MINERAL ECONOMICS AND BUSINESS

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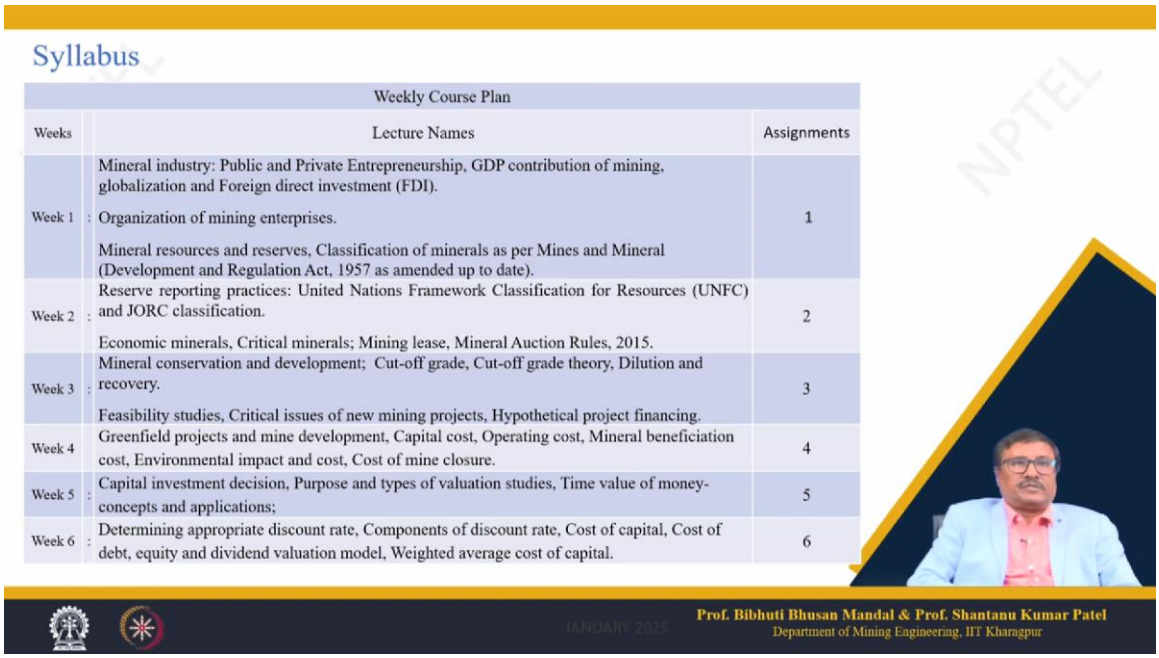
Week 1

Lecture 01 : Introduction

Hello everybody, I am Professor B. B. Mandal from the Department of Mining Engineering, IIT Kharagpur. I once again welcome you to the NPTEL course on Mineral Economics and Business. So, we will first look at the syllabus of this entire course, certain references, and the prerequisites for attending this important course on Mineral Economics



and Business. As you can see from the syllabus, we have a 12-week course, and in the first week, we will discuss the mineral industry in both India and the international scenario. Our public and private entrepreneurship, its contribution to the GDP, and foreign direct investments.

We will also try to understand the organization of the mining enterprise. Then, we will switch over to mineral resources and reserves and how we classify the mineral resources.

So that we can provide the correct or right information in the right format. We will then switch over to the statutory and legal framework that we follow for mining activities in India. In Week 2, we will, in detail, try to learn about the UNFC (United Nations Framework Classification of Resources) and also the JORC code.

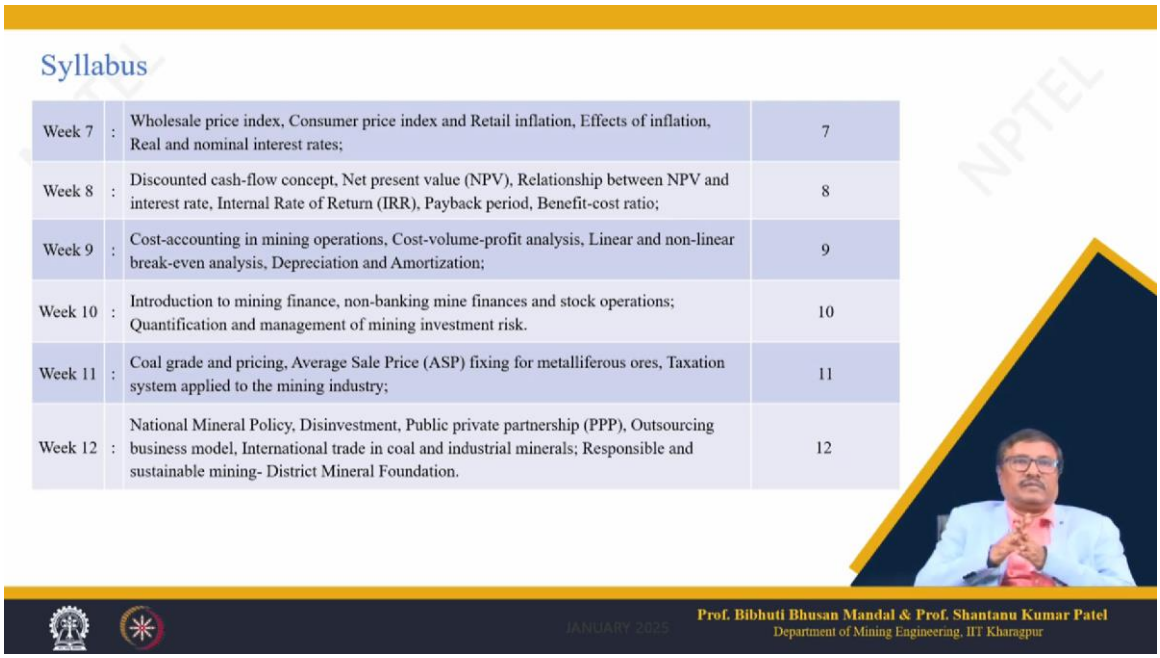
Economic minerals, critical minerals, mining leases, and mineral auction rules. These will also be covered in Week 2. Critical minerals are gaining importance in the mining industry, especially of late. Mineral auctions have become a very important step taken by the Government of India, boosting open participation from different funding sources in the mineral business. The third week will cover mineral conservation and development rules and how to implement them following the statutory framework.

Then comes the very important point of cut-off grade, which is an economic parameter for deciding how much will be mined and how much effort we should give to reduce waste, and how it is connected to the economics of mining. At the same time, the ideas about dilution and recovery will come up for discussion. Feasibility studies are very, very important. So, you can see in the same week we will also have feasibility—meaning project feasibility studies—to determine whether a project is feasible or not. When a proposal comes, how to judge if this project is feasible economically and technically when you get a new mining project. So, if you have— Hypothetically, okay, this is a mining project I am going to finance. So, how do I do that? How to assess the viability of the project, and what could be the possible future forecasting? At the same time, what are the sources from which I can get the money? To understand project financing, we first need to understand the costing part so that the cost versus future returns of the investment and returns can be compared. For that, we will cover the capital cost, understanding of capital cost, operating cost, and mineral beneficiation cost in Week 4.

Including the environmental impact and its cost. And a very important thing right from the beginning of any mining project. The implementation of the mine closure activity. Cost of mine closure. In Week 5, we have the capital investment decisions.

