Geomorphic Processes: Landforms and Landscapes
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Module No # 03
Lecture No # 13
Interior of the Earth &Plate Tectonics (Part IV)

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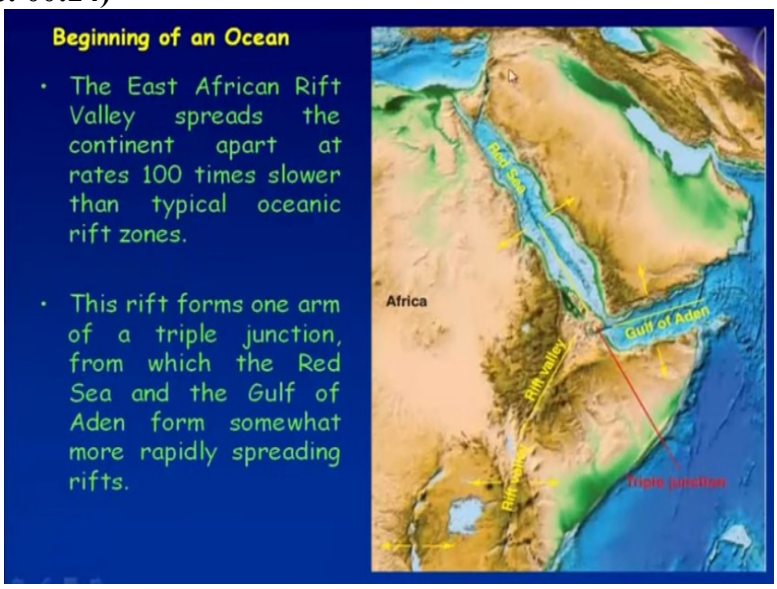

So welcome back so in the previous lecture we discussed about the opening of the rift valley and African continent and the location of the triple junction where 3 plates are moving away from one another and the example which were talking about that this movement at the Arabian plate is moving away from the eastern portion of the African plate is giving raise to the opening of the further opening of the gulf of Aden.

And here the African plate and the Arabian plate which are moving away from one another are giving rise to the opening of (()) (01:01) of the red sea. Now we will also see one example of transform fault which is been shown here at this location which is again the product or which is been produced because of the movement of this plate that is your African plate and movement of the Arabian plate. The Arabian plate is moving in this direction and the African plate is moving in this direction and this movement as given rise to the displacement or the formation of the transform fault or here.

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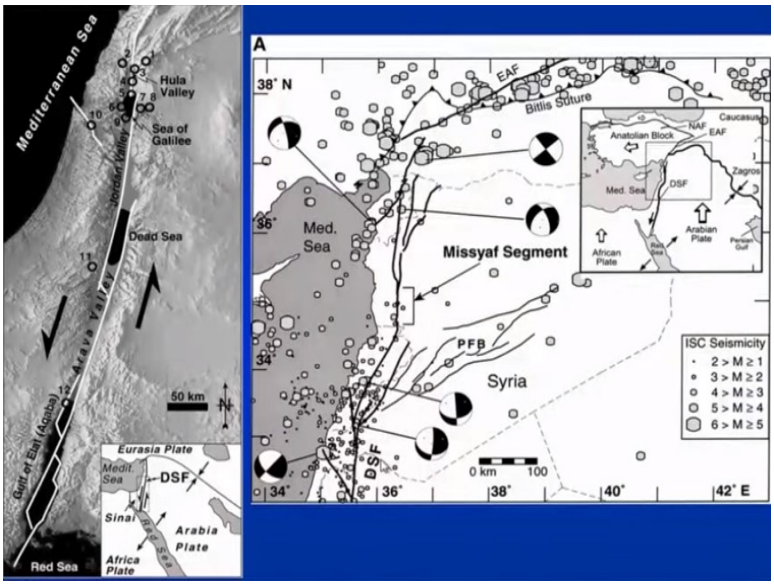

And this fault system is been termed as the dead sea fault system this is well evident by the movement between the Arabian plate which shows here that the Arabian plate is moving this direction and the African plate is moving in this direction resulting into the lateral movement along this margin. And this is well evident by the occurrence of the earth quakes which are aligned along this plate boundary.

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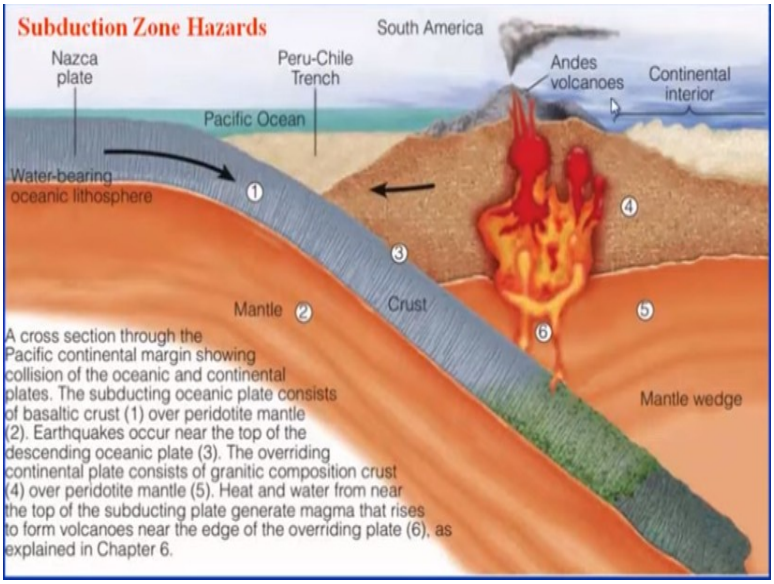

Now coming to this subduction zone as we were talking about so previously we covered the med oceanic centers or the med Atlantic grudge and the triple junction and the splitting up of the island. Now this is the part of the subduction zone where one plate is subducting below the

another one. And this example which is been shown is between the oceanic-oceanic plate and the oceanic plate in the front and with the continental plate over here.

