Surface Mining Technology
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Lecture 54
Seabed Mining - I

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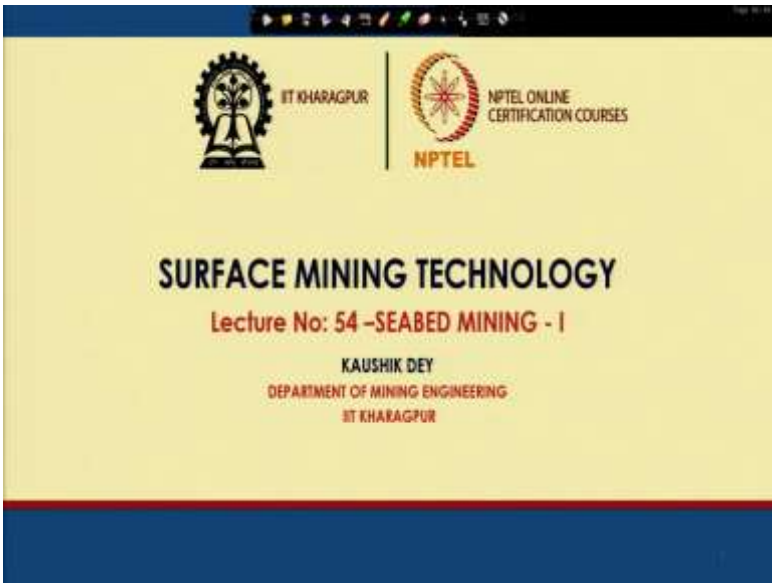

Let me welcome you to the NPTEL online certification course Surface Mining Technology, this is the lecture number 54. And in this lecture we will discuss about the mining of Sea beds, there will be two lectures on this. So we will discuss of Seabed Mining in these two lectures, this is the first lecture on that. So this is the 54th lecture.

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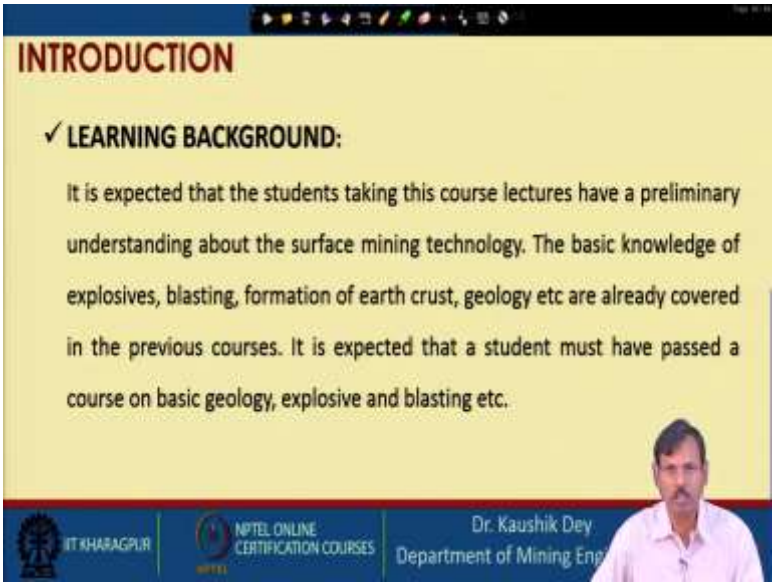

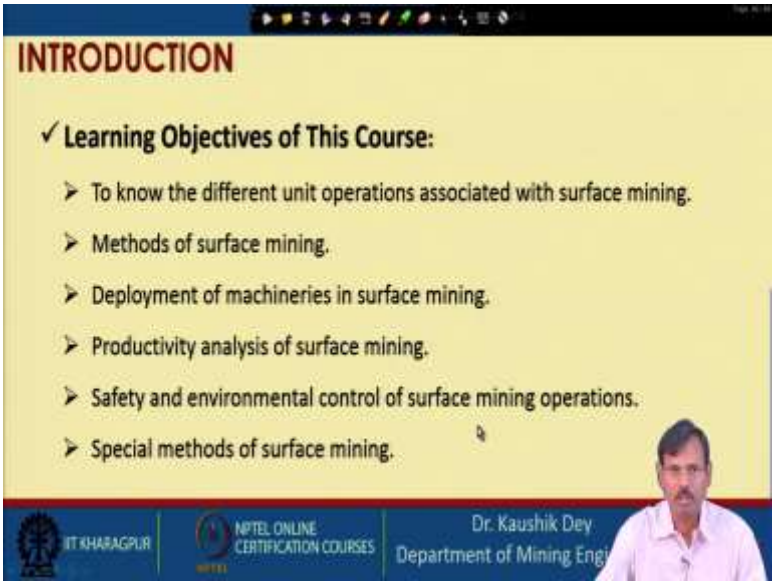

Let us have our once look on to the learning background required for Surface Mining Technology course. And these are the learning objectives of Surface Mining technology course, this is the objective.

