Earth Sciences for Civil Engineering
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Module 1
Lecture No 2
Introduction to Geosciences in Civil Engineering (Part-2)
&
Plate Tectonics and Continental drift (Part-1)

Hello everybody. Welcome back. So in last lecture, we talked about the and we stopped at the system concept and we very quickly discussed about the isolated system and the closed system. So today we will talk about the open system further.

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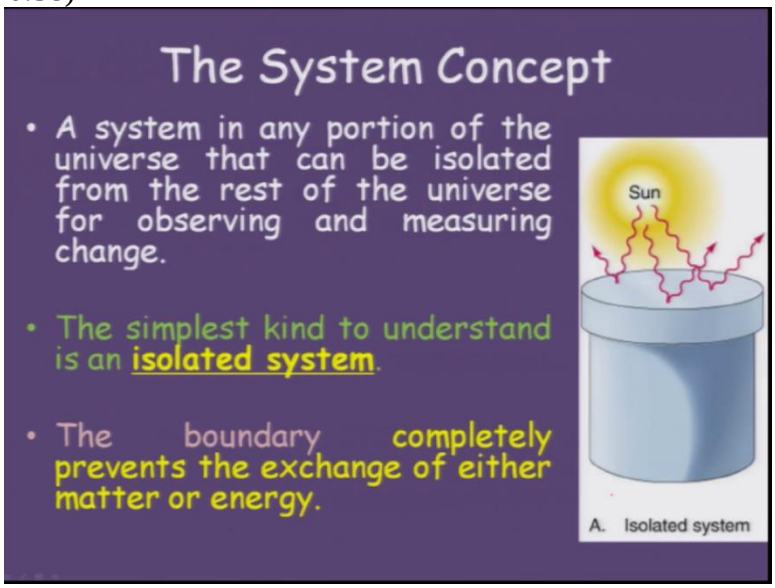

So very quickly going back again to those slights and then we move ahead. So the isolated what the bounty completely prevents the exchange of either matter or energy.

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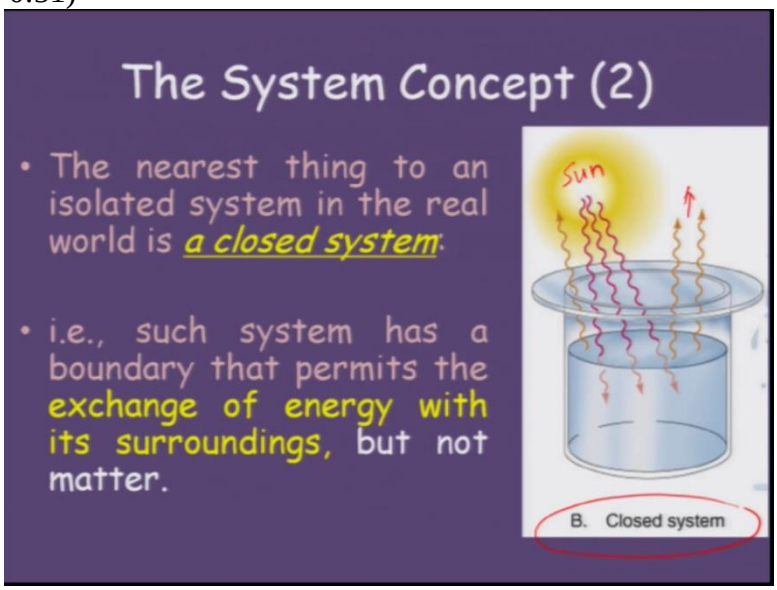

Whereas in the 2nd one, that is the closed concepts or the closed system, we are having the no exchange of matter but the boundaries will exchange will allow to exchange the energy. So this is what I was talking about that if you are having the radiation coming in, then we can say that okay fine, there is an exchange of energy but there is no exchange of matter in terms of this thing.

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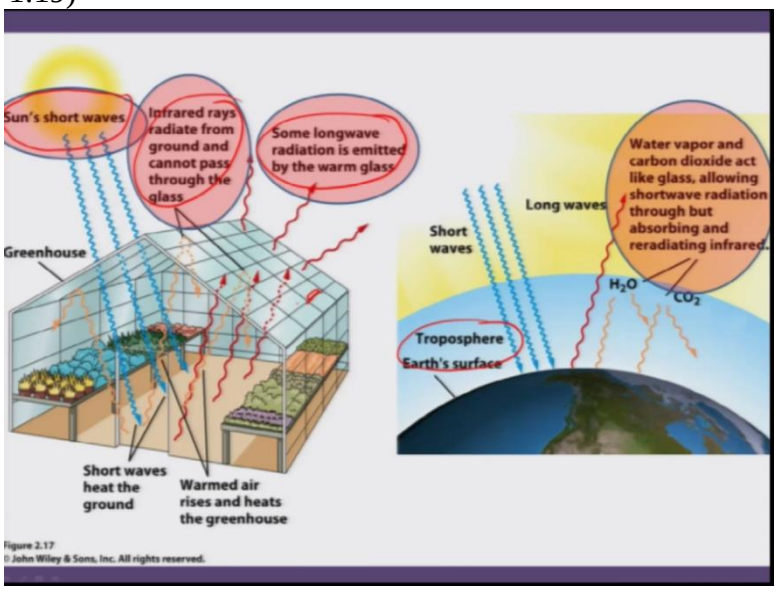

So these are best examples which explains about the, which we also call the greenhouse. So we are having the shortwave radiation coming in and we have the greenhouse what we call the class

which is very much similar to the troposphere. So the shorter waves are coming in and then we are having some of the radiation. That is what the, some of the long wave radiation is transmitted back to the atmosphere and some is reflected back again to the earths surface.

So that is what we have, which cannot pass through the glass. And that is what is very much similar to your atmosphere. So we are having the sun shortwaves coming in, that is the radiation. And then we are having the infrared which are radiated back to the ground which are not transmitted into the atmosphere. Whereas some of the long waves or the radiations which are transmitted into the atmosphere and very much similar to what we are looking at here.

That we are having the water vapours and carbon dioxide which acts as glass, very much similar to what we have seen here which does not allow or partially allow the radiation to move into the atmosphere.

