**Natural Hazards**
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**Lecture – 13**
**Plate tectonics and related hazards Part III**

So, welcome back.

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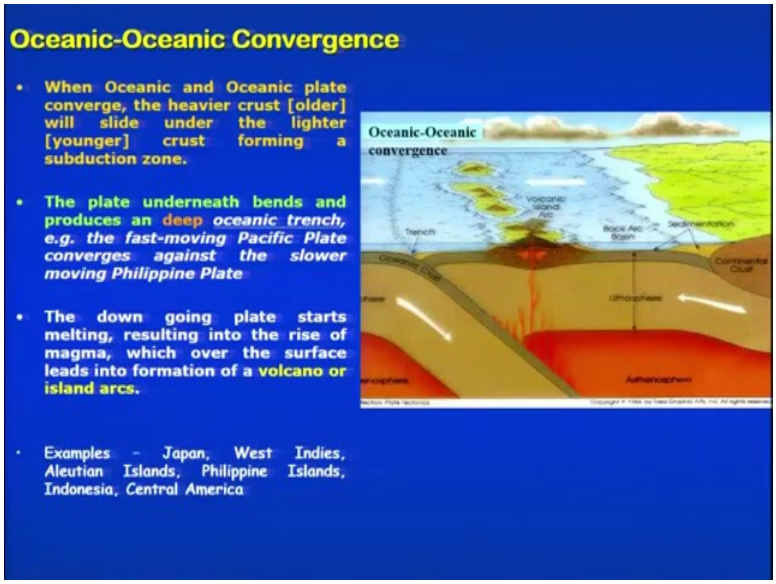


Now, oceanic-oceanic convergence as I told that the heavier crust heavier oceanic crust is the older one we will slide under the lighter one to form the subduction zone. The plate underneath bends and produces deep oceanic trench which has been shown here and which I was explaining in my previous sketches, that this is the portion which you will find and the deeper part and these are the termed as the trenches.

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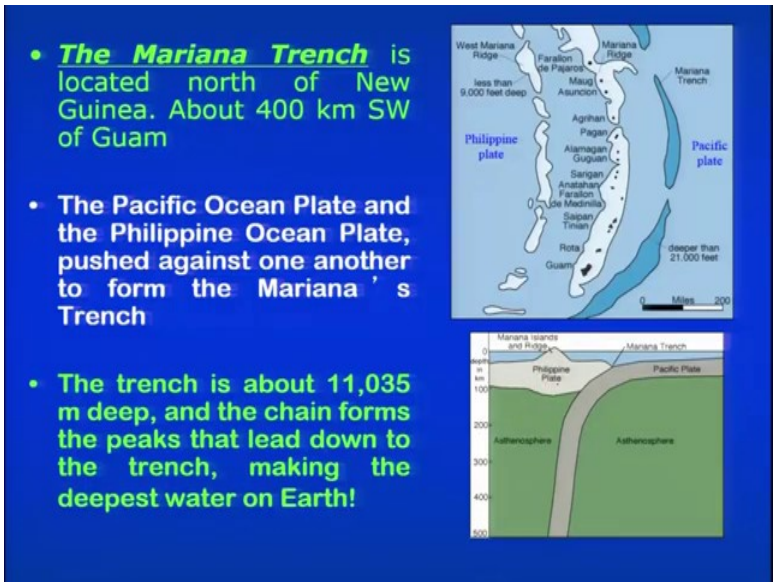


Further another good example that because of this phenomenon or the process we have the deepest part or deepest portion on this globe which is the Mariana trench.

So, the Mariana trench this is of almost about 11035 kilometers deep. It is 11035 meters deep and this exists between the Philippine plate and the Pacific plate.

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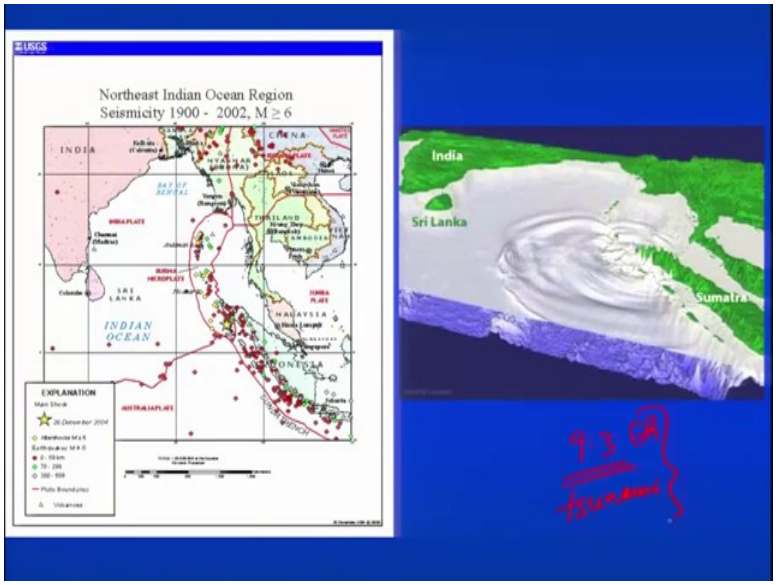


Now, hazard related to this coming to the Indian part we have the trench area or we also name this as an Sunda Andaman trench or Sumatra Andaman trench all we call this as a

Sumatra Andaman subduction zone and we experienced 9.3 magnitude and tsunami. So, this is an earthquake and tsunami in 2004.

