Elements of Ocean Engineering
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Lecture - 3A
Physical Oceanography – III

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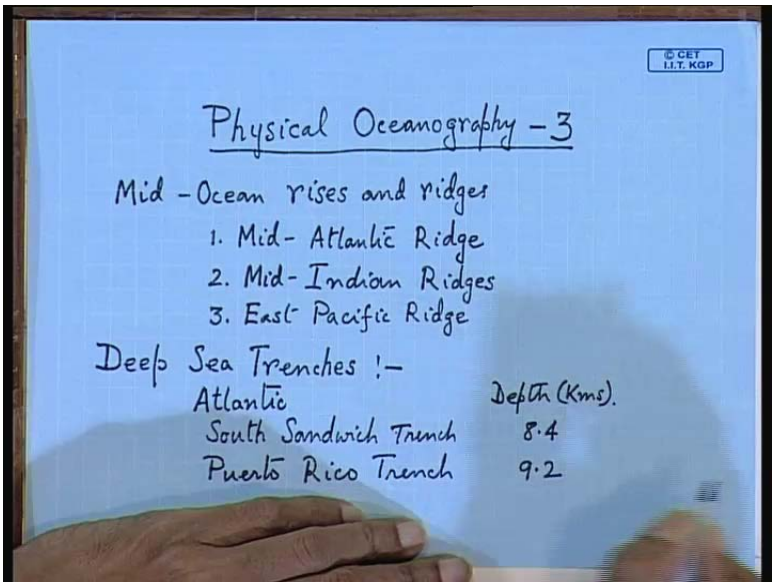

This is the discussion of the ridges and trenches. So, first you have the mid Atlantic ridge, now the reason I am telling you this is that, you will be aware of, what is the function of this ridges, and how you are going to solve your problems of ocean currents. Now, next is your mid Indian ridge, now these ridges actually separate your ocean basins, now the last one is east Pacific. So, these are the three ridges separating your basins, the primary reason is this act of sort of barriers to the ocean currents or ocean flow.

So, if you want to mathematically model the ocean current, you have to take this boundary conditions of this boundaries of the ridges. Now, similarly you have deep sea trenches, now what is the function of these deep sea trenches, why you should know the location of the trenches. So, ridges are actually boundaries for ocean current circulation, but deep sea trenches, so the first one in the Atlantic. So, these are the main elevations and depression from the, elevations of course, are the ocean ridges and the depressions are your trenches.

So, in the Atlantic, you have south sandwich trench, so depth you write in kilometers, so depth is 8.4. So that means, your water in mud will be circulating in this trench, so south sandwich trench is 8.4 kilometers. Next is the Puerto Rico trench, this is 9.2.

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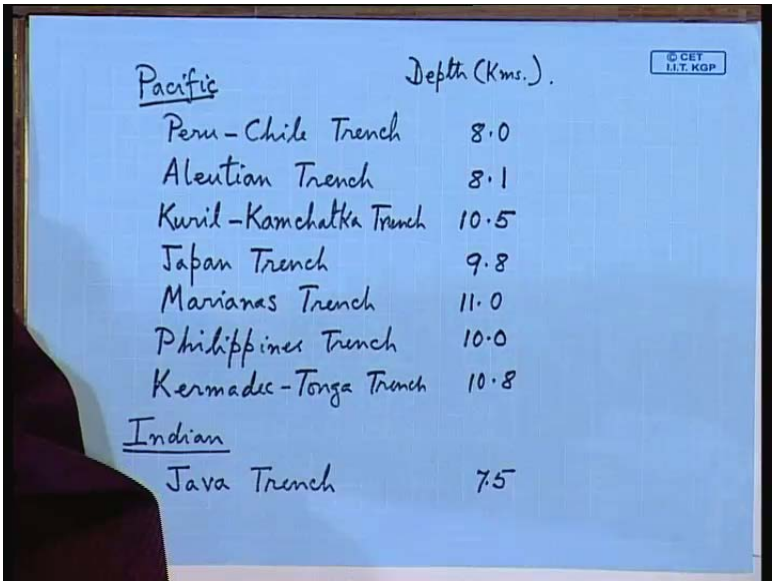

Now, in the Pacific, so here you have depth in kilometers, Peru Chile trench is 8 kilometers in depth. Next is Alention trench, Russia Kuril Kamchatka trench, so that is 10.5, Japan Japan trench is 9.8. So, in the Pacific you have deeper trenches Marianas trench, Marianas trench is 11 kilometers in depth. Then you have Philippines 10 and the last one is Kermadic Tonga, I think this is in Africa is 10.8, so the Pacific is having deeper trenches. The Indian trench, here the Indian ocean, here in Pacific ocean, here the java trench 7.5 kilometers, so these are the features of the trenches.