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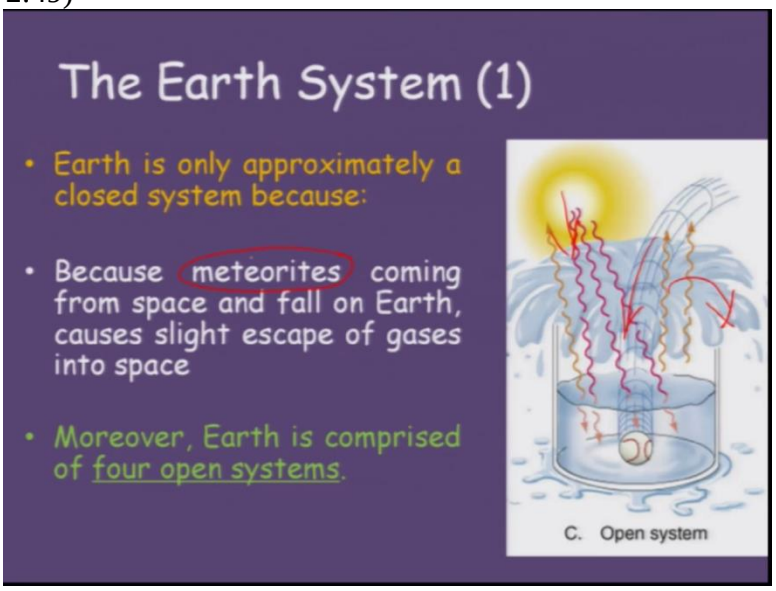

So in that sense, if you look at this and then if you consider what we talked about in the previous slide about the closed system, then this fits into the closed system but let us move to the last one. This is an open system. What happens here? If you are throwing something, some material or matter into the beaker, what has been shown here, then you are, in turn you are exchanging some material. That is, the water has been poured out.

But the radiation is there. So you have the energy coming in. You have the energy here but you are pouring it out actually here. So not only energy but also the matter has been changed. So

Earth is only approximately a closed system. It is not a completely closed system but it is approximately a closed system and the reason is because of the impact of meteorites what we see. So because of the meteorites coming from the space and fall on the earths surface causes slight escape of gases into the space.

So some gases have been escaping into the space but in a closed system, this was not happening. So we can say that Earth is more or less, approximately a closed system. It is not completely a closed system. But if you look at the internal 4 systems of the earth, then those 4 systems are totally open systems. Let us see those ones.

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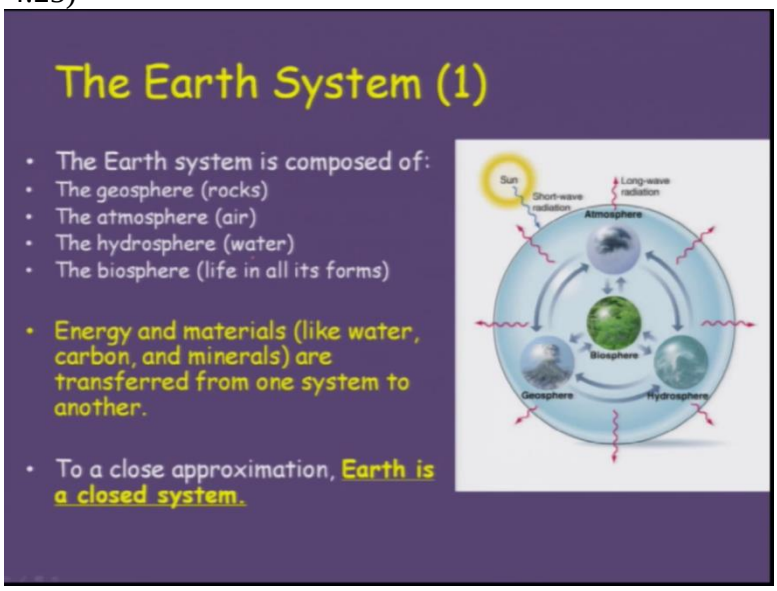

So earth system what we are having, so we have seen that earth system is partially a closed system. But within earth, we are having the other systems which are open. So earth system is composed of 1, Geosphere which is mostly made up of rocks. Then atmosphere, air and gases what we call. And then we are having the hydrosphere made up of water or comprised of water and then we have biosphere which comprises life in all its forms.

So energy and material like water, carbon and minerals, are transformed from one system to another. Hence they are open system. They are not closed system. So to a close approximation, Earth is a closed system but not a completely closed one.

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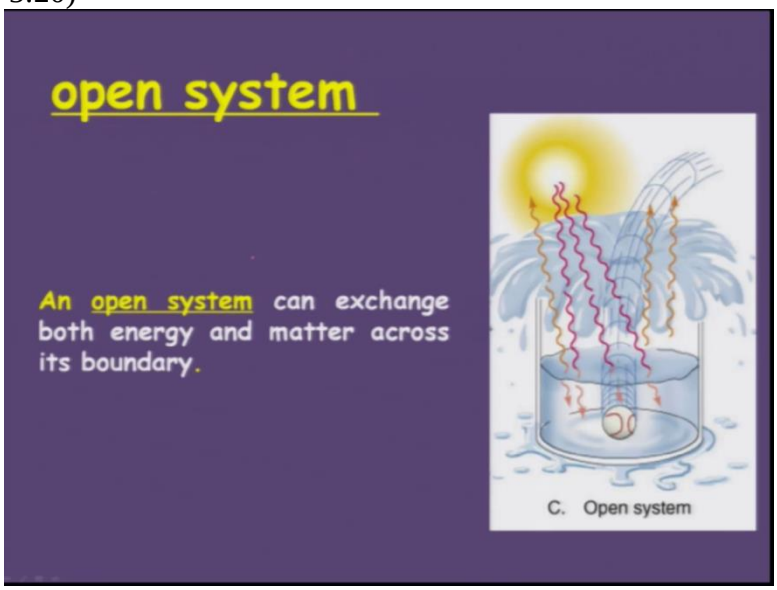

So open system. This we have already talked about. So this is an open system. It can exchange both, energy and matter across the boundary.

