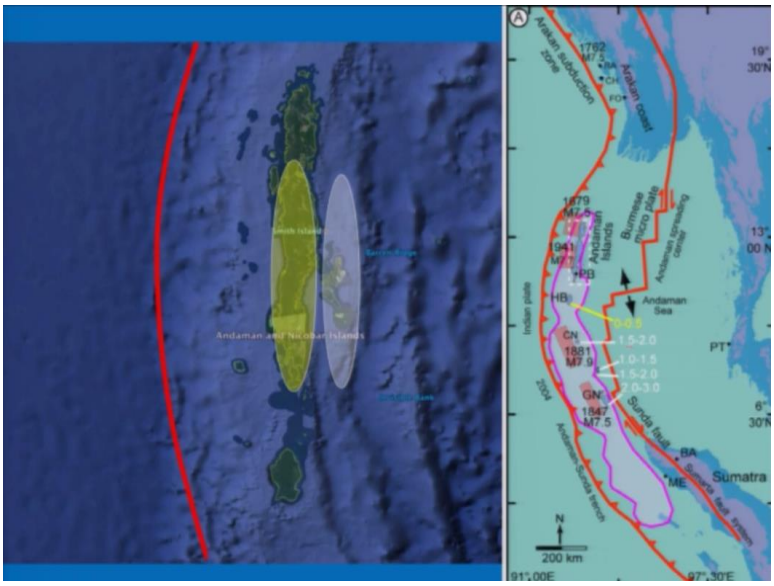

So, this is an Andaman Island and the trench portion is been marked here. So this is the, the subduction zone boundary between the 2 plates. And we will see some examples from this portion here as well as this portion here these are the smaller Islands which are sitting looking far away from the Port Blair, Port Blair is the citizen located over here and this portion also will we will try to see some landforms.

So, this I have already discussed about that we have like the this portion, the area was subsided by almost 3 meters, but during 2004 earthquake and further these are all areas which subsided by ranging from 1 meter 2 almost 3 meters here, whereas this portion got uplifted that is the eastern that the west coast got uplifted and the east coast subsided.

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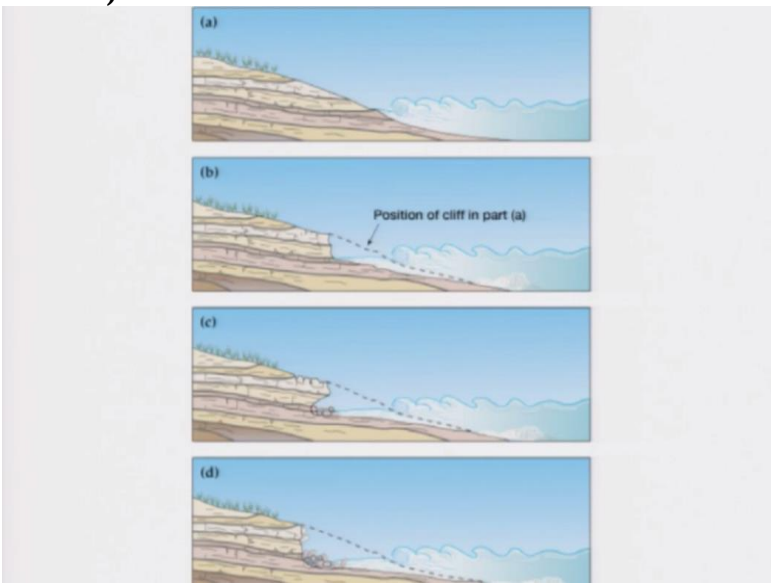

Now, as we were talking about the sea notches, the best sea notches which we came across were from kurmadera along the west coast of Andaman and this portion here. So, what again the sea notches are the erosional features, which are formed because of the tidal wave action. So, this sketch it shows that the waves coming in so, if you are having the rocky coastlines, then you will be looking at the sea notches if not then you will not be able to see the sea notches.

So, what we see here is that there is an erosion because of the wave action here and slowly it develops and very curved like C shape features along the coastline because of the high tide and

the low tide area. So, this is what we say that this portion is your the average or the mean tidal level and this portion is your low tide and this portion is getting eroded because of the high tide.

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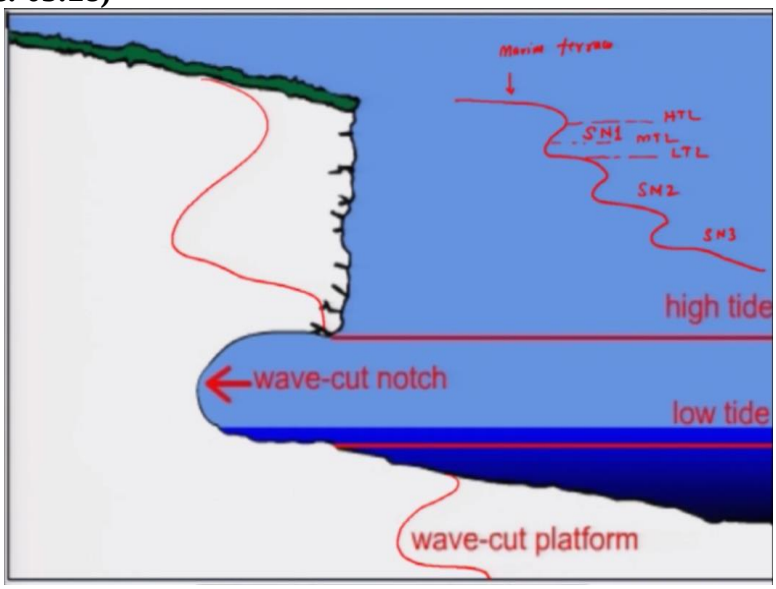

So, if you take the sea cliff and in wave action here so, you have the low tide so, this will be the bottom part of the sea notch and this will be the top part of the sea notch. Now, suppose the there is an change and the water level if the water level goes down then you will have the formation of sea notch somewhere over here like that. But if the water level goes up, then you will have the formation of sea notch somewhere work like that.

