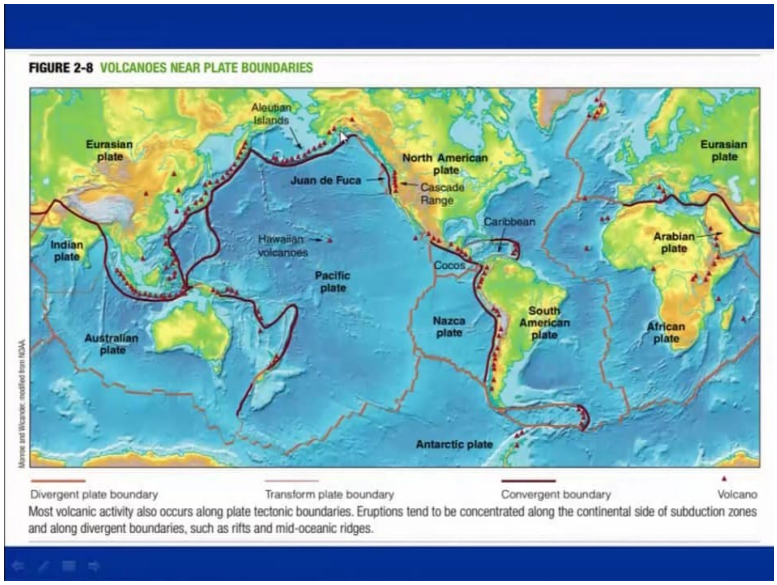
Geomorphic processes: Landforms and Landscapes
Prof. Javed N Malik
Department of Earth Science
Indian Institute of Technology- Kanpur

Module No # 03
Lecture No # 12
Interior of Earth and Plate Tectonics (Part III)

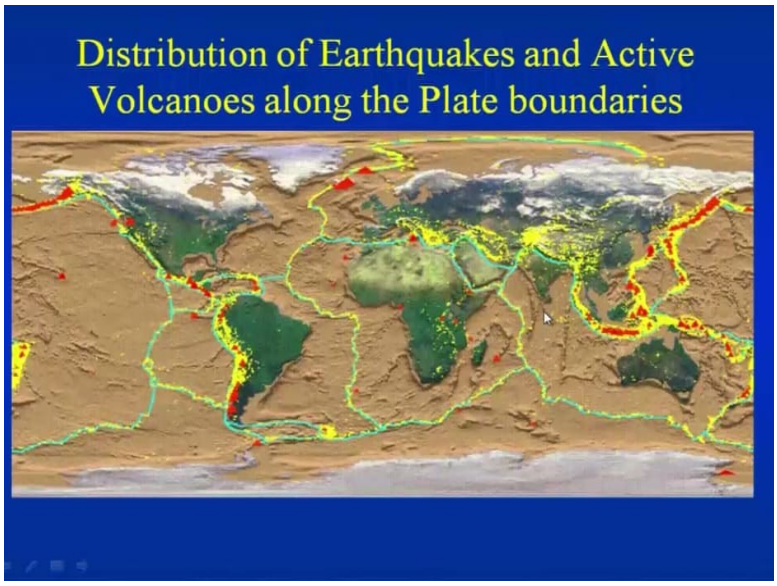
So welcome back so during the last lecture this was the last slide where we were talking about the plate boundaries.

(Refer Slide Time: 00:27)



And in one of the slide we discussed about the occurrences or the alignment of the earthquakes along the plate boundary. This slide shows the plate boundaries as well as the alignment of volcanoes with respect to the configuration or the relationship between the two plates that is one plate subducting below the another one. So the triangles which you should see here are indications of the existence of the volcanoes and if you carefully look at you see a sort of a ring here of volcanoes throughout in the Pacific and this area has been termed as Ring of Fire.