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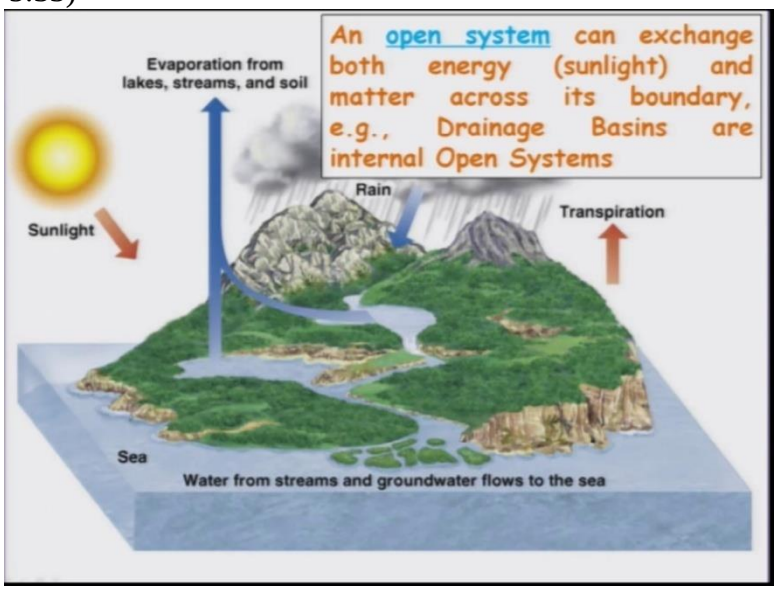

Now for example, why we call this as an open system? Because it can exchange both energy that is coming from the sunlight and the matter across its boundary. That is, for example, the drainage basins are internally which can exchange the sediments and the precipitations coming in. Hence we call this as an open system. This is not a closed system. But global hydrological cycle if we take in terms, it is a closed system.

It is not an open system. But the hydrological cycle within the system of the earth if you look at, we are having what we see as an open system because it has input and output, gets energy from Sun and precipitation, that is what we see in the form of rain and snow. It enters the system and water leaves the system. Hence, there is an exchange and we call this as an open system.

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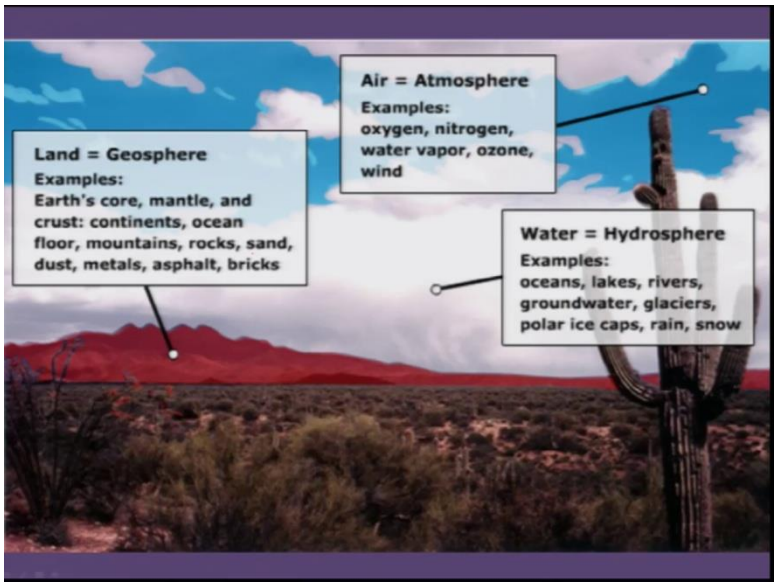

So with this, we have already talked. So I will just move ahead. Now what is? We are looking at the geosphere mainly. Geosphere, it comprises the earth's core, mantle. So this is the interior of the Earth we are talking about. And crust. Crust is the top layer of the Earth. And then we are

having the continents, that is the crust comprising of continents and ocean floors, mountains, rocks, sand, dust, metals and all that.

And then we are having the hydrosphere mainly comprised of water which comprises ocean, lakes, rivers, groundwater, glaciers, polar ice caps, rains and snow. And then we are having the atmosphere. We have the gases, oxygen, nitrogen, water vapour, ozone and wind.

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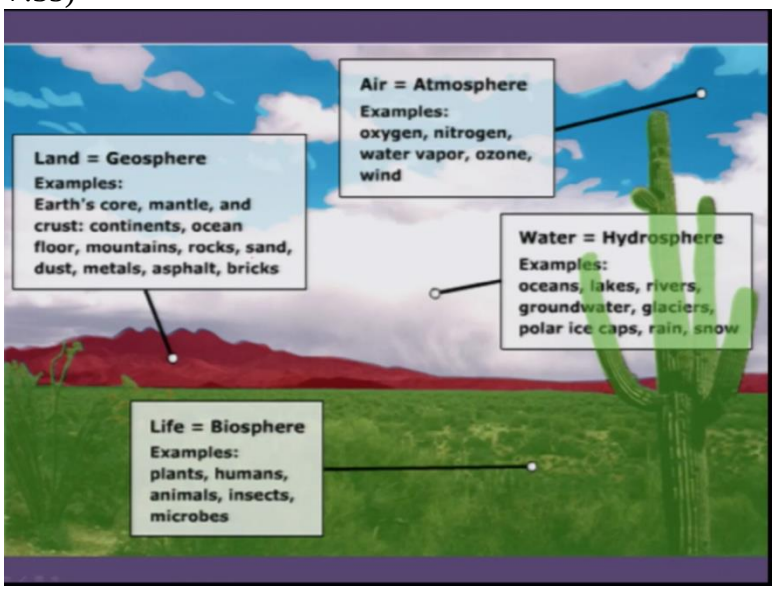

And then we are having the biosphere which is what we call the, it comprises of life. Plants, humans, animals, insects and microbes.

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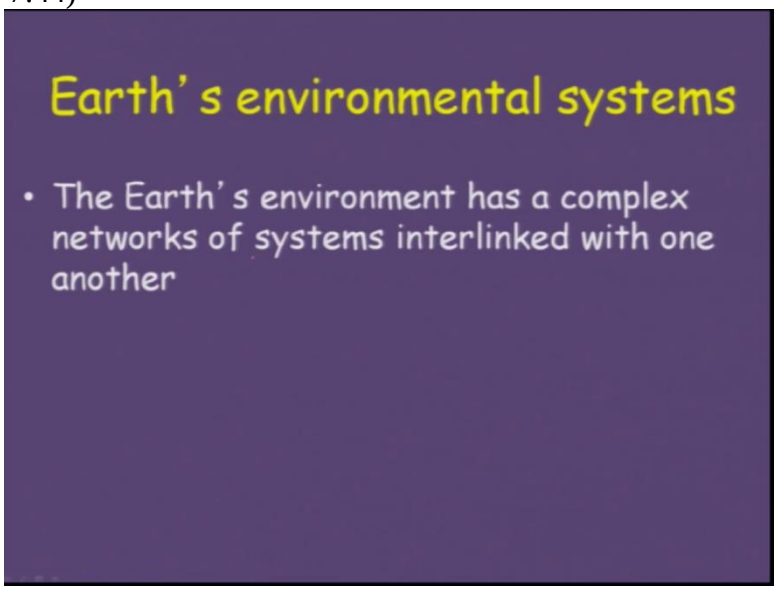

So earth's environmental system, now this is very much important.

