Elements of Ocean Engineering
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Lecture - 5
Sediments and Open Ocean

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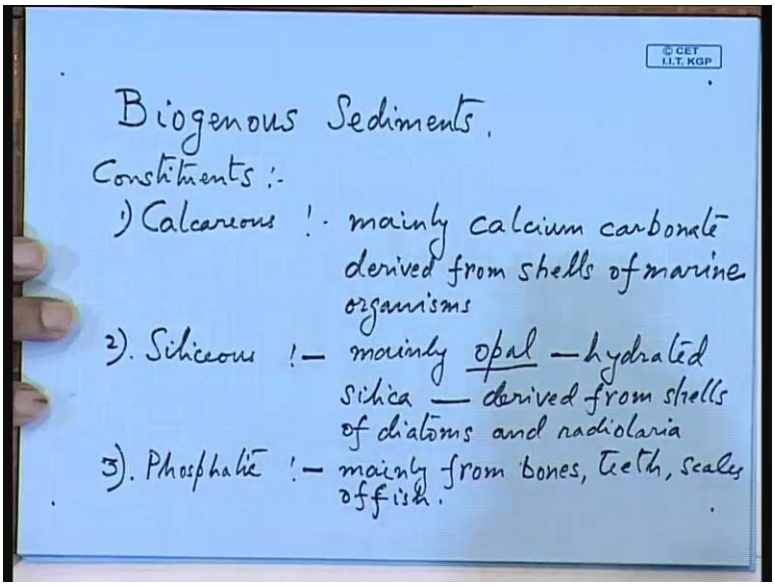

So, the two more types of sediments are remaining that is biogenous sediments and hydrogenous sediments. So, the first one, in the last class I told you that is the constituents of biogenous sediments. So, first one is calcareous. This is calcium mainly calcium carbonate derived from shells of marine organisms. The next type is siliceous. So, this is derived from silica or you can write mainly opal. So, this is hydrated silica and this is derived from shells of diatoms. So, in the last class I told you what are diatoms and radiolaria. So, these are marine organisms which are small and which have pseudo podia like and all that had told you. Last variety is phosphoric. So, three types are calcareous, siliceous and phosphatic. So, these are again mainly from bones, scales of fish.

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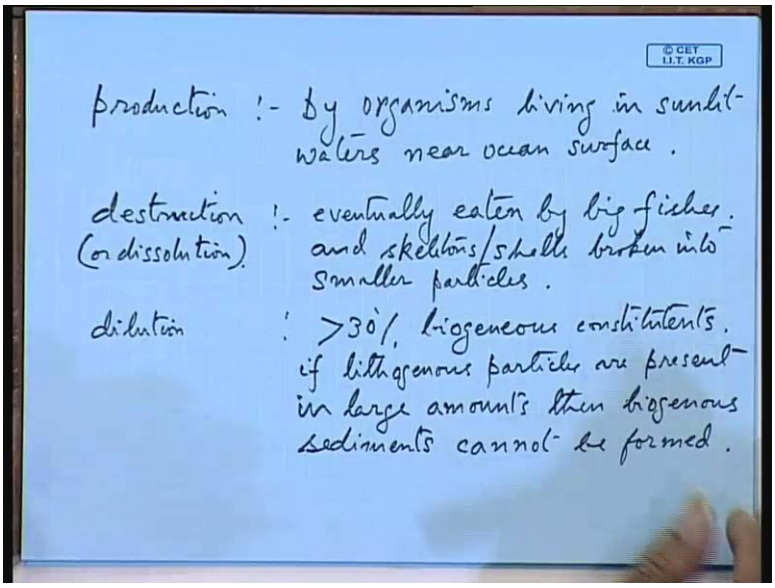

Now, these are production you write organisms leaving in the sunlit portion of the waters, sunlit water near ocean surface. So, this is production. Now, destruction or dissolution. Dissolution means they get dissolved in the sea water. So, eventually eaten by fish or you write by big fishes and skeletons shells broken into smaller particles and after this they get diversity on the ocean water. Now, the dilution greater than 30 percent biogenous constituents. So, if the sediment is greater than 30 percent biogenous constituents, so it will be called biogenous sediment. Now, if lithogenous particles are present in large amount, then the biogenous segments cannot be formed. So, this is the drawback. The last one is the hydrogenous sediment.