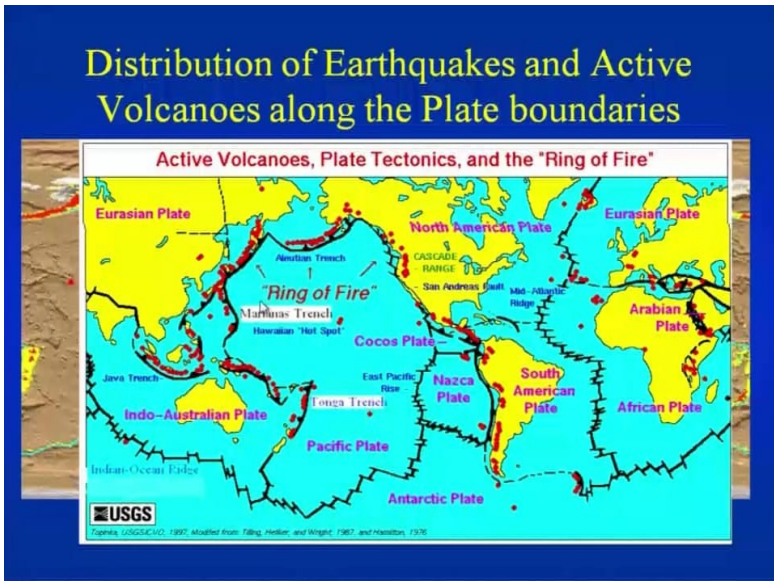
(Refer Slide Time: 01:27)



So distribution of earthquakes and active volcanoes along the plate boundaries has been shown here the yellow dots shows the distribution of earthquakes along the plate boundary and their triangle in red is the occurrence or the distribution of volcanoes along the plate boundaries. So keep in mind that the plate boundary between the India and Eurasia does not show any volcano.

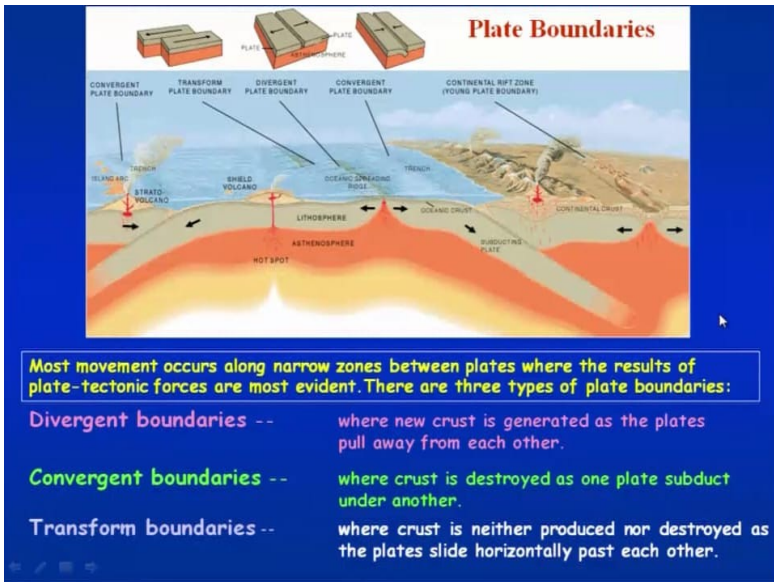
But there is one volcano which is active which falls within our Indian territory is the Barren Island in Andaman is one of the active volcano and it is the part of the subduction zone of Sumatra and Andaman over here and then this enters into the Himalayan origin belt. So this is an subduction collision zone between the Indian plate and the Eurasian plate.

(Refer Slide Time: 02:45)



So the distribution of the volcanoes if we look at along the plate boundaries in this region where I moving my cursor so based on this the distribution this area of Pacific has been termed as Ring of Fire.

(Refer Slide Time: 03:15)



So plate boundaries in total if we take most movement occur along a narrow zone between plates where the results of plate tectonic force are most evident. There are 3 types of plate boundaries now in the beginning I told that we have the boundary or the plate boundary where most of the time we keep on adding the crust and that is along the mid oceanic ridges or the divergent plate boundaries.