The purpose and types of valuation studies, time value of money—a very, very important part of this course—concept and application in the mining industry. Then, in Week 6, we have determining the appropriate discount rate: what discount rate you are applying, interest rate, discount rate, components of discount rate, and how to actually find out the right discount rate for project evaluation purposes. The cost of capital, cost of debt, means,

and this equity and dividend valuation model. Then, a very important concept like the weighted average cost of capital. Similarly, in Week 7, we continue with the wholesale price index, consumer price index—that depends on different selected items—for



understanding how it is increasing or decreasing, the retail inflation, the effects of inflation, real and nominal interest rates, and the effects of these in project evaluation. That is the idea.

So, the discounted cash flow concept, as you see in the 8th week, includes the net present value calculation (NPV), the relationship between the NPV and the interest rate, the internal rate of return, the payback period (after how many years you get the money that you have invested), and the most important, the benefit-cost ratio. In the 9th week, we cover cost accounting in mining operations. The cost-volume-profit analysis—if you have exposure to basic costing and economics—will allow you to enjoy the benefits of that knowledge. We discuss linear and non-linear break-even analysis, depreciation of assets, how to depreciate through the balance sheet, and how to book the depreciation cost and amortization. In financing, like in the 10th week, we introduce mining finance, covering both banking and non-banking operations, as well as stock operations.

Then, we explore how to quantify the risk associated with this kind of investment, as mining investment is a large-scale venture. So, it is not a small business. Most mining

companies require a huge capital investment right from the beginning. So, what is the risk involved? How do we estimate the risk associated with the investment?

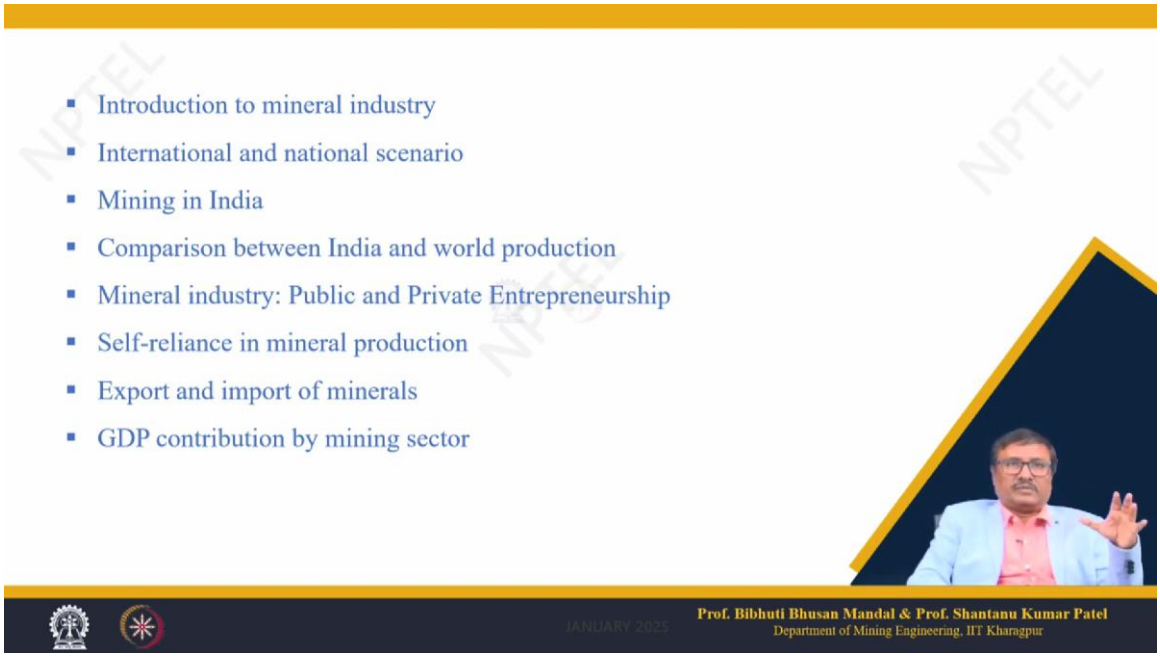
Then, we have specific lectures on coal grade and pricing, average sale price fixing for metalliferous ore, and the tax regime—meaning what kind of taxes apply and how they are calculated for the mining industry. Finally, in the twelfth week, we have important discussions on the National Mineral Policy issued by the Government of India. Our disinvestment policy has revolutionized the functioning and efficiency of mining operations. Public-private partnerships, like the outsourcing business model, have become extremely popular nowadays. Then, we'll move on to international trade in coal and industrial minerals.

And to finish with, we have a responsible and sustainable mining business. And there, we also have to think about how much we are giving back to or returning to society. The government of India has also instituted the District Mineral Foundation, through which these benefits are given back, and that is working wonderfully. They are really good decisions the government has taken, and this is helping the mining companies to assist society with a specific target for development. For all the weeks, you will have assignments that will be issued, which you have to complete and submit.

So, that will be there as part of the entire course. These are certain books and references for prerequisites, which means what you should know before joining this course: a basic

introduction to mining engineering or for those studying geology or earth sciences. They will have some understanding because, see, the mining terminology should not be new; otherwise, it will be a little difficult to understand the mineral economics and business course. For reference, there are good books like Gentry's book, which is very important and very famous, as well as Mine Investment Analysis. This is an SME publication.

We have one textbook by Professor S.C. Ray and Professor I.N. Sinha called Mine and Mineral Economics. There is one book called Mining Economics and Strategy, again an SME publication. We have a good book called Mining Capital by S. Michael and a Handbook of Primary Commodities in the Global Economy. This will give you an idea of international trade and a basic understanding of financial management. We have a very well-known book called Financial Management Theory and Practice by C. Prasanna.



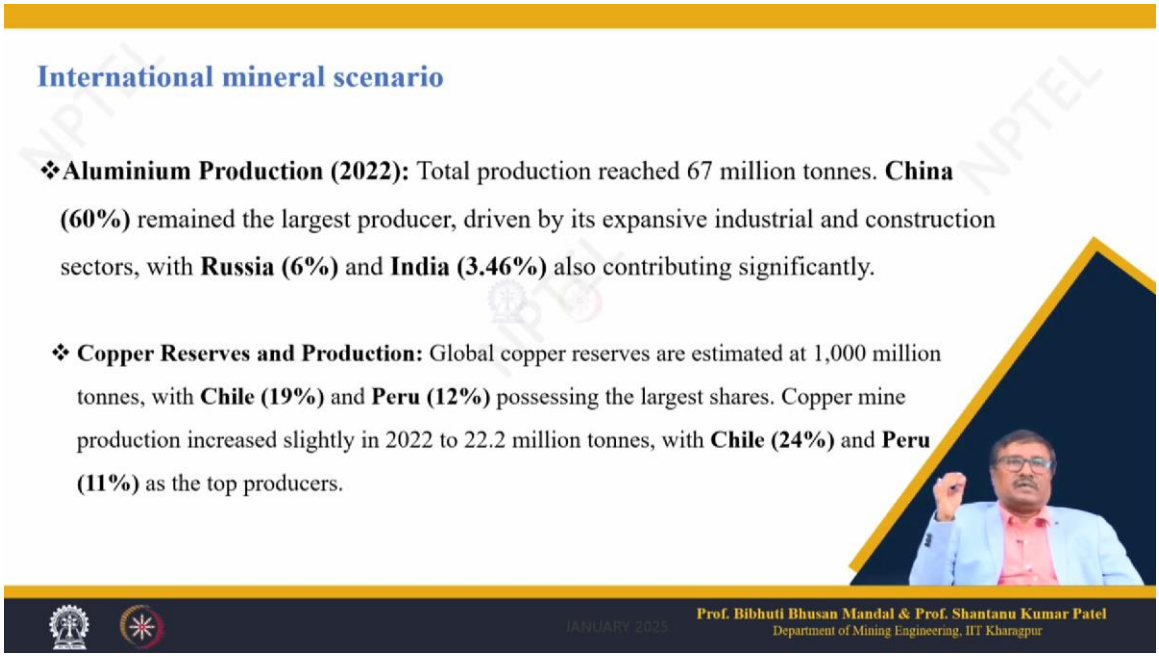
I think most of the engineering course students have been in touch with this particular book. So, these are the books that will be required at a minimum, but this is not exhaustive. We can have numerous resources from the internet which will help you understand the course, and I hope you will enjoy the course. Now, for today's lecture, we have these topics to discuss to start with, which means it is from Week One: Introduction to the Mineral Industry, like Indian minerals and the international scenario—both national and international. Mining in India, comparison between India and the world production, mineral industry, public and private partnership, entrepreneurship, self-reliance, how much self-sufficient we are in mineral production, export and import of minerals, GDP contribution by our mining sector.