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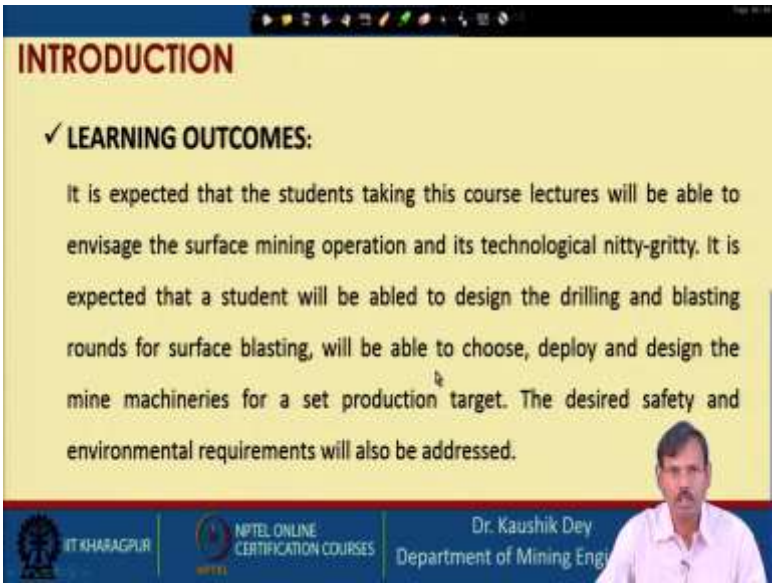

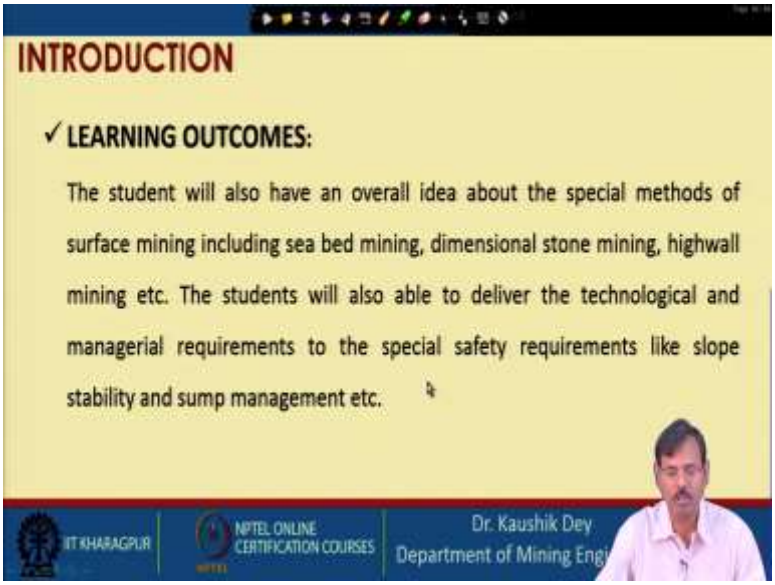

And these are the learning outcomes expected from the, from a participant of Surface Mining Technology course. There are few more learning outcomes expected.

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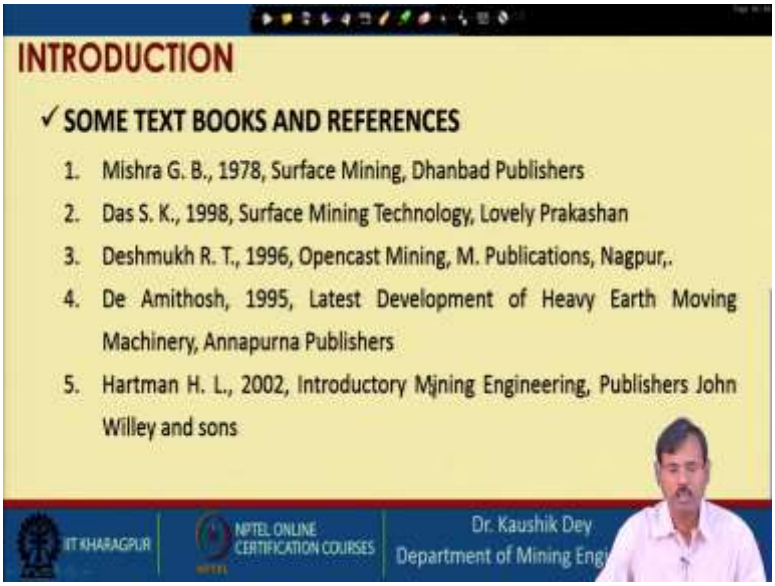

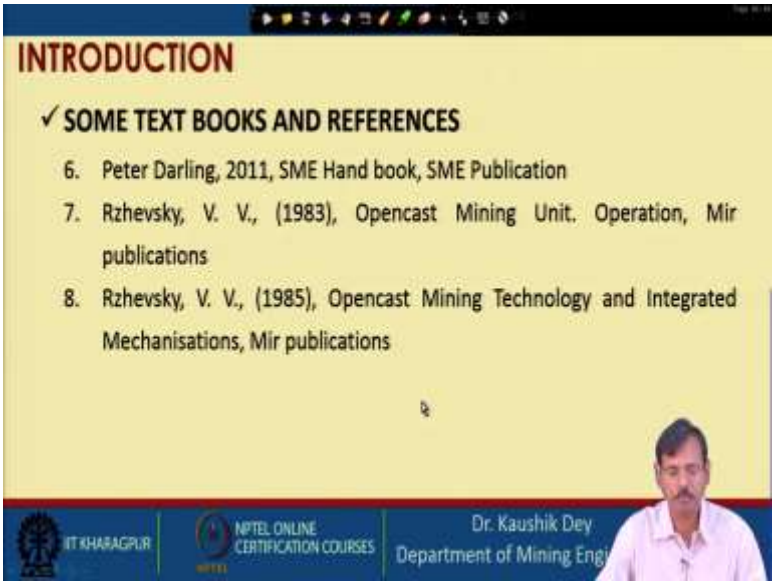

And these are some of the text books and reference books which are advised to follow.