Since the plate is been added newly formed plate has been added there the divergent plate boundaries are also termed as your constructive plate boundaries. So divergent plate boundaries where new crust is generated as the plate pulls away from each other then second one is your convergent plate boundary. Now this convergent plate boundary is where the one plate subduct below the another one.

Hence it is also termed as destructive margins and another one finally is your transform plate boundary where the crust is neither produced nor destroyed mainly the plate slide horizontal past each other. So if you see on the top here this three plate boundaries have been shown so one as your divergent plate boundary in the center then you have convergent plate boundary and third one is your transform plate boundaries.

And the cartoon below it shows the divergent where the continuous magma has been poured in and the new plate has been generated. So this is your divergent plate boundary where the plates are pulled away from one another then we have convergent plate boundary. Now the convergent plate boundaries are of two type that is based on the relationship between the tectonic plates or the lithospheric plates and that shows that in one case the oceanic plate has been subducting below the another oceanic plate the continental plate.

So oceanic plate is subducting below the continental plate now if you will remember here the initial during the previous lecture we talked about the density of the plates. So the oceanic plate is heavier as compared to the continental plate and that is one of the reason why the oceanic plate go below because this is the asthenosphere on which they are violently floating. So the oceanic plate is heavier it will subduct below the continental plate which is lighter.

So the continental plate is around 2.7 and this is around 3.2 this specific gravity whereas the another one the plate boundary is between the oceanic and oceanic plate and in this case the heavier plate will subduct. Now the question comes that how it is that possible that both the oceanic plates are one of the oceanic plates is subducting below the another oceanic plate.

So the older oceanic plate will be comparatively heavier as compared to the younger oceanic plate and in both the cases whether it is the oceanic-oceanic subduction or the subduction is between the oceanic and continental at the deeper part when the plate goes the melting starts and this melting of the plate will result into the volcanic eruptions on the surface. So wherever there is a continental oceanic plate subducting below the continental plate or the oceanic plate been subducting below the oceanic plate.

The angle at which the deeper part it will result into the melting of the plate and causes the formation of volcanoes on the surface of the continental plate and a volcanic arc on the surface of the oceanic plate one more feature is been observed is the hotspot. Now this hotspot is like a plume where the magma will be continuously poured onto the surface now this connectivity remains.

So if any lithospheric plate passes over it we will have the volcanic eruption on the surface or you can say that this lithospheric plate will have an active volcano wherever it passes through the plume or over the hotspot. So these are few things you should remember this one is the 3 type of plate boundaries divergent plate boundary, convergent plate boundary and transform plate boundary.

Divergent plate boundary new crust is generated hence it is also termed as constructive plate boundary convergent plate boundary the crust is destroyed so hence it is also termed as destructive plate boundary. Transform plate boundary where crust is neither produced nor destroyed so this is the transform plate boundary, this is your convergent plate boundary and divergent plate boundary is this one. So you have an transform is what here so there is the two plates just like as each other so these are few important points which we should remember.

(Refer Slide Time: 10:32)