So, this will give you a background or the knowledge or information from where we can start and move forward for a better understanding of the subjects. In the mineral industry, the importance is enormous. It plays a vital role in the global and Indian economy by providing essential raw materials for manufacturing, infrastructure, and energy. So, that includes the extraction and processing of metallic, non-metallic, and fuel minerals, and this adds to the economy. Not only that, it runs the economy; otherwise, you would be dependent on others.

So, self-sufficiency is equally important. Our mineral industry is categorized mainly into three groups. One, we call the metallic minerals like iron, gold, copper, and aluminium. These are very important metallic minerals. These are essential for construction, machinery, and the electronics industry. Non-metallic minerals are, say, limestone, mica, and gypsum.

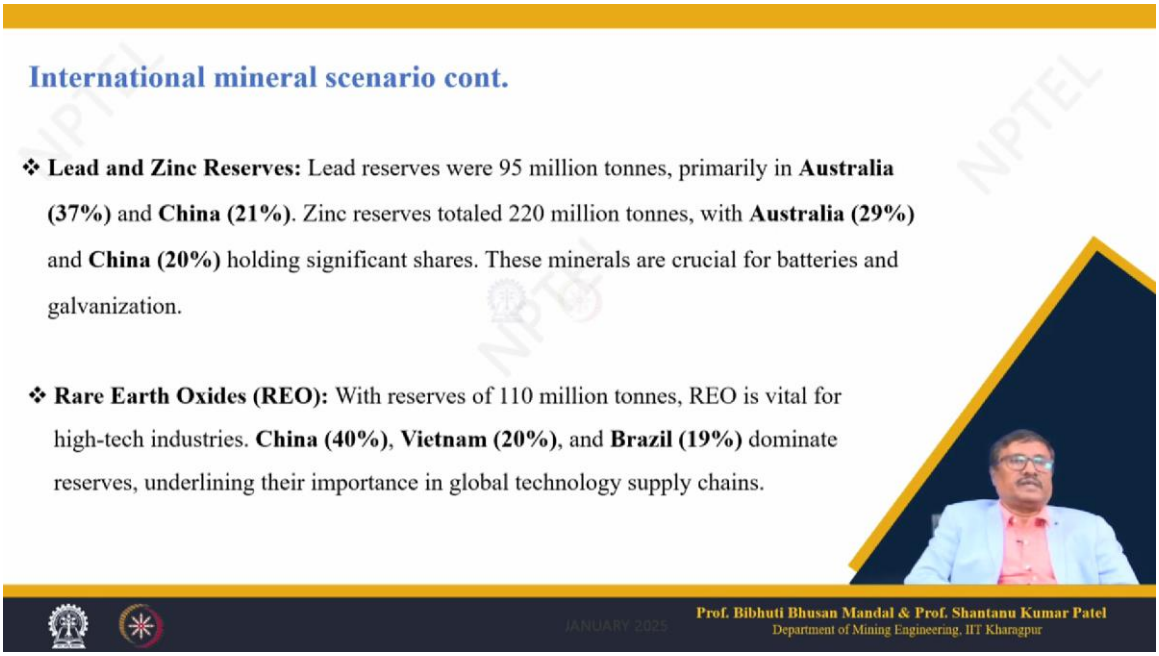
They are used in cement and ceramics, which are very important in construction and the development of any country. We have specific energy minerals like coal, lignite, and uranium, which are vital for energy production. Uranium has other uses as well, but we have nuclear power production from it, and without coal, we are largely dependent on it for our power supply. These are very important energy minerals. Now, in the international

mineral scenario, we will take some selected minerals and try to understand where we stand with respect to global production, referring to the available statistics from 2022. So, the



aluminum production was 67 million tons.

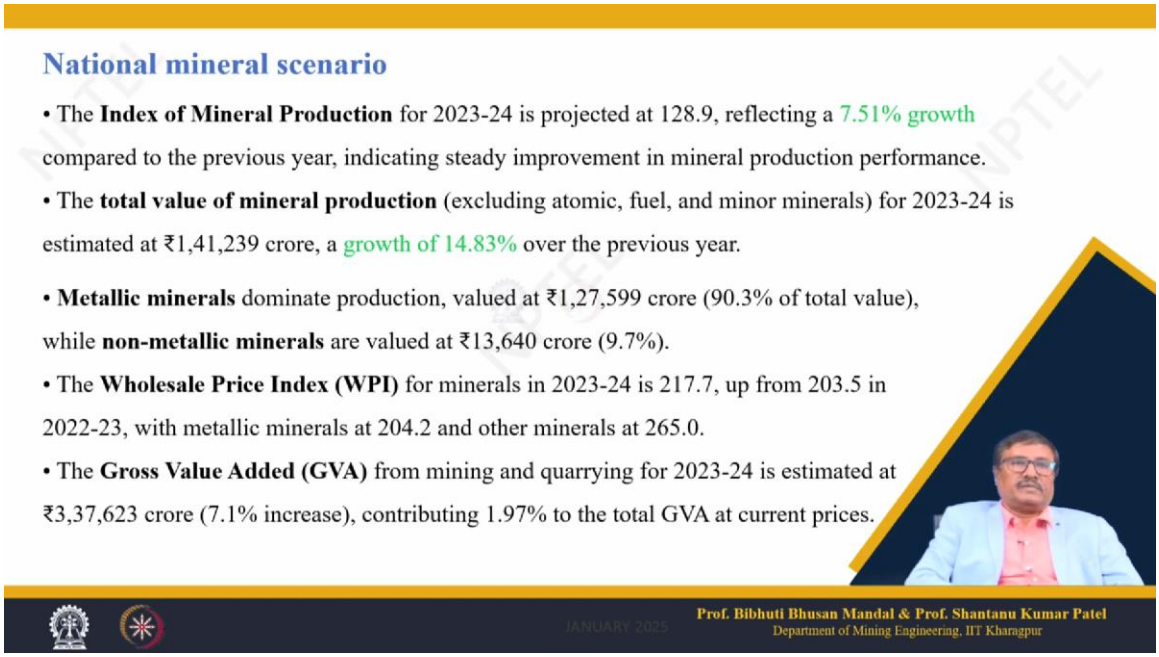
China remains the largest producer at 60 percent. It is essential in industrial and construction sectors. Russia has 6 percent, and India has 3.46 percent, contributing significantly. The global copper reserves are estimated at 1,000 million tonnes. Chile has



19 percent of it, and Peru has 12 percent. These South American countries possess the largest shares.