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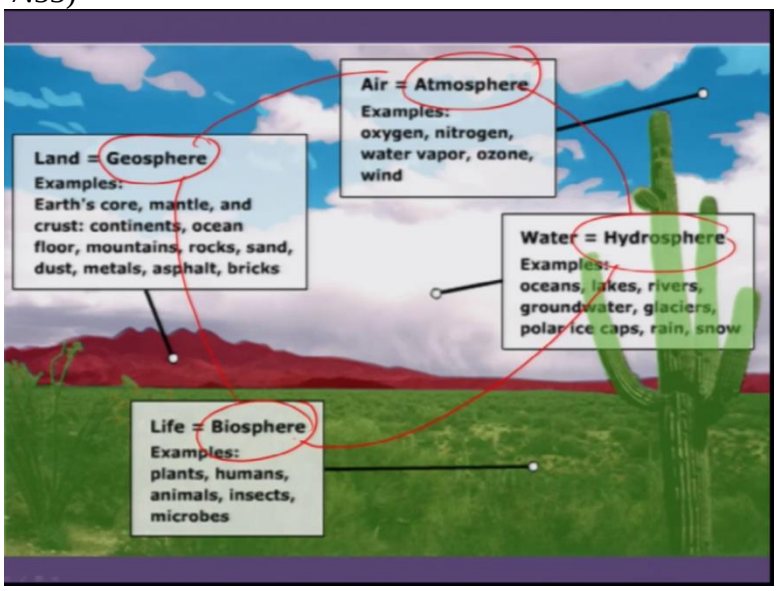

What we have looked at, like we are looking at the biosphere, so we are looking at the geosphere, we are looking at the atmosphere, hydrosphere and biosphere. So in short, all these are linked. What I mean to say is that if you disturb one, another will be affected and that is what is happening. Nowadays what we are talking about, the greenhouse effect.

We are talking about that we are pouring more of carbon dioxide in the atmosphere and all that and we are forcefully trying to change the climate. Or we are moving towards the hotter climatic conditions. We are melting the polar ice and all that.

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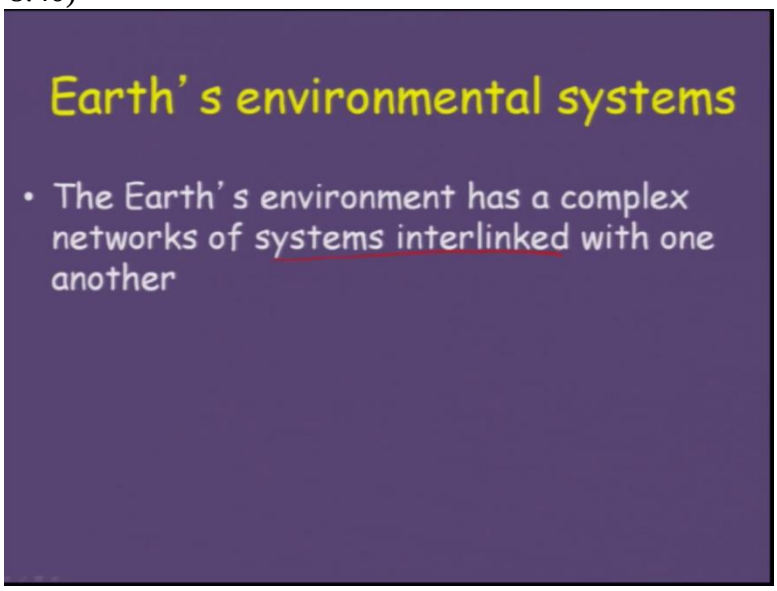

So those things have extreme importance. So they are what we call is they are interlinked. So all systems are interlinked with one another. You disturb one, the other will be affected.

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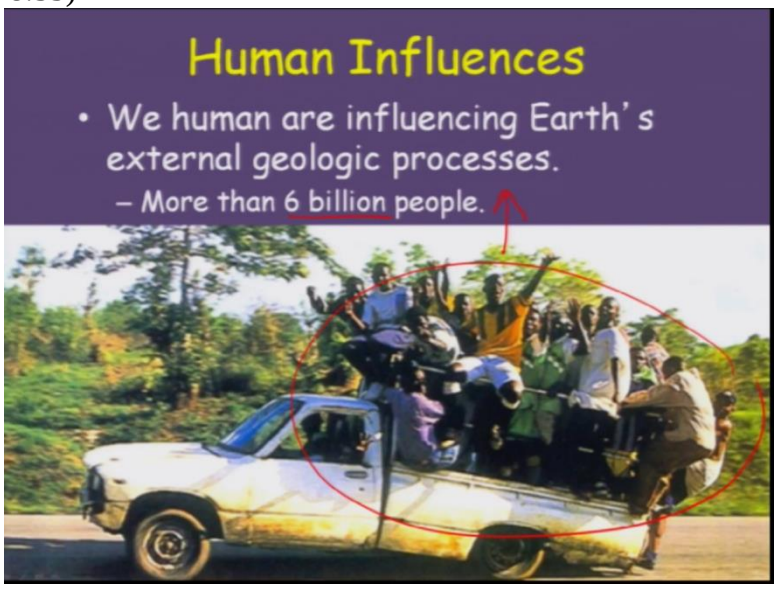

So human influence. What is the human influence we are looking at? We humans are referencing earth's external geological processes. We are not capable of doing something to change the internal process. But we are influencing the external geological processes. Now we are more than 6 billion people. So the population has gone up, extremely high and we are disturbing the, so what we have done is, we have overloaded this system.

So we can move with a normal this thing but we have overloaded. So we are moving in and overloaded fashion and we are disturbing the, influencing the, either the biosphere or geosphere or hydrosphere.