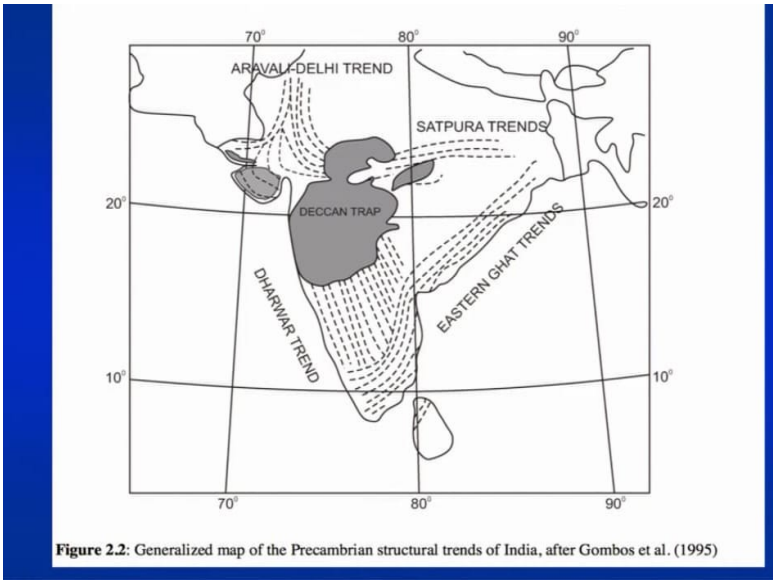
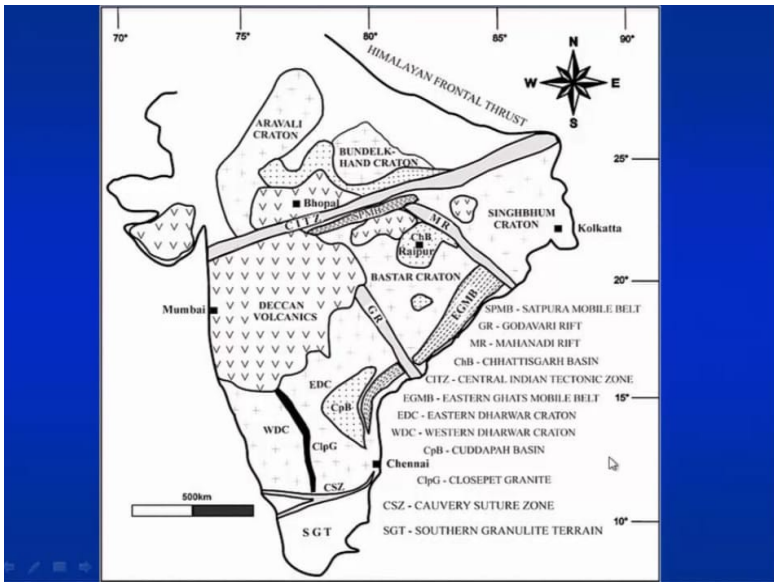


Figure 2.2: Generalized map of the Precambrian structural trends of India, after Gombos et al. (1995)

Now some of the postulations of the hypothesis which suggest the Indian subcontinent or the Indian landmass is the product of few small plates. So one is along this one that is Satpura area where this plate that is an Arvalian plate collided and along the Narmada suture zone then some people says that even the Guaj or Gujarat was a micro plate which collided and hence we see the final configuration of the Indian subcontinent.

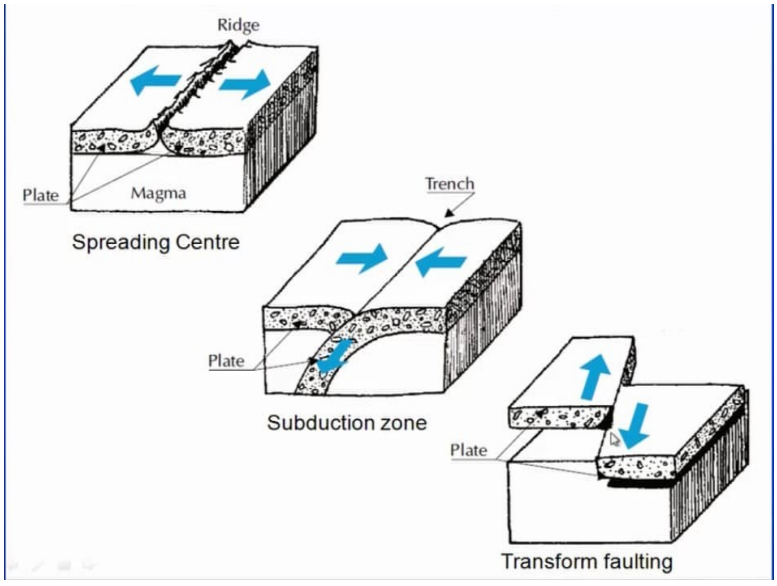
And what we were talking about we will see in coming slides the collision which is ongoing between the Indian plate and the Eurasian plate in the north and the product what we see is the towering height of Himalayas.

