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Critical Minerals: India's Race to Secure the Energy Transition Supply Chain

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SUBJECTS COVERED

ECONOMY ENVIRONMENT IR SCIENCE & TECH

CURATED & WRITTEN BY

Bharat Choudhary

UPSC Educator & Content Creator •
linkedin.com/in/epicbharat

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Critical Minerals: India's Race to Secure the Energy Transition Supply Chain

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WHY IN NEWS

India's National Critical Mineral Mission (NCMM), launched in 2025 with a Rs 34,300 crore corpus, is gaining operational momentum — with KABIL securing agreements in Argentina and the Geological Survey of India completing 368 critical mineral exploration projects — as India seeks to reduce its 100% import dependence for lithium, cobalt, and nickel essential for clean energy and electric vehicles.

WHY CRITICAL MINERALS MATTER

The global energy transition — replacing fossil fuels with electric vehicles, solar panels, and wind turbines — is as much a minerals challenge as it is an engineering challenge. The batteries that power EVs require:

Lithium: for lithium-ion battery cathodes

Cobalt: for cathode stability in NMC/NCA batteries

Nickel: for high-energy-density cathode formulations

Manganese: for lower-cost LFP battery variants

Graphite: for anodes (nearly all from China currently)

Solar panels require **silicon, silver, and tellurium**. Wind turbines use **rare earth elements** — particularly **neodymium and dysprosium** for the permanent magnets in offshore wind turbines and EV motors. Defence and semiconductor applications add **gallium, germanium, and indium** to the list.

The challenge: the mining, refining, and processing of these minerals is **highly concentrated** in a small number of countries — and dominated by China.

Mineral	China's share in global refining
Graphite	~90%
Rare Earth Elements	~60%
Lithium refining	~65%
Cobalt processing	~70%
Gallium	~80%

India, like the US, EU, Japan, and Australia, is highly exposed to supply disruptions from this concentration. A technological war, sanctions, or geopolitical crisis involving China could cut India off from the minerals it needs to achieve its own clean energy targets (500 GW renewable energy by 2030, 30% EV penetration by 2030).

INDIA'S MINERAL PROFILE — STRENGTHS AND GAPS

What India Has

India is **mineral-rich in certain categories**:

Mica: one of the world's largest producers (~25% of global production)

Bauxite/Aluminium: 2nd largest globally; large refining capacity through NALCO, Vedanta, Hindalco

Iron Ore: 3rd largest producer; fuels domestic steel industry

Chromite: significant producer

Titanium: substantial reserves of ilmenite and rutile (beach sand minerals in Tamil Nadu, Kerala, Odisha)

Thorium: India has ~30% of world's thorium reserves (important for future nuclear programme)

What India Lacks

India is **critically deficient** in:

Lithium: No significant domestic reserves identified until a 2023 GSI discovery in Salal-Haimana, Jammu (estimated 5.9 million tonnes — but quality and extractability unconfirmed)

Cobalt: No significant deposits; 100% imported

Nickel: Negligible domestic production

Rare Earth Elements: Monazite sand deposits exist but processing capacity is limited

Graphite: No significant production

NATIONAL CRITICAL MINERAL MISSION (NCMM)

Launched in **2025** by the **Ministry of Mines** with a corpus of **Rs 34,300 crore** (2025–2031), NCMM has six strategic pillars:

1. Domestic Exploration

The Geological Survey of India (GSI) is tasked with conducting **500 critical mineral exploration projects** over 7 years — targeting lithium, cobalt, nickel, REE, graphite, titanium, and vanadium. GSI has already completed 368 such projects.

2. Overseas Asset Acquisition (KABIL)

Khanij Bidesh India Limited (KABIL) was formed as a joint venture of:

NALCO (National Aluminium Company Limited)

HCL (Hindustan Copper Limited)

MECL (Mineral Exploration and Consultancy Limited)

KABIL's mandate is to identify, acquire, and develop critical mineral assets outside India. Key progress:

Argentina (Lithium Triangle): Rs 200 crore agreement; 3 lithium brine blocks in Catamarca province

Australia: Discussions on 5 lithium security projects under the India-Australia Critical Minerals Partnership (2022)

Namibia and Zambia: Cobalt and copper exploration discussions

The challenge with KABIL: India can identify and acquire mineral assets, but **refining infrastructure** remains in China for most of these minerals. Acquiring an Argentine lithium mine is only half the battle — the lithium still needs to be refined (likely in China) before it reaches Indian battery manufacturers.

3. Domestic Processing and Refining

NCMM includes incentives for building **domestic refining capacity** for critical minerals. PLI (Production Linked Incentive) schemes for advanced chemistry cells (ACC batteries) under the Ministry of Heavy Industries also incentivise downstream demand.

4. Recycling and Circular Economy

India generates enormous volumes of **electronic waste (e-waste)** — ranked 3rd globally in e-waste generation (~3.2 million metric tonnes per year). Phones, laptops, and industrial electronics contain recoverable lithium, cobalt, gold, and copper.

The **Recycling Incentive Scheme** (Rs 1,500 crore, 2025) targets recovery of **40 kilo tonnes of critical minerals annually from e-waste by 2030** — a significant domestic circular economy contribution.