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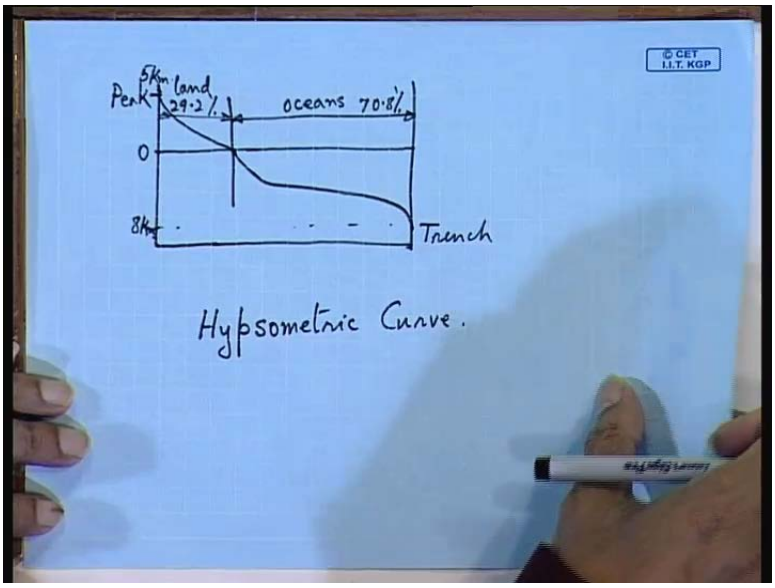

Now, this rough idea are you get from, what is called a hypsometric curve, so this is the highest elevation on land and somewhere here you are crossing the sea level and then, it is going like this to a trench. So, this is highest peak and the deepest trench, now sea level is somewhere here. So, peak is how much, let us say 5 kilometers and this is 0 and this is roughly, let us say 8. So, this percentage is consumed by oceans, 70.8 percent of the earth surface and the rest is your land elevation is 29.2. So, 70.8 percent of the earth surface is having a depression from 0 to 8 kilometers and 0 to approximately 5 kilometers is covered by land elevation upto 29.2 percent. So, this is called hypsometric curve.

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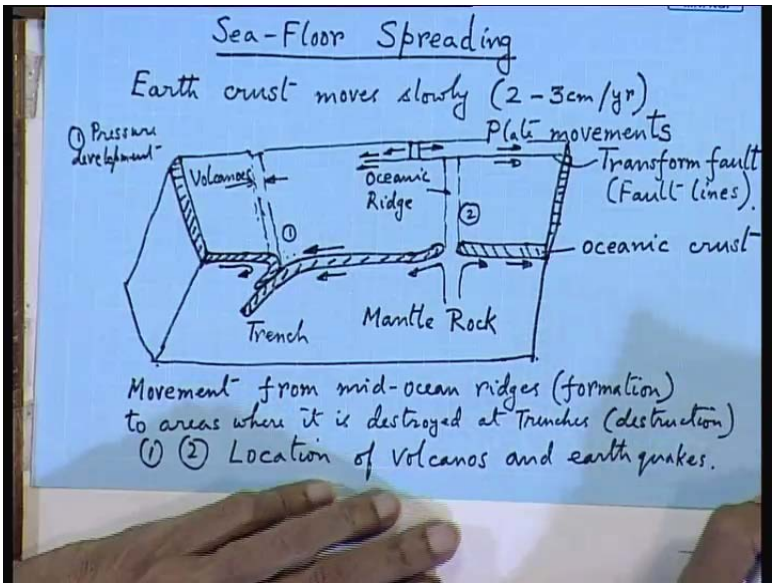

Now, next important diagram is, what is called sea floor spreading, now what is this, now here you will find, I have already told you that, the earth's crust is not stable. Apparently, since you are sitting on the floor you find that, you are not moving, but your earth's crust moves slowly. What is the speed, speed is approximately 2 to 3 centimeters per year, is the movement of the earth's crust.