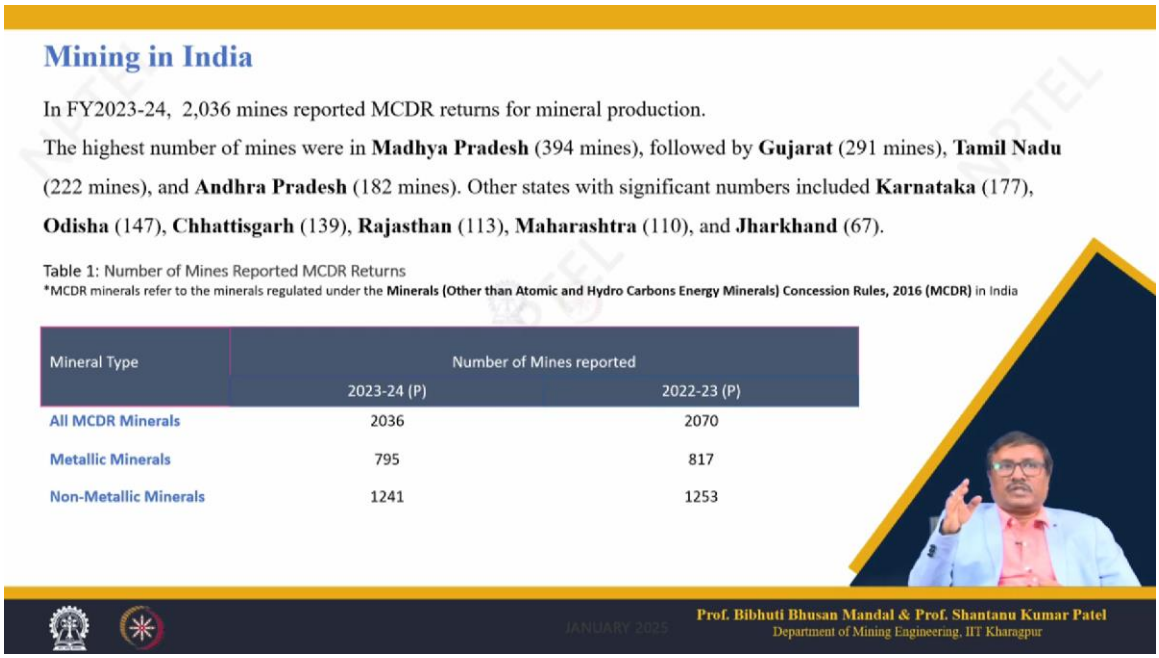
Copper mine production increased slightly in 2022, with Chile producing around 24 percent and Peru 11 percent as the top producers. In lead and zinc, lead reserves were about 95 million tons, primarily in Australia and China, whereas zinc reserves total 220 million tons, with Australia having 29 percent and China 20 percent, holding significant shares of the reserves. These minerals are crucial for batteries and galvanization. Now, we come to rare earth oxides, with reserves of 110 million tons. REO, or rare earth oxides, is vital for high-tech industries. China has a 40 percent share, Vietnam 20 percent, and Brazil 19 percent.

They dominate the reserves, underlining their importance in global technology supply chains. In India, we will quickly have a look at the national mineral scenario—that is, the Indian mineral scenario. The index of mineral production is projected at 128.9, reflecting a 7.51 percent growth compared to the previous year, like 2022-23. This is a steady improvement in mineral production performance. The total value of mineral production, excluding some atomic and fuel minerals, is estimated at ₹1,41,239 crore, which is a growth of around



14 to 15 percent over the previous year, as you can see. Now, if you go by the metallic minerals, they dominate the production, valued at ₹1.27 lakh crore, which is 90.3 percent of the total value contributed, while non-metallic minerals are valued at ₹13,640 crore, about 10 percent. Now, you will see that the wholesale price index—which will also be taught in this course—for minerals in the 2023-24 fiscal year is 217.7, up from 203.5 in 2022-23, with metallic minerals at 204.2 and other minerals at 265. Now, the gross value that we have added from the mining and quarrying industry for 2023-24 is estimated at ₹3,37,000 crore, a 7 percent increase compared to the previous year, contributing almost 2 percent to the total gross value added.

You can keep track of all these things if you visit the website of the Ministry of Mines and, of course, the Indian Bureau of Mines website. I have provided the website addresses (URLs) of these sites at the end of this presentation. Now, in the fiscal year 2023-24, the number of mines that reported to the statutory authority in India was 2,036. This is the official figure.

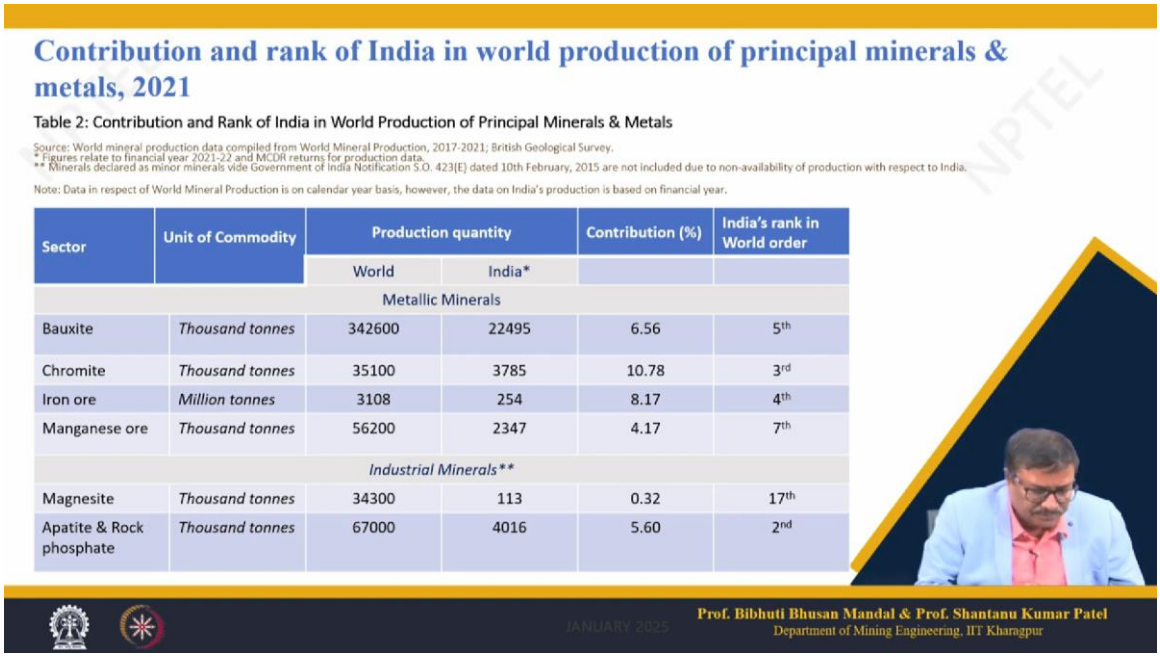


Submitting the returns at the end of the financial year. So, the highest number of mines are situated in the state of Madhya Pradesh, followed by Gujarat (291), Tamil Nadu (222), Andhra Pradesh (182). Other states with significant numbers include Karnataka (177), Odisha (147), Chhattisgarh (139), Rajasthan (113), Maharashtra (110), and Jharkhand (67). But this does not account for the very small mines. Maybe something is going on; they are

not reporting, as you can see in many states. This data is based on the returns submitted to the statutory authorities.

