Mineral Resources: Geology, Exploration, Economics and Environment

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Lecture - 31
Indian Mineral Deposits (Contd.)

Welcome to today's lecture, we are continuing our discussion on the mineral deposits Indian mineral deposits. And in the process we saw deposits of iron, copper, tin, and we will discussing the geological provinces the singbhum Craton, the dharwar Craton, and debaser Craton, and last class we were just discussing about the singbhum shear zone is an example of a metalotect, where their mineralization of copper molybdenum, some nickel, and more prominently uranium deposits occur, all along that shear zone which runs for about 150, 160 kilometers in an awkward shape; where we generally we have faced with a problem of the source of the metal, where the uranium could have a very obvious source of the granites.

Which are in close proximity and which could have given rise to a hydrothermal fluid, and mineralization must have brought about by deposition of uranium, when the conditions must have been oxidizing. Copper possibly could have been derived from the basic units like, the lavas basic lavas which occur nearby areas or also could be the granetoids could have been source for the copper. And because of their close association this copper, uranium and occurrence in close association with granitic rocks. In addition to the earlier held view of hydrothermal origin structurally controlled on a shear zone, these deposits also do have a I mean prospectively could be called as, could be labelled as iron oxide copper gold deposits.

Although the very basic idea of iron oxide copper gold deposit occurring in granetoids associated in the in the (Refer Time: 02:42) interior does not quite satisfy to the condition of Singbhum shear zone, this will possibly lead for wait lot of more study.

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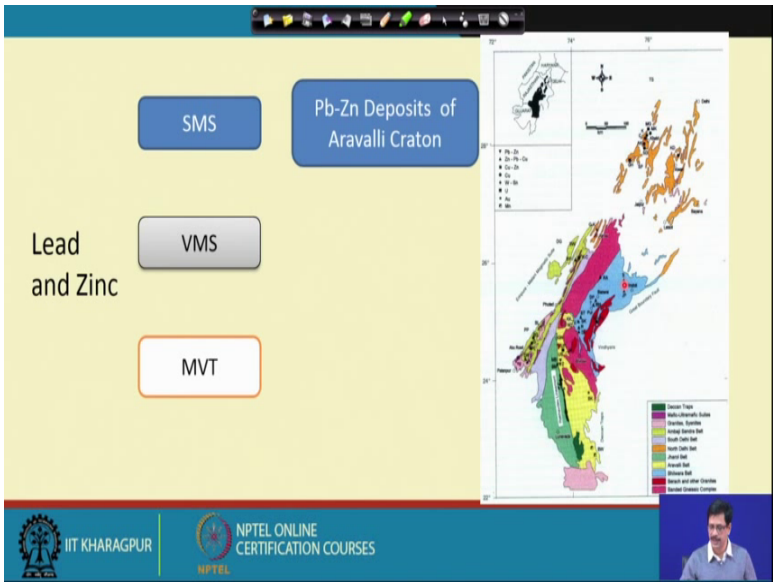

So, let us move on to the lead and zinc resources, where we have the 3 dominant types the sediment hosted massive sulfide deposits, the volcanogenic massive sulphide deposit, and the Mississippi valley type deposit, the last one which is put on a white box here is presumably absent In the Indian context.

Deposit of volcanogenic massive sulfide affiliation of the type of the most well-known lead and zinc source which is essentially the Kuroko type, which are which are also geologically pretty young such deposits as of now are not reported in the Indian context although, as we will be discussing about the Aravalli Craton some occurrences in the south Delhi fold belt with some of the features coming to lie coming to knowledge could possibly be, prospective candidates to be included in that, but we will discuss the Aravalli Craton in terms of it is well known metal potential of lead and zinc in the Aravalli fold belt..

So, here is the Aravalli Craton which is which we have already discussed about the north Delhi fold belt, hosting the Khetri copper deposit, here is the madan kudan and this is this is Khetri, this is the area where it is hosted by the rocks of the Alwar and Ajargarh, group of rocks of Delhi super group this is the south Delhi fold belt, here there is this the frame of this well-known deposit of Vambaji and Delhi which was essentially originally known as a hydrothermal deposit, and I would like to draw the attention to these areas where we have a number of important occurrences producing the most of the lead and

zinc in the country, and the one which is over here which is the Rampura Agucha deposit.