So, this I think you will be familiar to the geologist, but for your knowledge you should know that, the earth's crust on which most of your offshore structure will be situated, will be moving at the rate of 2 to 3 centimeters per year. Now, in this block diagram, you will see this movement and how it is affecting you. Now, here you will find geological folds, which are coming on the crust that is, rock formations.

Geological terms, these rocks are called plates and in civil, if you are happen to be in the civil engineering or geology department, where the separate subject which is called plate tectonics, which mainly deal with the movement of these rocks or plates of rocks. Now, they are the main cause of what earthquakes, that is why this separate branch of study has come called plate tectonics or rather you can write plate movements.

So, if you happen to build offshore structures, which are having the foundations from the ocean flow, you have to have some knowledge of this plate tectonics, anyway this is the rough sketch of a or a section of the ocean flow. Now, in this region, you will find two plates going against each other, the direction of motion are against each other. So, fold

has come in this region, which plate will go deeper down actually, depends on the velocity and the nature of the plate.

Now, here you will find development of a trench, this is a location of a trench, so very good location for existence of volcanoes, so trench is all, in that way if it is dangerous. Now, next is the occurrence of a ridge, so how this ridge is going to occur, so when two plates are moving towards each other, we have a trench. So, when two plates are moving away from each other, so in this diagram you can see that, these two plates are moving away from each other in opposite directions.

So, this is a location of a ridge, so this you called oceanic ridge, now in this direction you will find the plate movements to take place in this direction, so this is called a transformed fault. So, whenever you building an offshore structure, be careful about locating the trenches, ridges and fault lines. So, this is actually your fault line, these are prime location for existence of earthquakes. So, in India actually there is a fault lines on the Gujarat coast, where you have predominance of earthquakes.

Another fault line you will find near, where this recently the earthquake happened, is in the Java trench. So, Java trench is famous for earthquakes and Gujarat and also Japanese coast, so this is called a transformed fault and this is your mantle rock. So, your oceanic crust is floating on mantle rock and since it is floating, it is also moving. So, earthquakes is actually an important study for ocean engineers, it is a civil engineering subject, but once you do any engineering with the sea floor then, you have to have some knowledge of the earthquake dynamics or earthquake phenomena called sea floor dynamics.

So, oceanic crust is floating on mantle rock and it is having all this velocity in this directions. So, you can write that movement from mid ocean ridges, so movement starts from mid ocean ridges. So, you write formation to where, to areas where it is destroyed that is, a movement is stopped, so these are called trenches destruction, destruction of the movement. So, the oceanic crust is constantly forming, so the movement starts at a ridge and it is destroyed at a trench or it is stopped at a trench.

So, at this juncture, lot of pressure takes place, this area and these rocks are unable to bear this pressure then, there will be fracture will occur on the rocks. Rocks has fracture then, the liquid molten material will come out from the mantle rock. So, you have

volcanoes, so volcanoes and earthquakes, so this is your bottom profile or the bottom of the sea floor.

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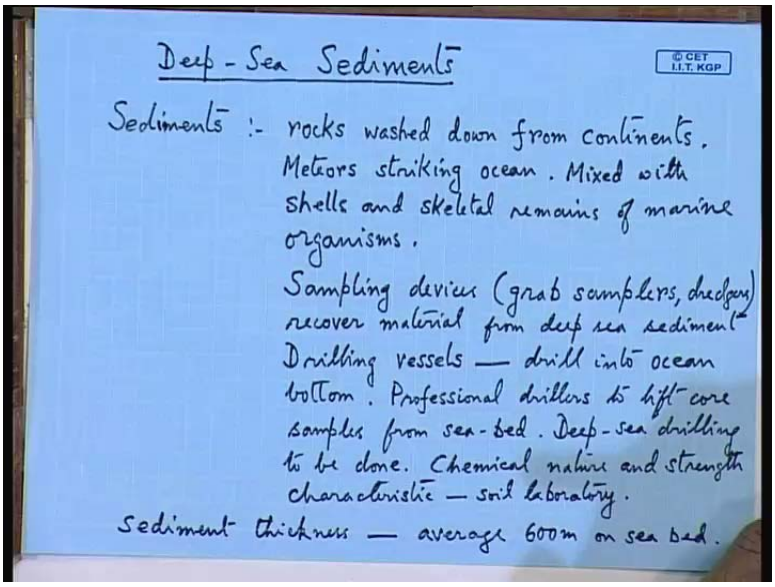

The next part is deep sea sediments, the ocean engineers since they have to build structures on the sea floor, you have to know, have some knowledge about sediments on the seafloor. So, these sediments are caused by what, now sediments are mainly rocks, washed down from continents. Here the primary cause for sediments, so one has to study what is called sediment transport, who want to go deeper into this formation of deep sea sediments.