(Refer Slide Time: 11:44)



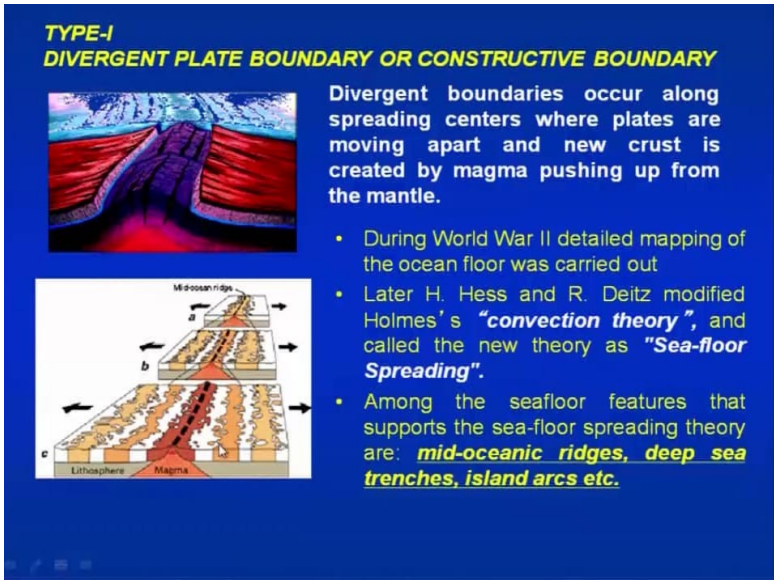
So these are the suture zone which have been shown here many suture zones which suggest that small micro plates collided or fused with the another one resulting into the major or the major plate that is Indian subcontinent. So you have small craytons which collided and this is the boundary which I was talking about the Narmada suture zone. Similarly this are also termed as smaller suture zones like Cauvery suture zones which has been shown here and likewise.

(Refer Slide Time: 12:34)



So in short spreading centre divergent plate boundary convergent plate boundary subduction zones and transform plate boundary where the 2 plates slide past each other. So only the lateral shift or the lateral movement or horizontal movement has been seen along the plate boundary or along the strike of this line.

(Refer Slide Time: 13:06)



So divergent plate boundary occur along spreading centers where plates are moving apart and new crust is created by magma pushing up from the mantle. So new crust is been added up continuously magma has been poured out through the spreading centers. Now this was been discovered that such spreading centers are responsible for adding new crust this happened during the World War II when the detailed mapping of ocean floor was carried out.

