

MINERAL ECONOMICS AND BUSINESS

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Week 11

Lecture 55 : Critical minerals

Hello everybody, we have a very special lecture today on the critical minerals. We have completed the lectures of the week 11, this is the last in the 11th week. And we will be switching over to mostly the national mineral policy trade and business in the last 5 lectures of the 12th week. But I thought that we should talk also about the very important initiatives taken by the government of India in respect of critical minerals. So, that I will be covering in this particular lecture.



Now what are these critical minerals all about? How do we define them? What is their importance? How they are globally distributed for availability? And the importance given by the government of India

that we will discuss and the establishment of the national critical mineral mission to achieve the objectives of better more mining of the critical minerals contributing

effectively to the development of the nation. How can you define the critical minerals? Now as you see from the definition that they are defined as those which are essential for the economic development and the national security is very very important they have been identified which are directly ah ah required for the economic development and also for the national security. Now the limited availability or say concentrated existence in certain geographical location makes them vulnerable to supply chain disruptions. They are not evenly distributed somewhere in the some part of the globe you see the mineralization is more.



Critical minerals

- Critical minerals are defined as those that are **essential for economic development and national security**.
- Their **limited availability** or concentrated existence in certain geographical locations makes them vulnerable to **supply chain disruptions**.
- Factors such as **import dependence, technical extraction difficulties, geopolitical risks, and environmental concerns** amplify their criticality.
- The significance of critical minerals lies in their **indispensability in modern technology, defense, and energy sectors**, making their secure supply crucial for global stability.



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So, unless you have well distributed things or multiple sources. many sources of the of the mineral, it cannot expect a stable supply chain. So, they are subjected to the vulnerability of the supply chain disruption because of their ah heterogeneous geographical distribution. Now the factors, important factors are import dependence in respect of critical minerals, the technical difficulty in the extraction process, the geopolitical risk, today I am having a good relation with country A which has agreed to supply the critical mineral to us. But tomorrow this may not continue because of the geopolitical events.

It can change. And there are of course environmental concerns that is related to the criticality of the minerals. Now, why they are so significant? Because they have become

indispensable in the modern technology, we will easily understand when we discuss further. Their use in different in the critical energy sectors and making their secure supply crucial for the global stability.



Why are critical minerals important ?

- **Foundation of Modern Technology:** Used in electronics, renewable energy, and advanced manufacturing.
- **Essential for National Security:** Crucial in defense applications like aerospace, radar systems, and communication networks.
- **Vital for Green Energy Transition:** Key components in solar panels, wind turbines, and electric vehicle (EV) batteries.
- **Economic and Industrial Growth:** Integral to industries such as automobile, healthcare, and infrastructure development.



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This has become so critical that they have they are indispensable for modern technology, they are used in defence, energy sector and for global stability therefore, they have become critical players. So, why they are important? I mean let us discuss these things a little bit more details. They are used in electronics, renewable energy, advanced manufacturing process. They are also required for the national security like defense applications like aerospace, radar system, communication network.

They are also vital for our green energy transition, the transition towards green energy like solar panels, the components in solar panels. In wind turbines and electric vehicle batteries. So, when you are transitioning from conventional to non-conventional green energy, there are key minerals or components that require these minerals, which have become critical because all these things are very important today. For overall economic and industrial growth, these minerals are integral to industries like the automobile industry, healthcare industry, or infrastructure development. So, they have become, without any doubt, critical minerals or minerals that are critical for the development of nations.

Global distribution of critical minerals

Geographical Concentration of Reserves

- Critical minerals are **unevenly distributed**, making some countries dominant in their supply.
- Key regions rich in critical minerals:
 - **China** – Largest producer of Rare Earth Elements (REEs), tungsten, and graphite.
 - **Democratic Republic of Congo (DRC)** – Holds 70% of the world's Cobalt reserves.
 - **Indonesia** – Leading producer of Nickel, essential for EV batteries.
 - **Latin America (Chile, Argentina, Bolivia)** – Known as the "Lithium Triangle", holding over 50% of global Lithium reserves.




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What is the global distribution of these critical minerals? Now, we can just try to outline the geographical concentration. They are unevenly distributed, as I already mentioned. So, some countries will dominate in their supply. For example, China is the largest producer of rare earth elements, tungsten, and graphite.