Which is one of the richest zinc deposit of the world, and here is the Rajpura, Rajpura Dariba deposit this is the Zawar deposit. So, on all along we have the lead and zinc deposits which belong to the sediment hosted massive sulfide SMS or the senem or z x type of deposit, as far as their characteristics are concerned and this is a the Aravalli Cratons metalogenic potential is quite high, here is the trans Aravalli region in which we see a lot of later granitic activity, and this is that area where the deposit of only possibly the only occurrence of a Skawn tin, Skawn deposit in Dhighana in the state in the state of Rajasthan occurs here..

These are the trans, trans Aravalli it melanie suit of rocks, and there are many such other important occurrences here which we are not coming to, but we conclude on the Aravalli Craton it is metal potential in terms of the lead and zinc.

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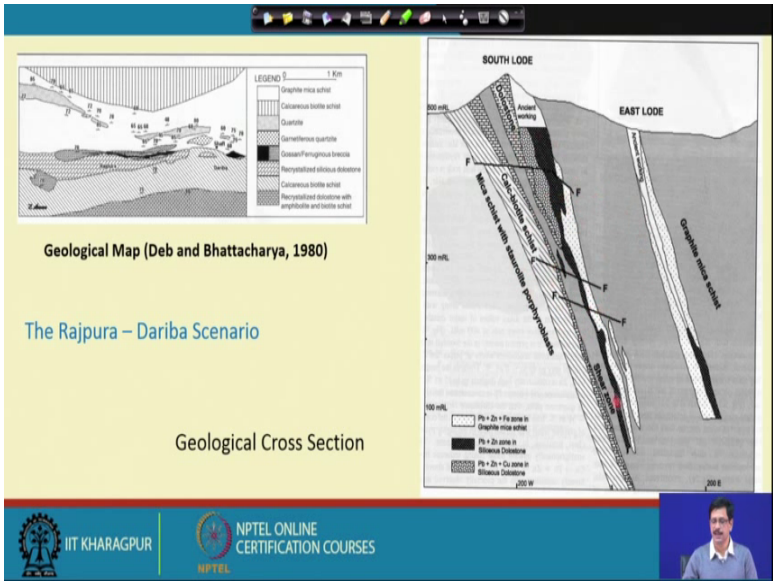

It's always good to see some of the cross sections for our better understanding. So, this map has been taken from sources mentioned here, this is the Rajpura Dariba deposit where the plan is shown here, and it is the section where we could see the ore body which is within the measure, measure of the ore body in the carbonate rocks.

Where is a silas stoller stone and this is the major ore bodies occurring here and some here it is graphite mica schist, and hosted by here is the micro schist is tolerate porphyry glass, and this this is a section of the Rajpura Dariba ore deposit which is more or less would look almost quite close to what we have seen in some of the classic deposit, like Sullivan in Canada although the setting will be different here it is matama forced country rock here, the deposits do exhibit the very well correct stratified well stratiform characteristics, although in the mineralization in Rajpura Dariba.

It is it has been proposed that the mineralization has taken place in 2 stages stages, the early stratiform ores were later on ore printed by a later phase of hydrothermal activity giving there should values, and those situations where the mineralization of mostly the arsenic antimony bearing phases mineral phases came into existence, and mostly formed in the later stage of mineralization.

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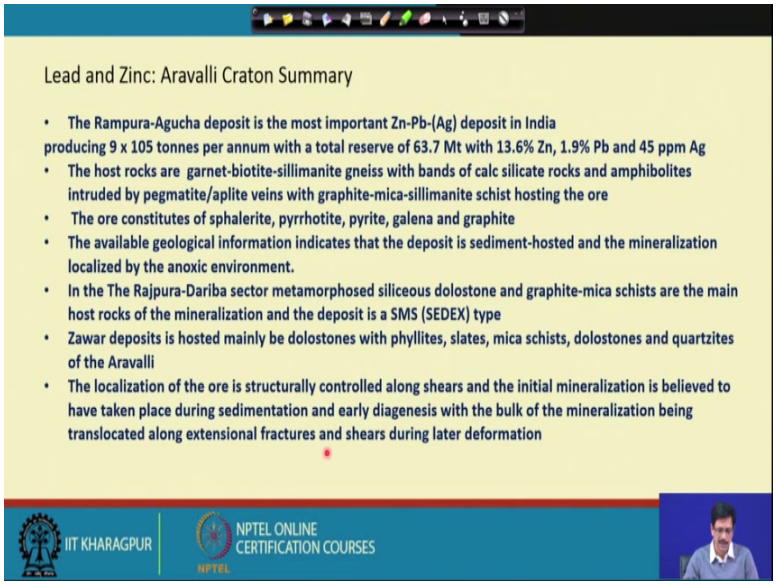

And so, in a way if we summarize the Aravalli Craton, scenario then the Rampura Agucha is the most important one lead zinc silver deposit in India, and a needless to mention that most of these deposits that we have discussed in this SMS category, and also some of the other deposit like for example.