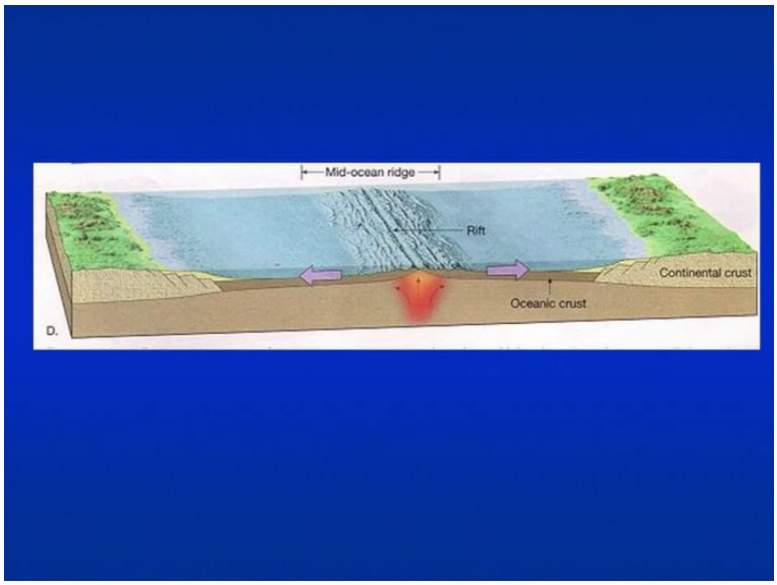
And later Hess and Deitz modified the convection theory of Holmes and called the new theory as a seafloor spreading. So the spreading centers were been termed as seafloor spreading where the seafloor is continuously spreading along the zone where the magma has been poured out on the surface in the oceanic crust and the new crust has been added. So among the seafloor feature that supposed the seafloor spreading theory are mid oceanic ridges, deep sea trenches, island arcs etc.

Now the color variation which has been showed here is nothing but the positive and negative magnetism. Now this was been identified again at the time of the World War II and the geologists proved that the magnetism or the earth magnetic field never remain same throughout the history since the earth was born there is an reversal which has been observed again and again.

So if you see from here this color has orange color is positive anomaly and the white color is negative anomaly.

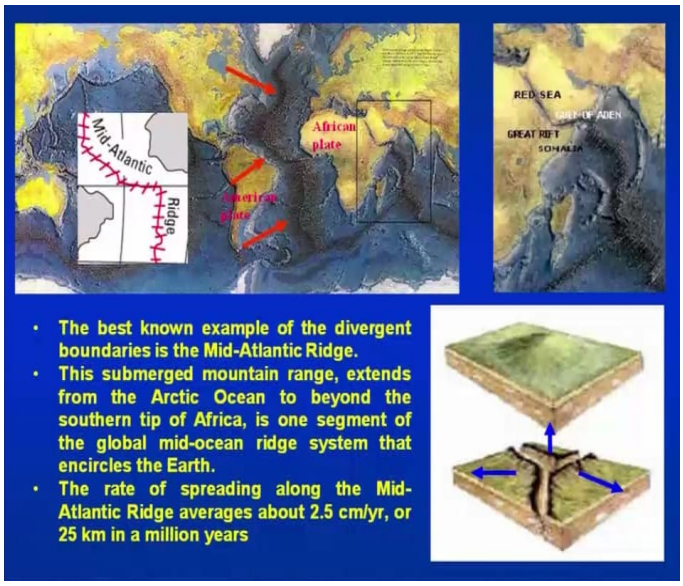
And as you move away from the center what they found was the crust was becoming older hence based on this two signatures one that the poles never remain at the same position that is north pole change to south and south to north which is been evident in the reversal of magnetic anomalies in the rocks. As well as the another evidence was that the new crust has been added continuously because of the continuous pouring out of magma on the seafloor and this theory has been termed as seafloor spreading.

(Refer Slide Time: 16:30)



Now the mid oceanic centers or the (()) (16:35) mid oceanic ridge is not only seen across the ocean floor but at one location it has also been seen on the surface of the continental crust.