Another small country, the Democratic Republic of Congo (DRC), has 70 percent of the world's cobalt reserves. Imagine, 70 percent of the world's cobalt reserves are in the DRC. Now, Indonesia is the leading producer of nickel, which is essential for electric vehicles. Again, in Latin America, Chile, Argentina, and Bolivia are called the lithium triangle. They have 50 percent of the global lithium reserves. Imagine that. So, for electric batteries, you see, we need lithium-ion batteries, and again, you need nickel for EV batteries.

So, it depends on Indonesia mostly, I mean, as the leading producer. And see, a highly politically disturbed country like the DRC, Congo, has 70 percent of the cobalt reserves. They are unevenly distributed, and then you can understand how critical it is to maintain a good and stable supply chain if you want to benefit from all these countries. Our dependence on imports—let us just try to find out. On lithium, cobalt, nickel, vanadium, niobium, germanium, uranium, beryllium, tantalum, and strontium, we had 100 percent dependency in the 2020 report.

India's dependence on imports

India is heavily reliant on imports for various critical minerals due to **limited domestic production and processing capacity**.

Sl. No.	Critical Mineral	Percentage (2020)	Major Import Sources (2020)
1.	Lithium	100%	Chile, Russia, China, Ireland, Belgium
2.	Cobalt	100%	China, Belgium, Netherlands, US, Japan
3.	Nickel	100%	Sweden, China, Indonesia, Japan, Philippines
4.	Vanadium	100%	Kuwait, Germany, South Africa, Brazil, Thailand
5.	Niobium	100%	Brazil, Australia, Canada, South Africa, Indonesia
6.	Germanium	100%	China, South Africa, Australia, France, US
7.	Rhenium	100%	Russia, UK, Netherlands, South Africa, China
8.	Beryllium	100%	Russia, UK, Netherlands, South Africa, China
9.	Tantalum	100%	Australia, Indonesia, South Africa, Malaysia, US
10.	Strontium	100%	China, US, Russia, Estonia, Slovenia

Source:
A report on 'Unlocking Australia-India Critical Minerals Partnership Potential' by Australian Trade and Investment Commission, July 2021.



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We had some byproducts even in copper smelting, but they were later purchased by some other companies. So, our critical minerals or very precious minerals like vanadium or molybdenum production is very low. So, practically, as of 2020, we can say that for all these, we are 100 percent import-dependent. You see how critical this is—unless we have some kind of base, some kind of our own production, our own availability, it is difficult because you have to maintain good connections and business relationships with all these countries which have been listed. as the import sources from where, in 2020, we sourced these critical minerals and for which we are 100 percent import-dependent.

Now, what are these foreign sourcing strategies when we are dependent on others? So, we can do strategic overseas acquisitions—like, you have critical mineral reserves where the business is open, then through your mining companies, you can go for overseas acquisition, do mining there, and bring it to your country. That can be done. Or we can do it through bilateral agreements. For example, we give coal or something to some country, and we get critical minerals in return. We can also have joint ventures and long-term contracts with those countries for supply.

Now also we have other these things the initiatives by the government of India, the Khanis Bidesh India Limited. This is for the acquiring mineral assets abroad, especially for critical mineral. They will try to find out those places where this critical minerals are

available. for and they are not being mined or some resource and reserve which is open for investment there. So, our companies can go and invest there and bring the mine and then bring the critical mineral in our country.



own country. And we must also promote through the NCMM the overseas acquisition so that you do mining there and bring the critical mineral here.



National Critical Minerals Mission (NCMM)

- Recognizing the importance of critical minerals, the Government of India has introduced **NCMM to ensure mineral security for the country.**
- This mission aims to **enhance domestic availability**, encourage **recycling**, and promote **overseas acquisitions.**
- **Financial commitment to the mission:**
 - The Government has allocated **₹16,300 crore** for NCMM.
 - Public Sector Undertakings (PSUs) will also invest **₹18,000 crore** in various initiatives under the mission.



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Now, the financial commitment to the mission for the government has allocated 16,300 crore for the NCMN to enhance domestic availability, encourage the recycling of critical minerals, and also to promote the overseas acquisition of mining reserves. Also, the PSUs, as I said in the previous slide, will invest another 18,000 crore in various initiatives under the National Critical Mineral Mission. What is the vision? What is their detailed vision? To enhance domestic production, that means, we want to strengthen exploration and mining efforts.

So that we reduce, as I said, reliance on imports, which is a very critical issue. If you fully depend—100 percent—on imports from other countries, anything can happen, and the supply chain will be disrupted. We need to establish advanced facilities for refining and processing critical minerals within India. So that even if you are mining, you should not send the concentrate or those minerals outside for processing and then get the materials back. No, not only production but also the processing of critical minerals—the facilities should be available within the country. That is part of the vision of our NCMM.