So, you will have the different level of sea notches in the area and if suppose the sea level has gone up then you will see the sea notch developing somewhere on the top of this so, in some locations what we find is that you have the multiple sea notches developed along the coast. So, such areas are important for us to identify if we come across and the coastal region. So, if you are for example, if we have here then this is the elevated surface or we can say marine terrace and this is sea notch 1 and this is sea notch 2 and this is sea notch 3.

So, this means that if we look at this one, then you have the this is the mean tide level whereas, this is the high tide level here. So, from here if we look at we will have the high tide level here, then you will have a low tide level here and this will be your mean tidal level and similarly, you can extend this further now, this 3 notches if suppose we are looking at this are indicative of that in the past the sea level was up to this portion. So, the water reached up to this portion which was

capable in developing this sea notch and further we see that the sea level has gone down either the sea level has gone down or the area has been uplifted.

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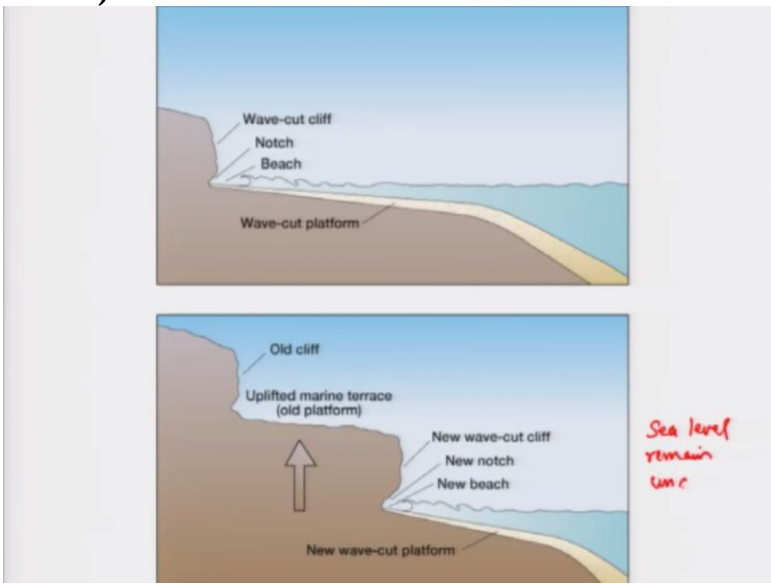

So, in most of the regions, scientists try to look at the sea notch, of course, they are erosional features, but they try to look at the sea notches and try to understand the past sea level changes, either it is because of the climate or because of the tectonic activities in that particular region and in the Andaman and Nicobar area, because we are close to the subduction zone. And one of the best examples, the lesson which we learned was from the 2004 earthquake; we understand that this area must have gone under the influence of tectonic activity in past also.

So, this is 2 diagrams, it shows that you have the formation of sea notch. And then if the area is uplifted, then this remains as an older sea cliff and see notch here. And then you have the formation of the new sea notch because of the lower portion of the area getting exposed to the ocean. So, in this case the sea level remain unchanged because the only the area got up. So, the area was uplifted. So, for example, if I as I was telling that you have the contact between the ocean water here.

And the cliff marine cliff or the coastal cliff, then you are having the erosion which is going on will be somewhere here but suppose you uplift this. Then the erosion will here and this portion will be seen sitting above the not the present day sea level.

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So this as the satellite Google the image of Neil Island which is one of the beautiful Island in Andaman Island chain, which is located east of Port Blair from the Andaman mainland. And what we found here is that we were very able to see multiple terraces developed here as well as sea notches.

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So let us see quickly what it shows. So we have again in this area, we found the sea notches, so you can see 1 sea notch here as we can see here also and then another one is here and third one is sitting over here. So 3 see notches we were able to fix and then one more is the younger one which is developing here. So in total, we have the prominent ones are this one this and then the smaller one is coming up in this portion.

So, close up of that, if you see you have clear cut see notch here another smaller one is coming here erosion is going on and the one is sitting here and further on the top and then we also found the wave cut platforms over here. So, this is the older 1 and then present 1 platform is sitting here.

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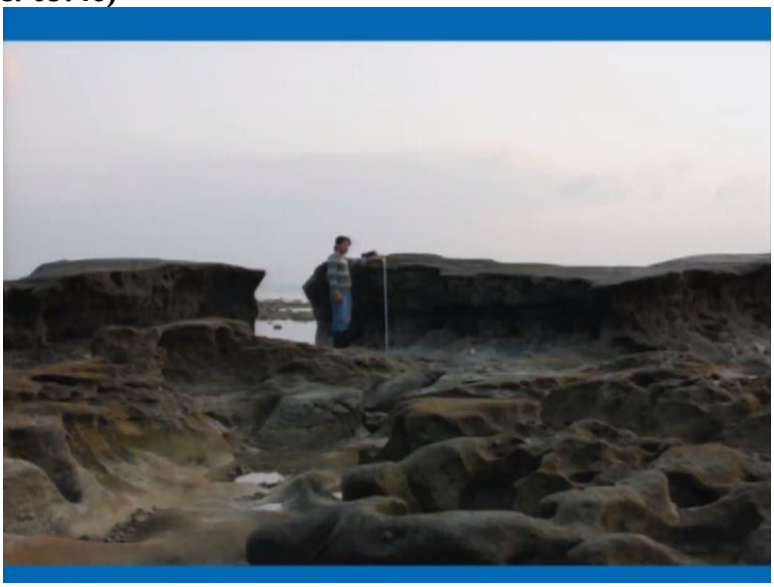

