India’s Path to Securing Critical Minerals

This editorial is based on “A push for critical minerals” which was published in The Financial Express on 27/07/2024. The article highlights India's strategic move in Budget 2024 to exempt customs duties on critical minerals like lithium, crucial for advancing electric mobility and sustainable energy. It underscores the country's efforts to reduce import dependency and support domestic production while enhancing its commitment to environmental goals and energy security

For Prelims: Union Budget 2024-25, Critical minerals, Lithium, Electric vehicles, Ministry of Mines, Rare Earth Elements , Gaganyaan, Minerals Security Partnership, Lithium reserves in Jammu and Kashmir, Khanij Bidesh India Limited.

For Mains: Significance of Critical Minerals for India, Major Challenges Related to Critical Minerals for India

The Union Budget 2024-25 recognizes energy security **as a key priority**, proposing targeted **customs duty exemptions for** critical minerals, including lithium. This strategic move underscores India's commitment to accelerating its electric mobility transition and advancing its zero-emission ambitions. As **lithium-ion batteries** remain the most critical and cost-intensive component in electric vehicles **(EVs),** this exemption aims to lower resource and production costs, incentivize manufacturing, and encourage innovation in electric mobility solutions.

India's heavy reliance on the **import and refinement of lithium and other critical minerals** presents significant challenges. By adopting a **more holistic approach to critical minerals**, India can better align its economic progress with environmental stewardship and strengthen its position in the global transition to sustainable energy and electric mobility.

What are Critical Minerals?

- **About:** Critical minerals are those minerals which are **essential for economic development and national security.**
  - The lack of availability of these minerals or **even concentration of existence, extraction, or processing in a few geographical locations** may lead to supply chain vulnerability and disruption.
- **Key Characteristics:**
  - **Essential for Modern Technology:** They are indispensable components in various technologies, from clean energy (solar panels, wind turbines, **electric vehicles)** to electronics, defense, and healthcare.
  - **Geopolitical Significance**: Their supply is often concentrated in a **few countries**, making them vulnerable to supply chain disruptions and price fluctuations.
  - **Environmental Impact**: Extraction and processing of these minerals can have **significant environmental consequences** if not managed responsibly.

- **Critical Minerals for India:** The Ministry of Mines has identified **30 such minerals crucial for India's technological and** renewable energy sectors.
    - A Committee was formed to assess and determine these minerals through international studies, inter-ministerial consultations, and empirical analysis.
        - The Committee recommends establishing a **Centre of Excellence for Critical Minerals** to periodically update and strategize the critical minerals list and develop effective value chains.
    - **The 30 Critical Minerals for India:** Antimony, Beryllium, Bismuth, Cobalt, Copper, Gallium, Germanium, Graphite, Hafnium, Indium, **Lithium,** Molybdenum, Niobium, Nickel, Platinum Group Elements (PGE), Phosphorous, Potash, Rare Earth Elements (REE), Rhenium, Silicon, Strontium, Tantalum, Tellurium, Tin, Titanium, Tungsten, Vanadium, Zirconium, Selenium, Cadmium.