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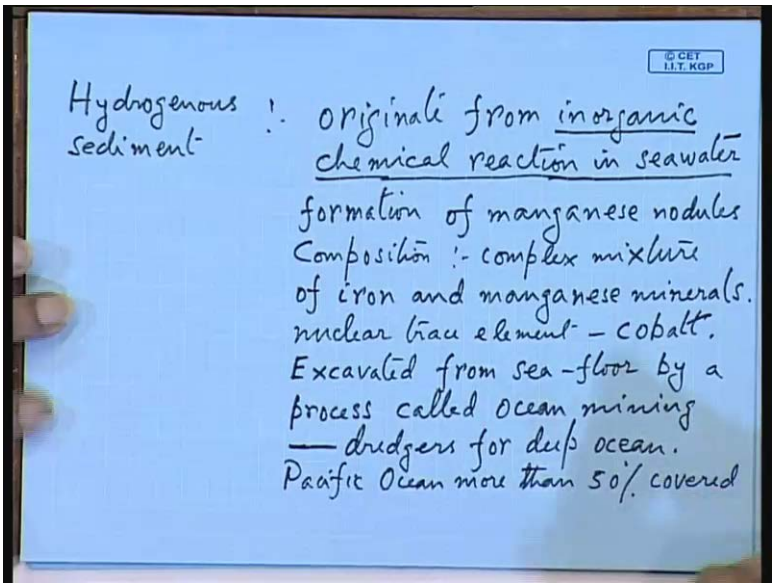

So, we are finished with biogenous, lithogenous and the last variety, hydrogenous sediment is formed from water. So, this originates from in organic chemical reaction in sea water over a large period of time. Formation of manganese nodules. As a result of inorganic chemical reaction in seawater, manganese nodules are formed. Now, what are these?

So, complex composition is complex mixture of iron manganese minerals. So, you will find the maximum quantity is the actual percentages you have got, but if you look at the genous, they give you the percentage of manganese and iron. Then you have nuclear trace elements and that is why people are running after these such as cobalt. Cobalt is also a nuclear element. So, that is also formed. Then you have iron and manganese. Copper is also present. So, these are excavated from the seafloor by a process called ocean mining. So, basically these are dredgers for deep ocean, Pacific Ocean more than 50 percent covered with manganese nodules.

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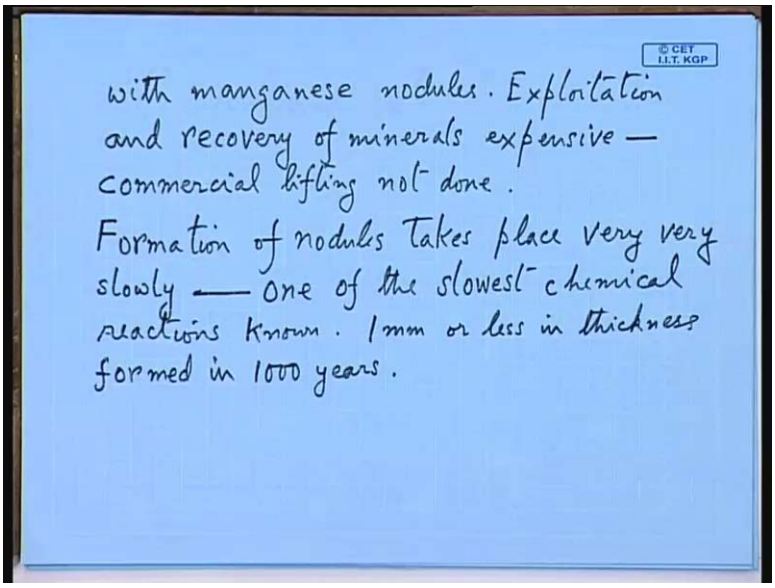

Exploitation there is lifting to the surface and recovering the minerals, that is called as exploitation and recovery of minerals expensive. That is why do not have commercial exploitation, right. Now, it is giving in the research stage. So, it is the minerals that you extract that is mainly, iron, manganese, copper and nickel is also present. The nuclear element that is called copper, their extraction and recovery of these minerals from large depths in large amount is still not possible. They are still in the research stage. Now, formation of nodules takes place very slowly. So, mankind is exploiting the natural resources of the ocean very fast.