Now, if you go—we call it MCDR minerals. That means the returns submitted to the Government of India following the Mineral Conservation and Development Rules. We—we—we are just calling it MCDR. So, all MCDR minerals means those that are being controlled statutorily, and the mines reporting to the Government of India.

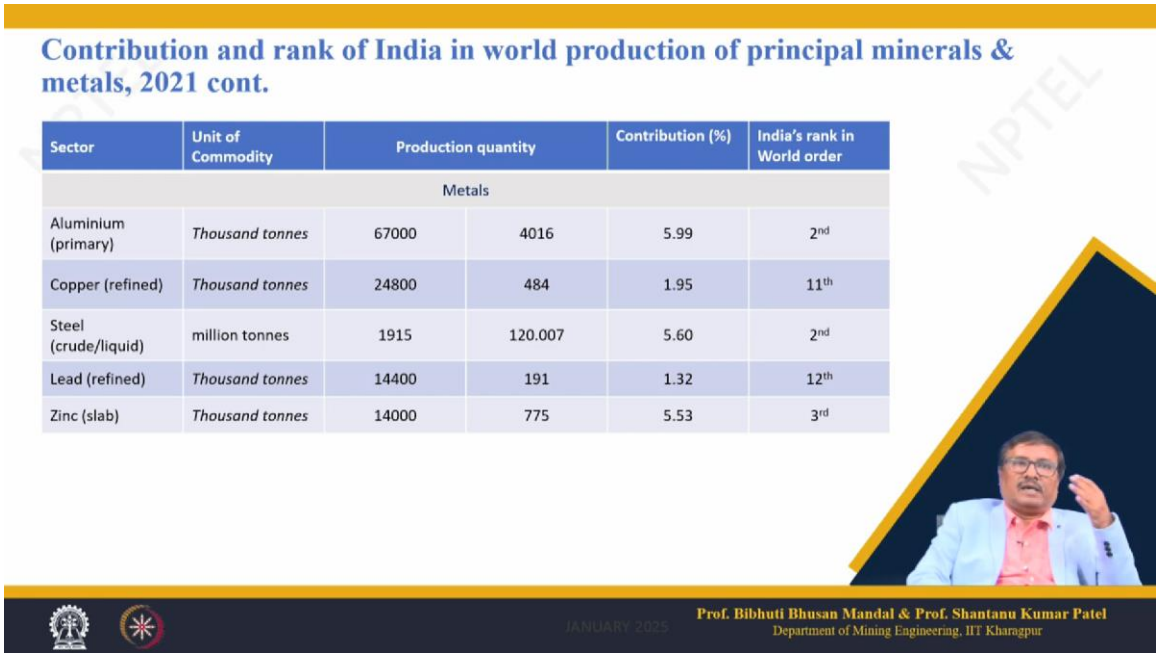
So, in 2023-24, it was 2,036. It varies—in the previous year, it was 2,070. We are going through the stigma of COVID, and then gradually recovering. Ups and downs are there, but the whole performance of the mineral sector is increasing. The metallic minerals: 795 out of these 2,036, and the non-metallic minerals: 1,241. Compared to 2020-23, where it was 2,070, the metallic minerals were 817, and non-metallic minerals were 1,253. Now, let us see how we are contributing to the world production regarding the production of principal minerals and metals. We will be referring to the figures from 2021 publications. What you see here is not only the contribution in percentage but also where you stand in the world order.



If you go by 1, 2, 3, 4, 5, where do we stand? So, it is in the box site, which is an extremely important box site. So, in 1000 tons, we have the figure here: you see 342,600 in 1000 tons,

and in India, we have 22,495,000 tons. So, the contribution is 6.56%, and we rank 5th. This varies; it can go up and down.

It usually goes up in bauxite; we have a very good contribution to the world production. In chromite, which is extremely important, it is practically an export item. So, in the world production, it is 35,100; the demand is too high, and the global demand is too high. We are producing only 3,785,000 tons in total, in 1000 tons. And the contribution is not less.



We are at 10.78%, almost 11%, contributing to the world production. And our position is third in the world. Our rank is third in that. Iron ore is also in million tons. Our business is too big in iron ore.

So, the world production is 3,108 million tons. We produce about 254 million tons, contributing about 8 percent, more than 8 percent. And our rank is fourth. Now, in manganese, as you see, it is 56,200 thousand tons. In India, we have 2,347, contributing 4.17 percent, more than 4 percent, and our rank is 7. In industrial minerals, the manganese side is also similar. We are contributing 0.32 percent, not much, and we rank 17 there.

Apatite and rock phosphate also place us second. Rock phosphate is extensively used for fertilizers. We are lucky to have large phosphate mines in Rajasthan. So, that is contributing to and helping the agricultural sector grow. Now, continuing with aluminum, the primary production, the principal minerals and metals. So, from aluminum, you can see the

production quantity from here. So, you see, contribution-wise, we are producing around 6 percent. In aluminum metal, we are second in world ranking.

The copper refined copper, we are 11th and contributing about two percent. Still, we are contributing about six percent. We are second again in world ranking. This is a big business here, a big mineral industry in India. We have refined and are 12th, contributing 1.32 percent. In zinc, we are third. There are big zinc mines in Rajasthan, which are controlled by Hindustan Zinc Limited. Hindustan Zinc Limited ranks us third in that. The mineral industry, as you can see, adds value and is the driving force we are adding to the whole economy, the running of the civilization.

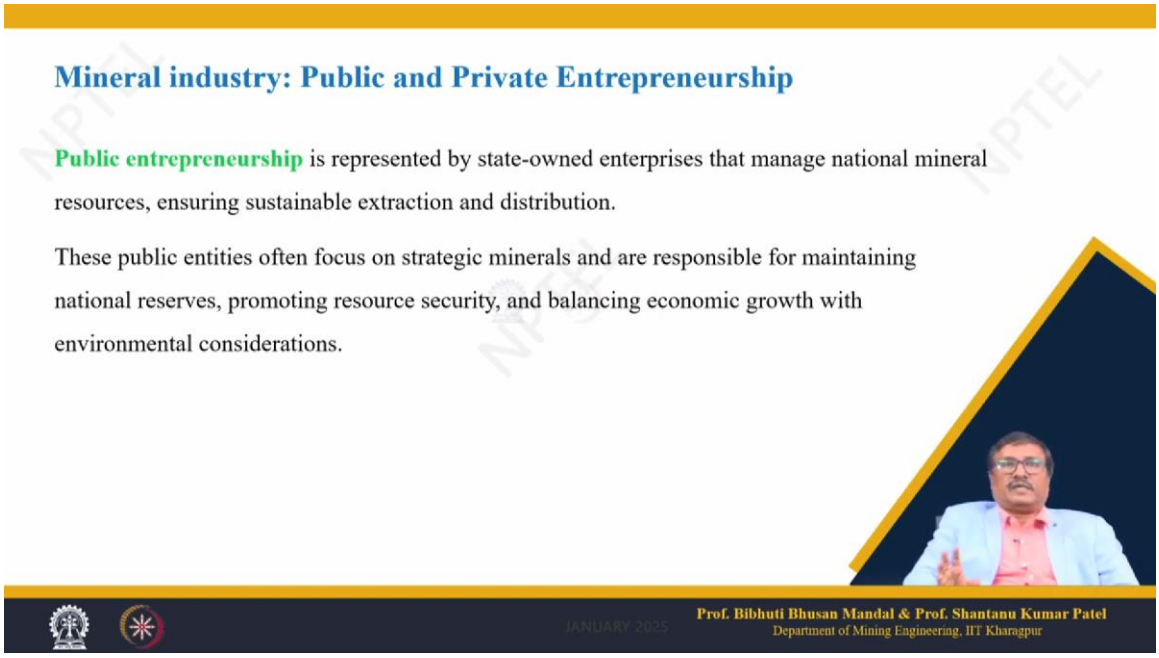
The mineral industry cannot be any overestimated it everybody knows the importance of the mineral. If we have the mineral and then you are supplying to your own country and exporting others you are helping the civilization to run. Here the running the business, how you run the business is very important. That means continuation or rather sustainability and not harming the environment and helping the growth of the society. That is the motto of the mineral industry.