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Multiple sea notches from so, this area is from the east coast now coming to the west coast of Andaman again we were able to pick up multiple sea notches. So, this is the platform here and the sea notch has been formed over here. So we found multiple platforms here, which I will show so there is an there is a typical of mushroom shape sea notch and this definitely could be or could be related to the uplift in this region.

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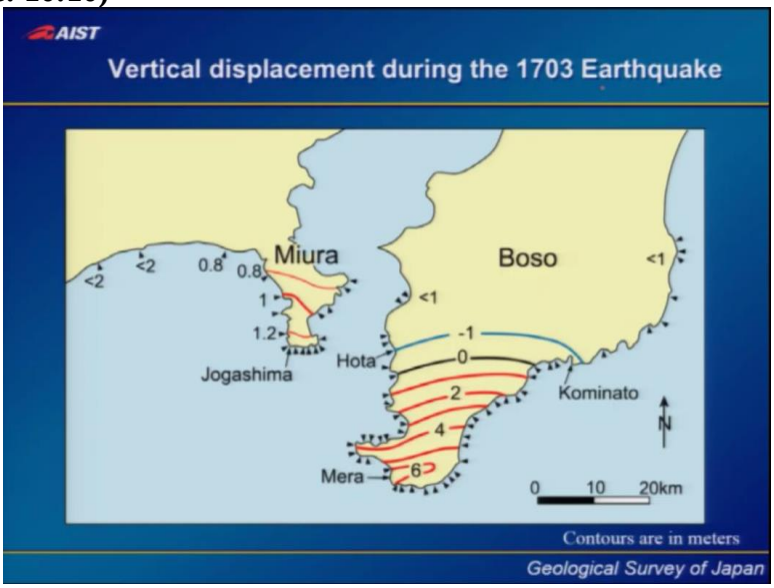

So, if we consider that the this was the erosional level of the previous sea level of where the ocean used to be, but now the ocean level is here because of the uplift this portion is subjected to the erosion. One of the best example we came across from Japan where vertical displacement during 1703 and later earthquake was been identified based on the land level change.

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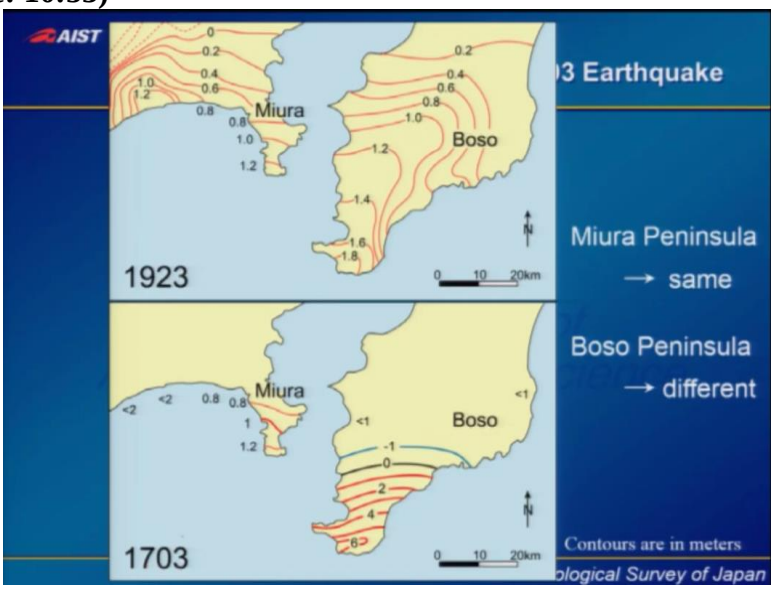

So, this is from the Miura and Boso Island where Boso Peninsula, the Miura and Boso Peninsula they have been affected. And they indicated a clear example where 2 earthquakes took place and they left their signature along the coastline that is one in 1703 and another was in 1923.

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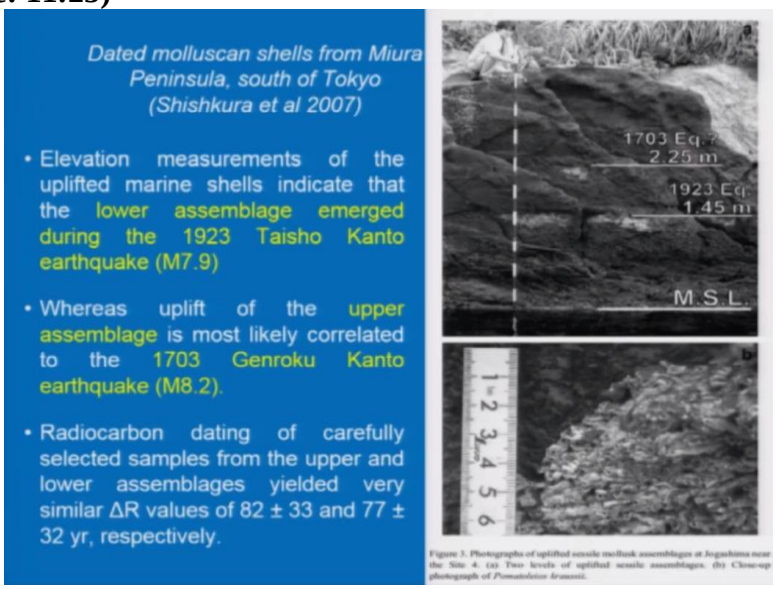

So, in short what the scientific groups have done is they have also tried to date the, because when there is not the tidal levels coming up to this portion, then there was there will be and the areas with the organisms will be the survival lines for the organism but once it is expected forced the they will die. So that what they picked up and the dated, so the elevation measurements of the

uplifted marine shells indicated that the lower assemblage emerged during 1923. So, this one it emerged during 1923.