First it is extracting all the oil and then it is extracting all the minerals. So, after a few 100 years, you will be left barren. So, formation of nodules takes place very slowly. You write this is one of the slowest chemical reactions known. The reaction speed is one millimeter or less in thickness formed in thousand years. So, this is one of the slowest chemical reactions, but we are fast exporting this resource just after your now. So, with this we have finished the sediment part that is related to your ocean floor.

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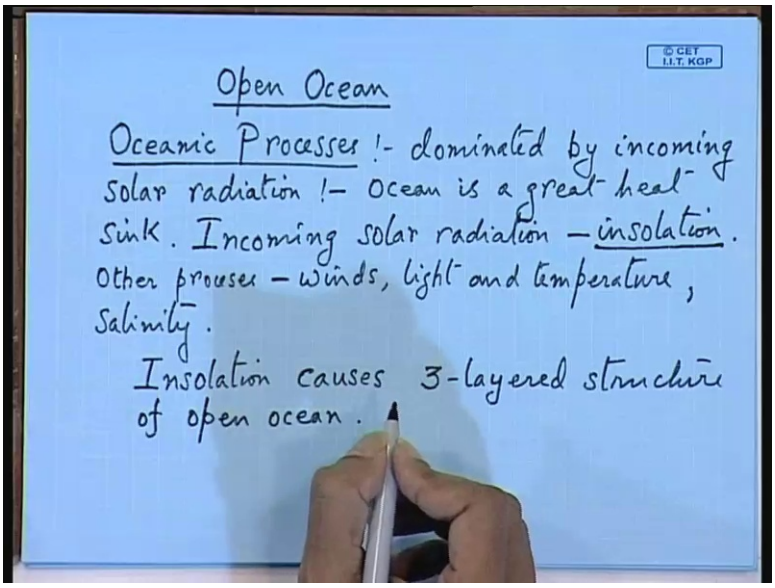

Now, let us see what happens in the open ocean. So, this is the last of your physical ocean, the open ocean. There are oceanic processes. Now, these are dominated by incoming solar radiation. So, portion is actual here great heat sink. So, the mankind is able to use this huge amount of solar radiation that is coming on to the ocean surface and solve most of your energy needs, but unfortunately we are not developed technology for this. Now, this incoming solar radiation is called insulation.

Yeah, ocean processes are influenced by heat coming from the sun that is called insulation. I have ordered the other processes. Other processes are winds, light and temperature. So, this plays an important role on your climate, winds, light and temperature. Of course, temperature is also influenced by incoming solar radiation. So, these are the sum of aspects which influence them.

The last one of course is salinity. How much saline your seawater is? Now, later on you will find salinity influences density of seawater and the result of change of density. You have ocean circulation. Now, because of this phenomenon, insulation causes three layered structure of Open Ocean. So, the main water body in the ocean is divided into three distinct layers. Straighter from this diagram you can see now what are these straighter? You will find the first one is called surface zone.

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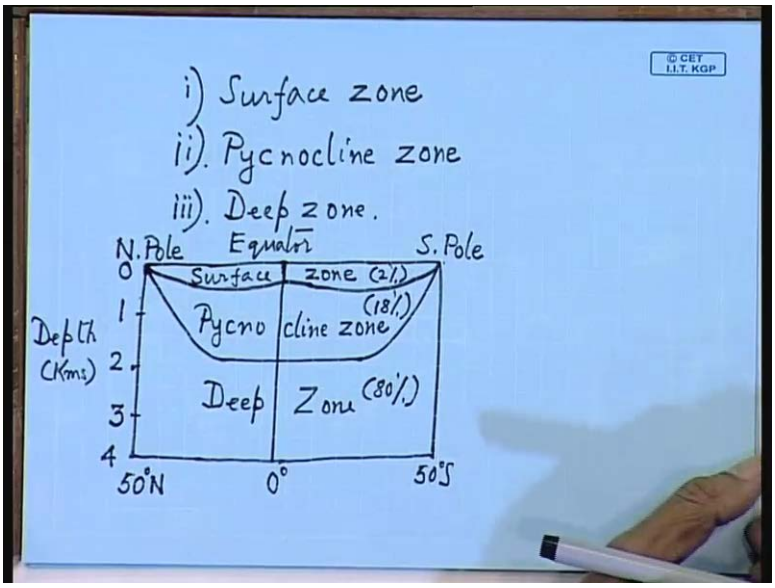