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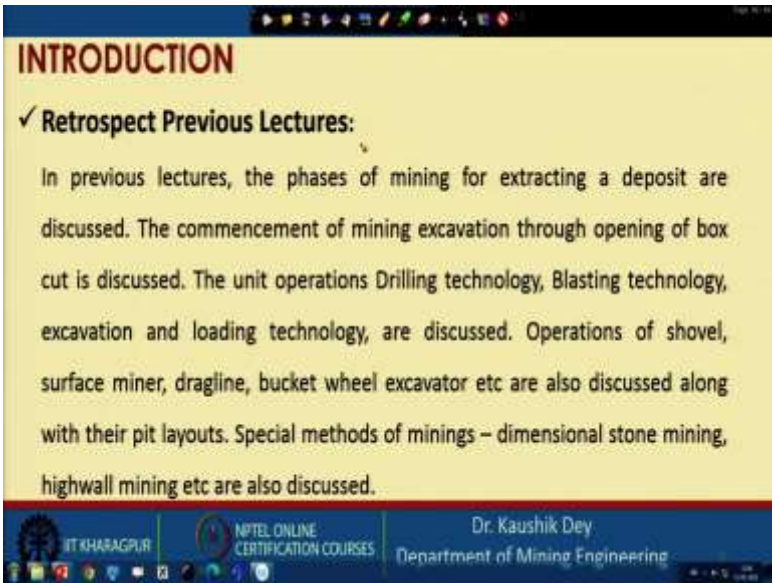

And let us look into so far what we have covered. So far we have covered the current status of the Surface Mining in the country in the world. We have covered the phases of mining a deposit, we have covered the box cut, opening of box cut which is the commencement of surface mining.

And we have covered the different unit operations drilling, blasting, excavation, loading and we have also covered the shovels, surface miner, dragline, bucket wheel excavator and other related machinery equipments. We have covered the dimensional stone mining; we have covered the high wall mining also.

And in fact it is well understood now, that surface mining technology is nothing but the mining with horizontal slices, where the horizontal slices are taken to excavate the material and gradually the stripping is carried out. So this is the Surface Mining Technology.

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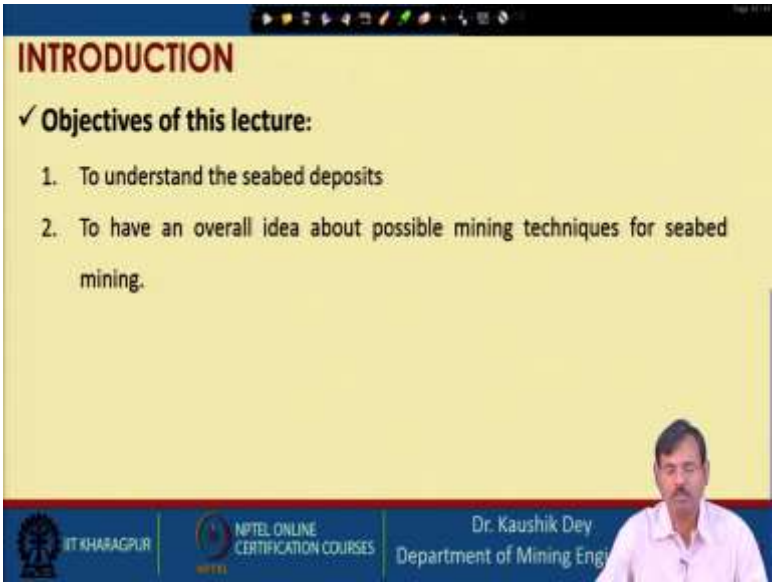

Let us see the objective of these lectures, that is the objective of lectures pertaining to seabed mining, so the there are two objectives, we want that the participant should understand what is a seabed deposit and should have an overall idea about the possible mining techniques for seabed mining.

So there is an idea that almost our surface deposits which are available in a intact land we have already excavated a significant portion of that, the remaining portions either in a very deep seated condition in the earth or sometimes they are locked with the inhabitances, etcetera. So the excavations of those deposits are becoming problematic.

However, as the civilization is there, we are having requirement of minerals, we are having requirements of metallic ores, etcetera. So that need has to be fulfilled, but our land lock area: the excavation potentials are reducing and the mining potentials are also reducing. Deep mining are often found not that much economical and that is creating a problem.

However, it has been found that significant portion of the economic minerals are available under the sea which are basically locked into the sea. But that can be easily taken out, so the thinking on that is under process and that is why the initiative has taken since last 50 years for excavating these things.