Another cause is meteors striking ocean, now while these rocks are going from your land to the sea, they are getting mixed with shells and skeletal remains of marine organisms. So, ocean engineers or geologists has to study the nature of sediments, if you want to build any structure, your civil engineer, he studies the nature of the soil, several branch of study he has made, that is called soil mechanics. You have to study the sediment nature or how much strength bearing capacity it has.

So, these are normally done by sampling devices, done by ships which are called grab samplers or sometimes they are also called dredgers. These are special type of ships, which have equipments for excavating soil, but how are you going to lift soil from the deep ocean floor. Deep ocean floor is, say of the average depth is 6 kilometers, now can

you design a dredger with a grab having 6 kilometers depth. So, what you are going to do, so that is the challenge, so recover material from sediment, from deep sea sediment.

So, that is special types of dredgers that we device for that, it will have a long conducted tube and sledges, where you suck the sediment and transport it up or else you can do by ships, which are called drilling vessels. So, you have to design special ships, which can lift samples of sediment from the seafloor, so these vessels basically drill into ocean bottom. So, drilling is another activity which is specialized, so there are separate organizations, which specifically teach and instruct or trained professional, what is called professional drillers.

What I am talking in the class that I want from knowledge, will not do for drilling, so professional drillers have to be trained to lift core samples from sea bed, that is not a very easy job, it is a risky job. And so personal and special equipments will be the there to do deep sea, this is called deep sea drilling. So, the main idea is to lift core samples from the sea bed and study the nature, so what nature you are going to study. So, you have to find out the chemical nature of these samples, chemical nature and strength characteristics.

We happen to be in the drill ship, the drill ship may have a lab of it is own, it will start analyzing the chemical nature and strength characteristics, you have to do it in a soil level drilling. So, in the civil engineering department, you have your soil mechanics lab, there you can study the strength characteristics of the sample that is, the shear strength, cohesive strength and all these things you have to study, bearing strength also. So, sediment thickness, average you write 600 meters, 600 meters on seabed, so this is the texture of the sea bed, with which you are drilling.

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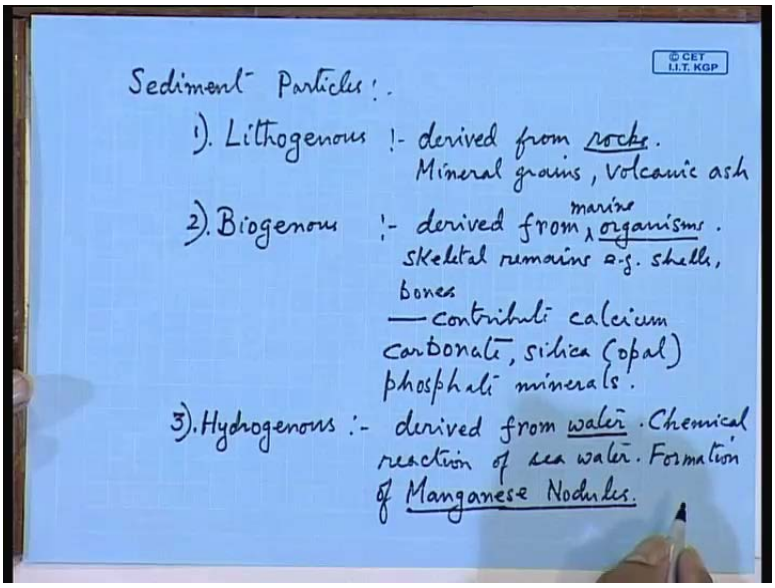

Sediment particles, the two broad categories are lithogenous, lithogenous means derived from rocks. Now, from where this rocks come, that is mineral grains volcanic ash, so the primary particle of sea floor sediment is lithogenous. Next, you have biogenous, so derived from organisms, so these are mainly skeletal remains, shells, bones, etcetera. This comes from what, the marine fish, whales, etcetera, which have died or there are corpses, so shells, bones.