5. International Partnerships

India is a member of the **Mineral Security Partnership (MSP)** — a 14-nation grouping announced in 2022 at the US initiative — comprising India, US, EU, UK, Japan, South Korea, Australia, Canada, France, Germany, Italy, Norway, Finland, and Sweden.

MSP coordinates investment in mineral supply chains and shares geological information to reduce China's dominance. India's role: contribute its processing capacity (bauxite, rare earths) in exchange for partner countries' lithium and cobalt resources.

6. Legislative Reform

The **Mines and Minerals (Development and Regulation) Amendment Act, 2025** granted the Central Government **exclusive authority over 24 "strategic minerals"** — overriding state government auction rights for these specific minerals. This is significant because mineral rights for non-coal, non-atomic minerals had traditionally been with the states under the Seventh Schedule.

INDIA-AUSTRALIA CRITICAL MINERALS PARTNERSHIP

India and Australia signed a **Critical Minerals Investment Partnership** in 2022, identifying:

- **5 lithium security projects** in Australia for joint development
- Shared geological survey data
- Australia's commitment to prioritise Indian offtake from Australian mines

Australia has the world's largest lithium reserves (~40%) and is already a major exporter. The Australia-India trade relationship has been transformed by the **ECTA (Economic Cooperation and Trade Agreement)** signed in 2022.

THE CHINA CHALLENGE

Why this matters geopolitically: China has spent 30 years building a systematic, state-directed strategy to dominate critical mineral supply chains:

- Chinese companies own or control significant shares of cobalt mines in the Democratic Republic of Congo (DRC, ~70% of global cobalt)
- China has built the largest lithium refining capacity globally through Ganfeng Lithium and CATL
- In 2023, China imposed export controls on gallium and germanium (semiconductor inputs) — signalling willingness to weaponise mineral dominance
- In 2024, China restricted graphite exports

India's domestic copper production (up 43.5% in FY26) and aluminium capacity give it some leverage, but its exposure on lithium, cobalt, and REE remains acute.

The **"China+1 supply chain"** diversification strategy — pursued by Japanese, South Korean, and US companies relocating some manufacturing outside China — creates an opportunity for India. But without domestic refining capacity for battery minerals, India remains a downstream assembler rather than a vertically

integrated manufacturer.

UPSC RELEVANCE

Prelims:

NCMM: Ministry of Mines; Rs 34,300 crore; 2025–2031

KABIL: JV of NALCO + HCL + MECL; overseas mineral acquisition

MSP (Mineral Security Partnership): 14 nations; India member

Mines Amendment Act 2025: Central authority over 24 strategic minerals

GSI: 368 critical mineral exploration projects completed

Recycling Incentive Scheme: Rs 1,500 crore; 40 kT by 2030

India's strengths: bauxite/aluminium (2nd), iron ore (3rd), mica, titanium

India's gaps: lithium, cobalt, nickel, graphite (100% imported)

Lithium Triangle: Argentina + Bolivia + Chile

Mains GS-3: Energy security; clean energy supply chains; India's mineral diplomacy; EV ecosystem; e-waste recycling; China's mineral dominance **Mains GS-2:** Mineral Security Partnership; India-Australia relations; critical minerals and geopolitics

📌 FACTS CORNER — KNOWLEDGEPEDIA

NATIONAL CRITICAL MINERAL MISSION (NCMM):

Launch: 2025; Ministry of Mines

Corpus: Rs 34,300 crore (2025–2031)

Duration: 7 years

Six pillars: domestic exploration, KABIL, domestic refining, recycling, MSP, legislation

KABIL:

Full form: Khanij Bidesh India Limited

JV: NALCO + HCL + MECL

Mandate: overseas critical mineral asset acquisition

Argentina deal: Rs 200 crore; lithium brine in Catamarca province

MINERAL SECURITY PARTNERSHIP (MSP):

Members: 14 nations — India, US, EU, UK, Japan, South Korea, Australia, Canada, France, Germany, Italy, Norway, Finland, Sweden

Launched: 2022 (US initiative)

Purpose: coordinate investment in critical mineral supply chains

MINES AMENDMENT ACT 2025:

Central government gets exclusive authority over 24 strategic minerals

Overrides state auction rights for these minerals

INDIA'S CRITICAL MINERAL PROFILE:

100% import-dependent: lithium, cobalt, nickel (+ 7 others)

Strengths: aluminium (2nd globally), iron ore (3rd), mica (~25% global), titanium (ilmenite/rutile)

Thorium reserves: ~30% of global supply

J&K lithium discovery (2023): 5.9 million tonnes (unconfirmed quality)

LITHIUM TRIANGLE:

Countries: Argentina + Bolivia + Chile

Global lithium reserves share: ~65%

China refines ~65% of global lithium

INDIA E-WASTE:

India: 3rd largest e-waste generator globally (~3.2 MT/year)

Recycling Incentive Scheme: Rs 1,500 crore; target 40 kT minerals/year by 2030

CHINA MINERAL CONTROLS:

2023: export controls on gallium + germanium

2024: graphite export restrictions

Cobalt: Chinese companies control ~70% of DRC production

INDIA-AUSTRALIA CRITICAL MINERALS PARTNERSHIP (2022):

5 lithium security projects identified

> ECTA (India-Australia Economic Cooperation and Trade Agreement): signed 2022

Sources: Ministry of Mines, PIB, The Hindu

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