And this was older and whereas the uplift of the upper assemblage is most likely correlated to 19 and 1703 earthquake in Kanto region. So, this what they have used as a marker to understand the land level change because the sea level will remain almost same during this period but the area has gone up and this is clearly indicated by the dead shells, the marine organisms along this line, so they dated this and that helped them to conclude or infer that this a 2 signatures of the dead marine shells are correlated with the uplift during 1923 and 1703.

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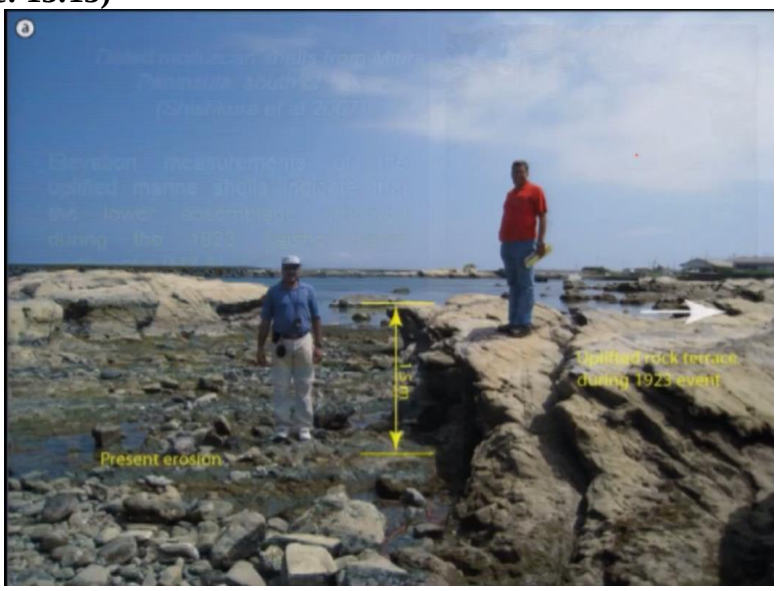

So, this is the example here. So, this portion is the present day erosion level here and this is the uplifted. So, this is an older erosion platform. So, area has been moved up or uplifted by almost 1.5 meters and this was during 1923 earthquake. So, earlier erosion, so, older erosion of platform now, the present erosion is going on over here.

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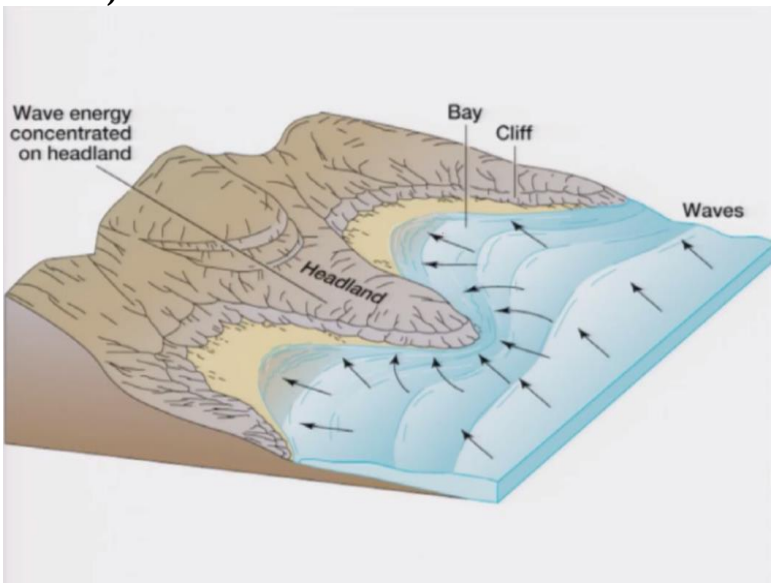

There is a close up of that. So, this is an indicative of this an older 1. So, this was the surface which was subjected to erosion until 1923 AD and after that this is the area which is see here. So, are we talking about the wave energy concentrate concentrated on headlands? So, you will have the erosion because of that. And if you are having the conflagration of the shoreline slightly curve and the waves are approaching in the different direction or angle as compared to this one you will have the position in the Bay area.