However, so far the practical exploitation or commercial exploitation of the seabed deposits are not significantly come out, occasionally some excavations are made but significant excavation of the those are not made in in a whole hearted way. Though in some cases close or adjacent to the sea excavations are made like in Indian condition if you are considering Indian rare earth, they are excavating the beach sand which is close to the sea.

But those sands are basically excavating, but those are also underwater excavations, so underwater excavation is having some potential and those are basically carried out. So seabed excavation is basically one type of underwater excavations but a number of pros and cons are there. So during these lectures we will discuss about those things and I hope this will be very, very interesting.

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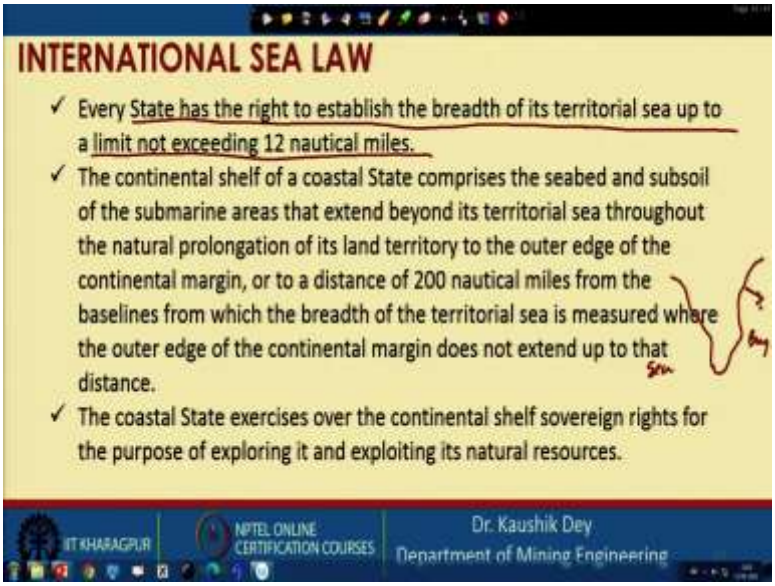

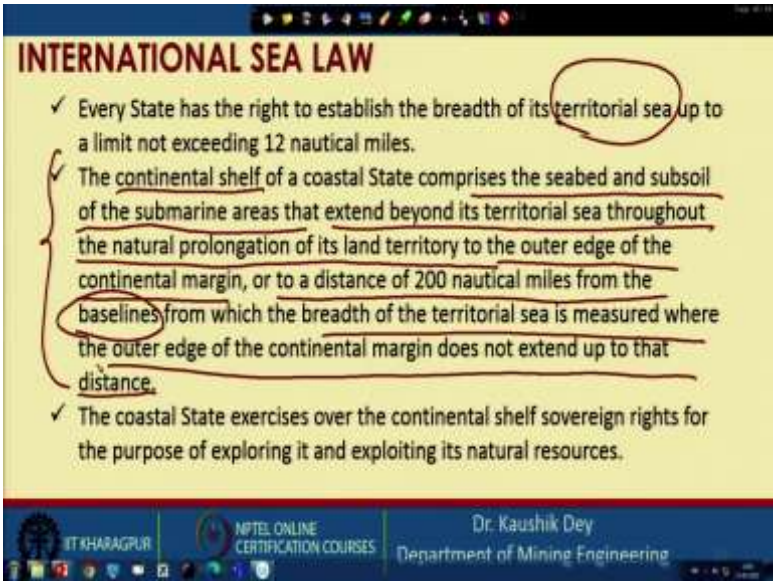

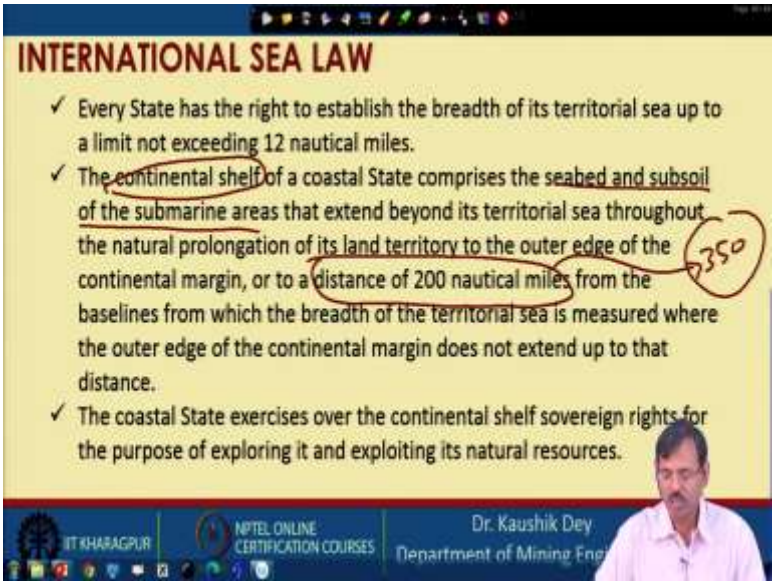

So before this, let us first understand what is international sea law. In 1984 actually sea laws has come out from 1950s onward after the Second World War, but one global understanding has been made in 1980 to 84 onward. And that time, a number of common understanding is made, one of this common understanding is that every state has a right to establish the breadth of its territorial sea up to a limit not exceeding 12 nautical miles.