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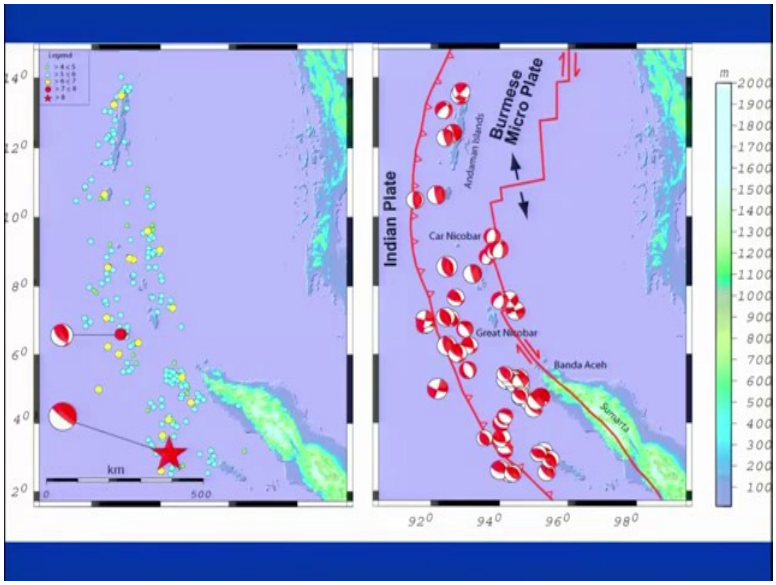


So, when we plotted the earthquakes which we collected from the data bank it shows very clear alignment along the trench. So, this is my Andaman island over here and this is a Sumatra and the earthquake of 2000, there is a 2004 and another and the same day after a few minutes another earthquake was been triggered was here close to Car Nicobar Great Nicobar. This is in Great Nicobar here this small island is the Car Nicobar and then you go further this is on Andaman Islands.

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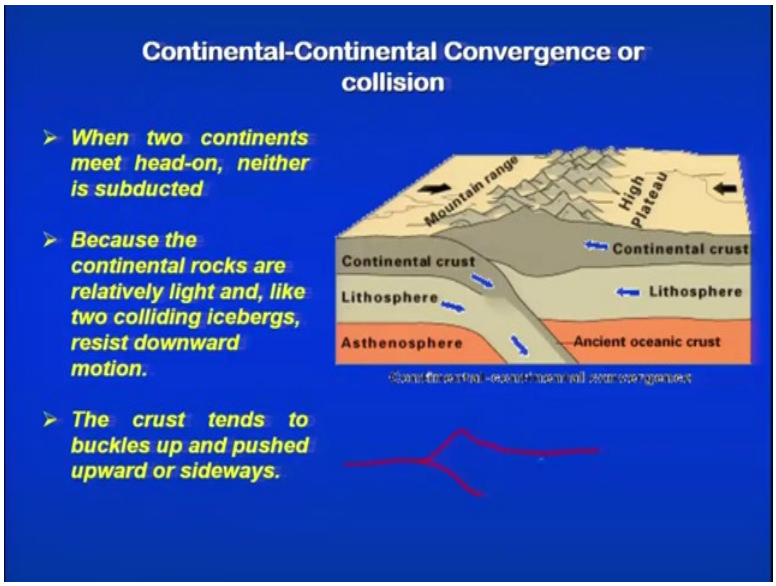


So, continental-continental subduction: as we were talking about that we initially had this configuration that one plate subducted below another one and this was because we had an oceanic plate in front of the or the continental Indian subcontinent. So, continental crust now collided finally, with the I will the Tibetan plate the Eurasian plate and what we see is the rising up of the Himalayas.

So, when two continental continents meet head-on, neither subduct. Because the continental rocks are relatively light and like two colliding iceberg resist downward motion and finally, what we see is that curse crusts tends to buckle ups and this is what we see that two plates are colliding and we are able to see the rising up of the 'The Himalayas'.

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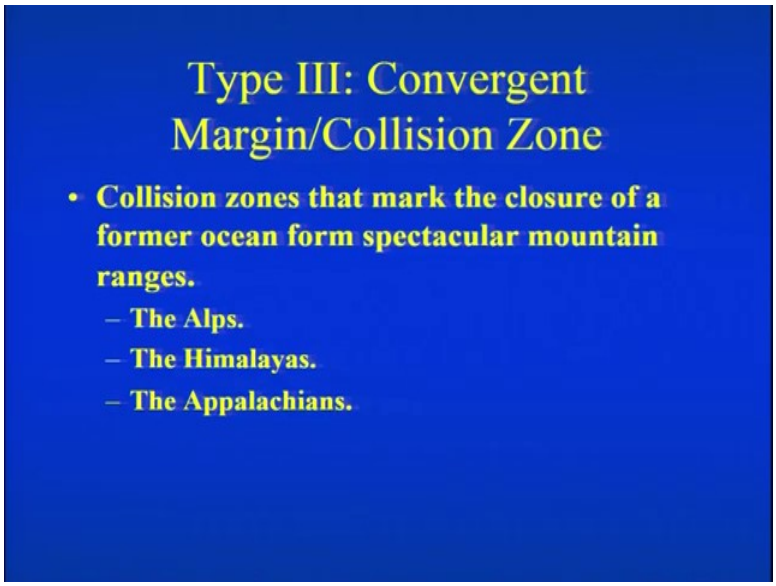


Convergent margin or collision zone if we take that marks the closure of the former ocean. So, we also say that in front of the Indian continental plate we had the oceanic plate where Tethys sea existed before.