In the singbhum shear zone or in Khetri, these deposits essentially which are the copper deposits they do also contain some gold and silver which come as by-products, adding to the total production of gold in the country, and the Rampura Agucha deposit is most

important with a good amount of reserve and the as I said this zinc is one of the richest zinc deposit in the world, where the zinc concentration can go to 13.6 percent to 8 percent to maximum, that hosts rocks are garnet biotite sillimanite gneiss and this this deposit also has a distinction being the in the highest rate of metamorphism rock, where we get the almost like in (Refer Trade: 09:02) grade metamorphism garnet biotite sillimanite gneiss with bands of calc silicate rocks.

And also with graphite mica sillimanites the ore serves tolerate be rotated pyrite galena, and the available geological information indicates there is a sediment hosted mineralization and the localized by anoxic environment, in the Rajpura Dariba sector they metamorpho siliceous dolostone and graphite mica says that the main host rocks, and it is say sediments in sedimentary excellent a prep of deposit, it is preserving it is all it is characteristics in the form of sulfide rid mites, where the hand specimen of the ores where it could be very clearly seen the sulfide layers being confirmable with the with the plastic shale layers.

The Zawar deposit is mainly hosted by dolostone with philites and slates mica schists, and the localization of ore is structurally control along shears, and the initial mineralization is believed to have taken place during sedimentation and early diagenesis, with the bulk of the mineralization being trans located extensional fractures and shears during later deformation, because we visualize that these deposits essentially all originated from intercontinental reef type of sedimentary basins, and which also subjected to later stage of deformation.

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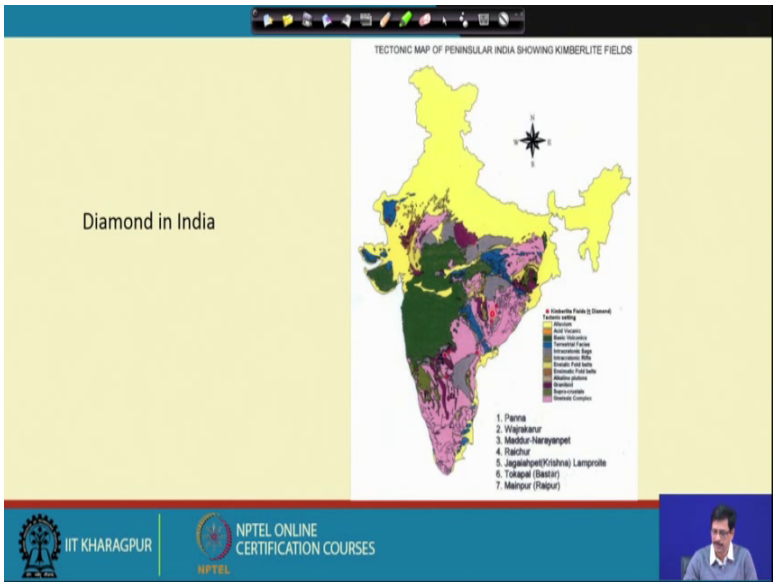

Well I mean even though we are not going too much into the details of it, this is the scenario of the diamond occurrences in in the country we could see from the red dots that they are localized they are mostly occur in the dharwar and the Baster Craton, and if only the low locality here in the Linnaean boundary of the Vindyan, and the Bundelhkand Craton going by the way the diamond bearing kimberlites originate, we have seen that they will they will only be occurring in the parts where there will be a thick continental crust, and where the intrusive with the extrusive body in the form of the kimberlite pipes, we will be bringing them up from the deeper part where the diamond stability field in the in the upper mantle.

So, these are the ones in Panna in Wajarcorrod, and in this is the Krishna this is a lamproit. And so, the point that basically we made here, that off let these chronic blocks where there have been a few discoveries, but their potential in the in the context of occurrence of diamond difference kimberlites, and there they have they provide ample opportunities for further exploration, and they have the they seem to be having high potentials in terms of the occurrence of diamond bearing kimberlites..