So, the mineral industry that involves extraction, processing, distribution of the natural resources in a particular form and which will be required for various sectors like say manufacturing, construction, energy, electronics where you need lot of copper and many other metals. They play a significant role in driving the economic growth and the industrial

development as a whole. So, how to organize this thing? This is not true that in the right in the beginning after the independence there are lot of public entrepreneurship. The government sector was the dominant to start the employment and the the economy to run forward, grow a step forward.

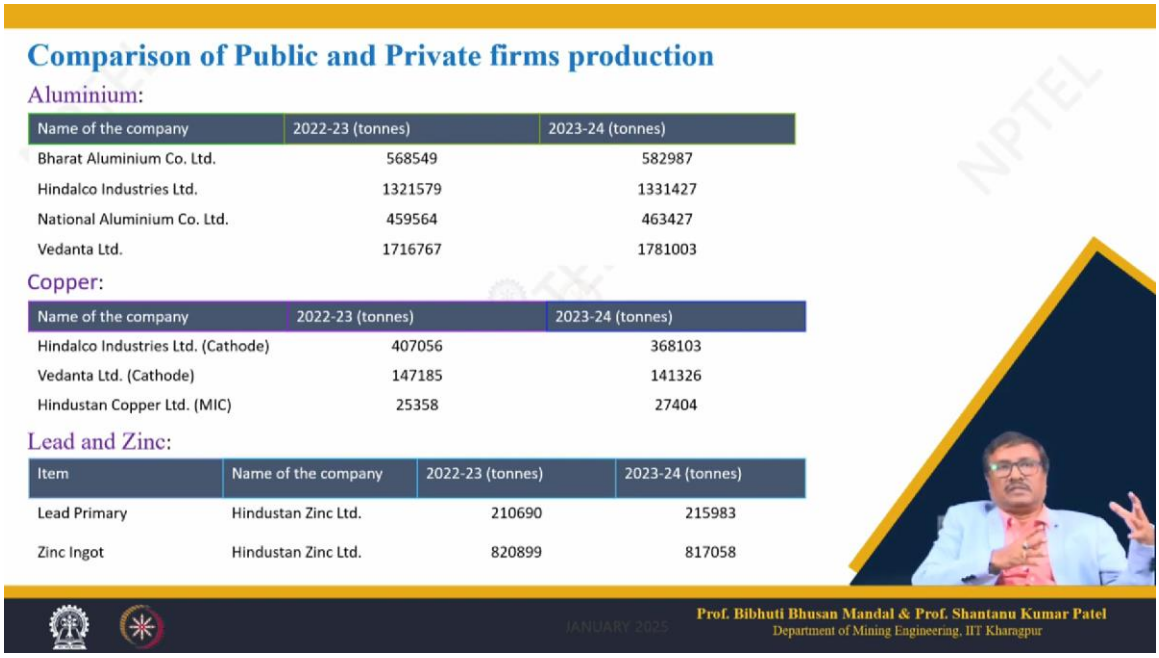
But then then slowly and now especially In last 10 years or so, the private sector participation in minerals has seen phenomenal growth. And the private entrepreneurship in mining, that drives innovation because there is a lot of financing in this. The innovative ideas, the technology import from outside, the latest or the state of the art, the mining technology, the efficiency of work, investment in advanced technologies as I was saying just now. So, the private companies are key players in mineral exploration.

You will see that in recent years, the number of private companies operating and conducting mining businesses in coal, iron, aluminium, and other sectors has increased. The development of new mining projects and the introduction of best practices enhance productivity and increase competitiveness in the market. Whereas in public entrepreneurship, the business is definitely present. These are state-owned enterprises. We manage the national mineral resources.



We ensure sustainable extraction and distribution. We also promote resource security, meaning we have government agencies to produce certain important minerals for our own

consumption. Additionally, we balance economic growth with environmental considerations. Since it is entirely under government control, we have better oversight here. Otherwise, we would need to supervise other entrepreneurial activities. With public entrepreneurship, we have direct control. There are good public-private entrepreneurship models where they are combined. There are also public sector enterprises that have adopted the outsourcing model, meaning many activities have been outsourced to contractual agencies. However, the core functions, such as managerial duties, safety, and mineral development, are retained by the main company, while the rest is delegated to private agencies.



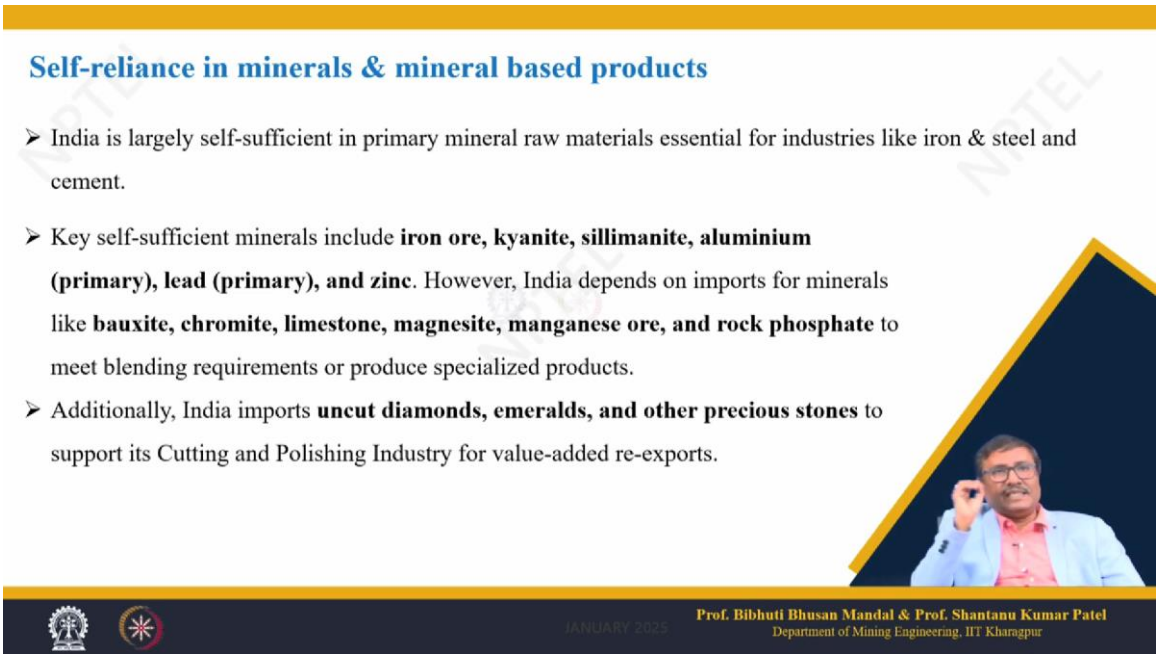
Private firms also employ contractual agencies. We will discuss this when we talk about the organization of mining enterprises. Now, let us compare the production of public and private firms, for example, in the aluminium sector. Consider BALCO (Bharat Aluminium Company), Hindalco Industries Limited, and Vedanta Limited. These figures are from 2022-23 and 2023-24.