So, we have Alps, we have Appalachians, we have Himalayas which are the example of your convergent margin and collision zone.

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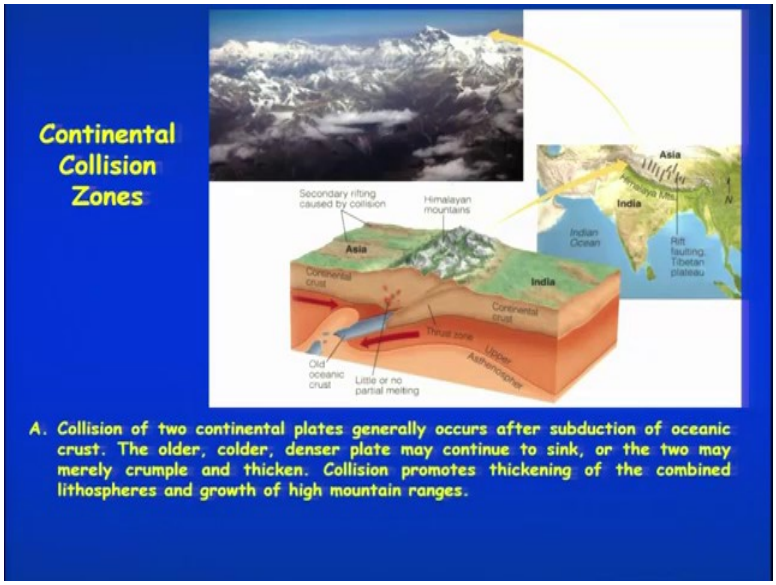


So, continental collision: so, we do not see now the oceanic plate this was older and not much is happening in terms of the subduction of course, because this plate was dragged

below we have some portion which slips beneath and the overriding plate and resulting into the formation of the Himalayas.

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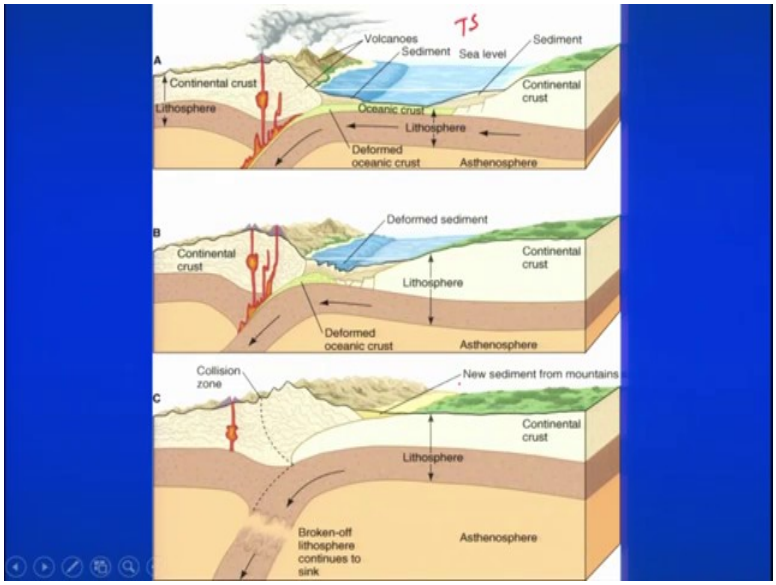


So, this explains this diagram explains that what we have been talking about that initially we had the continental plate and in front of the continental plate we had the oceanic plate which was occupied or covered by Tethys sea and slowly as this movement progressed subduction was there and we had volcanic eruptions also, but slowly if this resulted the closure of the that the Tethys sea and finally, what we see. So, was less this phenomenon died out because there was no oceanic plate or the source for the magma to come up and finally, there was total collision which resulted into the formation of the Himalayas.

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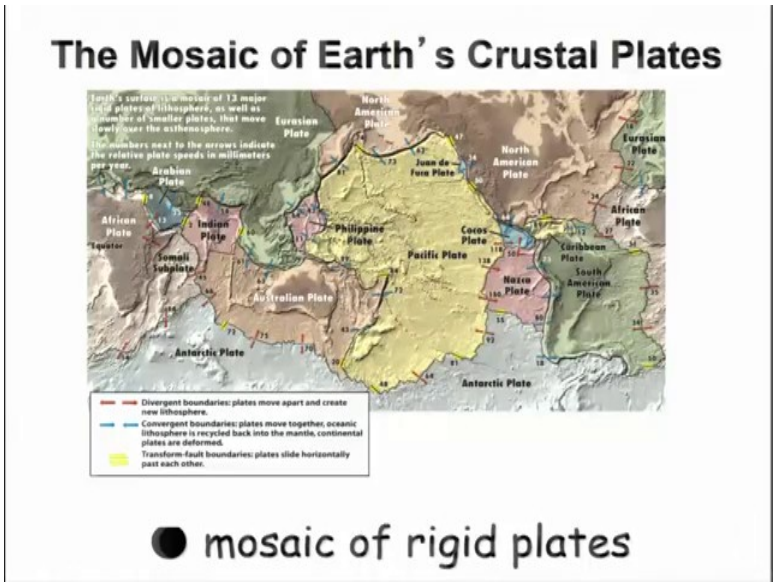


If you look at in total the configuration of the tectonic plates which we have discussed quickly and then we have the different plate boundaries I have talked in detail about this.