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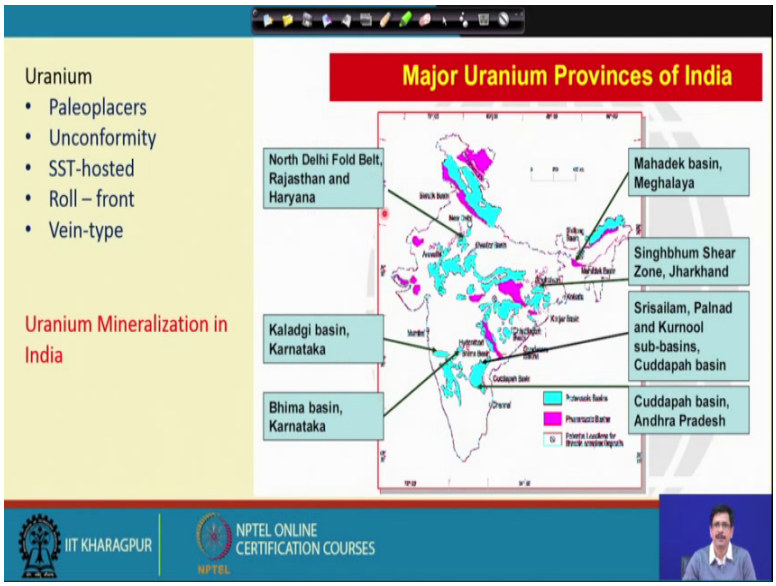

We will have a brief overview of the uranium mineralization in the country which is critical and which is also as of a very strategic importance, and we know that this is one of the metals for which explode maximum exploration efforts are being made, and the agency governmental agency like the atomic mineral directed to exploration and research have been putting a lot of effort in exploring for diamond for the for uranium resources in the country, and there has been some amount of success in the recent past.

As we could see here before that let us see the different genetic types of deposits that we have seen for a for uranium, the paleoplacers like the way to at restaurant type, unconformity like the Athabasca basin and Alligator river in australia, and some important deposits will there happen to be the richest amongst the uranium deposits of the world, the tabular sandstone was to deposit the roll front type and the vein type, vein type we have already seen occurring in the singbhum shear zone, where the mineralization is in the main singbhum shear zone within the sistos rocks, sistos country rocks, and roll front type deposits are as yet not very well not very well reported in the Indian context, but the unconformity, and some of the deposits do seem to have the affinity towards a unconformity type, and one such could be as tabular type..

Sandstone hosted deposit that you see in the colorado plateau. So, these are the areas this is the singbhum shear zone which is already discussed, this is Cuddapah basin on the north western, and the south part of the Cuddapah basin, there are 2 important

occurrences the north western part of this Asylum pollard, and the Kudan sub basins of Cuddapah basin, and here is the southern part of the Cuddapah basin, this is the Bhima basin in the where there is also a report of uranium Kaladgi basin this is the north Delhi fold belt which we just discussed in the context of copper.

And this is the one which is from the Mahadek basin in Meghalaya. So, these are the areas in which mineralization of uranium has been reported, in different there they do exhibit diverse lithologies and geological setting..

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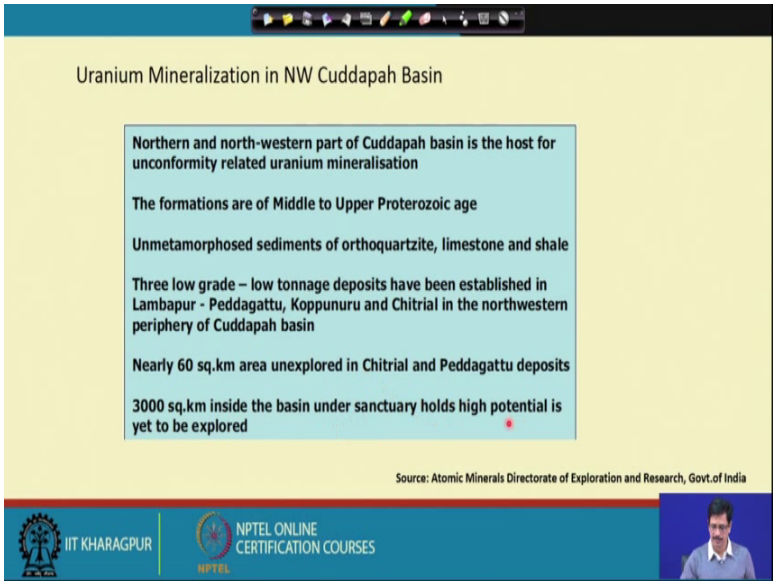