These are the things that we know about the aluminium sector. And here you see in aluminium we have Nalco, which is a public company, a public entrepreneurship enterprise, and Bharat Aluminium, Hindalco, Vedanta—these are private. So, you can compare these things and see the private sector participation in the national mineral sector

in India. In copper, you see we have basically Hindustan Zinc Limited—sorry, Hindalco Industries Limited—and Vedanta Limited; they are producing this copper. Here, cathode.

But in Hindustan Copper Limited, we are actually doing this: we are now selling the concentrate. Now, we are not producing the copper cathode nowadays. So, Hindustan Copper Limited is selling this concentrate to Hindalco Industries mainly, and they are producing this. They can also import the concentrate from other countries and produce copper cathodes. That is why we have written that Hindustan Copper Limited—we have in brackets, within brackets, we are calling it MIC or the metal in concentrate—that is not the copper cathode, copper cathode.

Now, in lead and zinc, we have primary lead from Hindustan Zinc Limited and zinc ingot also—in ingot form, we have Hindustan Zinc Limited; both are controlled by and owned by Hindustan Zinc Limited. So, this is completely private sector participation in the zinc sector in India. Now, how much are we self-reliant, how much are we self-sufficient in producing our important minerals like primary raw materials, which are essential for the iron and steel industry and the cement industry? These key self-sufficient minerals include iron ore, kyanite, sillimanite, aluminium primary, lead primary, and zinc. However, India also depends on imports.

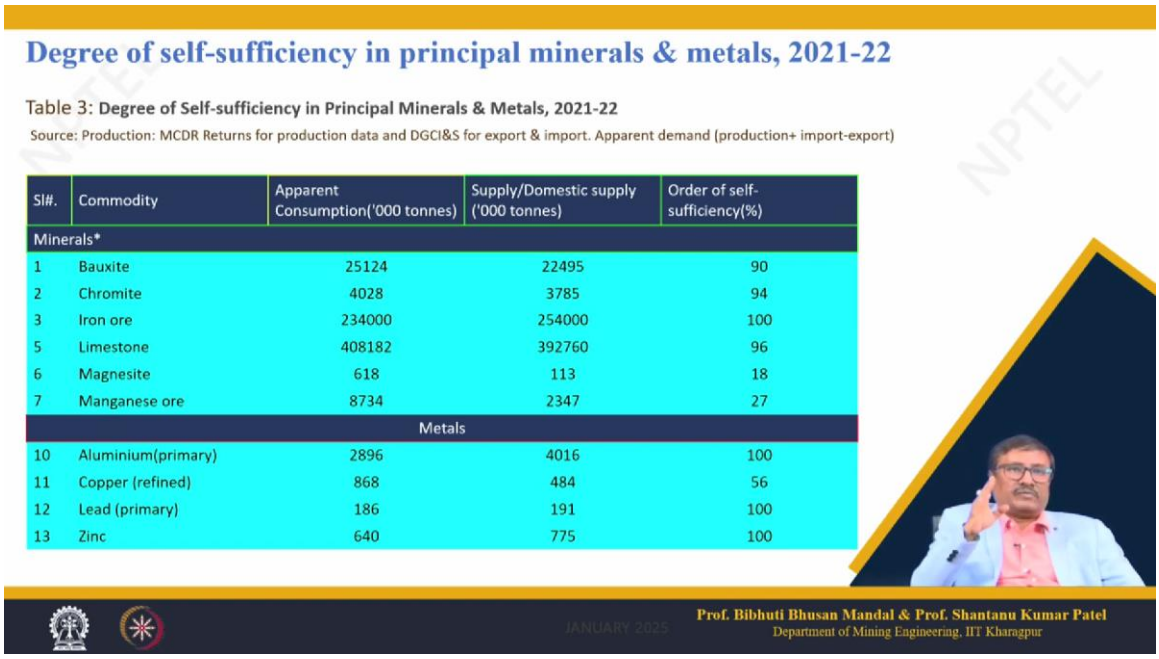


For minerals like bauxite, even chromite, limestone, magnesite, manganese ores and rock phosphate to meet blending requirements or produce specialized products. Additionally,

India imports uncut diamonds. So, that goes mainly to the Gujarat where we have very famous world famous diamond cutting industry. Emeralds and other precious stones to support its cutting and polishing industry for value added re-export. So, we do that we have value adding through different processing and then we re-export to other countries.

If you see by the order of self-sufficiency, how to measure it? So, we have the consumption and how much we are supplying from the domestic resources. We will take just an example, for example, bauxite. So, we need say in 1000 tons, we need 25,124 and we are supplying say 22,495. So, we are 90% self-sufficient in this, 90%.

See in iron ore we have these two figures where we where we are we can supply more than that. That means we are 100 percent sufficient in this self-sufficient on iron ore. In limestone also almost 100 percent, 96 percent. Then you that helps in the cement industry. So, also in manganese ore of course, we we have 27 percent.



In aluminium primary metals we are 100 percent self-sufficient, we do not require the primary aluminium to be imported. Copper of course, we need to import 56 percent, we produce approximately we supply approximately 40 percent or 45 percent say and rest we have to we rather sorry we are about 60 percent we are supplying, 40 percent we are bringing from outside. Lead we are 100% self-sufficient whatever is demand we can supply and zinc also we have we are 100% self-sufficient as you can see from the table on the

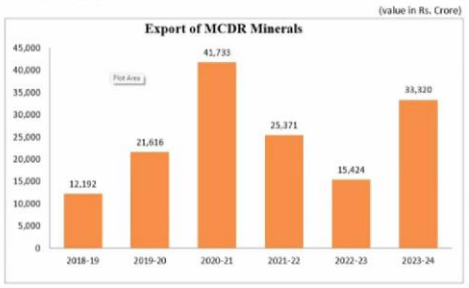
screen. In export and import in mineral industry that plays a crucial role and in meeting the demand for the various minerals. When the domestic production is especially insufficient you need to import or you need some specialized minerals without which certain activities cannot be continued.

So, then you need to import those things. So, India with its abundant mineral resources remains a significant player in the global mineral trade. So, we also depend on imports definitely, but we also sufficient quantities for certain things which we can export. Export and import figures are you see here year wise. So, this is in value in rupees crores.