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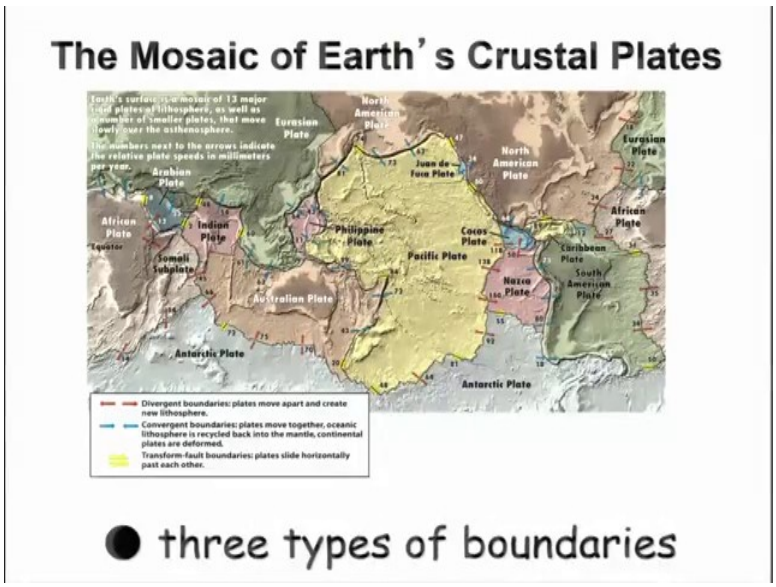


So, the rigid plates what we have there are three types of boundaries.

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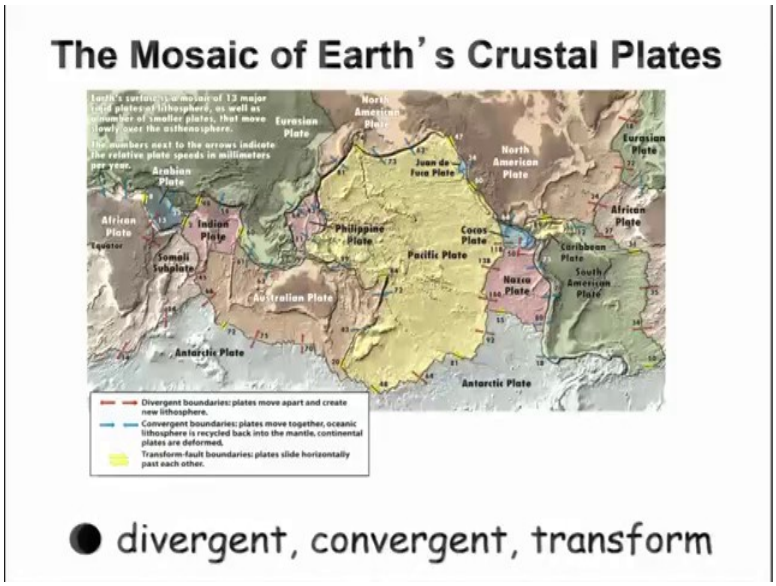


So, one is your divergent, convergent and transform.

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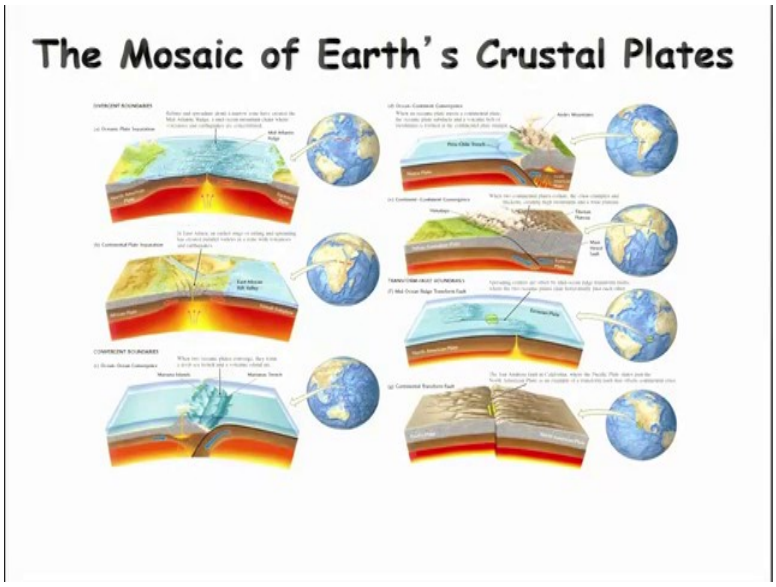


So, if we look at in detail few of them one by one quickly and then, you will be able to understand better.