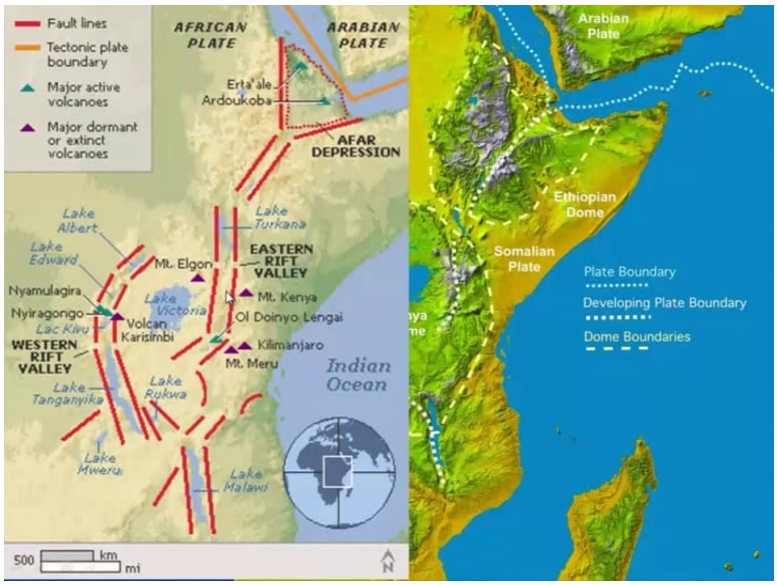
(Refer Slide Time: 16:52)



And we will talk that in coming few slides so this spreading center if you see are been mark by blackish gold feature along here. So it covers a larger distance or the area in ocean so this is your mid-Atlantic ridge and then we have also the triple junction where 3 plates move away from one another so this is known as triple junction. So best known example of divergent plate boundary is mid-oceanic ridge or also termed as mid-Atlantic ridge.

This submerged mountain range extend from the Arctic in the south to beyond the southern tip of Africa is one segment of the globe mid ocean ridge system that encircle the earth. So it starts from south and it all reached right up to the north so this is one of the major feature the rate of spreading along the mid-Atlantic ridge averages about 2.5 centimeter per year or 25 kilometers in a million years.

(Refer Slide Time: 18:35)



So if we look at the triple junction which exists over here in this region where 3 plates are moving apart from one another so you have the rift that is the African plate and the Arabian plate. So you have Arabian plate and then the part of this plate is also moving away and this plate is also moving in this direction. So you have 3 plates which are moving away from one another and this area we will be discussing one in coming slide this area is now started opening up and there were news in few months back that this rift valley in African continent has started opening up. So time will come that this will separate out an new ocean will be added here.

(Refer Slide Time: 19:43)

So this film it shows the evidence of the cracked which is formed in this region so what you will see is the Ethiopia, Kenya, Tanzania and Mozambique will separate out from the African continent so please watch this video.

(Video Start Time: 20:03)

A massive crack in the ground that is estimated to be up to 50 feet deep is opened up in Kenya seemingly overnight the crack stretches along Kenya's great rift valley and many scientist believe it could end up splitting the continent apart Debora patta is tracking developments from Johannesburg South Africa. Imagine waking up one morning to find a massive crack running in your home that is what happened to Elliott in (()) (20:29) forced to dismantle his house by hand before it was lost to the earth below.

He lives in my (()) (20:36) part of the great rift valley in Kenya a region that has already provided a treasure trove of some of the most important archaeological finds in history and this latest discovery is so significant scientist predicted will be the fourth line along which history is made once again. As Africa splits into two continents although that would happen for a very long time says geologist Ben Andrews fortunately this does not occur instantly.

So it is going where were many ten's of millions of years away from having two (()) (21:08) the crack in Kenya sits along the 3700 mile long east African rift geologists say that rift is growing larger as two tectonic plates move away from each other. As this movement continuous over the next 50 million years a large chunk of the continent will eventually split off creating an island that will consist of parts of several African nations.

Scientists for the most part agree that the continent is splitting in two but there is debate over exactly how this most recent fracture was revealed. Andrews believes the earth did not suddenly split in two but that it formed over 100's of 1000's of years. It looks like it was probably something that already existed and had been filled with ash and other material and then it was flushed out by recent rainfall.

Joining me now from Johannesburg CBSN news foreign correspondent Debora patta she is gonna talk to us a little bit about this. Split so Debora this giant crack in the earth opened up in what seems like a matter of days can you give us an idea of how large it is and what geologists

say may have caused it. It is quite phenomenal really that I mean it is about 50 feet deep and 60 feet wide I mean imagine something like that just suddenly appearing.