So portion of the continental plate or continental interior and this is the oceanic plate which is subducting below the ocean of the continental plate. So this as given rise to at volcanic eruptions on the surface at the example which is been shown here is between the Nazca plate and south American plate and the mountains which you see aligned along the south American plate or the Andes volcanoes which are all aligned along the plate boundary.

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So along this subduction zone that is the subduction taking place between the Nazca plate and the south American plate the Andes mountain which have been seeing here are marvelous.

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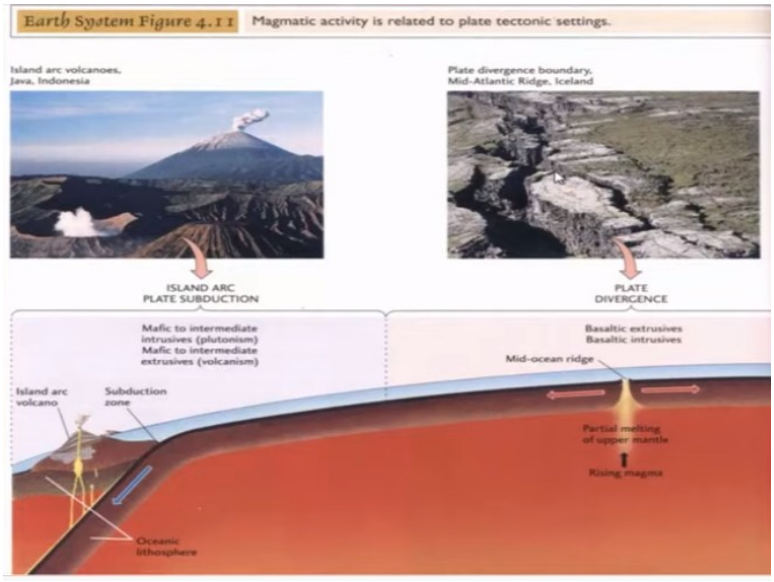

Now one more example of this spreading center which is been seen on the surface is of the example of the divergent plate boundary is in Iceland. So the volcanic distribution of the volcanic eruption or we can be seen or the magma which is coming right up to the surface is can be seen in 2 ways. One is along the volcanoes and second is along the divergent plate boundaries.

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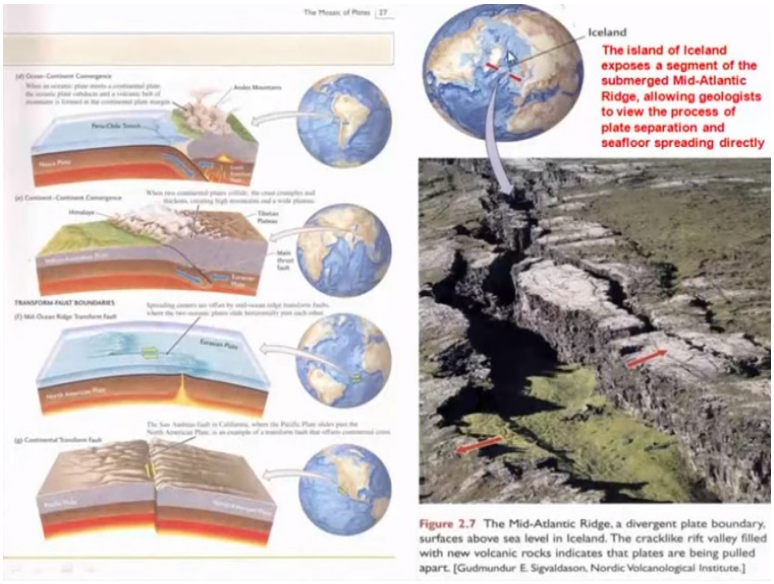

So this is the example the island of Iceland exposes to the segment of submerged Mid Atlantic ridge allowing geologist to view the process of plate separation and seafloor spreading directly very much similar to what we were looking right now and few slides before or in the previous lecture on the opening of the rift in African subcontinent. So this is the example which shows the

signature of the mid oceanic ridge which is seen on the surface on one of the island that is Iceland which shows the example of the 2 plates moving away from one another.

So this is an example of med Atlantic ridge on the surface and the location which is been shown here is through this location so this is the location of the Iceland and the mid-Atlantic ridge which passes through this one.