Means whatever it is, if say this is our Indian territory, this is Arabian Sea and this is Bay of Bengal and if we are considering this from this coastal baseline, in fact there is a definition of the baseline also. So if you are going through the details of this international sea law these are all available in the website. So if you are looking into this you will find out how that baseline has to be established, those are already made there.

So if you are considering the baseline at this position, from the baseline to 12 nautical mile naturally, this is the property of that particular country. So no other ships or whatever is there they cannot or any citizen they cannot enter into this 12 nautical mile without the approval of the concerned state. So up to the 12 nautical mile it is the state property, all those fishermen, etcetera., they are allowed to carry on their fishing etcetera up to this and there is no restriction on these acceptances.

There is a definition of continental shelf of a coastal state comprises the seabed and sub soil of the submarine areas that extended beyond this territorial sea. So territorial sea was up to 12 nautical mile, this is extended beyond territorial sea throughout the natural prolongation of its land territory to the outer edge of the continental margin or to a distance of 200 nautical mile from the baseline.

So baseline we have already discussed, there is a definition of the baselines which the breath of the territorial sea is measured, where the outer edge of the continental margin does not extend up to the that distance. This portion is directly taken from that international Sea law. And this is very, very important that means it is allowing a distance up to a 200 nautical miles can be considered as the continental shelf.

And that territory is having a right on the seabed sub soil of that marine area. So that means if any deposit is found within that range that can be easily exploitable by that concerned state with a notification to the international Sea units. So we will, that is having a standard right, in fact as per that it can also extend develop to 350 nautical mile also, so that is also there are rules for that.

But we are not going into the details that means we are having the scope where we can carry out excavation of seabed deposits up to a certain depth and that those are easily exploitable. So this is very, very important part and continental shelf sovereign rights for the coastal states having the rights for exploiting its natural resources. So they are having the right to exploit these things as their property considerations of those areas.

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So now owning that, everyone is now interested in Seabed Mining, so Seabed Mining is basically also termed as the deep sea mining. And generally seabed mining is the excavation of the deposits of the sea floor. And deep sea mining where the depth of excavation is 200 meter or greater is considered.

But when all these things are carried out, monitoring has to be carried out by the international authority. So as per the web source availability Japan was the first country to successfully mine its seabed of 1600 meter on its continental shelf of Okinaka; Okinawa coast in 2017 and this is a photograph of the same. Though this is before that also, it is carried out but not a systematic way not in a continued way it is made.

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SEABED MINING

https://www.youtube.com/watch?v=vMs_hoBdGSw&t=2s

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SEABED MINING

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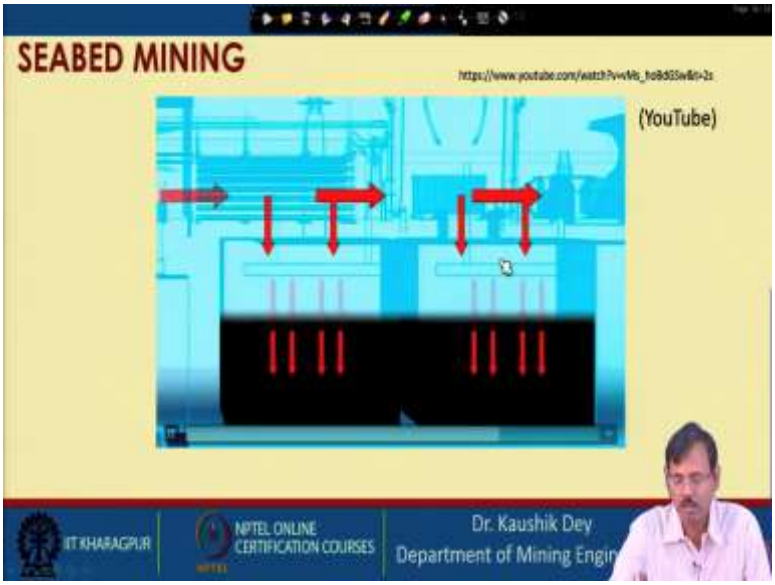

So this is an animated video which is showing the possibilities of Seabed excavation using a technique. So where the sea obviously ship has to be placed there then an excavator has to be lowered till it is reaching to the seabed. Then the excavator is allowed to dig the material so excavate the material or this is another way of excavation where the excavation is made.

And the material, this is a boom type excavator and the material is sucked, after this excavation the material is sucked. And then pumped to the ship and from the ship it can be from the ship it can be transferred to the boats and that can be in the boats and that can be sent from this through this boat from the sea to the land coast.

So in fact in the ship itself the dewatering has to be made and the water has to be recharged into the sea and the same water may be used for taking out the or slurry transportation of the cut material. This is a general idea this is a generalized idea.

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This is another video, similar animated video where this type of excavator is allowed see this is self-propelled type crawler mounted self-propelled type excavator. So the excavator is reaching even up to a depth of more than 2 kilometer, this is now more than 4 kilometer deep also this can work. And this is self-propelled type with a little power it can move.

And now it is basically taking out or excavating the material and this excavated material is is now taken out through this pipeline. This material is taken out through this pipeline there are power boosters here which is increasing the pumping capacity and the material is taken out like this.