We will just see some of them. So, the characteristic in the north western Cuddapah basin, is that it is the middle of proterozoic age formation of the middle proterozoic age, and there unbutton off host orthoquartzite and limestone and shale, there are low grade low tonnage deposits generally the most of the deposits they are occurring the so far discovered in the Indian context.

Do not happen to be as rich as we see in many of the deposits ore type deposits like for example, in the deposit which are hosted in the singbhum shear zone, the grade possibly goes in the level of point 04 or point 05, point 08 or at the most point one, weight percent of u 3 weight mostly in a very low grade. So, those are the types of rocks or the ores which are only delineated on the basis of the of the intensity of the gamma ray that comes out of the during the radioactive integration, and they are identified as ore on the basis of that, and the ores are treated by acid leaching process and the finally, recovered

in the form of the magnesium diuranate which is the yellow cake and such kind of so, this uranium mineralization in the singbhum shear zone like in one (Refer Time: 16:26) there the dominant process of extraction is the acid leaching,.

I will just site why this is important because when the host rock type varies that becomes a so, you the technology has to be different or the different methodology has to be adopted for recovery of the uranium. So, here we see a nearly 60 square kilo metered area explored, the there are still some scopes of discovery of such type of deposits here and the genetic type is not very well known here..

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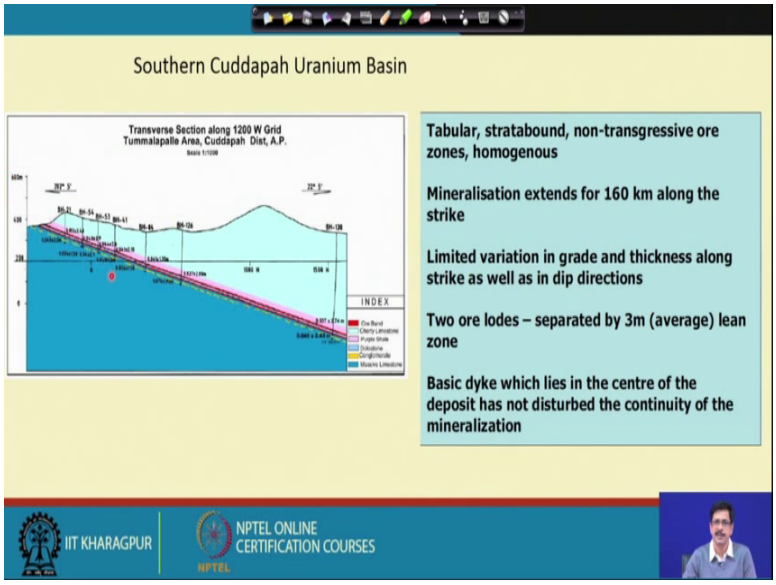

So, this is the Tummalapoli deposit in southern Cuddapah basin of Andhra Pradesh. So, here it is as interesting could be seen here the red line is the ore band there are 2 bands of ore containing uranium mineralization, here within dominantly chatti limestone and massive limestone. So, here is a deposit where it differs from the deposit, which we saw in the singbhum shear zone being hosted by limestone. So, it is a tabular strata bound non-trans missive ore zones homogeneous the mineralization extends for the 160 kilometer along the strike, the limited variation in grade and thickness there are 2 ore lodes which is shown here separated by 3-meter basic dykes, which lie in the center of the deposit is not disturbed the continuity mineralization.

But they are there so, this deposit as I was discussing has pose the problem of recovery because it cannot be the ore cannot be recovered by acid leaching process. So, there was

an alkali leaching process which was devised for recovery of the ore of uranium from this ore here..