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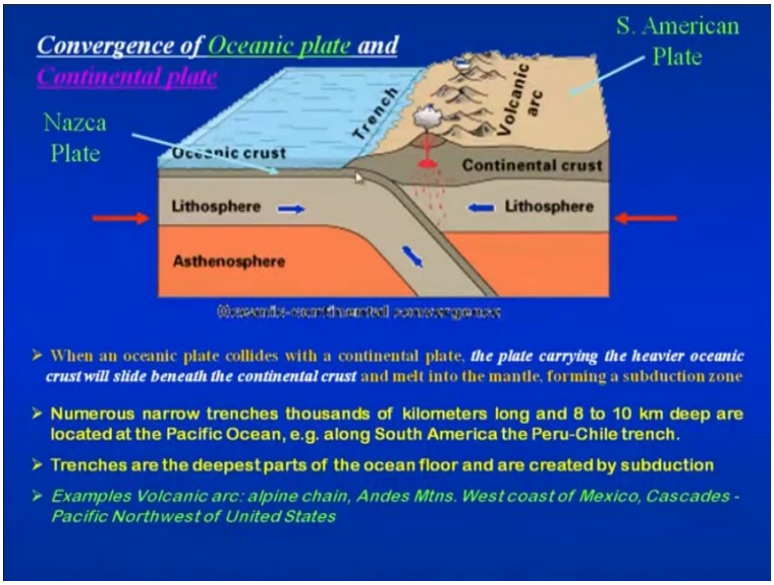

So again the same one the example of oceanic and continental plate Nazca plate and South American plate. Where the oceanic plate is subducting below the continental plate which has given rise to Andes mountain and the volcanic arc on the continental crust and one common feature which we will find in both the situation whether it is oceanic convergence or oceanic continental is the trench. And this portion that is at contact between the 2 plates is termed as trench.

And the best example of trench the deepest part is the Mariana trench so when an oceanic plate collide with the continental plate the plate carrying the heavier oceanic crust will slide beneath the continental crust which is comparatively lighter and melt into mantle forming a subduction zone so this will form a subduction zone and it moves over subduct below it will melt and give rise to an volcanic arc on the surface.

Numerous narrow trenches thousands of kilometer long about 8 to 10 kilometer deep are located at the pacific ocean. Now one of the trench which is comparatively shallower but this also exist between the south American plate at the Peru-Chile trench south American that is it is named as Peru-Chile trench. Trenches are deepest part of the ocean floor and are created by subduction example one is volcanic arc, Alpine chain, Andes mountain, west coast of Mexico, Cascades – pacific northwest in United Stated. So these are the examples which you can see of volcanic arc which are developed because of the oceanic and continental subduction zone.

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So this is an example of the subduction zone which exist between the Nazca plate and the south American plate and the bold line which is been seen here is the deeper part as compared to the both the plates because it is darker and this is the deeper part which marks the trench and the contact between the 2 plate Nazca plate and the south American plate. And the Andes mountain runs almost along this one which also comprises several active volcanoes.

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And one of the active volcanoes so this again the Google image the previous one is also Google image and this is also Google image which shows the location of the trench over here and these are the 2 plates one is oceanic plate and other it has the continental plate and this whitish portion or the snow peaks or the volcanoes or the mountains covered by snow.

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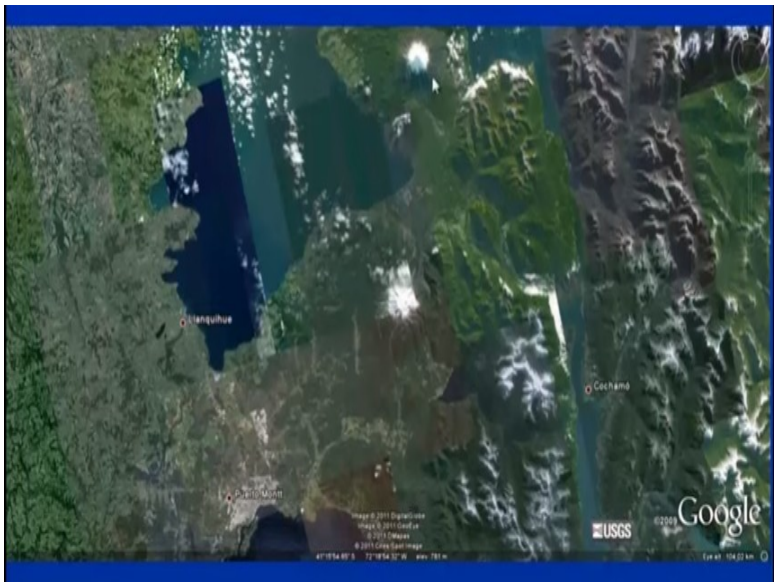

So one of the the volcanic cones are few are shown here.

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So these are the active volcanoes this is the same example of the active volcanoes.

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This are the same example of the active volcano term named as Osorno volcano on Chile this portion which you are able to see is the Osorno volcano in Chile and it resembles or similar appearance to the mount Fuji of Japan.

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This is an another one

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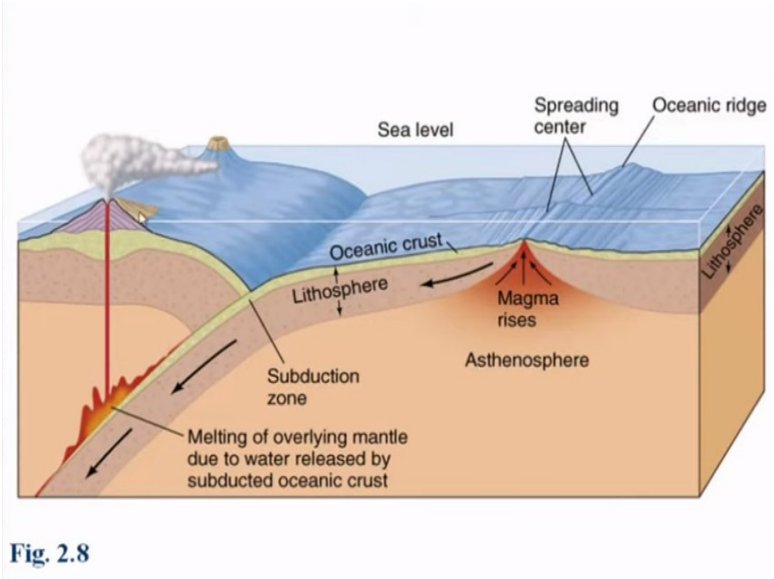

Fig. 2.8

So oceanic crust subducting below the oceanic crust the heavier one will subduct below and similar what the volcanic arc is been seen on the continental crust it will also been seen as island arc on the oceanic crust.