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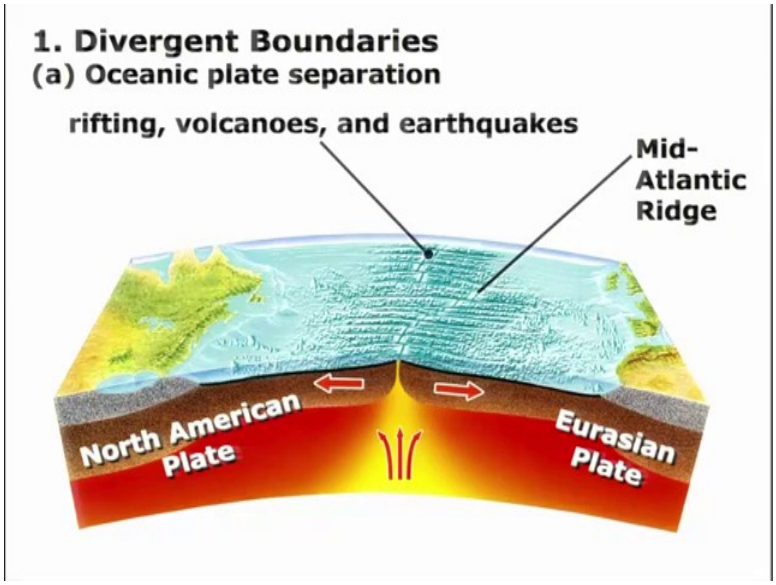


So, we have divergent plate boundary which here has been shown there is an oceanic plate separation where I told on that day that we keep on having the new crust added along the spreading centers and the area which has been seen on the globe is your Mid-Atlantic ridge which covers a very large part.

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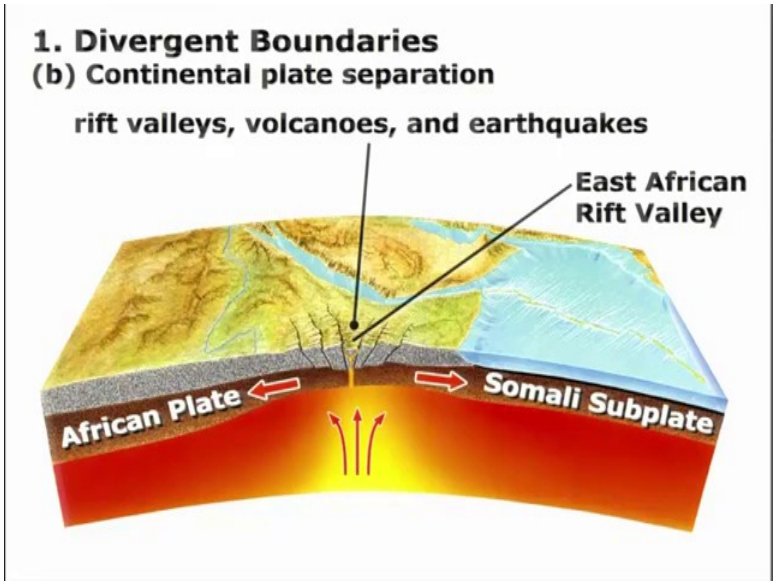


And, then we have the rift valleys and the best example of this is in East Africa and I was talking about that there is a recent opening which has been experienced in this region in the eastern part of Africa.

So, we have rift valleys, volcanoes and the earthquakes. So, earthquakes in the previous slide also you will experience earthquakes, but these earthquakes along the divergent plate boundary or the or the boundaries which are just passing through will not be so deadly in terms of the magnitude and all that.

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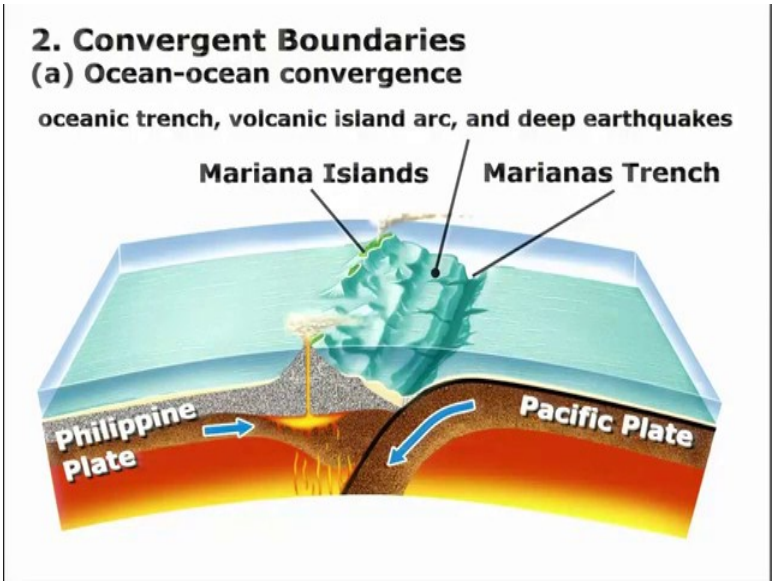


And, then we have trenches where we have convergent plate boundaries between oceanic-oceanic and the addition what we will see and other than the trenches we will have the volcanic eruptions because we have one plate which is moving down subducting below another one.