So this is the slurry transportation system used through this pipeline and this is the water, after it is taking out in the ship dewatering is made and this is taken out or you may release that to the sea itself. So you can carry out this type of excavation in a deep sea condition also which is 4 kilometer 5 kilometer deep.

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So you can see ocean holds a treasure trove of valuable resources sand, gravels, oil, gas has been extracted from the sea. In fact, India also is excavating oil sources from the Bombay high in addition mineral transported by erosion from the continents to the coastal areas are mined from the shallow shelf.

And coast of diamonds, from the coast of south Africa, Namibia as well as tin, titanium, golds are thus available in the source of Africa, Asia and South America. So these are the common materials which are available. India is also carrying on mining in the seacoast through Indian rare earth.

Ocean mining is tried very recently, the major focuses are made on the manganese nodules specially for Indian considerations, Indian ocean and Bay of Bengal both are having a good

source of manganese nodules. Gas hydrates, cobalt crusts and sulphides and sulphides muds are also available, where the volcanic eruptions are there at a depth of 5000 to 4000 meter.

And this sulphides muds are containing metallic sulphides, which are the popular metallic ores so that is why below the sea beds are very, very valuable resources of mineral deposits and that is why we are interested on this.

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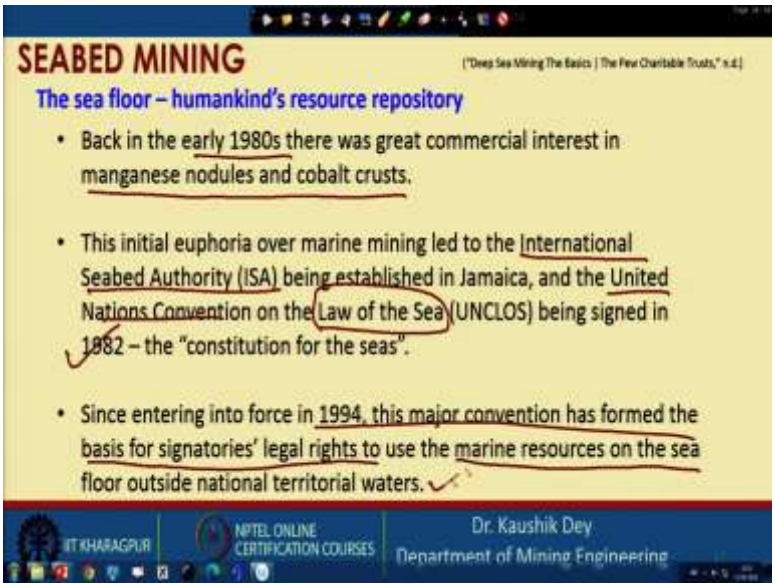

So in early 1980s the efforts are made for the excavation of the manganese nodules etcetera. And international seabed authority was established by United Nations and United Nations has established the law of the sea in 1982 which is, based on which this International Seabed Authority is basically working.

So 1994 onwards signatories asked for the legal rights for excavation of the marine resources in the sea, outside sea of the national territorial waters. And, that is why all the efforts are made to regularize this mining practices by this International Seabed authority.

So 60 percent of the world seabed that lies beyond the national jurisdictions comes under the Law of Sea and known as the Law of Sea Treaty. And economic zones which we have already discussed as the continental zone are basically considered which is not more than the 200 nautical miles.

So this is the continental shelf, in continental shelf this is considered as the exclusive economic zone of individual countries known as their continental shelf and coastal nations can have their monopoly on excavating in this continental zone. So that is the as per this convention this is already established.

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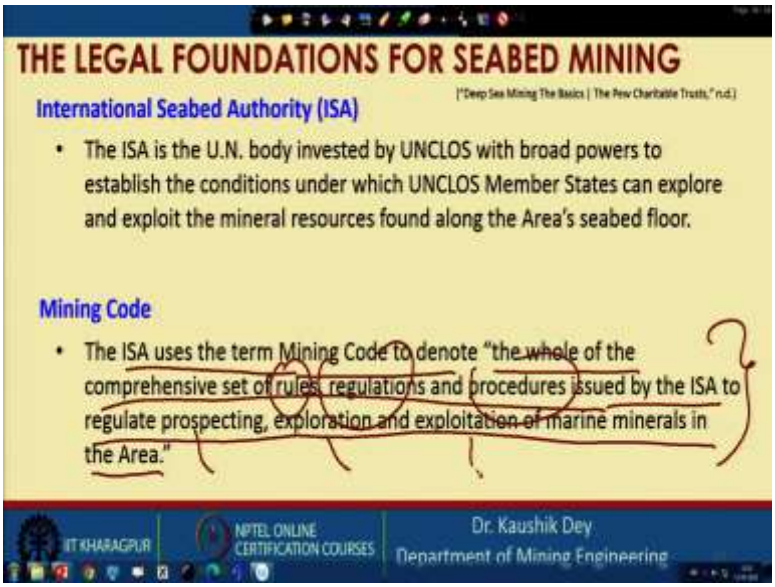

And International Seabed Authority basically has the power to regulate all these things and uses the term mining code to denote the whole of the comprehensive sets of rules, regulations and procedures issued by the International Seabed Authority to regulate prospecting, exploration, exploitation of marine minerals in the area.