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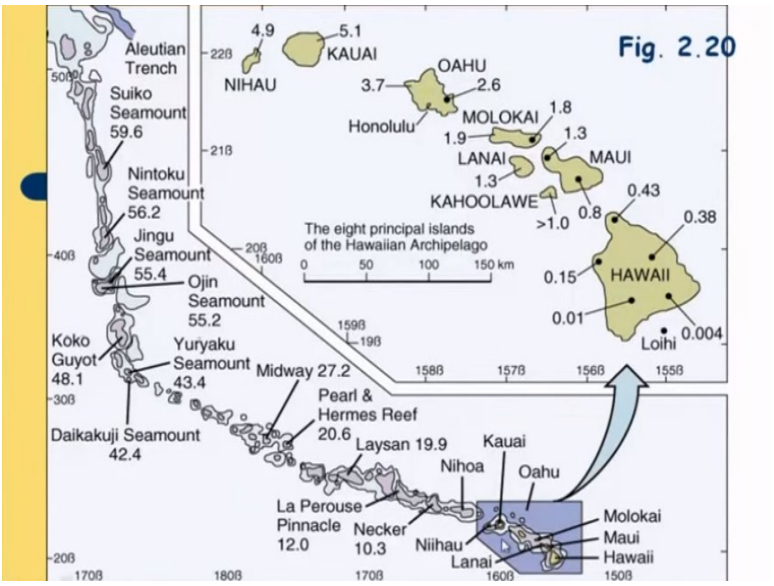

Now this is one of the best example which shows the plate motion over the hot spot. So if you remember we are talking about the hot spot this is one of the example which also helps in understanding that the plates have moved from its original location and have been moving over the time. So this shows the location of active volcano and the dormant volcanoes this are all dormant volcanoes and this portion is active volcano in Hawaii. So this is Hawaii chain of islands which were active in the past while passing over the hotspot beneath.

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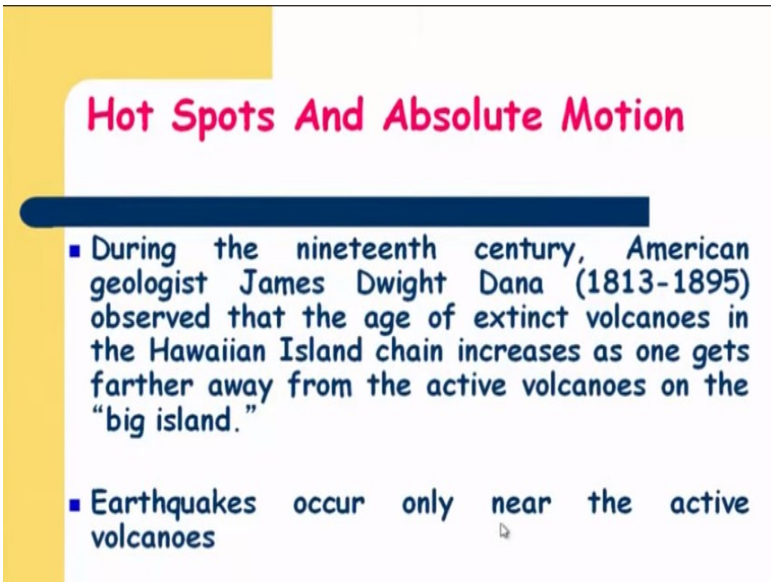

So hotspot and absolute motion which was been given based on the location of the active volcanoes and dormant volcanoes. So this happen when Dana in nineteenth century an American geologist observed that the age of extinct volcanoes in the Hawaiian island chain increases as

one gets farther away from the active volcanoes on the big island. So this is the big island over here and one if one moves away from the big island then they found that the observation was that the volcanoes become older. Earth quake occurrence only near the active volcano was experience.

So this is an another addition example over the signature which shows that the activity is only along the active volcanoes of the earth quakes as well as it is young in in terms of the age also.

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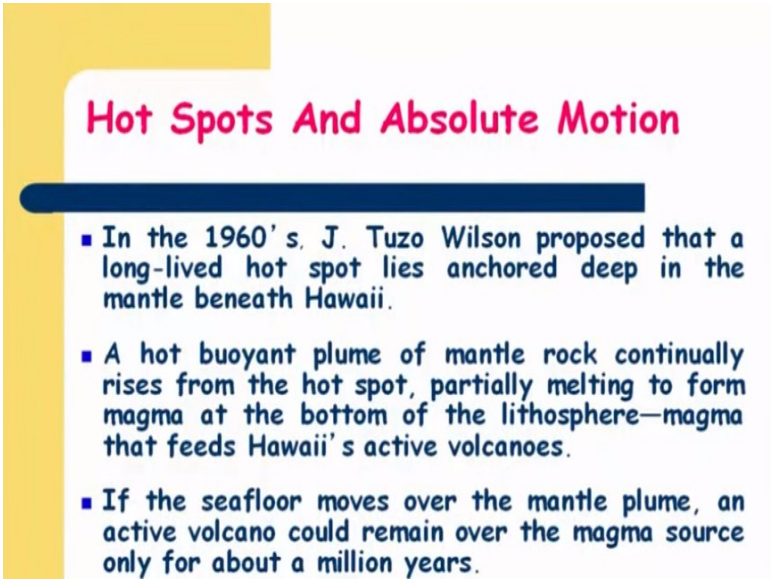