So, we have oceanic trenches, volcanic islands and deeper earthquakes. Over in the first two slides you may experience shallow earthquakes.

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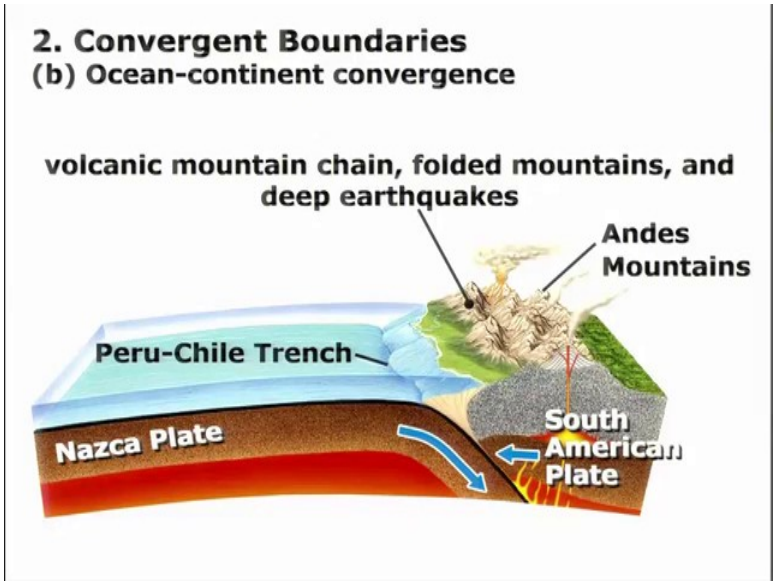


Convergent boundaries again between the oceanic and continental plates. Again, you have volcanic mountains because again this we are having the plate which is going down, hence we have a source of material which is getting into the asthenosphere and we have volcanic eruptions on the surface.

But, here the difference is only that we are having oceanic and continental. So, oceanic plate is subducting below the continental. We will also see the trenches here as we were talking about in the previous slide where we are having oceanic ocean convergence. Here also we have we will get the mountain volcanic mountain chains, folded mountains, and deep earthquake as well as shallow earthquakes.

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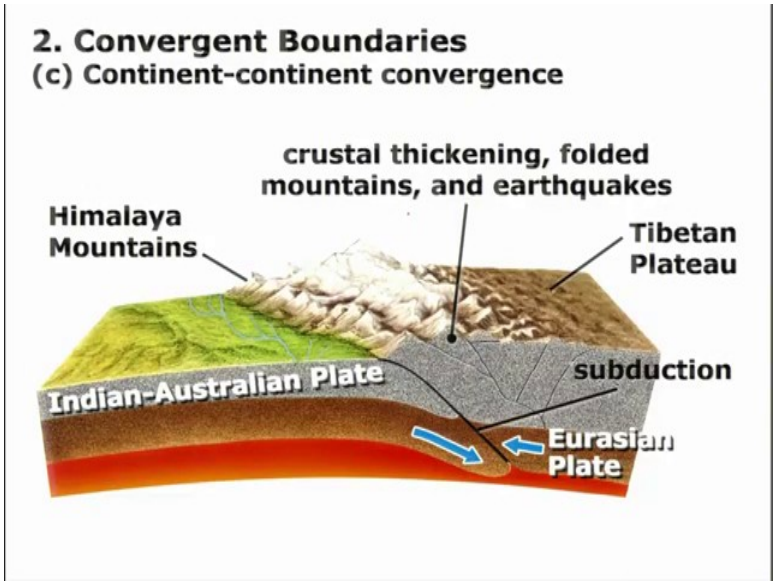


Then another one is continental-continental convergence. So, the one of the best example is your Himalaya which we have discussed in detail. So, right now what we see in the northern part of the India we see and traveling height or the mighty Himalayas which is the result of the convergence boundary continental-continental convergence.

So, here we have a very thick crust, folded mountains and earthquakes and as I told in the previous two, we also experience we shallow, intermediate and deep earthquake whereas, here in this case we will mostly experience shallow earthquakes.

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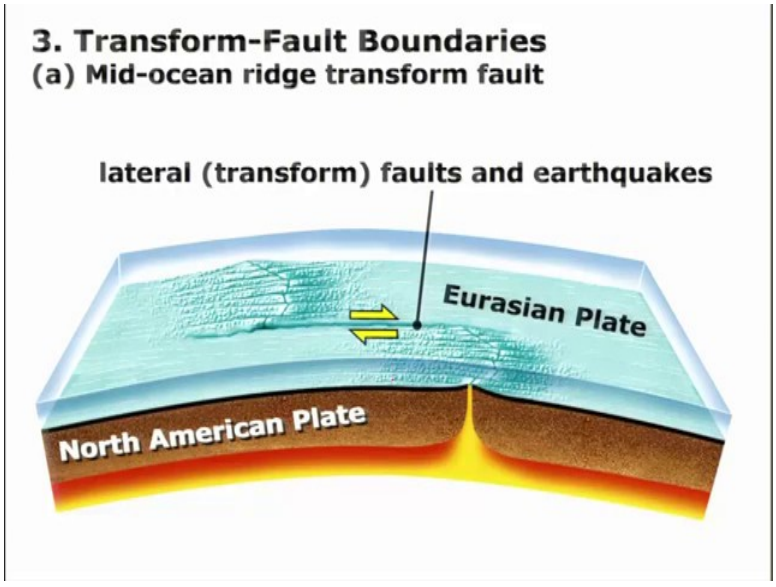

Then, we have transform-fault boundaries, mid-ocean ridge transform. So, just we see a lateral moment along the faults and of course, the earthquakes, but the earthquakes will not be a very large magnitude.