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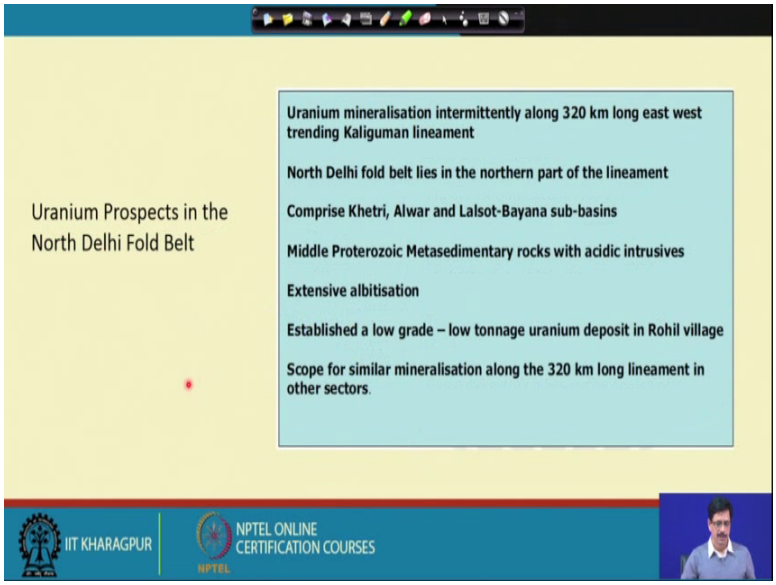

The north Delhi fold belt, it is intermediately along the 320-kilometer-long is to extending Kaliguman lineament, the north Delhi fold belt lies in the north part of the lineament, this comprises this Khetri Alwar and Lalsot Bayana sub basins which we just saw before.

And these are middle proterozoic, and there has been extensive albitisation. So, it could possibly be still be coming under the hydrothermal type of mineralization here..

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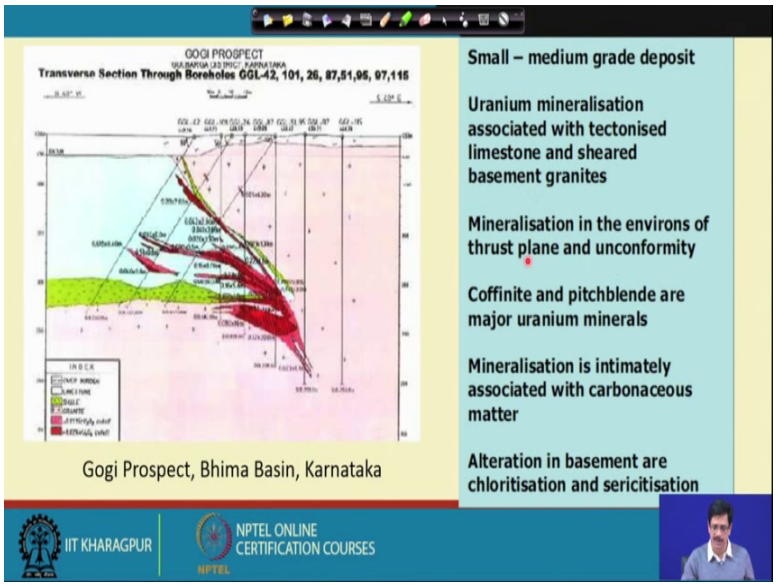

And this is the in the Kaldgi basin this is the Gogi project in Bhima basin in Karnataka, this is small medium rate deposit, here the mineralization is associated with tectonised limestone, shear basement granites, the mineralization in the environments of thrust plane and unconformity and coffinite and pitchblende are major uranium minerals, and mineralization is intimately associated carbonaceous matter which we could possibly make a comparison of the situation of unconformity related deposits..

Where the mineralization has to the there has to be a carbonaceous horizon for the deposition of the uranium, as UO2 as plus 4 state. And so, this deposit looks to be somehow a little close to the unconformity deposit, where it is associated with the thrust plane and unconformity..