And in 1960 Wilson proposed that a long lived hotspot lies anchored deep in the mantle beneath Hawaii. So below the Hawaii island there is an hotspot which is continuously supplying the lava on the surface which is resulting into the volcanic eruption on the surface. So as the plate moves the older volcanoes dies out and become dormant. So a hot buoyant plume of mantle rock continually rise from the hotspot partially melting to form magma at the bottom of the lithosphere.

Magma that feeds Hawaii's active volcanoes if the seafloor moves over the mantle plume and active volcano could remain over the magma source only for about a million years. So after million years the plate will must have moved ahead and the new volcanoes which start forming. So this is absolute motion theory which talks about the volcanic chain and the active plume or the magma chamber which is sitting below the Hawaii and chain of islands.

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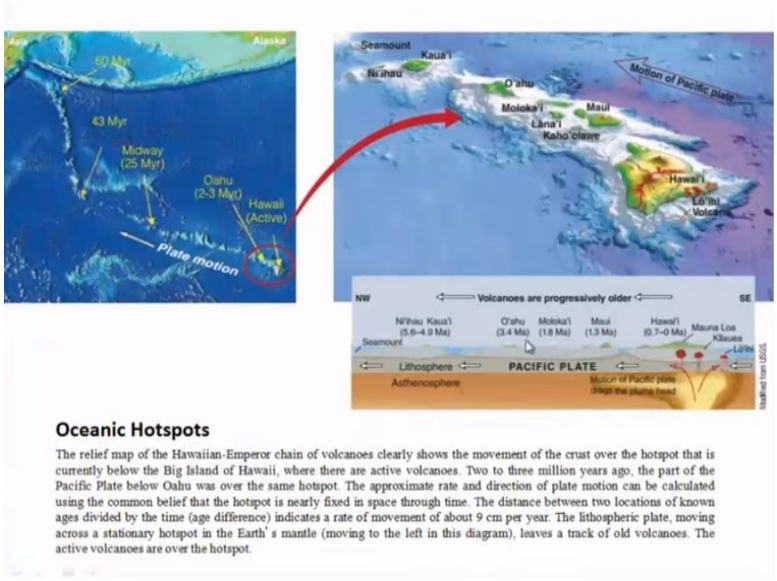

Oceanic Hotspots

The relief map of the Hawaiian-Emperor chain of volcanoes clearly shows the movement of the crust over the hotspot that is currently below the Big Island of Hawaii, where there are active volcanoes. Two to three million years ago, the part of the Pacific Plate below Oahu was over the same hotspot. The approximate rate and direction of plate motion can be calculated using the common belief that the hotspot is nearly fixed in space through time. The distance between two locations of known ages divided by the time (age difference) indicates a rate of movement of about 9 cm per year. The lithospheric plate, moving across a stationary hotspot in the Earth's mantle (moving to the left in this diagram), leaves a track of old volcanoes. The active volcanoes are over the hotspot.

Now further strengthening of the evidence of the plate motion was been achieved based on the change in the direction of the islands which are aligned along this. So this also shows that fun point of time the plate direction or the motion changed from one direction to another direction. So this at present the movement of the plate is in almost is east north east direction whereas earlier it was close to north south.

And hence one moves from the active big island of the Hawaii the age becomes older so you have 25 million years over here in the midway whereas here it is 2 to 3 million years at further it is around 43 million years at the junction over here. So this also shows that if you move away from the center of the active volcano over here and Hawaii the age increases.

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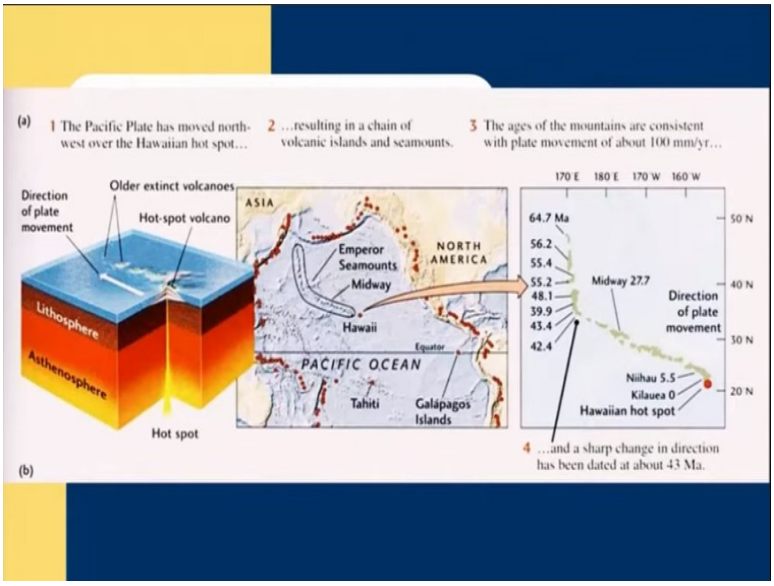

So this shows that the pacific plate as moved north-west over the Hawaii hotspot. So hotspot exist here and the over the hotspot the plate as moved so this is the it is west direction is this direction is your west north west or you can say it is west north and this is almost north south. And this resulted in a chain of volcanic island and seamounts so this whole portion shows this at this was the point and if you take where the this change in the angle this was the point at 43 million years back the change in the direction occurred.