We encourage, through NCMM, recycling and the circular economy. That means we are promoting efficient recovery of critical minerals from electronic waste and end-of-life products. So we can recycle and bring them back into the economy. So, we call it a circular economy. Also, the NCMM will try to strengthen global collaboration for sustainable and long-term access to essential minerals abroad.



Vision of NCMM

Key goals of NCMM:

- **Enhancing domestic production:** Strengthening exploration and mining efforts to reduce reliance on imports.
- **Developing processing infrastructure:** Establishing advanced facilities to refine and process critical minerals within India.
- **Encouraging recycling and circular economy:** Promoting efficient recovery of critical minerals from electronic waste and end-of-life products.
- **Securing international partnerships:** Strengthening global collaborations for sustainable and long-term access to essential minerals.

The slide features a video inset of a man in a light blue shirt gesturing with his hand. The background of the slide is white with a yellow header and footer. The footer contains logos for the Ministry of Mines and the Department of Atomic Energy, along with the text 'Mineral Economics and Business' and the names 'Prof. Bibhuti Bhushan Mandal & Prof. Shantanu Kumar Patel, Department of Mining Engineering, IIT Kharagpur'.

So, how much I mean what are the minerals that has been identified and selected. So, a three stage assessment was conducted to identify minerals criticals to India and considering the global critical mineral strategy what the other countries have done and through inter ministerial consultation. And of course, the empirical evaluation based on the economic importance and supply risk of any mineral, so that they can be termed as critical minerals. So, various ministries and organization including the Ministry of Power, Department of Atomic Energy, DAE, NITI Aayog, they have contributed to identifying the critical minerals as you will see the critical mineral list. So, based on all these 30 minerals were identified for critical like the net import reliance and the resource availability we have identified 30 as critical minerals.

as you can see in the list latest list antimony, beryllium, bismuth, cadmium, cobalt, copper, gallium, germanium, graphite. These things lithium, molybdenum, platinum, nickel, phosphorus, potash all these things and the rare earth elements all these lanthanum from lanthanum to your yttrium all these under rare earth element. all have been ah

identified as critical minerals. Here also you see selenium, silicon, tantalum, tin, titanium, tungsten, vanadium, zirconium all this comes under the critical minerals now. We have identified these things for which we are import dependent or our resource is very poor, we need to explore them where the resource available, whether we can go for acquisitions of mining properties abroad and reduce the import dependency, we can bring the mineral that we mine abroad.



Identification and selection of critical minerals

- **Assessment Process:** A three-stage assessment was conducted to identify minerals critical to India, considering global critical mineral strategies, inter-ministerial consultations, and empirical evaluations based on economic importance and supply risk.
- **Stakeholder Involvement:** Various ministries and organizations, including the Ministry of Power, Department of Atomic Energy, and NITI Aayog, contributed to identifying critical minerals relevant to their sectors.
- **Final List of Critical Minerals:** Based on the assessment, 30 minerals were identified as critical for India, considering factors such as net import reliance and resource availability.



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And also ah now the recycling of these material within the country after use. So, that again in in in in in terms of upon import dependency this helps in future. The government has allocated as I said earlier that 16300 core for the development of the an exploration of critical minerals through NCNN. So, the budget aims to enhance domestic capacity, promote research on this and reduce dependence on import this is very important. That means, we have to enhance our domestic capacity production capacity availability from the domestic resources.

List of critical minerals in India:

- | | | | |
|------------------|--------------------|--------------------------------|---------------|
| 1. Antimony | 15. Nickel ✓ | 19. Rare Earth Elements (REE): | 20. Rhenium |
| 2. Beryllium | 16. Platinum Group | • Lanthanum | 21. Selenium |
| 3. Bismuth | Elements (PGE): | • Cerium | 22. Silicon |
| 4. Cadmium | • Platinum ✓ | • Praseodymium | 23. Strontium |
| 5. Cobalt | • Palladium | • Neodymium | 24. Tantalum |
| 6. Copper | • Rhodium | • Promethium | 25. Tellurium |
| 7. Gallium | • Ruthenium | • Samarium | 26. Tin |
| 8. Germanium | • Iridium | • Europium | 27. Titanium |
| 9. Graphite | • Osmium | • Gadolinium | 28. Tungsten |
| 10. Hafnium | 17. Phosphorous ✓ | • Terbium | 29. Vanadium |
| 11. Indium | 18. Potash ✓ | • Dysprosium | 30. Zirconium |
| 12. Lithium ✓ | | • Holmium | |
| 13. Molybdenum ✓ | | • Erbium | |
| 14. Niobium ✓ | | • Thulium | |
| | | • Ytterbium | |
| | | • Lutetium | |
| | | • Scandium | |
| | | • Yttrium | |