So, the ocean waters are stratified into three layers. First, there is called surface zone, second layer is called pycnocline zone. Pycnocline is where we have maximum density variation and the last one is called deep zone. Now, from this diagram you will be able to make out what are these three zones. So, this is what is happening in the open ocean. Now, this water mars you divide into three regions. Middle line is near the tropics or the equator that is our country is mostly affected or it is in this region equator. The other extreme you write South Pole is opposite you North Pole, and depth is you are interested up to 4 kilometers below the ocean surface.

So, this is four here, here two. So, this is 1, 2, 3 and 4. So, let us study where that is affected by this oceanic processor are limited to 4 kilometers below the surface. So, this is debt in kilometers. Now, what happens between the North Pole and South Pole covering the equator is you write this is 50 degree north, this is zero degree your equator and this is 50 degree south. Now, you have a surface zone. Now, this is even less than one kilometer in thickness. So, it is going like this from the north pole to the south pole, and you can see in the equator actually the depth of the surface zone is decreasing.

Now, next you have up to 2 kilometers near the pycnocline zone. The diagram actually goes like this. So, the top one is surface zone. Next you write pycnocline zone and below that is yours the deep zone. Surface zone constitutes 2 percent of the water mass

followed by 18 percent in the pycnocline zone. Rest how much is there? 80 percent. So, deep zone waters constitute 80 percent of the water mass

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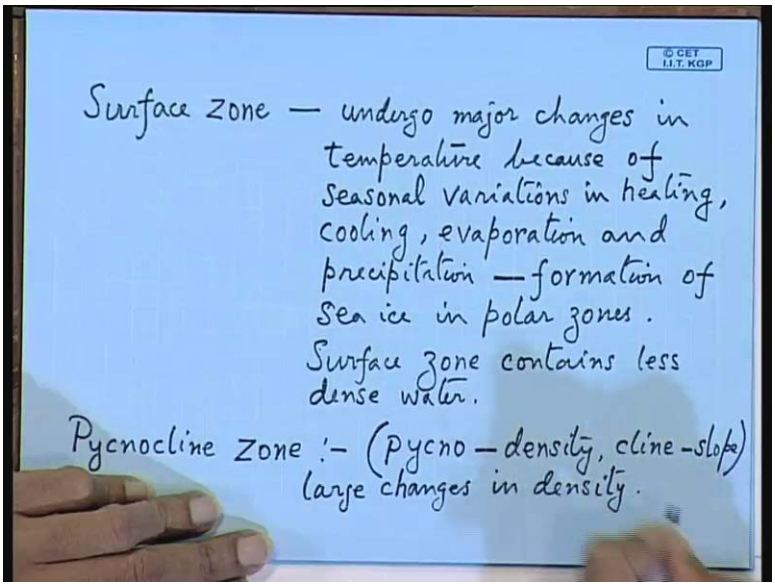

So, the distribution of the three layers between the North Pole and South Pole. Now, from this diagram, let us first analyze what is happening. So, what is happening at this surface that is called the surface zone? So, surface zone obviously undergo major changes in temperature. So, this zone is the most affected by the incoming solar radiation. So, this is affected by major changes in temperature because of seasonal variations in heating. So, you have to have a good knowledge of thermodynamics. We want to analyze the rising in the temperature.

So, later on I will give you an equation where you can calculate the heat flux. So, seasonal variation in heating, cooling and the result of this heat, also you have a evaporation and precipitation. Now, your maximum evaporation and precipitation will work on your tropics and formation of sea ice in Polar Regions or other you write polar zones. Now, surface zone contents less dense water. The density is less. That is why it is remaining at the surface. If the density is high, obviously will go down to be depths. Now, this zone as derived from these two words. Now, after this we end the surface zone.