So the short change in the direction has been dated at about 43 million years and the age is of the mountains are consistent with the plate movement of about 100 millimeter per year. So the plate motion is 100 millimeter per year and this will this has been moving because based on the ages they also worked out the what is the movement of the or the velocity of the plate which is moving over the hotspot.

So this is this are few examples which shows the clear cut indication or the evidence or signatures that the plates are moving from one place to another place and plates are also diverging from over the spreading along the spreading centers or they are spreading a long away from one another along the rift valleys like what we have seen in Africa. So African plate shows the rift valley where the 2 plates are splitting with respect to one another and the Hawaii islands chain shows that the movement of oceanic plate over the hot spot and also this plates are capable in changing the their direction.

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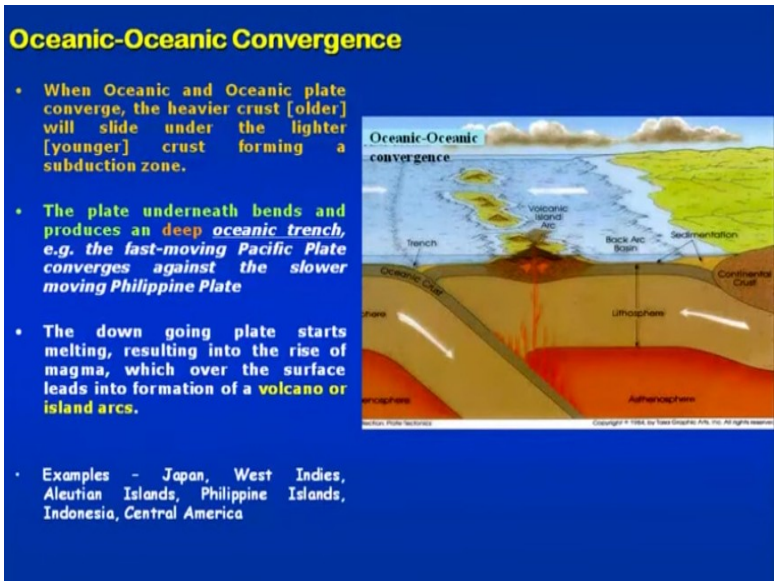

Coming to the oceanic-oceanic convergence an oceanic-oceanic plate converge the heavier older will slide under the lighter one and similarly you will be able see the formation of the volcanoes on the over-riding plate and this will happen because the subducting plate will melt in the deeper part of the mantle resulting into the formation of volcanoes. And similarly what we see the example of such plate boundaries are along Japan, West Indies, Aleutian Islands, Philippine Islands, Indonesia, Central America.

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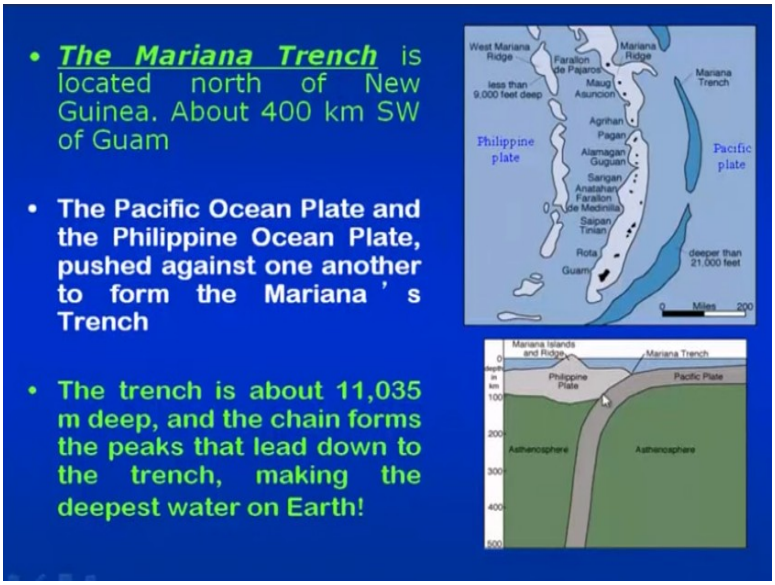

And the best example of the trench let us it most deepest portion on the earth is the trench Mariana trench which is 11,035 meter deep and this exist between the Philippine plate and the pacific plate. So the pacific plate is subducting below the Philippine plate at an very high angle

and this has given rise to the deepest part or the deepest portion on the earth it is almost 11035 meters deep which exist between the Philippine plate and the pacific plate.