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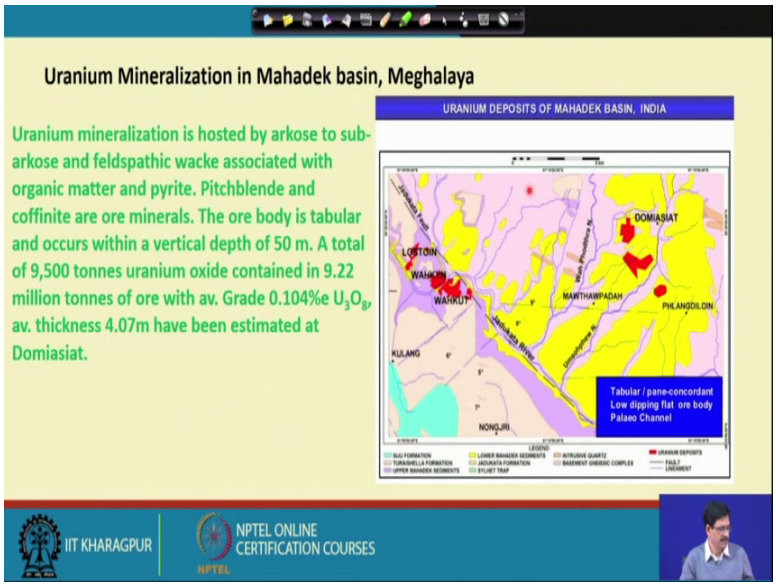

This is a uranium mineralization in the Mahadek basin Meghalaya and this from the setting geological setting and the lithological association it has a close correspondence or a kind of a similarity with the tabular type deposits hosted in sandstone, which you see in the Colorado plateau here the mineralization is hosted by Arkose to sub Arkos feldspathiswacke associated with the organic matterm, and pyrite organic matter becomes a very favourable locale for deposition of uranium in the form of UO2.

And then ore body is tabular and occurs within a vertical depth of 50-meter total of 9500 tons of uranium oxide, contain in 9.22 million tonnes has been deported here. So, here the grade is about point 104 percent almost going to about thousand p p m of U3O8 within thickness 4.07 meter and so, this is the scenario as far as the uranium mineralization of the country is concerned..

So, this brings us to a close of discussion on the Indian mineral deposits, and as you could see it has not been very exhaustive discussion, there are many other occurrences which we could not discuss because of the because within the timeframe, but what basically the insight that we acquire from here, is that the Indian subcontinent totality or the peninsular India in particular, there are lots of areas who have a high much higher potential for occurrence of many of the metals, like the base metals copper, lead, zinc, gold, and how and of course, we did not discuss about the chromium this the important deposit which is of the chromium deposit which occurs in the Singbhum Craton as I

mentioned on the northern and southern extreme we are in the northern extreme it is very close to the singbhum shear zone.

Where it occurs in the form of the ultramafic bodies which have the chromate occurrences like in Rorobur area in in Zarkhand, and the southern part where just about the southern extreme of this Singbhum shear zone we get a multiple we get a huge ultramafic complex in the Sukkinda area, which is essentially a an area where it is a it is actually the major source of chromium, and that puts us into a convenient situation of being 5th largest producer of the metal in the in the world, and not only that.

The Sukkinda area also a major prospects for nickel, there which we saw in the process of the residual concentration process, where the nickel gets enriched in the form of the nickel a furnace clay, which have very much present in the in the Sukkinda Nousahi chromate belt of orissa which is the southern part of the Singbhum Craton, and not only that the belts are also very actively being worked for platinum group of metals and some progress has already been made in that. So, we do have a lot of prospects of producing these metals in near future, the platinum group of metals nickel from the ultramafic complexes of Sukkinda Nousahi area.

And so, we see a wide diversity in the in the age distribution, where most of the deposits are belonging to the arki and the proterozoic the metal deposits and bearing, and also mention also has to be made about the, important mention has to be made about the east coast bauxite which is a result, of residual concentration process and which has given rise to huge boaxite accumulation, on the east coast of eastern coast of India and the aluminium being mostly be derived from the aluminium bridge cornolitic source rock, and there are many other deposits other occurrences say for example, the saucer mobile belt the source of group of rocks.

Producing the most of manganese in the country, and also if we do not mention about the our beach place of deposit, it would not be a complete this complete idea about the mineral potential of the of our country the..