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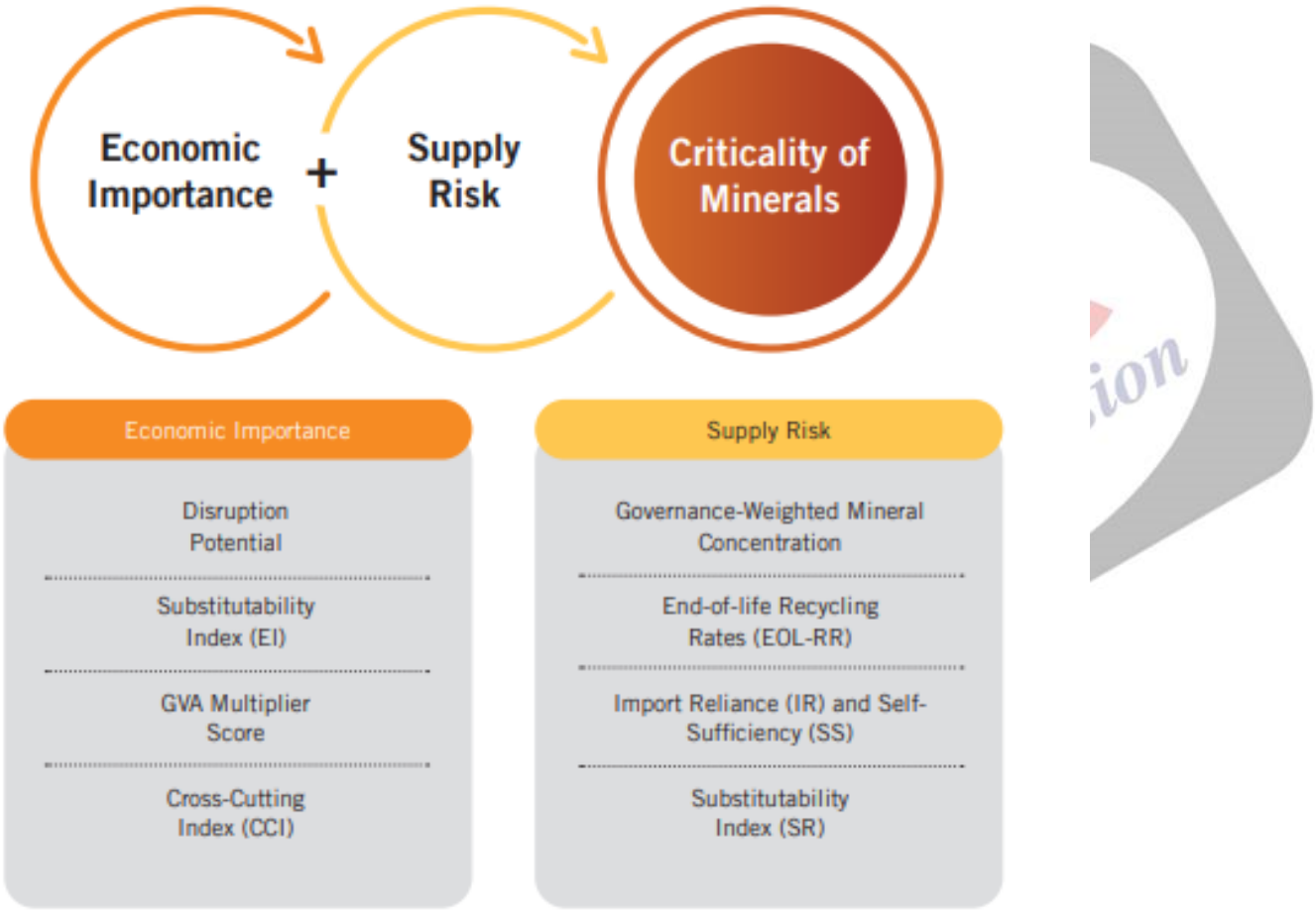

Why are these Minerals Considered Critical?

- **Energy Transition and Electric Mobility**: Critical minerals, especially lithium, are crucial for India's transition to clean energy and electric mobility.
    - The country's lithium imports jumped from **Rs 13,673.15 crore** in FY2022 to **Rs 23,171 crore** in FY2023, underlining the growing demand.
    - With India aiming for **30% electric vehicle penetration by 2030 (India's EV Vision)**, secure access to these minerals is vital.
    - The recent customs duty exemption on critical minerals in the **Budget 2024** demonstrates the government's recognition of their importance in accelerating EV adoption and reducing production costs.
- **Space Exploration and Satellite Technology:** India's ambitious space program, including missions like Gaganyaan, relies heavily on critical minerals.

    - The Indian Space Research Organisation (ISRO) has been expanding its capabilities, with plans for a space station by 2035.
    - Rare earth elements and other critical minerals are essential for manufacturing high-performance magnets, specialized alloys, and advanced electronics used in satellites and spacecraft.
- **Renewable Energy Infrastructure:** Critical minerals are crucial for India's renewable energy targets, including achieving **500 GW of renewable energy capacity by 2030.**
    - Minerals like **indium, gallium, and tellurium are essential for solar PV technology** , while rare earth elements are vital for wind turbines.
    - Securing these resources is not just about meeting climate goals, but also about ensuring energy security and reducing dependence on fossil fuel imports, which could have significant positive impacts on India's trade balance and energy autonomy.
- **Digital Economy and Telecommunications:** As India's Digital Economy expects to reach **1 Trillion Dollar** by 2025, the demand for critical minerals in electronics and telecommunications infrastructure is set to soar.
    - The success of initiatives like Digital India and the rollout of 5G networks heavily depends on minerals such as **gallium, indium, and tantalum.**
- **The Silicon Heart Dependent on Critical Minerals:** Semiconductors, the brains of modern electronics, heavily rely on critical minerals.
    - Elements like **silicon, germanium, and gallium** are fundamental to semiconductor production.
    - India's Semiconductor Mission aims to boost domestic semiconductor manufacturing, underscoring the critical role of these minerals in achieving technological self-reliance and reducing import dependence.
        - Also, the National Quantum Mission and IndiaAI Mission heavily rely on Silicon.
- **Geopolitical Influence:** Securing critical minerals enhances India's geopolitical standing and bargaining power.
    - The country's participation in global forums like the Minerals Security Partnership (MSP) and bilateral agreements, such as the recent **India-Australia Critical Minerals Investment Partnership**, demonstrate its proactive approach.
    - These initiatives not only secure supply chains but also position India as a key player in global mineral diplomacy.