Now, these are main contributors to calcium carbonate, silica this is called opal and phosphate minerals. If you want to do your chemical and strength analysis, so you do segregate all these sediment particles, lithogenous and biogenous, these are the different characteristics. The last variety is hydrogenous, so hydrogenous is, so first one is derived from rocks, derived from rather you write marine organisms, the last one is derived from what, is derived from water.

So, this is chemical reaction of sea water, sea water actually main physical component of sea water is what, salt. So, it will have ionize, ions will be present which will aid chemical reaction. Now, as a result of this, over a large period, you have formation of manganese nodules, so they are rich in iron, cobalt, nickel and manganese. So, these manganese nodules are found because of chemical reaction of seawater, so these are hydrogenous sediments. So, mostly these manganese nodules, you will find in the Pacific ocean.

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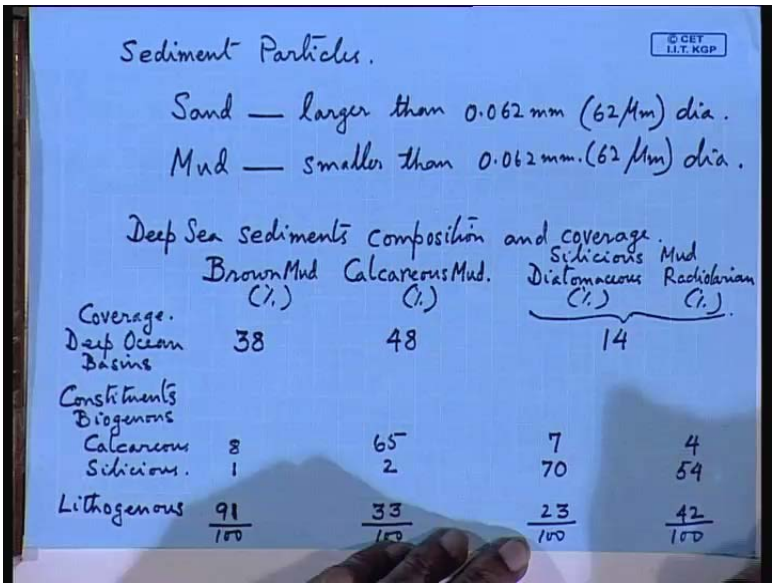

Now, sediment particles, now if you want to do engineering in the land, so you have to know what is the soil and here sediment particles. Now, the first segregation is between sand, what is sand and what is mud? Now, in structure engineering, strength characteristics differ from sand and mud, so sand is, the particle size is larger than 0.062 millimeters or you can write 62 mu m, micrometer, this is in diameter, so that is the definition of sand.

Mud is smaller than this, smaller than 0.062 millimeters, so this is your physical demarcation between sand and mud. Now, deep sea sediments, composition and coverage, so some knowledge has to be there in your minds, if you want to build any offshore structure. So, I told you, offshore structures are built around a specific site or a environmental location. So, your composition of sediment in the Pacific ocean, Indian ocean and the Atlantic ocean will great Deberry.

Now, here you segregate into brown mud, next you have calcareous mud then, you have siliceous mud and siliceous there are two varieties, diatomoceous and the other one is called radiodarian. Coverage you write deep ocean, deep ocean basins you have, coverage means the area. So, 38 percent of ocean basins are covered by brown mud, 48 percent of ocean basins are covered by calcareous mud, rest is 14 percent there is a siliceous variety.

So, this is the area coverage and coming to the composition, you have constituents, I think this do not have time now. First you biogenous, now under biogenous you have two categories that is, calcareous, the siliceous, the last one you have lithogenous, lithogenous are derived from rocks. Now, constituent you write, calcareous is 8 percent, siliceous is 1 percent and this is your brown mud composition and this is 65 and this is 2, so how much it comes and lithogenous composition is 91, so you add, this total will be 100 percent.

So now, you can see, actually this is the margin, anyway I will be this write little bit about this. So, here the calcareous mud composition is 65 2 and the rest is lithogenous you have 33, so this is 100. So, brown mud composition is 8 percent calcareous sediment, 1 percent siliceous and 91 percent constituent is of nitrogenous variety will be there in brown mud, whereas in the calcareous mud, you have only 33 percent. And coming to the siliceous mud, the diatomaceous you have 7 diatomaceous and the other is 70. The rest is 23 lithogenous and radiolarians is 4, this is 54 and 42, so total is 100, so this is giving you the chemical composition.

Thank you.