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And, then promote research because better I mean the wasting of these minerals or I mean that is the very critical. So, we need to utilize them most and the processing should be available in house in our own country. And, overall dependence on imports should be minimized as much as possible. So, the PSUs are also playing significant role in the critical mineral investment as I have shown earlier and again I am repeating that about 18000 crores INR has been earmarked for the state owned enterprises like NMDC, Nalco and HCL to strengthen the exploration and processing of the critical minerals. Now, at the moment other than even though we have listed this 30 critical minerals, but we are giving importance specific importance on lithium, cobalt, nickel and rare earth element.

Financial allocation for NCMM

- The Indian government has allocated **INR 16,300 crore** for the development and exploration of critical minerals through the **National Centre for Mineral Materials (NCMM)**. ✓
- This budget aims to enhance domestic capacity, promote research, and reduce dependence on imports.
- **Public Sector Undertakings (PSUs)** are playing a significant role in critical mineral investments.
- **INR 18,000 crore** has been earmarked for **state-owned enterprises** like **NMDC, NALCO, and HCL** to strengthen exploration and processing.
- Focus areas include **lithium, cobalt, nickel, and rare earth elements**.



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This is focus Critical, entire critical minerals are in focus definitely, but we are giving the country is giving, India is giving special importance, specific importance to lithium, cobalt, nickel and the rare earth element. As far as the mission outcomes, so the NCMM aims to enhance domestic mineral production by the execution of the 1200 exploration projects a big one. And auctioning we have identified that we have critical minerals in 100 blocks. By say 2030 to 2031 fiscal year we should have completed we should we should complete the exploration of 1200 projects exploration projects and we must have auctioned this thing 100 critical mineral blocks.

So, this will first thing this will ensure the domestic availability which is the prime criteria. In at least 15 strategic minerals like the graphite, lithium, potash and there are we must have heard the lithium deposit near Jammu. So, the government is giving importance on that whether we can mine that lithium. It has gone through the auction process repeatedly. Hopefully, we will be solving this problem and we will have our own lithium source.

Mission Outcomes of NCMM

- NCMM aims to enhance domestic mineral production by executing 1,200 exploration projects and auctioning 100 critical mineral blocks by **FY 2030-31**, ensuring the domestic availability of at least **15 strategic minerals** such as graphite, lithium, potash, and rare earth elements.
- The mission targets **reducing import dependency**, with domestic production meeting up to **10% of the annual demand** for critical minerals by 2031.
- To secure a stable supply, Indian companies plan to **acquire at least 50 overseas mining assets**, focusing on key battery minerals like **lithium, nickel, copper, cobalt, and graphite**.

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Now this NCMM also targets reducing the reduction in import dependency by increasing the domestic production and to the level of 10 percent of the annual demand by 2031. and to secure stable supply Indian companies plan to acquire at least 50 overseas mining assets reserves and resources focusing on key battery minerals. this electric vehicle this is creating lot of issues lot of focus on the lithium, nickel, copper, cobalt and

graphite because of the motor the lithium battery And all these your mobile phones they require the lithium ion and there are all batteries are now switching over to lithium. So, there is a huge demand for lithium and the motors they require more cobalt, more copper, nickel these things.

The focus is towards lithium, nickel, copper, cobalt and graphite and we are trying to acquire at least 50 overseas mining assets to meet our requirement in India. We want to develop also skilled workforce that means about 10,000 professionals specializing of mining, processing and recycling of critical minerals. The mission also support innovation by establishing 3 centers of excellence and also 4 regional mineral processing hubs for the specialized in the critical minerals processing. And the to accelerate the project execution there are regulatory frameworks that has been streamlined for faster approval. and transition from exploration to production.