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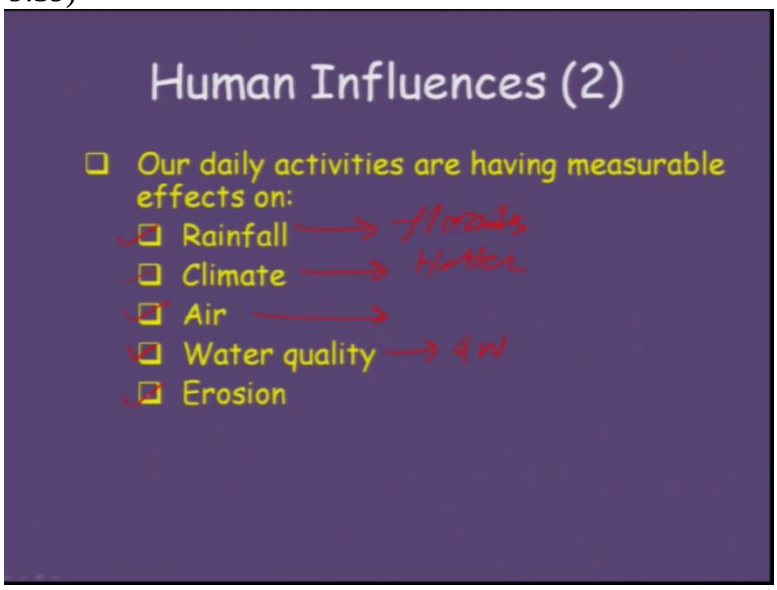

Now, our daily activities if you take, we are surrounded by many such processes and we should know about it. So our daily activities are having a measurable effect on this. What we will have? What will be affected is the rainfall. So we have seen that nowadays we are having very erratic rainfall and all that. We are moving towards the hotter climatic conditions. Then we are having more of air pollution by influencing or putting an, we are deteriorating the water quality by either adding the toxic elements or we are, improper waste disposal if we are doing.

So we are also affecting or influencing the water quality. Of course, we are resulting in erosion. So very simple. We can talk about that, if you are cutting the trees, you are exposing the Earth's surface to erosion. So we are putting, we are having more of erosion and all that. So if you look

at, you can say that okay fine we have affected more, the rain cycles and all that we are doing. Then this may affect, resulting into flooding in the region.

And this, we are moving towards hotter climate. So we are having hotter climate. Of course the pollution of air is there and all that. So if you can remember this, what happened in Delhi recently?. The people were being forced to move less or put less vehicles on the road and we came up with an odd and even. And water quality of course, we keep on crying about the poor water quality. That is mostly we are talking about the groundwater.

And then we are talking about erosion in the hilly areas. So this, we all know that there is a considerable effect because of our daily activities on the Geo system or maybe you can talk about the earth processes. But these are all external processes, not internal.

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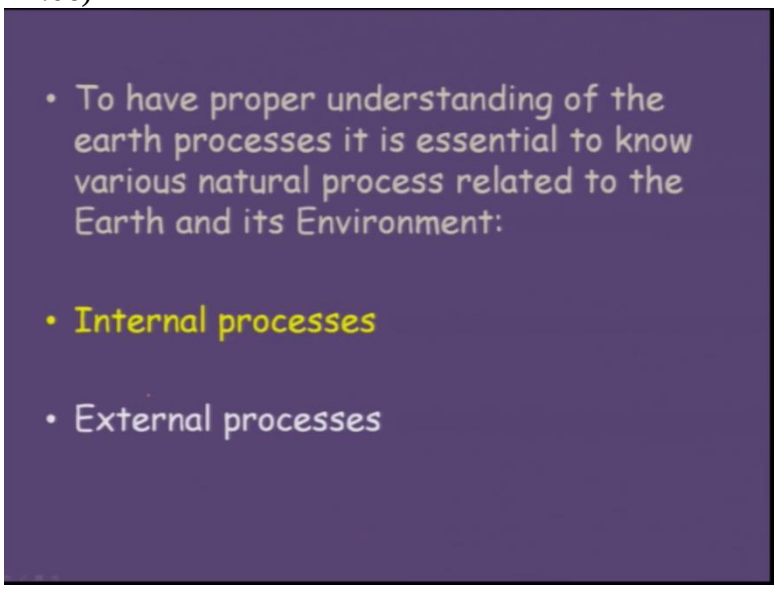

Now to have proper understanding of earth processes, it is essential to understand the natural processes. That what we call the geological processes mainly related to earth and its environment. As I told the beginning that all these systems what we are looking at, either it is biosphere or geosphere, atmosphere hydrosphere, they are interlinked. So we need to know and understand the natural processes related to earth and its environment.

So we will talk about the internal processes and we will go, as we move in this course, slowly we will talk about the internal processes, plate tectonics and all that. And then we will talk about the external processes.

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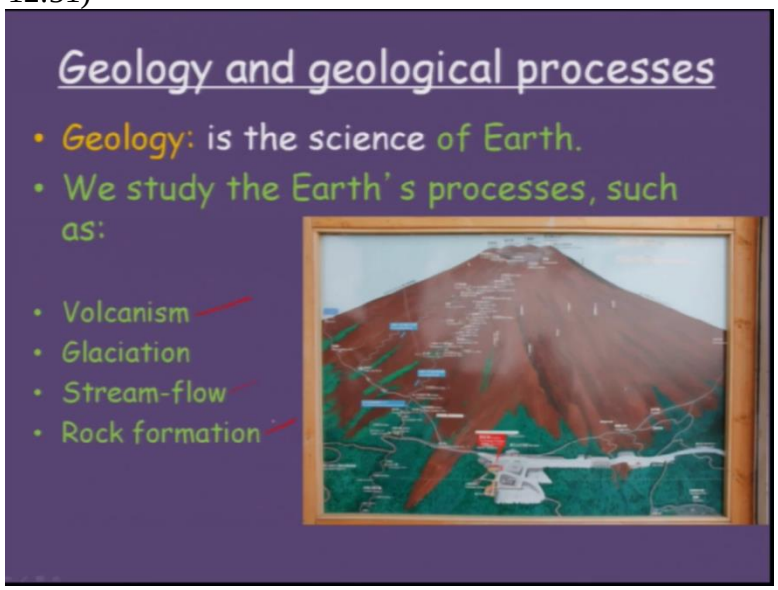