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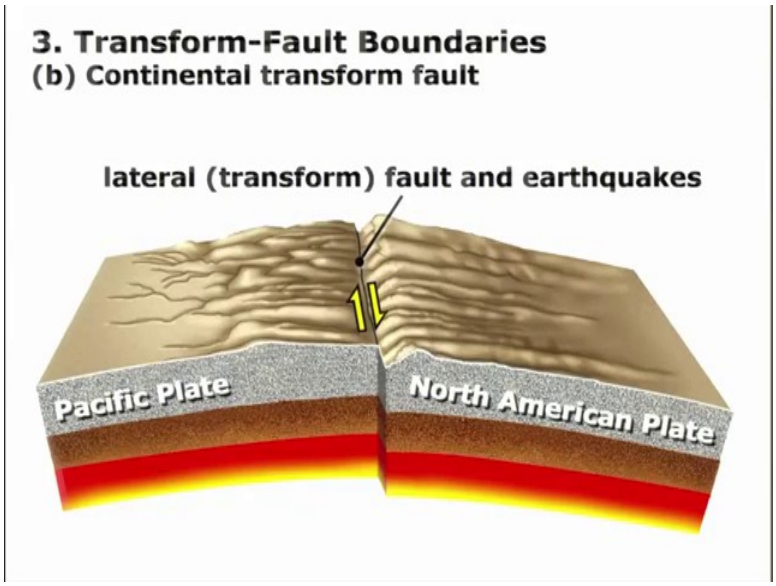


Then we have the similar transform fault boundaries which we see along the continentals and the best example is between the pacific plate and North American plate and one of the major fault boundary or the transform fault which has been which is seen because of the movement between the pacific plate in North American plate is a San Andreas fault system. So, you have lateral our transform fault and of course, we have shallow earthquakes experienced along such boundaries.

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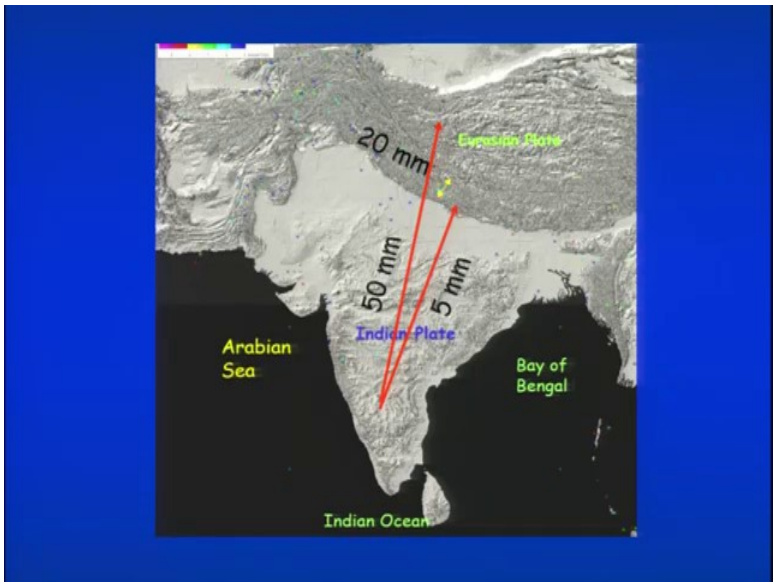


We have the discussion we can have on that what exactly we understand about the hazard based on the GPS measurements here.

Now, if you take this is a plate boundary here between the Indian plate and the Eurasian plate and we all understand that there is like threat from an earthquake in this region. And, recently as I have discussed already that we had in 2015 earthquake in Nepal. But, other than that many research groups have come up with in and hypothesis and probably based on the numerical modeling that whole front which extends for almost 2500 kilometers will rupture in one single go.

Now, what we understand based on the GPS measurements between the two plates is that you have between the point here in Bangalore and with respect to that this is the fixed point here which moves towards the Eurasian plate, the total convergence which has been measured is around 50 millimeter.

However, this 50 millimeter is not same all along the arc here. It varies, but some places it is bit higher some places it is bit a lesser, but out of this 50 if we take almost 5 millimeter like this very little amount of this is a just a 5 millimeter has been consumed by this plate, that is up to Himalayan foothills what we see is that only 5 millimeter is been consumed from 50 millimeter, rest left out is almost 45 millimeter.

Now, from that 45 millimeter per year of convergence; that means, there is an velocity the Indian plate is moving towards north northeast at an within velocity of 50 millimeter per year. Now, out of that around 20 millimeter has been taken up by the Himalayan range. So, when I say Himalayan range then we include the Shivaliks then lesser Himalayas and then higher Himalayas.