You can see that in near 2020-21 when the just the COVID hit, then we reached about say 41,733 rupees crore. This was the export that we had. which was definitely hit in the next 2 years and we are again recovering in 2023-24 about 33,320 crores in the export. And import as you can see also has increased our industrial activity is increasing 2021-22, 22-23 and again 2023-24 we have 66,895 crores that we are importing. So, here what we need to do and what we are doing also that we are the government is encouraging opening new mines and then producing more minerals and metals all these things.

So, that we are we become less dependent on the on the import rather we can increase our export and we can add more to our economy. So, GDP contribution as that we have we have 2.1 percent to about 2.5 percent contribution in the GDP the gross domestic product.

Export and Import of MCDR minerals during 2018-19 to 2022-24



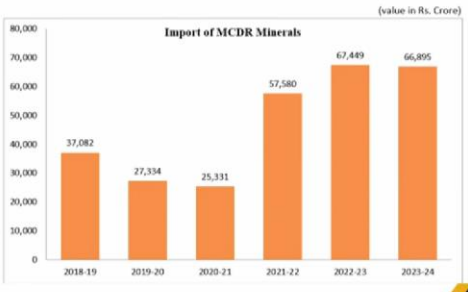


Fig 2: Export and Import value over the years (Indian Bureau of Mines)

*Note: Figures are for all minerals except fuel/coal, gold/diamond and minor minerals

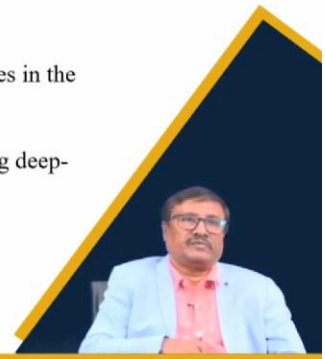
MCDR minerals refer to the minerals regulated under the **Minerals (Other than Atomic and Hydro Carbons Energy Minerals) Concession Rules, 2016 (MCDR) in India

Now, it plays a vital role in supporting key industries like power, steel and infrastructure. Of course, there are other things which are which can be included in mining, but then that is not here. This is a typical we have the official account of this.

In practical figures, the mining contribution may be more than this. This sector has the potential to help India reach 30 trillion dollar economy by say 2047 and create 25 million jobs. Now, the recent policy reform including exploration, a license through auctions and that has changes and the changes that we have made in MMDR Amendment Act 2023 aim to attract private investment more than ever before. Now, we are attracting more and more

GDP contribution of Mining Industry

- The Indian mining sector contributes 2.1% - 2.5% to GDP and plays a vital role in supporting key industries such as power, steel, and infrastructure.
- The sector has the potential to help India reach a USD 30 trillion economy by 2047 and create 25 million jobs.
- Recent policy reforms, including exploration licenses through auctions and changes in the MMDR Amendment Act 2023, aim to attract private investment.
- Focus on developing exploration capacity, incentivizing investment, and unlocking deep-seated and critical minerals to fuel future growth.



private investment. We are we are focusing on developing exploration capacity, incentivizing the investment.

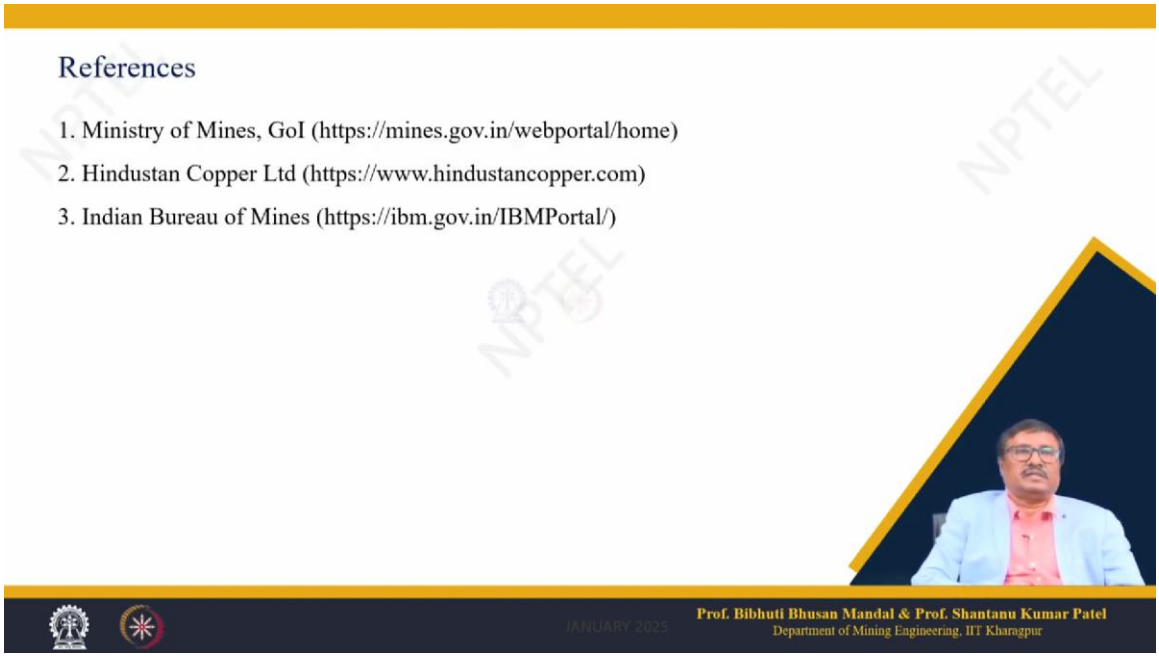
That means, we are we are giving more incentive when you are getting foreign direct investment. There are lot of facilities offered when it is done and then unlocking deep seated and critical minerals to fuel future growth. The critical minerals which was lying idle we are trying to mine and again to increase our contribution to the production of critical minerals. The primary sector, the mining being, a primary sector, it strengthens the economic diversification and it helps in the growth of the auto, chemicals and real estate, further enhancing the nation's economic stability. It has a direct impact on the regional economy especially the mineral rich areas and then we can promote the development of local infrastructure like the road, school, hospital, other facilities.

We can give provide access to the social services and overall regional economy. So, this plays a significant and vital role especially of minerals like iron ore, bauxite and coal which are in high demand globally. This not only enhances the India's trade balance but also its position is better in the global market. you can say in a summary that it plays a pivotal role economic growth that is needless to say and for the industrial development overall development it contributes in a significantly to the country's GDP here and supporting key sectors like as we said in power steel and manufacturing both private public partnership

entrepreneurship and combination about this kind of investment that drive the sector forward and it has become more dynamic than ever before.

We have public enterprises we for the strategic resource management and sustainability of the business, private whereas the private sector is bringing as you said innovation, competition and the efficiency in the operation. So, it is not only meeting the domestic demand but also we are boosting exports. We are providing employment opportunities to millions of people, particularly in rural and then isolated mineral region. All as the sector or the mining sector evolves, then the integration of the new technologies reforms in the statutory and which is more open market, which is open market and then sustainable practices.

This will enhance its contribution to the India's economy on a sustainable basis. So, with this I come to the end of this particular session the beginning of the of the module 1 of the course and we have you can use this references like the for for more information you can refer to the ministry of mines A Government of India website I have given here. Some information we took from the Hindustan Copper Limited website and a very famous one the Indian Bureau of Mines. From that portal also lot of information and for even for the past years also we can have all those information at one place.



If you are interested in learning more, you can visit those sites, download the materials from there, and learn more about these things. With these things, we come to the end of this first lecture. See you in the next lecture. Bye-bye.