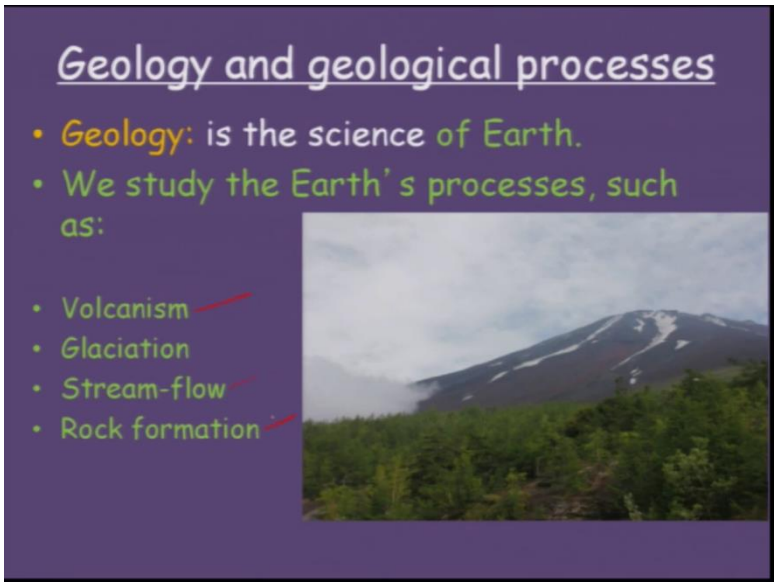

So geology and geological processes if you look at, what is geology if you define in short? Geology is the science of earth and we study the Earth's processes such as volcanism, glaciation, stream flow, rock formation. So here we will be talking about the volcanism, we will talk about the stream flows and we will talk about the rock formations. This is a picture of Fujiyama from Japan.

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And then, we will also try to understand the chemistry of the earth material. So we see those very very beautiful rock crystals or the minerals which we are looking at here, one is the diamond. Then we are having rock crystal and then we are having the Ruby. So to understand the minerals, dissolved minerals, and then we can also talk about the mineral resources which is extremely important for our Indian subcontinent or for our country. And then of course, we will talk about the rock formation and then rock formation.

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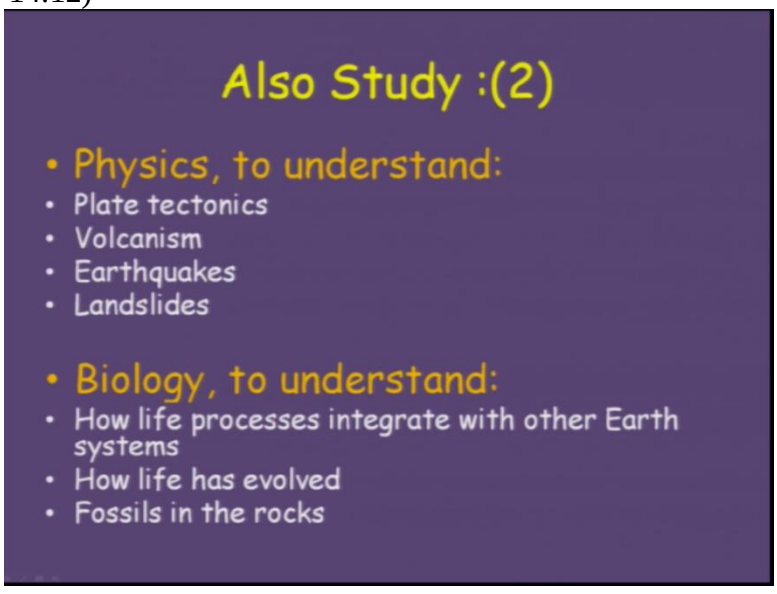

No geologists mostly try to study and understand the physics of the earth to know the plate tectonics. Then talks about the volcanism and earthquakes mainly. Then landslides. And then biology if you want to understand, then you talk about how life process integrated other earths systems and then how life has evolved. And the fossils in the rocks, they try to look at and try to understand how the things evolved over the time.

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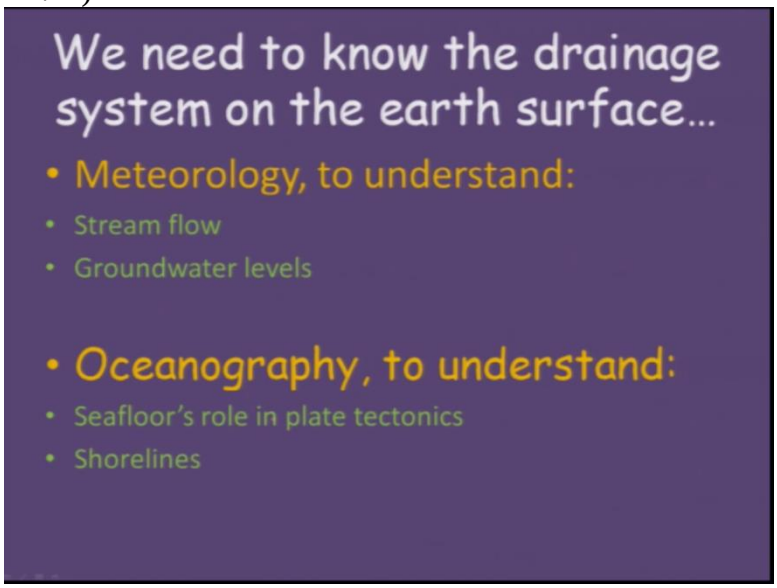

Then we also talk about, we need to know about the drainage system on the earths surface. So you need to understand the meteorology, steam flow, groundwater levels or stop and then if you go to the oceanography to understand the seafloor roles in plate tectonics, shorelines, how they have changed, how they have modified over the time.