Now, next is your pycnocline zone. So, ocean engineers were doing ocean thermal energy conversion. So, they are interested in this layering of the water and what is the

change in temperature. So, pycnocline zone, it is derived from these two words that is pycno is density and cline means coming from inclines. So, that means slope. There is a large density gradient in this region, large changes in density. Now, what happens because of this, because of large changes in density?

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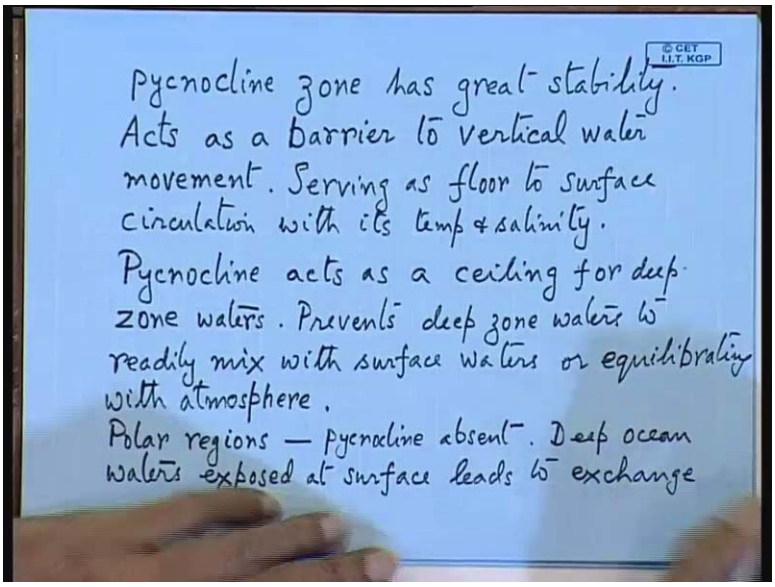

You have ocean circulation. So, that we will come back later. Now, this zone is particularly stable. Pycnocline zone has great stability. Now, because of this stability, what it is doing. So, surface zone is affected by temperature and wind. So, it has great stability. So, this acts as a barrier to vertical water movement. So, from the diagram that I have drawn, you can see this zone where as pycnocline zone from this diagram you can see at the equator. This zone is deepest, that is depth of the layer is deepest at the equator. That means, at the equator the deep zone water cannot come to the surface. So, this zone is acting as a flow for this surface zone and acting as a roof of the deep zone. Here you will find the poles. This is the South Pole, this is the North Pole. There is no pycnocline zone. So, that means, at the poles deep zone water can come to this surface. There is no barrier.

So, lot of circulation of the ocean water takes spaces at the poles rather than at the equator. So, the equator zone is more effective by solar radiation acts as a vertical barrier to water movement serving as floor to surface circulation with its temperature and salinity. So, in the poles, is it advantages or disadvantages? You can see from the

diagram that there is no pycnocline zone and deep zone. Water can come to the surface. So, that means, there is a vertical circulation that is conducive for fishes for the moment of the food and you will find rich fetching field in the arctic waters that is the main reason serving as a food. Temperature and salinity of the surface zone does not go below. So, this also acts as a ceiling for deep zone rather you write for deep zone waters.

Now, the mechanism is to prevent deep zone waters to readily mix with surface water. So, prevention of mixing is taking place or equilibrating with the atmosphere. So, it is mostly unaffected by winds and incoming solar radiation. So, polar region I told you this is absent. So, what is the climate of polar region? Pycnocline zone absent, deep ocean waters exposed at surface leads to exchange of gases.