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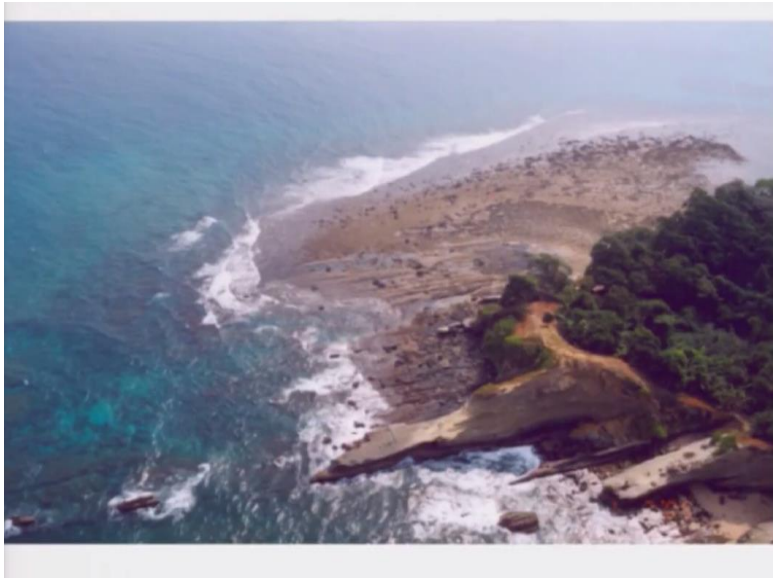

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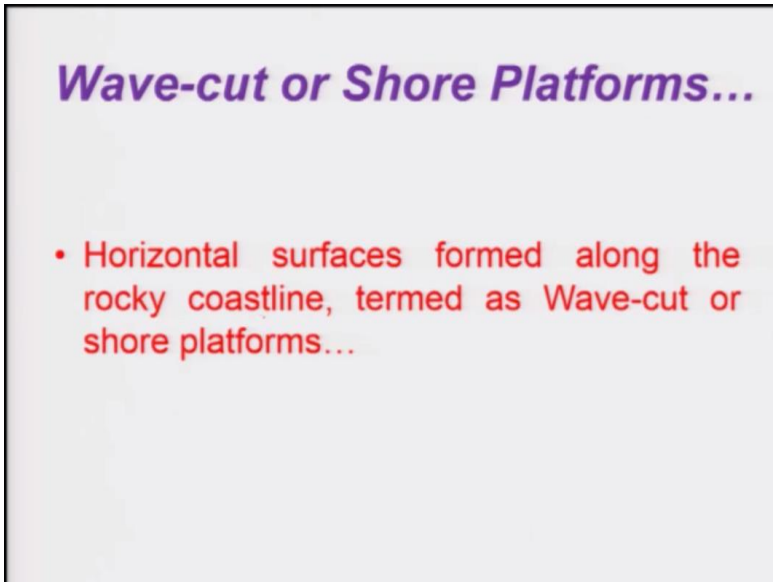

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So, wave cut or shore platforms, they are basically the horizontal surfaces formed along the rocky coastline termed as wave cut shore or shore platforms. And if you see there is an example again from the Neil Island, so, very flat area is exposed to erosion which is in this is the indicative of the present day shore platform of wave cut platform.

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So, again from Andaman what we identified along with the cliffs or the sea notches, we were able to pick the platforms, the older platform erosional platforms or shore platforms and along with that the respective sea notches as well as the present day erosional platform so, shore platforms. So, if you look at this one, this is the wave cut platform 1 this is the present 1. So, this you are having a WC2, so, this is the second 1, so the sea level was up to this, which was eroding this platform, but now it is here.

So, the area has been uplifted and the sea notches which we see is almost like the top 1 here, this 1 and the 1 is this here, third 1 is this and the fourth 1 is this 1, which is related to So, if I just put here and you have this 1 here, which goes like that. So, you have the erosion going on here, then you are having another 1 and then small 1 is sitting here. So, this could be an and related to some in the small fluctuations during that time, but this is the major 1 and then you have this 1 here and third 1 is sitting here.

So if we find some signatures or the dominance of the marine dead cells here, we will be able to take this sea notches and talk about the history of tectonic uplift or at least we can say the land level change or sea level change in this area.

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So, this is again the wave cut platform here along with that we see the beach and this photograph was taken aerial photograph after 2004 Sumatra and Andaman earthquake. So, what used to reach up to this because the wave will result into the formation of beach here? So, the water used to go and come back here that is your linear flow pattern will result into the formation of beach but now what is happening is this whole portion is been exposed to the erosion.

And this is farming your wave cut platform or you can say shore platform and this was because of the uplift in this region and this photograph is from I was taken along the west coast Andaman and Nicobar Island.

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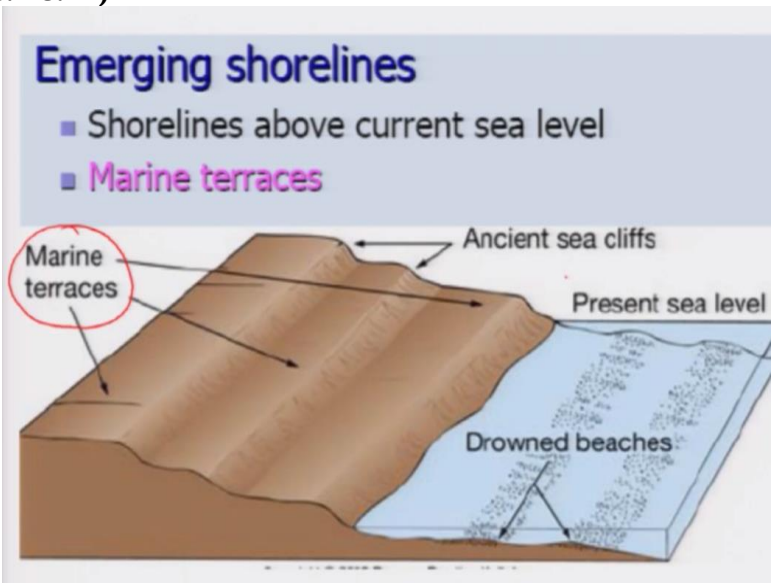

And another important feature, which we see, as we were talking about the fluvial terraces we come across usually the marine tourists and again the marine terraces are the abundant platforms of indicate during the different sea level. So, present sea level, you have this erosive cliff, and this flat area is your marine terrace. So here what we see as at least 3 marine terraces and further if they are drowned beaches that also one should take into consideration when we are talking about the tectonic uplift or subsistence or sea level change.