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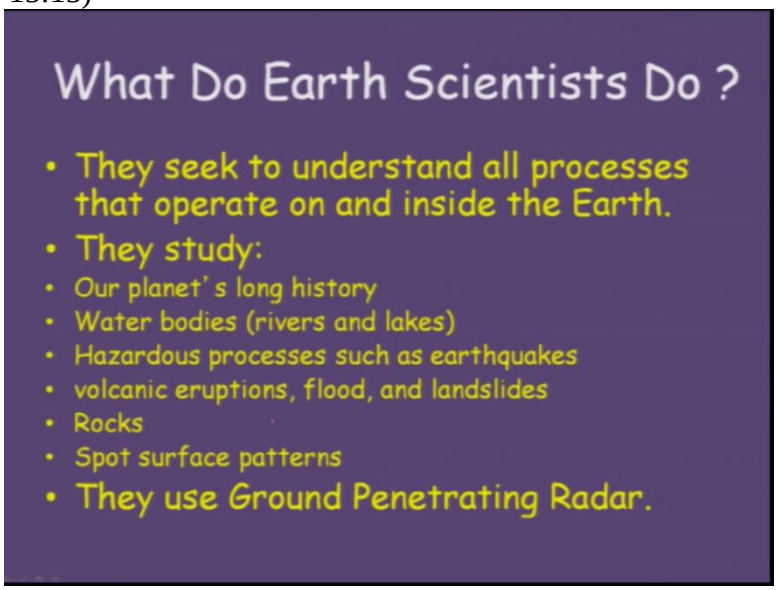

And what do earth scientists do mainly? They seek to understand all the processes that operate on and inside, that is internal and external processes within the earth. They study mainly like our planets long history, how it evolved and all that, come up with lots of theories and postulations that how the planet was evolved and they talk about the rivers and lakes water bodies mainly.

Then hazardous processes such as earthquakes, tsunamis and all that. Volcanic eruptions, floods and landslides. They talk about rocks. And spot surface patterns. So they too look at the, with the help of remote sensing, they try to study the surface process or surface morphologic. They also use, this is just an example to give but usually, the earth scientists, they use different type of geophysical techniques to understand or they penetrate the subsurface and try to understand the subsurface material as well as the morphology.

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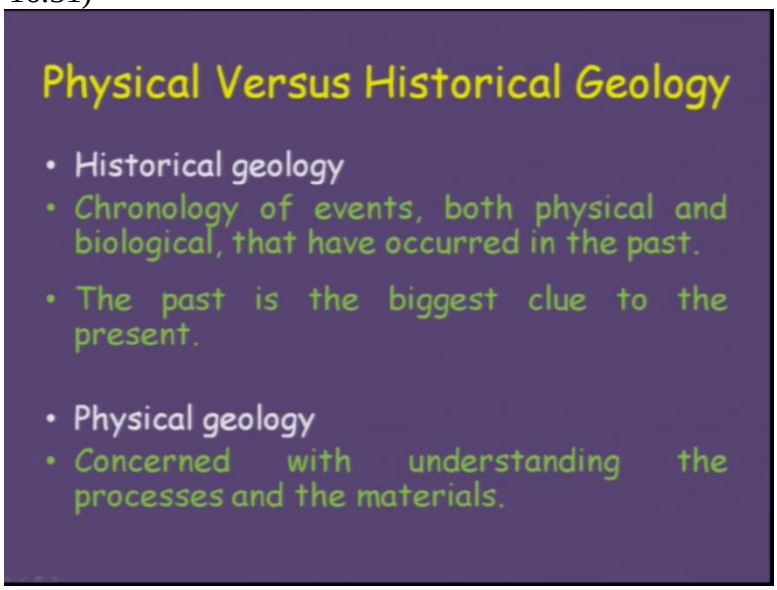

So they try to look at the physical vs historical geology. So of the events because as I told that there are particular period where there was an extinction. For example in Jurassic, we talk about the extinction of dinosaurs and all that. So what was that event? Why that species got extinct? It was because of massive volcanic eruptions. So whether there were some events which resulted into the drastic or affected the species or it got extinct.

So those can be studied and the chronological order can be built up in that term. So the past is the biggest clue to the present. So we usually try to understand the past. What happened in the past? And whether similar pattern will be repeated in the future. So, that we can predict. Then we have the physical geology concerned with the understanding of the processes of the material.

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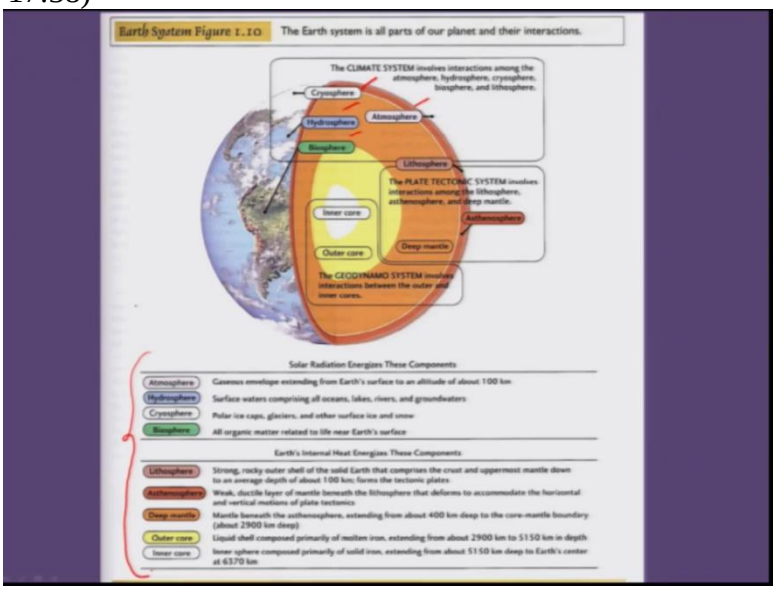

So now in total what we have discussed if you look at the Earth as a whole system, so earth system if you look at, we have the cryosphere, we have the atmosphere, the hydrosphere and biosphere here. And which involves, that mainly deals with the climate system. And then we are having the inner side. What we are having, the plate tectonics.

So we are having climate system which exists over the surface or we can say the external process and this is the internal process what we are having, the plate tectonics which involves the interaction amongst the lithosphere, asthenosphere, these details I will talk when we are talking about the internal of earth.

So what is the asthenosphere and what is your deep mantle and core and all that? But in short, these all are linked. That is what we called as the interlinked system between one another. Now what we will do is, we will go to another topic and that is what we are going to talk about, the plate tectonics.