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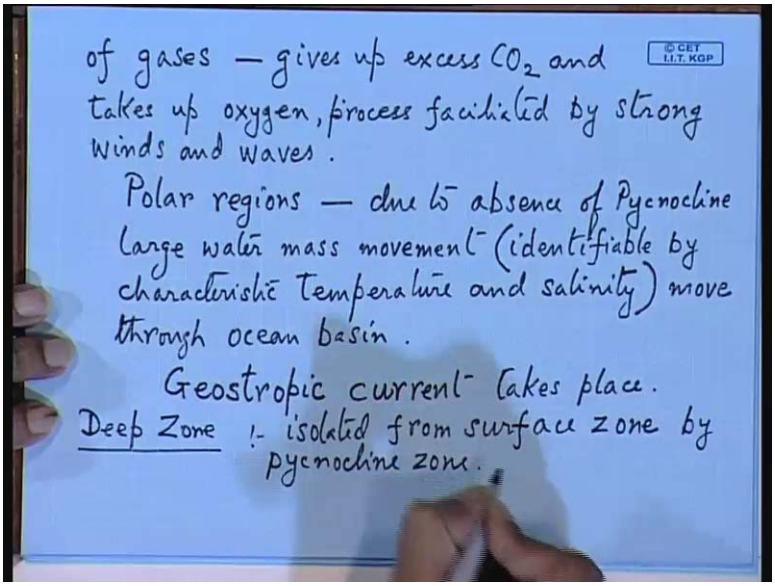

So, this is what taking place at the poles. It gives up excess CO2 carbon dioxide and takes up oxygen and this process is facilitated by strong winds. So, in the polar region, you have strong condition that is strong winds and waves. Polar region rejected the environment harsher. So, in this region you do not have the pycnocline barrier. So, what happens here the polar region due to absence of pycnocline zone, what I told you is the rich fishing harvest that comes from the ocean basin. The other is more important which affects climates is large water mass movement. So, you will notice just below the Arctic region, top of the Antarctic region, you have used circulation of water mass. So, large

water mass movements and these are characterized or rather you write identifiable by temperature and salinity. So, you have removed the barrier.

So, now what you get is a global ocean current circulation taking place at the entire Antarctic. So, large water mass movement identify characteristic temperature move through ocean basin. What is the ocean basin? So, ocean basin is the diagram that is that I have drawn is the bottom part of ocean. So, that is occurring at deep zone. So, what is the deep zone? You have basin. So, you can see in this diagram that the ocean basins come here just below the deep zone.

The deep zone is lying on your basin and here is the huge circulation going across the circulating throughout the globe at the Arctic Antarctic region. So, that is what is called the Geostropic current. There is a huge current. So, later on we will discuss the type of currents that is taking place in the ocean. So, this we have finished last on of course little bit about deep zone. So, this deep zone has also some characteristics what I told you this. So, this is mainly isolated from surface zone. This is main characteristics by what the pycnocline zone. This is one of the characteristics of the deep zone.

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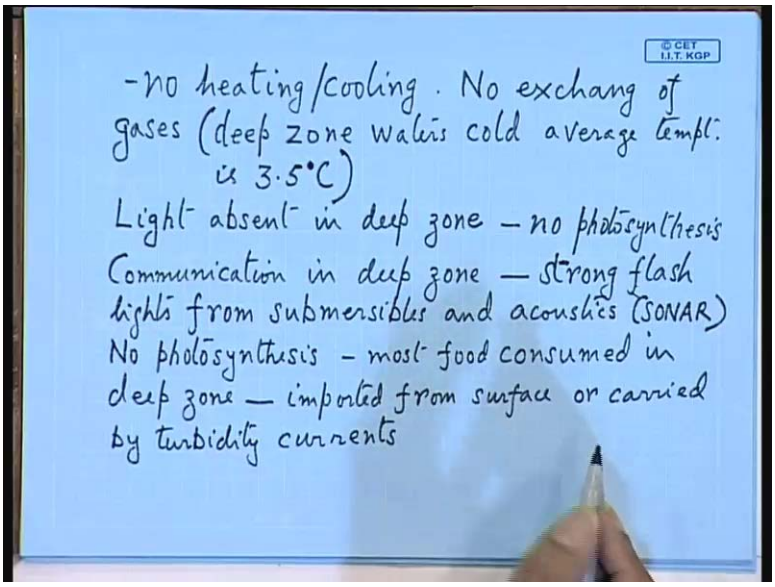

Now, as a result of this, there is no heating cooling, no exchange of gases. Deep zone waters are cold average temperature. So, this is three and a half degree centimeter and surface water temperature, it can vary from minus one point submersible degree centigrade to high as 30 degree centigrade near the equator of the topics, but deep zone

waters because they are unaffected by this surface zone. You will find mainly around three and a half up to four degree centigrade. Another characteristic is light absent in deep zone. So, if we happen to go below 4 kilometers from the ocean surface, you are in perpetual darkness. So, that is light is absent in deep zone as a result of there is no photosynthesis. So, how you are going to communicate in the deep zone? Complication in deep zone waters is mainly done by strong lights. You have submersible, you should have a focused light. It is a one means.