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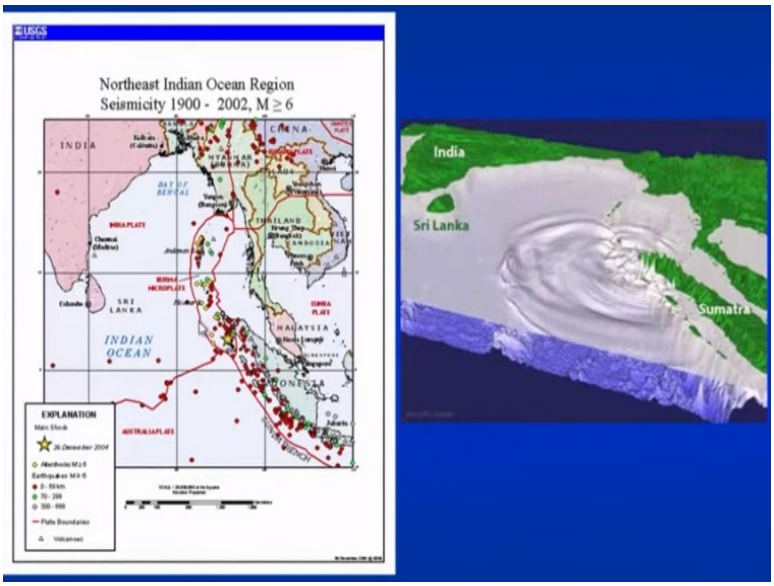

Further similar trench but not so deep and the subduction zone also exist between this Sumatra that is Indo-Australian plate and the Burmese micro plate at this was one of the plate boundary which was responsible in generating the mega subduction zone earth quake of 2004 that is the 2004 Sumatra Andaman earth quake which occurred along the Sumatra Andaman trench magnitude was 9.3.

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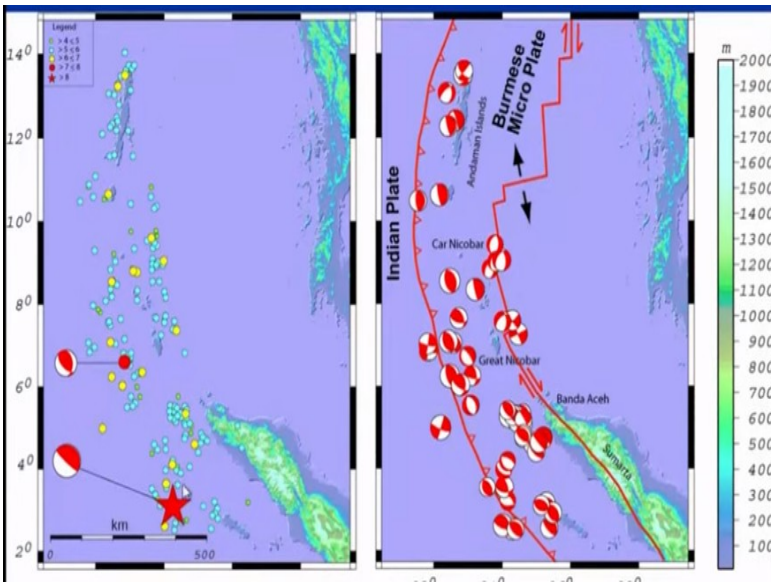

So this is the location of the trench which exist between the Indo-Australian plate and the Burmese micro plate and this circular features or the pitch and ball diagrams which you see here are the location of the or the fall plane solution of the occurrence of earthquakes and that big star over here shows the location of 2004 mega earth quake.

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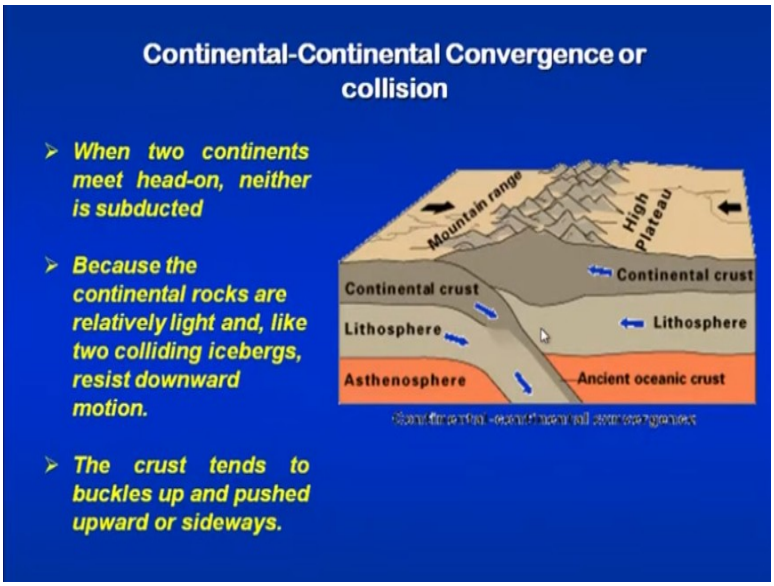

Continental-Continental convergence in collision now this is the plate boundary which exist between the 2 continents. So either you call this as an collision zone or this zone along which initially subduction took place and later there was collision. Now why we call collision because both the continental crust are of similar density. So one of the reason when 2 continental plates meet head-on they meet or they will collate but neither is subducted.

Because continental rocks per relatively light unlike 2 colliding icebergs resist downward motion. Hence when 2 continents collide or meet each other then what we see is collision so the boundary between the Indian plate and the Euro-Asian plate is the collusion plate boundary or we can say convergent because that earlier Ancient oceanic crust subducted. So the original process of subduction and then the collision.

Now because of the collision the crust tensed to become thicker and it buckles up upward as well as sideward. So this will grow sideward as well as upwards and further if you remember we are talking about in the isostasy that this portion will thicken up. So the roots will be deeper into the asthenosphere.