So whatever exclusive economic zone is obtained for by each states or each country, in that zone how the mining has to be carried out all those rules, regulations and procedures for prospecting, exploration and exploitation is basically governed by the International Seabed Authority.

So it does not directly comes under the apex body of the country but it is coming to the International Seabed Authority. The main reason is that any pollution, any safety hazards are basically creating the problem to the international sea beyond that.

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So that is why this part is very, very important. And that is why deep sea mining is in a nutshell you can see deep sea mining, this is the future mining requirement. This has to be incorporated and should not be avoided, we are having significant deposits, the deposit quantity is significant.

Now you can see these the occurrences of different zones are shown, distribution of the cobalt crust, this is the distribution of the cobalt crust, this is the manganese nodules, so this is the manganese nodules, availability of this. So if you look into this you can see India is

having here, so we are having some close manganese nodules available in this place and black smokers are also available some of this in this place.

So these are close to our territory, we are having excavation rights on them. So apart from that these are deep sea deposits explored scantily. So it is not fully explored, we do not know how much deposit is there, only few deposits are found using some of the geophysical techniques. Because the bottom part of the sea is not accessible and that is why it is not explored fully, so a partly it is explored and a few of the deposits have identified mostly based on the satellite imaging techniques.

And these are the depth of the sea which are shown that means the manganese nodules which are available to us is at a depth level of 5000 to 6000 meter. So which is considered as a very deep seated deposit. But this is depth of the sea and below that so it is available.

So that is why this is, these are the sources where things are there and we are already having extracting our oil in the Bombay High at this region. And it is also prospecting that the significant oil reserve is also available in this area which we are predicting may be excavated or may be fully explored in the future.

So these are the occurrences of the different seabed minerals, but we are so far commercial exploitation of the seabed mineral is not started yet. And second part is that only experimental excavation is already carried out by Indian rare earth in the country. So this is the current status of the seabed mining in the country.

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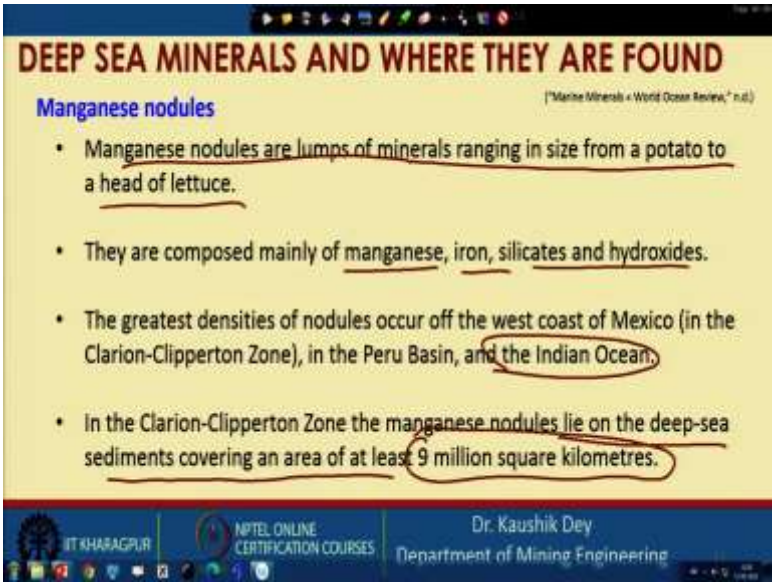

Now let us look into the different deposits manganese nodules are the lumps of mineral ranging in size from a potato to the head of a lettuce. These are basically composed of manganese, iron and silicates and hydroxides.

And these are available in the Indian Ocean and manganese nodules lie on the deep sea sediments covering an area of 9 million square meter at least which is expected. So there is a significant deposit of manganese below the sea. And this is the view of the manganese nodules below the sea.

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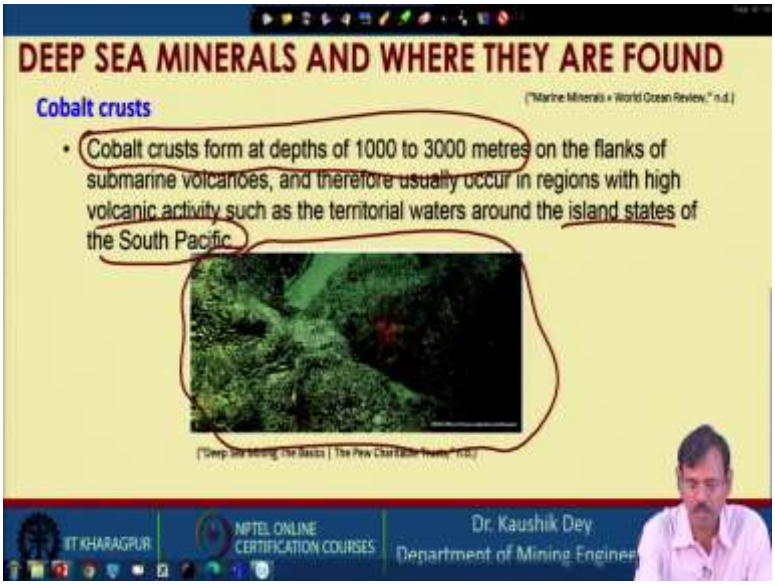

Similarly, we are having cobalt crust, cobalt crust are in general available at a depth of 1 to 3 kilometer. And on the flanks of the submarine volcanoes and therefore usually occur in the region of high volcanic activities. So it has been found in the island states of the South Pacific sea where it has been found significant cobalt crusts are available and this is the photographic view of the cobalt crust as it is obtained in the website.