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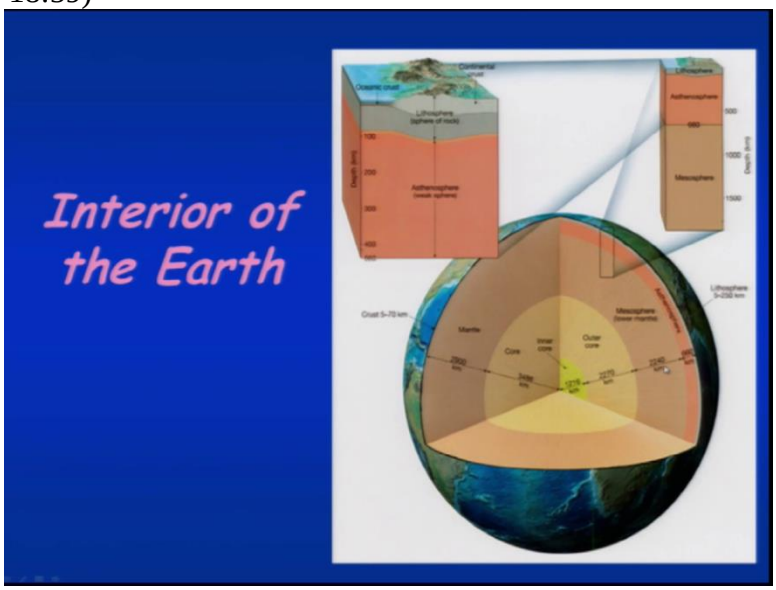

So before we get into the part of plate tectonics, we will talk about or discuss about the internal structure of the Earth. And then we can move and talk about the plate tectonics part. Because then, if we are not having the understanding of the internal structure of the Earth, then we will not be able to understand the processes that is the plate tectonic process. So internal, as we discussed very briefly that the interior of earth is not homogeneous. It is not homogeneous.

It is having different layers. So we have like core, we have mantle and then we have crust. These are the broader classification of the Earth.

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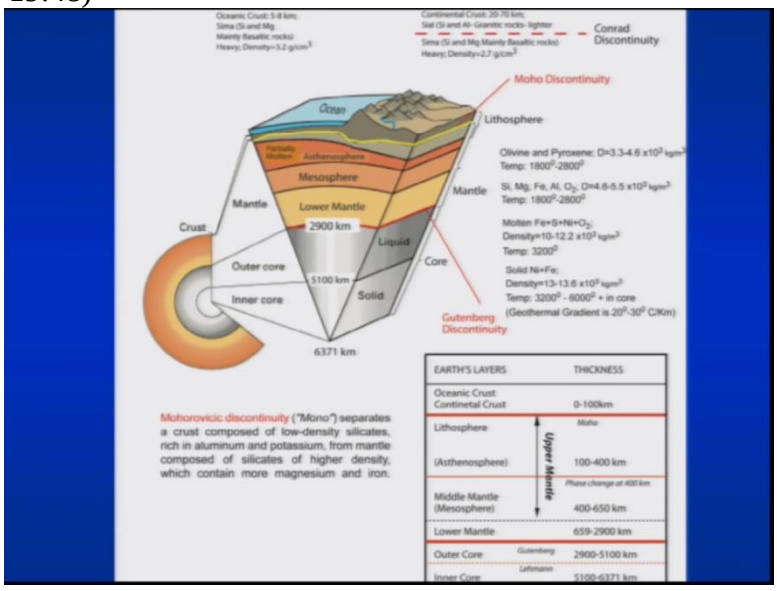

Nowadays is in very much detail, which talks about, of course when we talk about, we will be talking about the interior of earth, and the seismic waves and all that. We will talk about how the seismic waves helped in knowing the variation of the material or the boundaries of different layers within the earth's surface. So whatever we have marked, for example, if you are looking from the surface, we are having the oceanic crust and we are having the continental crust.

So these are the 2 crusts we are having. And this forms the lithosphere. So this we are having, the lithosphere which is comprised of oceanic crust and the continental crust. And its thickness is very meagre because if you look at the total radius of the Earth, we are having almost like 6370 kilometres. So we are having very thin portion of the earth that is lithosphere and that is comprised of continental crust and the oceanic crust.

So if you look at the details here, you may refer when you are given the slides. So what we are having here is that we have the oceanic crust, the thickness is almost like 5 to 8 km and the thickness of the crust that is what we are having of the continental is 20 to 70 km. And then, it has another very important characteristic which we should remember is that the oceanic crusts are heavier. They are having around 3.2 G of density whereas the continental crust is comparatively lighter and it is around 2.7.

The reason is that the oceanic crusts are comprised of heavier rocks. Mostly, the basaltic rocks are comparatively heavier whereas the continental crust are comprised of the material of the rocks which are made up of silica and magnesium. So they are comparatively lighter as what we see in the oceanic crust. Of course, we are having further lighter ones which are extremely like comprised of what we call silica and aluminium.

So we call that as Sial, silica and aluminium. Mostly, the granitic rocks. We see in the or we find in the continental crust, they are lighter. We also have the slightly heavier ones which we Sima and mainly we are having this silica and then we are having the magnesium. And the contact between these 2 or the boundary between these 2 is termed as Conrad discontinuity. Now discontinuities have been identified by various seismologists and geologists and they have been named accordingly.

So this is the boundary between the lighter rocks and the heavier rocks within the continental crust. Whereas here there is no such boundary which exists and the oceanic crusts are

comparatively thinner. But even though they are thinner, they are heavier as compared to the continental crust. Then if you move further down, then we are having the contact, that is the boundary between the lithosphere, the top surface, the oceanic crust and all that and the lithosphere we are talking about.

Then we are having the boundary which is marked as a Moho discontinuity. Now Moho discontinuity, it separates the crust comes rise of low-density silicate which an aluminium and potassium from the mantle, that is mantle is again the upper part. If you look at here, this part is the mantle completely which is comprised from here up to this part. This is the mantle part. So from mantle composed of silicate and higher density, which comprises or which contains more magnesium and iron.

So this is the boundary between, the Moho is the boundary between the crust or we can set the lower part of the mantle here. And then, we have another one which is a very important one, it is termed as the asthenosphere. The asthenosphere is which occurs at the depth of 100 to 400 km. And this layer is partially molten.

This layer is responsible for generating convection currents or convection within the layer because of the heat flow. And this is responsible for the moment of the plates or the continental or the oceanic crust on the surface. I hope you people might be knowing that this oceanic crust and the continental crust are moving.

They are not stable. So they are having the relative motions with respect to one another and they are not stable. So asthenosphere is responsible for that. And then we are having mesosphere, we are having lower mantle. And then we have this one that is the outer core is liquid one. So we will continue this in the next lecture. We will start with the interior of earth.