Mission Outcomes of NCMM

- Developing a **skilled workforce** is another priority, with **10,000 professionals** specializing in mining, processing, and recycling.
- To support innovation, **three Centers of Excellence (CoEs)** will be established. The mission also includes the creation of **four regional mineral processing hubs** to strengthen domestic refining capabilities and reduce reliance on international processing centers.
- To accelerate project execution, **streamlined regulatory frameworks** will be implemented for **faster approvals and transitions from exploration to production.**

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That means expedite the process to critically examine where the bottlenecks are, how fast we can move from the from the exploration projects to the final products . So, it is being very critically ah supervised as to the progress of this mission, so that we can meet the our our our aims our objectives. to reduce the import dependency to improve our domestic supply and also see that the demand that is required I mean that is there in our country is made from our own sources and we reduce the import dependency as minimum as possible as low as less as possible. We want to strengthen the global

partnership and trade agreements with resource rich nations which are already having that. So, that we can develop good partnership and get the minerals from outside sources.

So, and also we will have a national critical mineral stockpile That means if you are having surplus if you are producing more or producing more than what we can could consume then we can have a stockpile that means a reserve. So, that if there is a supply disruption then we can meet this from the stockpile that means there will be reserved a buffer available to the nation. So, that you can continue the steady supply for the development and of the nation using the critical minerals as we have described and discussed throughout the lecture today.

Mission Outcomes of NCMM

- Strengthening **global partnerships and trade agreements** with resource-rich nations will ensure a secure supply of critical minerals and access to advanced mineral processing technologies.
- **A National Critical Minerals Stockpile** will be developed to safeguard essential minerals against global supply chain disruptions.

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If you want to know something about the recycling programs, then we can say that the pilot projects already India has launched the pilot project for the lithium ion battery recycling So, that by recycling you reduce the dependence on import and also the e-waste processing already financial support has been provided and secondary extraction of the art element. Then we have the end of life product recovery initiative that means the machines or the circuit board and many other electronic or the batteries are already say it is the end of life. So, what we do? term called the urban mining.

It is discarded in many cities towns there towns hundreds of towns of this discarded electronic materials are there and the batteries are discarded. So, what we do that mining

Critical mineral recycling programs

Pilot Projects and Financial Incentives

- India has launched **pilot projects for lithium-ion battery recycling** to reduce import dependency.
- Financial support is provided for **e-waste processing and secondary extraction** of rare earth elements.

End-of-Life Product Recovery Initiatives

- **Urban mining** of discarded electronics and batteries is being promoted.
- Policies support **Extended Producer Responsibility (EPR)** to ensure companies recycle critical minerals.
- Research is ongoing to improve the efficiency of **rare earth element recovery from industrial waste**.



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urban mining that is recovery from those things, collecting those discarded electronic boards and the batteries and from there that so that we can recover the critical minerals from those discarded things. So, we call them an urban mining. Now, this extended producer responsibility is to ensure companies recycle the critical minerals.

So, if your company is using these things. So, they are not just simply throwing it away. Can we have a policy to ensure producer responsibility? They can also involve themselves in recycling and make it available in the market again. So, we are also conducting research to improve the efficiency of rare earth element recovery from industrial waste. So, our domestic availability becomes higher than what we have today.

Future roadmap for NCMM

Targets for 2030 and Beyond

- Achieve self-sufficiency in at least 50% of critical minerals by 2030.
- Expand domestic mining capacity through enhanced **exploration programs**.
- Boost **recycling and circular economy** initiatives to recover critical minerals.
- Develop **India's first large-scale lithium refining facility** to support battery manufacturing.



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So, what is the future roadmap of our National Critical Mineral Mission? By 2030 and beyond, we want to achieve at least 50 percent of the critical minerals by 2030. We will expand domestic mining capacity through exploration programs, which have been greatly enhanced by the support provided by the National Critical Mineral Mission. As I said, we want to boost recycling of critical minerals and improve the circular economy to recover these critical minerals from waste materials. And we want to develop India's first large-scale lithium refining facility to support battery manufacturing.

This is a short-term future roadmap for the National Critical Minerals Mission. This will help us, as I said, reduce dependency on imports because the National Critical Mineral Mission has approached the problem from many sides and different perspectives. So, no stone remains unturned in achieving our target—to reduce import dependency and make the exploration-to-production process as fast as possible. We will establish different organizations through which we can acquire properties in other countries to source critical minerals. From all aspects, we have—and the Government of India has provided fiscal fund support to all these targets.



Hopefully, with this, we will be able to achieve our targets in the near future. If you want to read something, you can read these things in the Ministry of Mines. We have a specific document available on the National Critical Mineral Mission. There is a June 2023 report

by the Ministry of Mines where you can get the complete list of the critical minerals and associated information, which will be very helpful for understanding critical minerals as a whole. Thank you very much.