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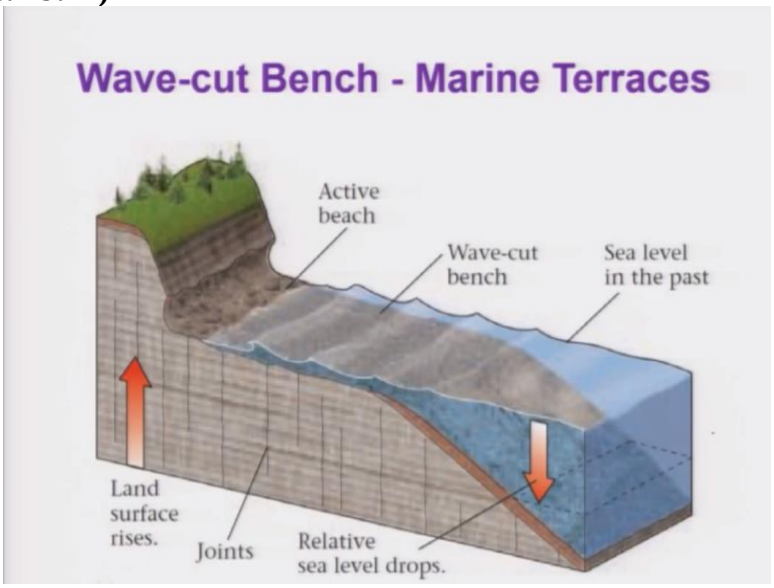

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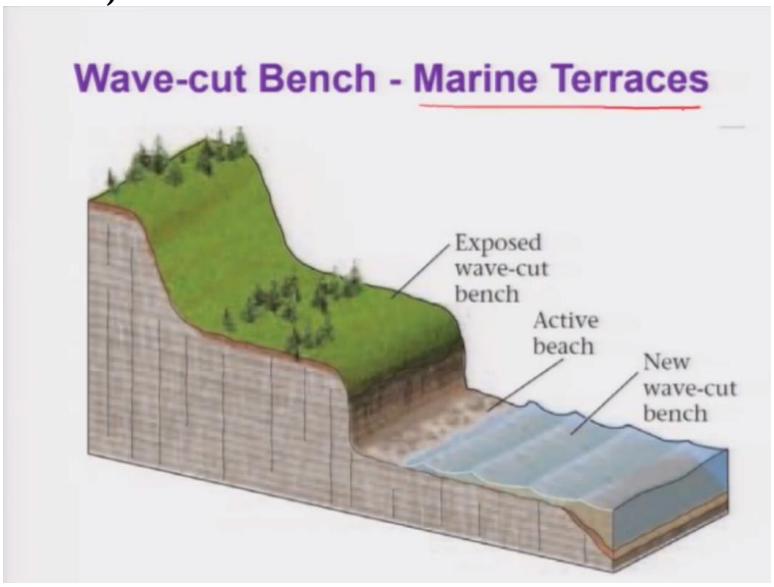

This in same example which shores the process resulting to the formation of cliff sea cliff and the sea notches so, if the water recedes because of the uplift or because of the sea level change.

Then you will come across not this area will exposed and resulting to the formation of a bench like feature which we talk we say marine terraces.

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So, this photograph, if we look at then what we see as on we have 1 surface here and other surface here and then third is drowned here. So, we see the drowned marine terrace in this region this photograph was taken from Kamorta Island in the from south of Port Blair. Now looking at marine terraces this what it looks like. So, you have the flat surface and the cliff here. So, you can you make come across multiple marine terraces.

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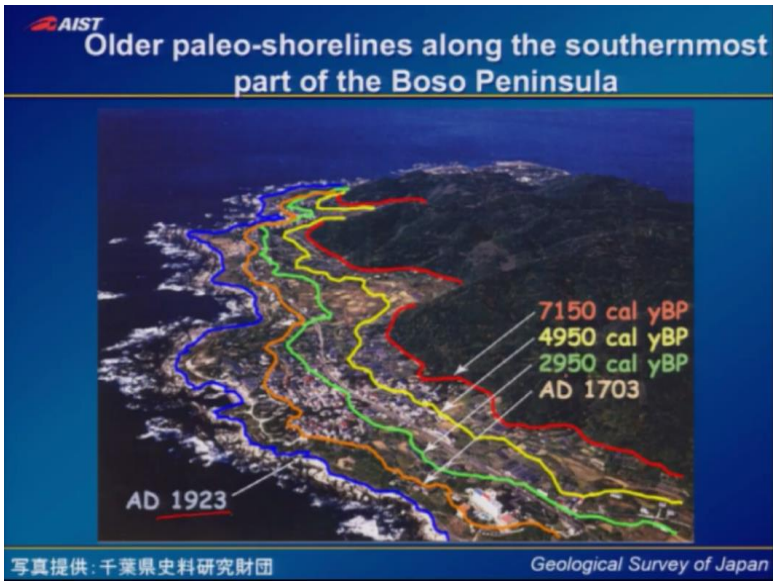

So, multiple marine terraces in example, from Boso Peninsula. So what did they did when they, they looked at the, the area here, they were able to pick multiple terraces in this region. And these are the boundaries of and those terraces were been correlated again, as we were looking in one of the slide the sea notches. So we have been having the notch or the wave cut platform here like that. So this was a 1.5 meters and what the uplifted during 1923 earthquake.