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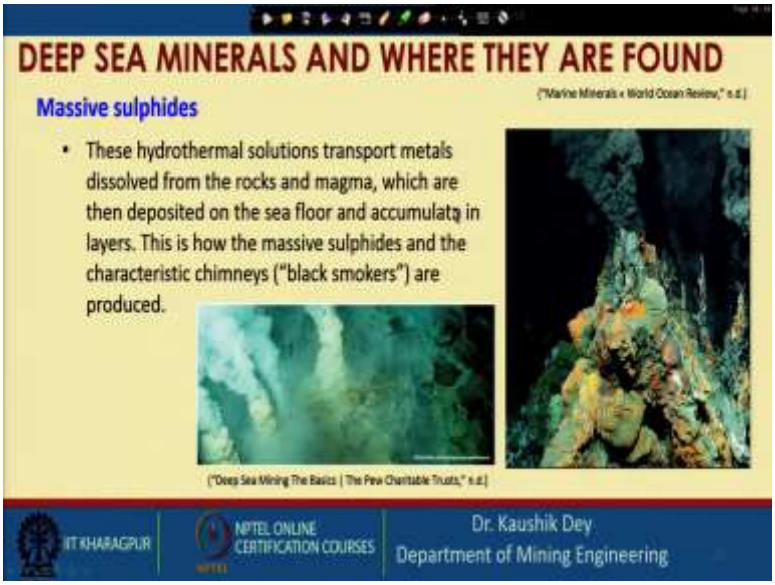

Apart from that we are having massive sulphide deposits and you know the sulphur that is also occurred in the sulphur rich black smokers area. And this sulphide deposit all, it is understood that most of the metallic sulphides are available here at the submarine plates boundaries where the exchange of heat and element occurs between rock in the earth crust and the ocean due to interaction of volcanic activities with sea water.

So whenever there are volcanic activities found like Japan coast or South Pacific coast in those cases, these black smokers are available and black smokers means you can understand the sulphur rich minerals may be there.

And these are also found at a depth of several kilometers and where the magma has come out from the chamber at a temperature exceeding 400 degree Celsius in those cases, these black smokers occurs and in which the massive sulphides are expected for those cases. And these are the photographs of the black smokers.

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So this is in general instruments used for explore the sea level, so basically this cactus grabs etcetera are used, so let us read out this one. So generally echo sounders are used to identify the depth, identify the depth of the bed. Then remotely operated vehicles are sent with camera and grabbing arm, so that the samples can be collected from the seafloor as per the image obtained by the operator at the sea and its guidance the grabber will, grabbing arm will grab the material.

Then autonomous underwater vehicles can drive down in the seafloor as per the instructions given and also return back to the ship after the, its hour of movement. Then large samples are collected using a dredger and which is stored behind the sea or having a grabbing arm and suction system also. Then the water are taken out from the samples, then the samples are having measured for physical and chemical properties and in that also crushed and also different chemical analysis are carried out on those samples.

So apart from that the drilling onto the bed is also possible, but so far the exploration expansion has not continued yet. And this is the exploration technique of the seabed so far carried out in the territorial or you can consider in the continental shelf by the different countries. And this is the most common exploration techniques.

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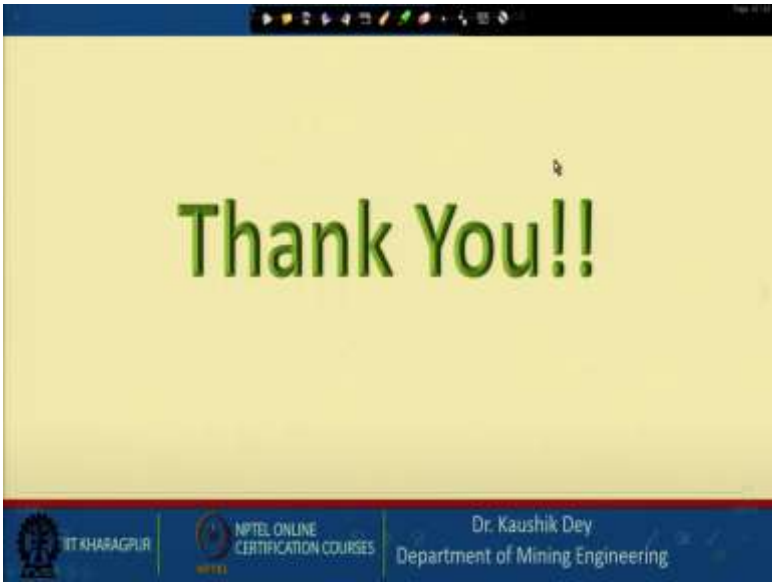

These are the references, so let us close this excavation, this seabed mining technique in this place; we will continue seabed mining technique for the next class also. Thank you.