So, any objectives on the ocean floor so; that means, if you want to retrieve you should have strong lights in the submersible and the other means of complication is by noise or by sound. So, communication in deep zone waters, communication in deep zone flashlight, strong flashlight from submersibles and acoustics. So, if you want to retrieve an object which has sunk titanic pieces or then you have to cover the ocean floor with strong flashlight and sonar, this is called sonar arise. So, under water communication is done by this method.

So, no photosynthesis. So, then what happens? So, most food is consumed by fish in the deep zone. So, these are imported from surface or carried by turbidity current. So, turbidity currents as I told you that are mainly caused by earthquakes in the deep ocean. So, they are the main carriers for your food for the futures. There is no other way because if you can extract some food from the surface zone in the polar region under equator, of course you cannot do anything because your pycnocline barrier is coming.

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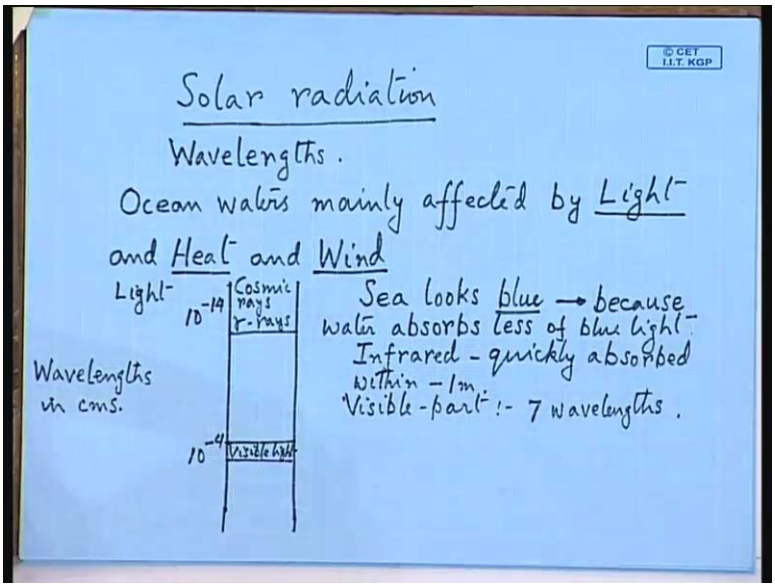

Now, the next is solar radiation. Now, prior to going to this solar radiation, we should look at the wave lengths. Now, what are these wavelengths? Now, the oceans are mainly affected by two parameters. What are these two parameters? Both come from the sun affected by light, water and heat and rather the parameter which effects so far told you is called wind. Now, in the mythological study you find wind is also created from the heat that is the solar in solution that is coming to the earth. Now, before we go into this, let us have a look at the wavelengths.

So, this is your scale light. Wave length is coming somewhere here. This is 10 to the power minus 14 cosmic rays gamma rays. In short I am writing like this. Now, wavelength is standing in centimeters. Now, the reason is, what is the reason behind this sea looking blue? So, the deep ocean water if you have a look at them, they are blue in color. What is the reason behind this? Water observes less of blue light. The light or white light that you see consists of 7 wavelengths out of which the blue is the least observed. Mostly it is reflected. So, that is why the naked eye you see is blue waters. So, the ocean waters are blue.

Now, before I think this time what is this infrared doing? Infrared radiation is doing cause of heat in the ocean. So, this is quickly absorbed within one meter. Now, next you have the visible part. So, I will give you this diagram in next class. Now, this consists of seven wavelengths. Now, before that in the scale where we come, this visible light in

which somebody has giving the other scale. This is 10 to the power minus 4. This is visible light. So, in the next class, we will finish this and discuss about insulation.

Thank you.