So, another 1, the older terrace at the higher level was correlated with 1703 earthquake and then the lower terrace was correlated due to uplift during 1923 in Boso Peninsula, Japan. Similarly, further, more terraces we have been picked up and they have been correlated with different events. So they have dated those surfaces and they have correlated this with different events. So, one, what we see here is these are the 2 1 year there is the youngest 1 close to the ocean 1923 is now 1703 and then further older 1, they have correlated with 2950 before present that is even which has been recorded at that time, then 4907 1000 years or so.

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So this is again an example of the wave cut platform, which one can see from the 1703 earthquake, this was the old 1, and then this was the uplift at that time. Another one we see this present 1 and this platform was existed until 1923. So, after that because of the uplift of the area, there is the present. Wave cut platform or the bench which one can see in Boso Island.

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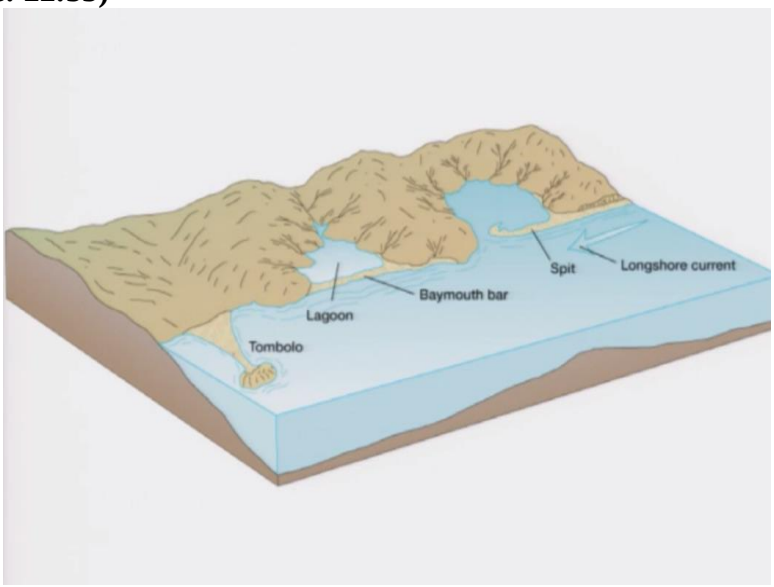

And others common features which you will come across long with the spit, as we have discussed that this will develop because of the long show currents we will have the enclosure of suppose this the spirit extend further this side. So, this will result into the enclosure of the water body and that what we termed this as an lagoon and tombolo is basically and the land form which is connected with the mainland through a very narrow bridge type feature in the area.

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And that is again related to your so, again, let us look at the depositional landforms. So the portion landforms will come across basically being mostly the beaches and tidal flats, coastal dunes, salt marshes, spit and bars and beach ridges, barrier islands, mangroovs and tambolo. So, the previous slide which we were looking at the or the mainland here and then extension of the narrow way this is again because of the positional feature.

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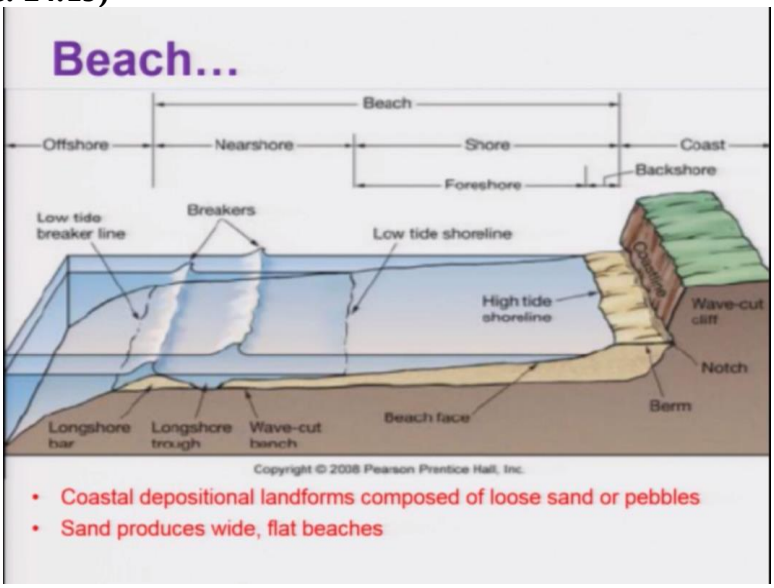

So, coastal the positional landforms composed of loose sand and pebbles, sand producers wide flat beaches. So, close to the coast, you will have if there is not the deposition area and so, they

will be here to before the tides to come and deposit then you will find most of the areas you will find the beach formations.

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Then one of the best beaches from Andaman so you have the sea cliff here as well as in various semicircular features here in the Bay area and the formation of beach an example of beach from Andaman.