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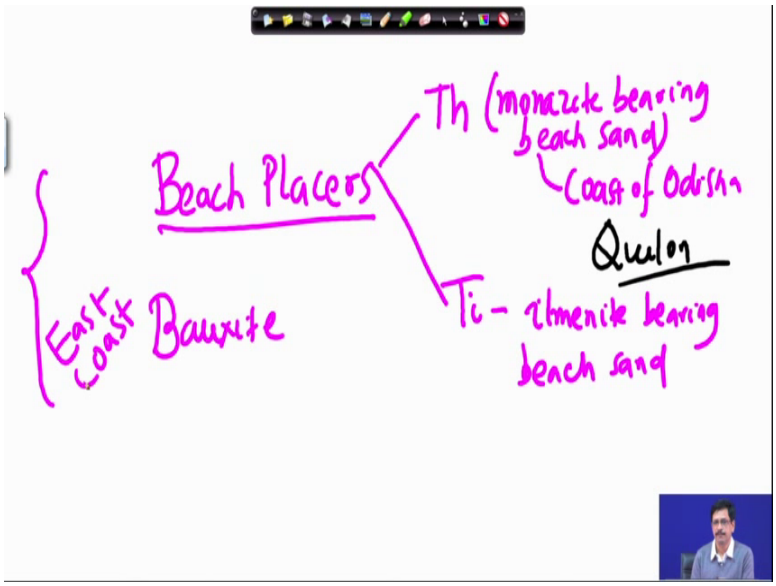

We get the beach placers deposit in the in the country, all along the eastern coast even up to the up to with the coast of Kerala, where we get the resources of thorium, in the form of the monazite bearing sand beach sand.

They there are many such important occurrences on the coast of orissa and in fact, this particular type of deposit makes us, one of the major in terms of the thorium resources which has given rise to the technology of thorium based nuclear power plants, that is already in order and such kind of so, these kind of place or occurrences they sporadically occur in many parts of the coastline in the in India, from the eastern coast from orissa goes to all along to kerala, where the famous Quilon beach is very well known for it is rare earth element occurrence, we do also have this beach pleasure as a coming.

As a rich source of titanium, there are eliminate bearing sand which are which also do occur in many parts of the eastern coast, and they are going to be the most rich resources of titanium for our domestic consumption, and for industrial purposes. So, this these are the ones which the. So, along with the bauxites, these places and the bauxites which is basically the very well-known east coast bauxite, occurring in the southern part of Odessa and further to the south. So, these only are the ones which are the deposits which are young in the quaternary.

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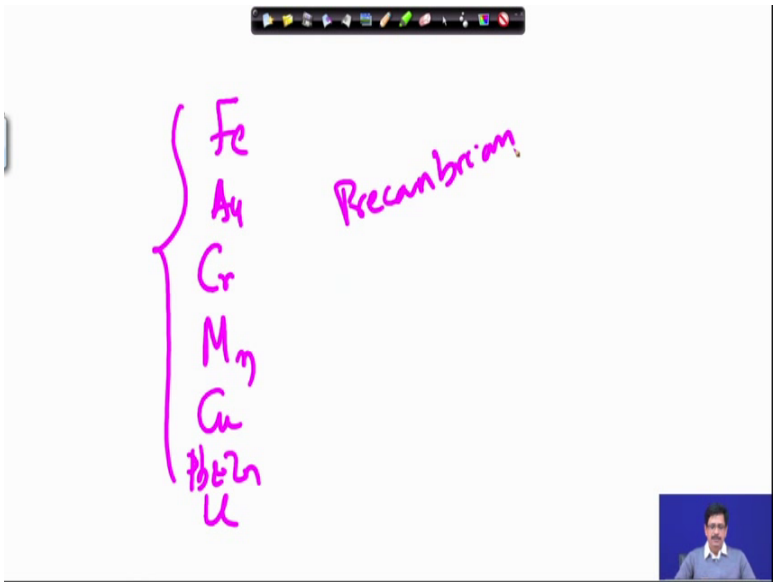

Otherwise rest of the metal resources which are our the resources of iron, gold, chromium, manganese, lead and zinc, copper, lead and zinc, uranium. So, most of deposits, most of these deposits mostly in the precambrian they occur along with the precambrian rocks. And so, that is how that is that is all about the situation that we can depict about the mineral potentials of the country, the important localities for very active and further exploration are the coastal areas for their accumulation of rare earths and titanium, and the vast tract of granites which are as yet not known to be mineral potentially may deposit bearing.

They also do provide a lot of scope for further exploration, and if I mean if such exclusion efforts are continued we could possibly be able to discover a few more such deposits and to meet the demand of many of the metals in the country.

So, that is all about the a very brief overview of the metal or the mineral potential of the Indian subcontinent, barring some of the deposits in extra peninsula like in the there are some base metal deposits occurrences from the Sikkim Himalayas area, which are reported and were previously also being worked out records of old mining activities are there.

So, with this I conclude discussion on the Indian mineral deposit..

Thank you.