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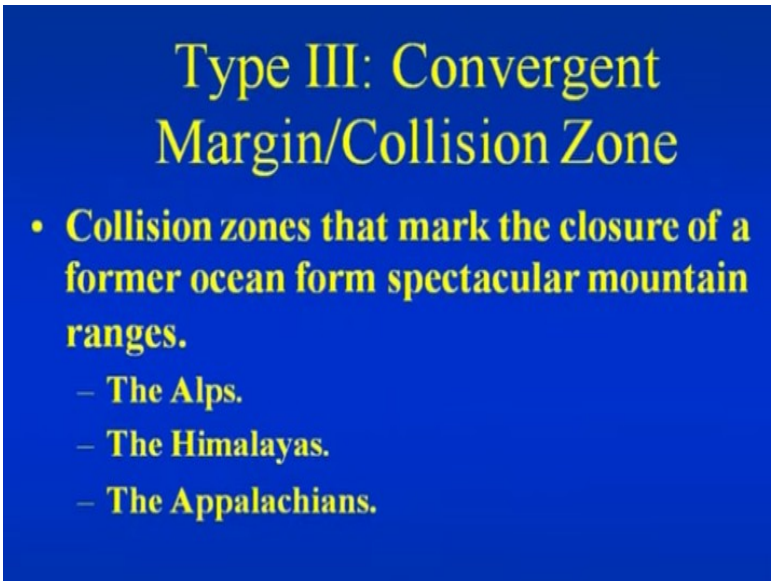

So type of convergent plate boundaries or the collision plate boundaries are one is Alps and the Himalayas and Appalachians. These are 3 spectacular mountain chains are the range which are the example of convergent plate boundary or the collision plate boundaries.

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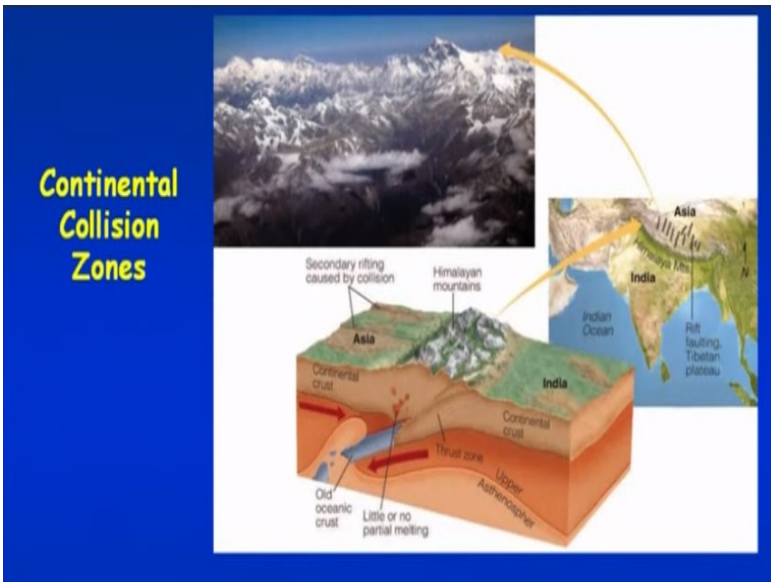

So Himalayas the collision plate boundary which exist between the Indian plate and the Eurasian plate.

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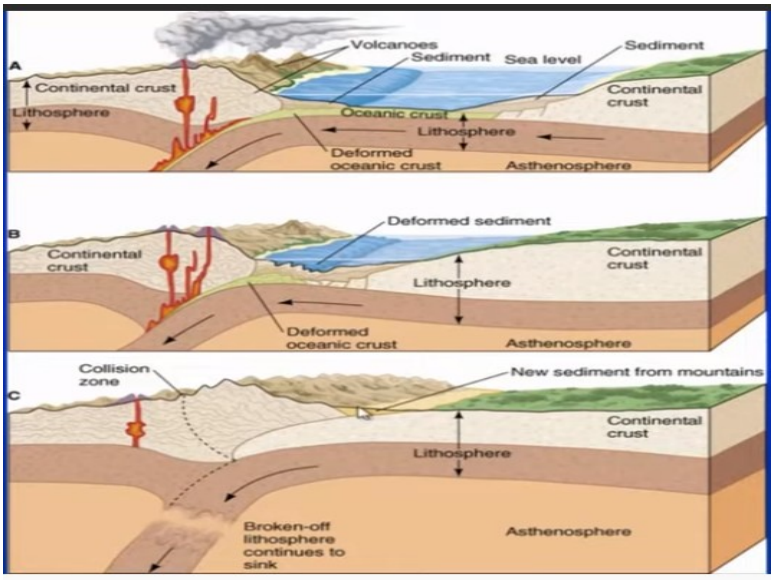

So what we see here is that initially the Indian plate subducted below the continental plate of Eurasia. So initially again when the oceanic plate was subducting below the continental plate we had volcanic corruptions and the sea portion or the portion of the oceanic plate occupied by Tethys sea starting closing up. And finally what we see is the buckling up of the continental crust because of the collision and the oceanic crust with subducted it broke off.

So broken off Lithosphere continues to sink whereas the collision when it started it resulted into the closing up of the Tethys sea and then formation of new basin at the plate boundary which is termed as the Indo-Gangetic plane. So we will stop here and we will continue in the next lecture and talk about the formation of the Himalaya with few more slides thank you so much.