So, almost 20 is been taken by this, 5 has been taken by the rest of the Indian plate. So, 25 goes still left out is half of that and then it is believed that rest of the that is the half of the convergence has been taken up by the other faults like Karakoram faults and further faults which are setting in China.

So, in that sense if we take 20 millimeter in this area it is it is quite dangerous because now, this 20 millimeter is building up the strain within the rocks and that we are going to talk in the coming lectures that what is the chances of having earthquake in near future and what are the features which we see on the surface and how we can identify those features preserved on the earth surface.

Whereas to a 5 millimeter which you see here of course, have been responsible for triggering couple of earthquakes which have been experienced in this portion of one is the Latur earthquake then we had and earthquakes couple of earthquakes from Gujarat in one was in 2001, Bhuj earthquake and another one which was comparatively larger in 1819 that was an eleventh earthquake. But, in between this two earthquakes there was another one is 1956, the magnitude was around 6.5.

So, but the question which always remains and bother us that why this portion of the western India has in capability of triggering so many earthquakes. So, that that always is a big question. Whether it has an influence of a district tectonic domain which is in part of the convergence plate boundary a Chaman fault system which exists in Pakistan or it has an influence of the subduction zone which exist here that is in Makran subduction zone.

So, these are a few questions which bothers us that that a small portion which is sitting quite away almost like 400 kilometers away from the plate boundary is having in capability of triggering so many earthquakes in sequence. So, if you take the earthquakes over here we had one in 1668, then we had in 18 19, then with 1956, then 2001.

So, these are few one, but we have been able to pick up more earthquakes which have occurred around thousand years back from present and that is like is there is one basic question which is bothering us that why this portion is capable of triggering so many earthquakes.

So, as I told in one of my lecture that a lot many GPS stations are been installed here and more are in progress which will help us in understanding that which block in this region, is having more strain and which block you will be responsible in triggering a large magnitude earthquake in near future.

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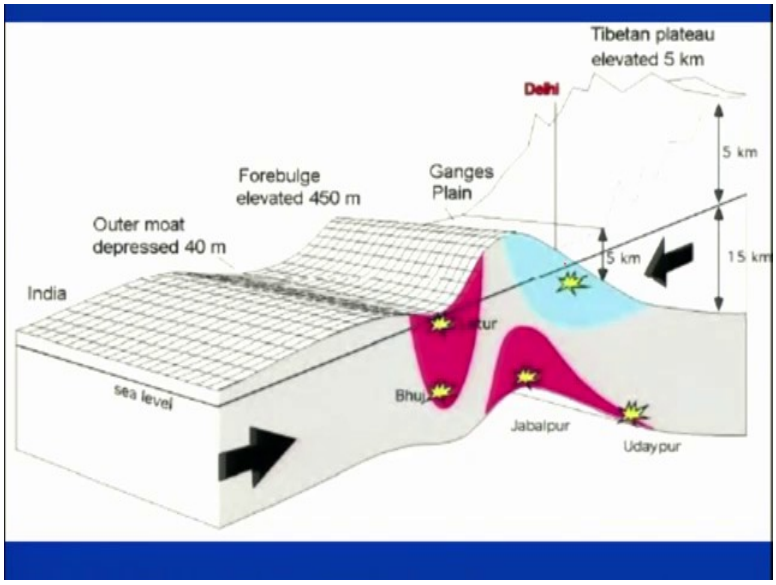


So, if we take a cross section this is given by Bilham which talks about that whole area and that is the whole plate is flexing up it is not just the the Himalaya which is under the strain and is capable of triggering the earthquake, but the whole plate is flexed up and of course, the closer that is close to the plate boundary is having more strain develop or the energy stored which will be released the faster.

So, if you just look at this one here that with the 20 millimeter and 5 millimeter, so, more amount of strain is been getting stored here. So, more number of earthquake and in very short period whereas, 5 millimeter will allow the plate to a cumulate energy over a very long period. So, this is the this is the one of the difference between that we will have earthquakes in this particular region within longer time gap in terms of the recurrence whereas, in this area we will have a shorter recurrence interval.

So, this also explains that the yes, of course, we have like experienced the Bhuj earthquake and there was an Latur earthquake which has been listed here and then we have also had in Jabalpur earthquake and Udaypur earthquake. So, this Jabalpur earthquake was of course, the magnitude was not so large. It was less than greater than 5.5 in less than 6, but Bhuj earthquake was around 7.6 and even Latur was around 6.5 to 6.7.

So, these are the earthquakes which poses lot of questions that why the area which is sitting far away from the plate boundary is triggering so many earthquakes. So, answer somewhere lies here that of course, the whole plate is under strain, but the earthquake frequency in this particular area will be lesser as compared to the in along the plate boundary.

So, I will stop here and then I will continue in the next lecture talking about the active faults and the landforms, how we can identify and why the active faults are so important. Of course, I have covered this part in greater detail, but in this course, we will try to bring some case studies. So, that you can understand in flow about the earthquake process and the landforms which are being generated because of the earthquake and how we identify those features on the surface and how we understand the past history of the earthquake.

Thank you, so much.