Although geologists in part are saying that actually it way all along just hidden away from the world and that because of some heavy down pour in recent weeks in Kenya. It cleared away what essentially was volcanic ash which is a lot softer than normal rock and that is how it came to be revealed. Although not everyone agrees with how this was formed but that is certainly a lot of geologists are saying that is probably what happened.

You know I know a lot of people are really interested in the science behind this and some of the pictures are really amazing but I am very curious about the people on the ground because as you know Debora thinks like this can affect people lives in a significant way. So how are people reacting and what does this mean for people living in the surrounding areas how could their lives be impacted?

It already has taken place for some people (()) (23:17) what we have seen some people who literally woke up to see a giant crack in their home. Can you imagine waking up to something like that one man say that he started screaming and trying to grab as many belongings as he could not actually physically dismantle his home by hand as quickly as possible before it could be sort of sucked in by this giant crack that had appeared there.

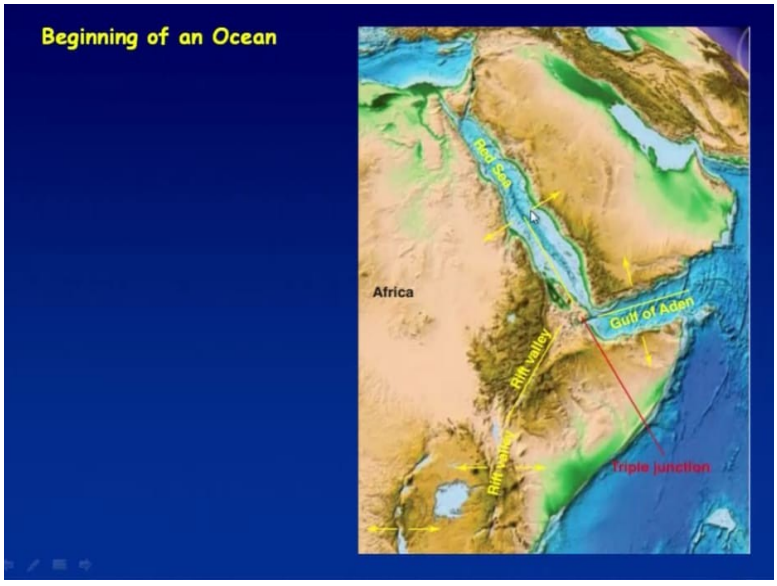
He now has no way to go so it is one thing to dismantle your home and move but where do you move to this is the Rift valley this crack lives on a line that is about 3700 miles long and there are falls along there so this could happen again the road in the area a giant fissure fracture appeared in that road. It is now been filled up with the rocks so the cars can continue to move over but this could not be a permanent thing it could happen again.

So it really has impacted quite severely on people living in the area and it is a long term problem that the Kenyan government is going to have to deal with they wanted a railway line to go through this area but how can you have a railway line going through what is essentially an area that you know could see this kind of problem again in the very near future. It is a story that is to be to continued Debora patta perhaps for the next couple of years certainly the next couple of million years we appreciate it as always thank you

(Video End Time: 24:38).

So this was a small movie which explains the reality on the ground an African subcontinent and as you must have noted down that this process will take millions of years but yes this process in on. So the initial portion of the talk or the lecture in which we were talking about the splitting of islands or the plates diverging from one place to another place. However the movement of the tectonic plates or the lithospheric plates this is the best example which we are fortunate enough to understand and see happening in the present time.

(Refer Slide Time: 25:37)



So this is what is taking place along the rift valley and the point which we were talking about the triple junction is between the African plate, Arabian plate and the plate over here. So this plate is moving away from one another which is been shown between the Gulf of Aden and here also this plates are moving away from one another which is showing the opening of the Red sea. So we will stop here and we will continue in the next lecture thank you so much.