What are the Major Challenges Related to Critical Minerals for India?

- **India's Import Dependency:** India's heavy reliance on imports for critical minerals poses significant economic and strategic risks.
    - This dependency is particularly concerning given the geopolitical concentration of these resources.
    - China's dominance in processing (**67% of lithium, 73% of cobalt, 70% of graphite, and 95% of manganese)** poses a significant risk to India's supply chain security.
    - This monopolistic control leaves India vulnerable to supply disruptions, price volatility, and potential geopolitical leverage.
- **The Exploration Conundrum**: Despite recent efforts, India's domestic exploration for critical minerals remains in its infancy.
    - The country's geological surveys have identified potential deposits in regions like **Jammu and Kashmir,** but large-scale commercial extraction is yet to materialize.
        - The recent discovery of **5.9 million tonnes** of lithium reserves in Jammu and Kashmir, while promising, requires significant investment and time for development.
    - The slow pace of exploration is exacerbated by challenges such as **complex geology, lack of advanced exploration technologies, and regulatory hurdles.**
- **Missing Links in the Value Chain**: India's limited capacity in **processing and refining critical minerals** presents a significant bottleneck.
    - While the country may secure raw materials, the **lack of domestic processing** facilities forces reliance on other countries, primarily China, for refined products.
    - This gap in the value chain not **only increases costs but also limits India's ability to capture the full economic potential** of these resources.
    - The absence of a robust domestic processing industry also hinders the **development of**

downstream manufacturing sectors, such as **battery production and electronics manufacturing**, crucial for initiatives like 'Make in India' and the National Electric Mobility Mission Plan.

- **Balancing Extraction and Ecology**:The extraction and processing of critical minerals often come with significant environmental costs.
    - Mining operations can lead to **habitat destruction, water pollution, and increased carbon emissions.**
    - India, already grappling with environmental challenges, faces the dilemma of balancing its critical mineral needs with ecological preservation.
    - For instance, potential lithium mining in the **ecologically fragile regions of Ladakh** raises concerns about water scarcity and biodiversity loss.
        - An average silicon chip manufacturing facility today can use**10 million gallons of ultrapure water per day.**
    - Developing environmentally sustainable mining practices while meeting the growing demand for these minerals presents a complex challenge for policymakers and industry alike.
- **Price Volatility- A Double-Edged Sword:** The market for critical minerals is characterized by extreme price fluctuations, impacting India's manufacturing costs and competitiveness.
    - **Lithium prices have surged dramatically in recent years,** affecting the economics of electric vehicle production.
    - Price volatility creates uncertainty for investors and industries reliant on these minerals, **hindering long-term planning and investment.**

Net Import Reliance for Critical Minerals of India (2020)

Critical Mineral	Major Import Sources (2020)
Lithium	Chile, Russia, China, Ireland, Belgium
Cobalt	China, Belgium, Netherlands, US, Japan
Nickel	Sweden, China, Indonesia, Japan, Philippines
Vanadium	Kuwait, Germany, South Africa, Brazil, Thailand
Niobium	Brazil, Australia, Canada, South Africa, Indonesia
Germanium	China, South Africa, Australia, France, US
Rhenium	Russia, UK, Netherlands, South Africa, China
Beryllium	Russia, UK, Netherlands, South Africa, China
Tantalum	Australia, Indonesia, South Africa, Malaysia, US
Strontium	China, US, Russia, Estonia, Slovenia
Zirconium (zircon)	Australia, Indonesia, South Africa, Malaysia, US
Graphite (natural)	China, Madagascar, Mozambique, Vietnam, Tanzania
Manganese	South Africa, Gabon, Australia, Brazil, China
Chromium	South Africa, Mozambique, Oman, Switzerland, Turkey
Silicon	China, Malaysia, Norway, Bhutan, Netherlands

Note:

The Mines and Minerals (Development and Regulation) Amendment Act, 2023 introduces key reforms to enhance exploration and mining of critical minerals in India.

- **Omission of Six Minerals from Atomic Minerals**: Lithium-bearing, titanium-bearing, beryllium-bearing, niobium-bearing, tantalum-bearing, and zirconium-bearing minerals are removed from the atomic minerals list to **promote private sector involvement and increase production.**
- **Central Government Auction:** Central Government will **exclusively auction mineral concessions for critical minerals**, with revenues benefiting State Governments.
- **Exploration Licenses**: New exploration licenses will be introduced for deep-seated and critical minerals, aiming to attract foreign direct investment and junior mining companies, enhancing exploration and production capabilities.

What Measures can India Implement to Manage its Critical Minerals Requirements?