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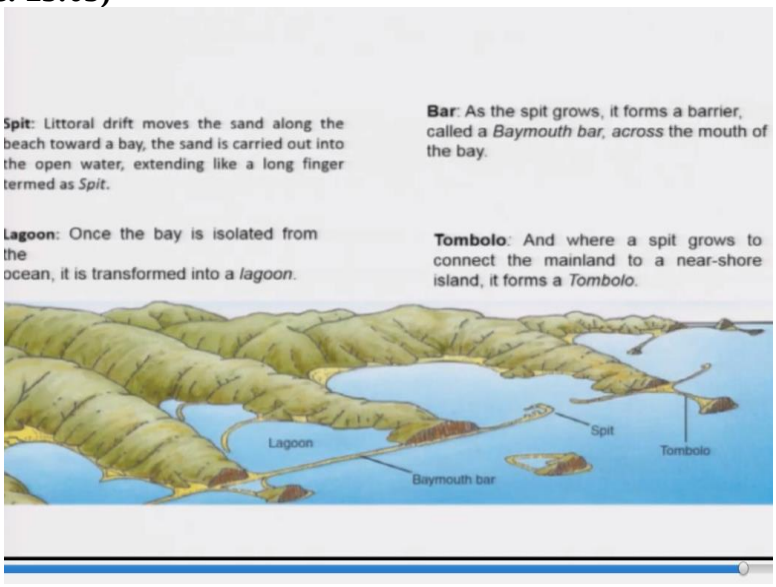

So, this will not go into details you can just go through it. This is what we were talking about the lagoons and the spit and tombolos. This is an example of spit and spit as resulted into formation of an lagoon here enclosure of this, the extension of spit. And tambolo is connected through the

deposition featured here with the mainland. Spit and beaches also will result into the formation of lagoon or the back wash or the brackish water.

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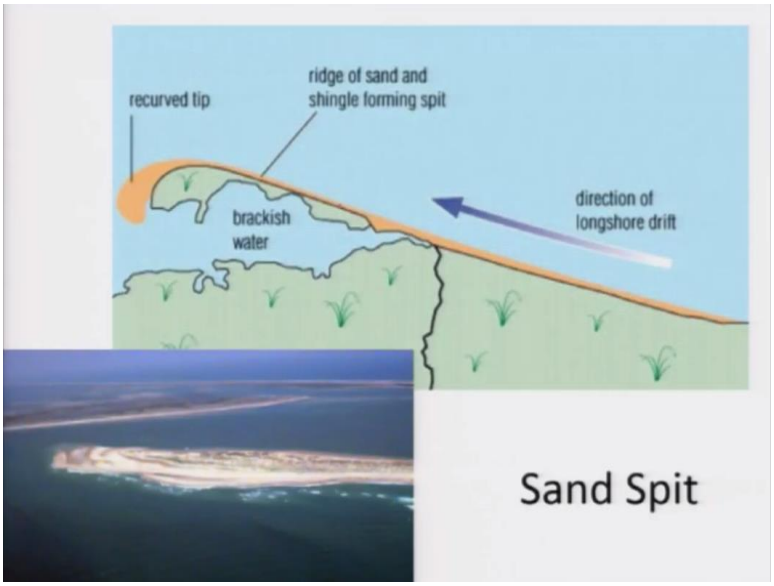

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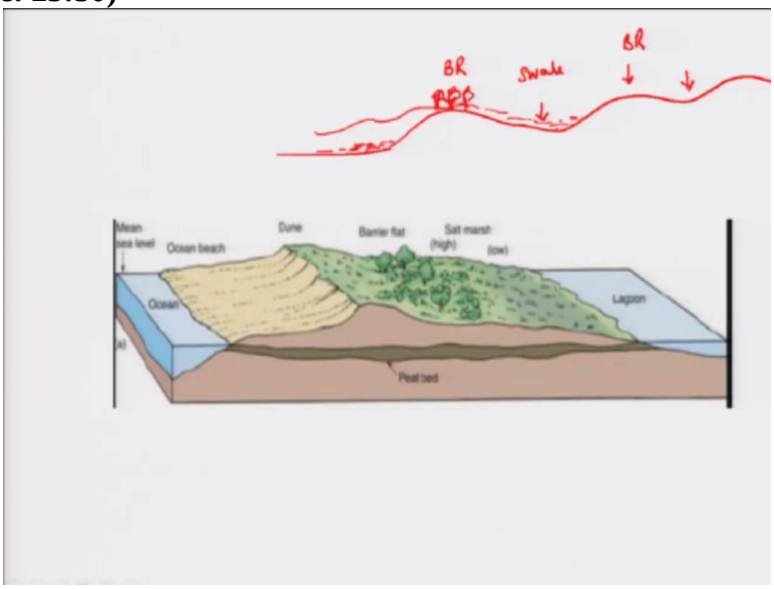

Now, another important part which we will be coming across when we are talking about the tsunami deposits getting preserved for us it is very important to identify the environment whether it is in lagoon environment or the lagoon environment change to the beach environment or we have the back marsh. So usually what we find is that if this is the ocean area and then you are having slightly like this topography and you may come across just try it again you may come across like you have so you have a beach which may come across another beaches.

So you have the deposition of the beach here and this is your beach ridge and this is your swale and this is again the beach ridge this will area now mostly what happens that when the tsunami

comes and it will erode. So, this is suppose this is a vegetated area. So, this will erode and deposit the material in the swell region. So, most of the time what we do is we try to locate such geomorphology in the coastal region and try to hunt for the tsunamis.

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There is a photograph of the development of the lagoon in Car Nicobar area from Andaman. So, lagoons are enclosed and protected by barrier beach so if you go across this then you are having wonderful beach and do so this portion what you see in the light, the brighter light is the ocean side. And then we walk down to if you walk down through the city then you have the beach which here and then behind this you have the lagoon.

So if I put the topographic profile from this side then you will have something like flat and then coming up and then getting into this 1. So with this I will stop here and we will discuss few more features and the landforms in the next lecture. Thank you so much.