- **Critical Mineral Diplomacy:** Forging a **Global Alliances for Resource Security** India should intensify its " **critical mineral diplomacy**" efforts, establishing strategic partnerships with resource-rich countries. This could involve:
  - Expanding the mandate of Khanij Bidesh India Limited to negotiate more government-to-government deals.
  - Creating a **Critical Minerals Intelligence Unit** to monitor global trends and opportunities.
  - Offering **technical expertise, infrastructure development, or other incentives** to secure preferential access to minerals.
- **Circular Mineral Economy:** Develop a robust circular economy for critical minerals through:
  - Implementing **advanced e-waste recycling technologies** to recover valuable minerals.
  - Creating a **national database of end-of-life products** containing critical minerals.
  - India could set up specialized recycling zones in major cities, equipped with state-of-the-art technologies to extract critical minerals from e-waste, potentially recovering up to**50-60% of rare earth elements** from discarded electronics.
- **Mineral Tech Leap**: Boost technological capabilities in critical mineral extraction and processing through:
  - Establishing a **Critical Minerals Technology Mission**, similar to the successful **space and atomic energy programs.**
  - Offering **tax incentives for R&D investments** in critical mineral technologies.
  - Creating **industry-academia partnerships** focused on developing cutting-edge extraction and processing techniques.
  - Facilitating **technology transfer agreements** with global leaders in mineral processing.
- **GeoMapping Revolution:** Intensify and modernize domestic mineral exploration efforts by:
  - Employing **advanced geological mapping techniques**, including AI and machine learning.
  - Conducting **comprehensive aerial and satellite surveys** of potential mineral-rich areas.
  - Encouraging **private sector participation in exploration** through risk-sharing mechanisms.
  - Streamlining the process for granting exploration licenses.
- **Green Mining Initiative**: Develop sustainable mining practices tailored to India's unique ecological context:
  - Implementing **strict environmental standards** for critical mineral mining.
  - Developing a comprehensive land rehabilitation program for mining sites.
  - Creating a **sustainability rating system for mining operations.**
  - Establish a "**Green Mining Innovation Fund**" to support the development of **water-conserving lithium extraction methods** suitable for arid regions like Ladakh.

- **Skill India for Critical Minerals**: Address the skill gap in the critical minerals sector through:
    - Introducing specialized courses **in critical mineral geology, extraction, and processing in technical institutions.**
    - Establishing vocational training centers in mineral-rich regions.
    - Creating a national certification program for critical mineral professionals.
- **Mineral Processing Parks:** Establish dedicated mineral processing zones to boost domestic capabilities:
    - Offering **tax incentives and simplified regulatory processes** in these zones.
    - Ensuring world-class infrastructure including power, water, and logistics support.
    - Encouraging **co-location of related industries to create synergies.**
- **Mineral-to-Market Corridors:** Create dedicated infrastructure corridors linking mineral-rich areas to processing hubs and markets:
    - Establish **smart logistics hubs** with real-time tracking capabilities.
    - **Integrate renewable energy sources** to power these corridors.
    - Include data connectivity infrastructure for IoT and smart mining applications.
    - For instance, developing a "**Lithium Corridor**" from Ladakh to **manufacturing hubs in Gujarat**, with solar-powered logistics centers and 5G connectivity throughout.

Drishti Mains Question:

Discuss the significance of critical minerals for India's economic development. Evaluate the potential risks associated with their supply chain vulnerabilities and propose strategies for mitigating these risks.

UPSC Civil Services Examination Previous Year Question (PYQ)

Prelims:

Q. With reference to the management of minor minerals in India, consider the following statements: (2019)

1. Sand is a 'minor mineral' according to the prevailing law in the country
2. State Governments have the power to grant mining leases of minor minerals, but the powers regarding the formation of rules related to the grant of minor minerals lie with the Central Government.
3. State Governments have the power to frame rules to prevent illegal mining of minor minerals.

Which of the statements given above is/are correct?

(a) 1 and 3 only

(b) 2 and 3 only

(c) 3 only

(d) 1, 2 and 3

Ans: (a)

Q. What is/are the purpose/purposes of 'District Mineral Foundations' in India? (2016)

1. Promoting mineral exploration activities in mineral-rich districts
2. Protecting the interests of the persons affected by mining operations
3. Authorizing State Governments to issue licenses for mineral exploration

Select the correct answer using the code given below:

(a) 1 and 2 only

(b) 2 only

(c) 1 and 3 only

(d) 1, 2 and 3

Ans: (b)

Mains

Q. Despite India being one of the countries of Gondwanaland, its mining industry contributes much less to its Gross Domestic Product (GDP) in percentage. Discuss. **(2021)**

Q. "In spite of adverse environmental impact, coal mining is still inevitable for development". Discuss. **(2017)**
