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Rare Earth Elements in Plain English

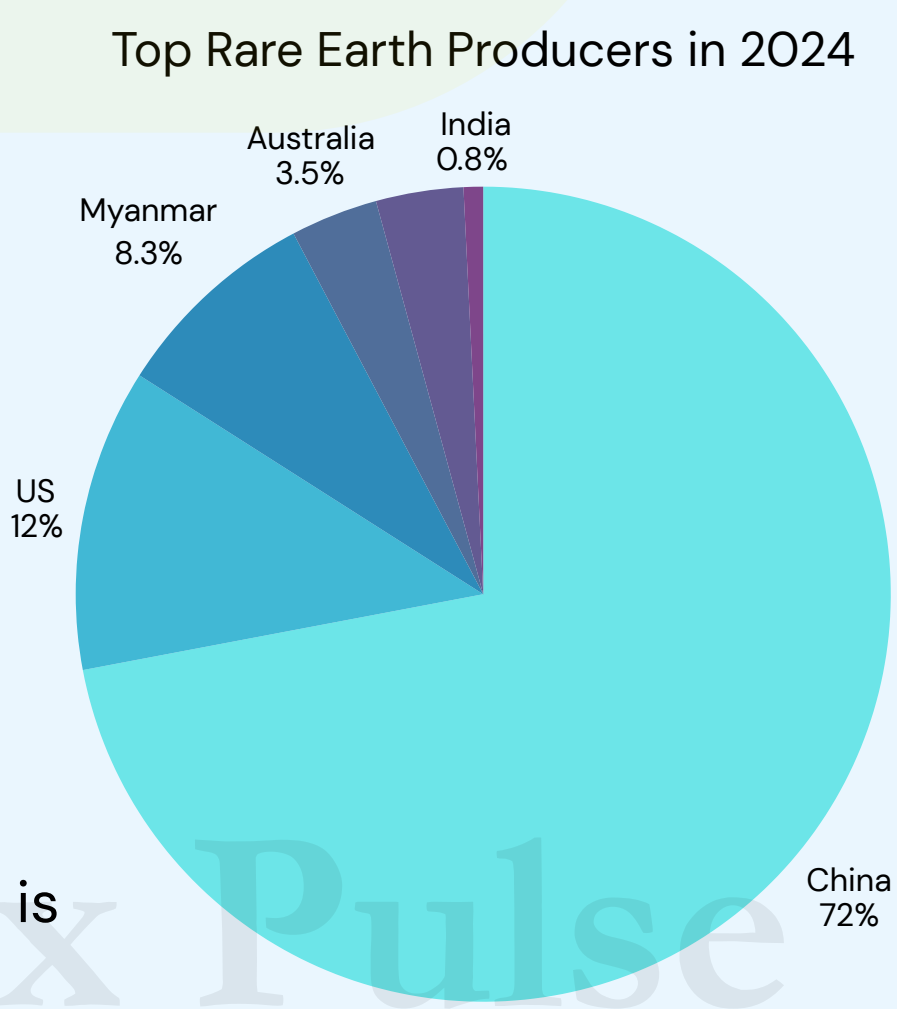
Understanding China's Dominance and Global Supply Chain Vulnerabilities

Why Are They Called 'Rare'?

They are called 'rare' only because they occur in very low concentrations in earth's crust.
To extract a small quantity, mountains of clay have to be processed. The processing tends to be complex and highly polluting.

The Reality of Reserves

So, REEs aren't rare. Global REE reserves are estimated at 110 million tonnes.
In contrast, only 50,000 tonnes of unmined gold is believed to remain in the earth's crust.



- Cerium (the most abundant REE) is about as abundant as copper.
- Cerium is also six times more abundant than lead.
- Neodymium (crucial for EV magnets) is as abundant as cobalt.
- Dysprosium (another magnet essential) is twice as abundant as bromine.

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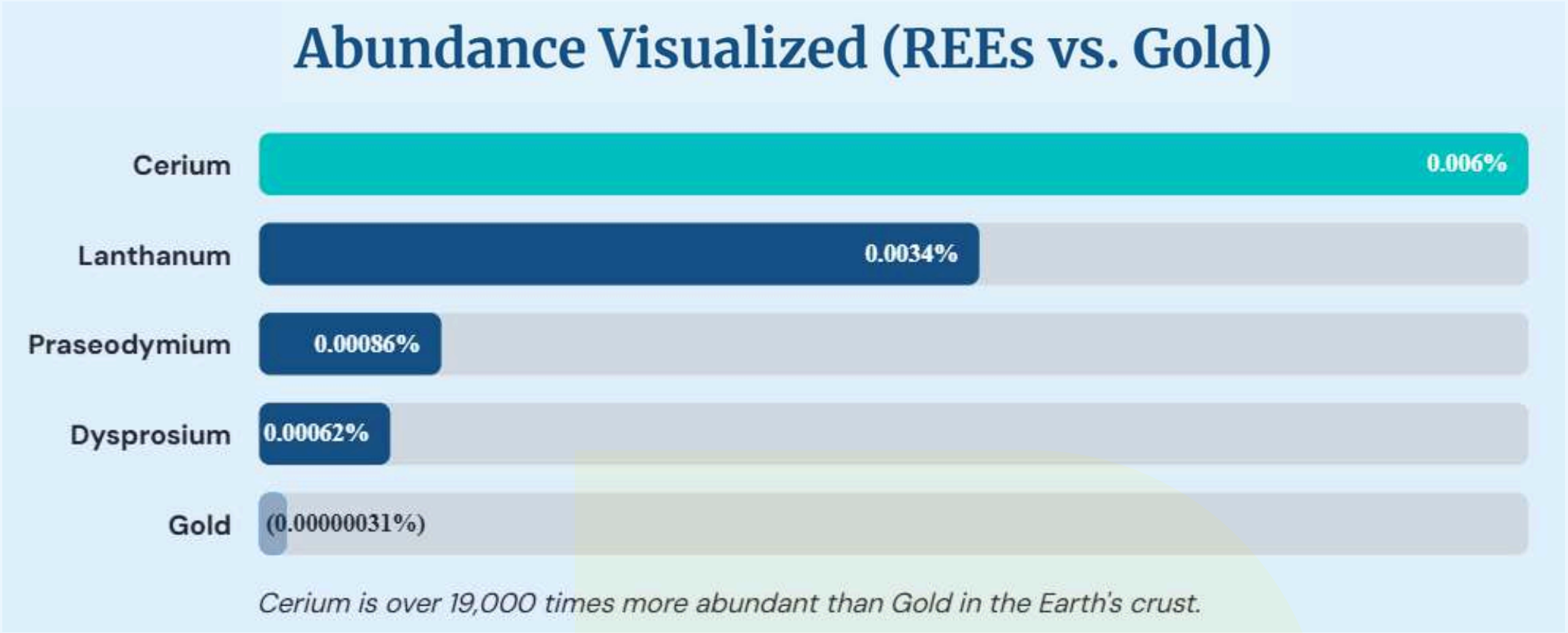
info@petrotexpulse.com



The Global REE Landscape: At a Glance

110 Million Tonnes

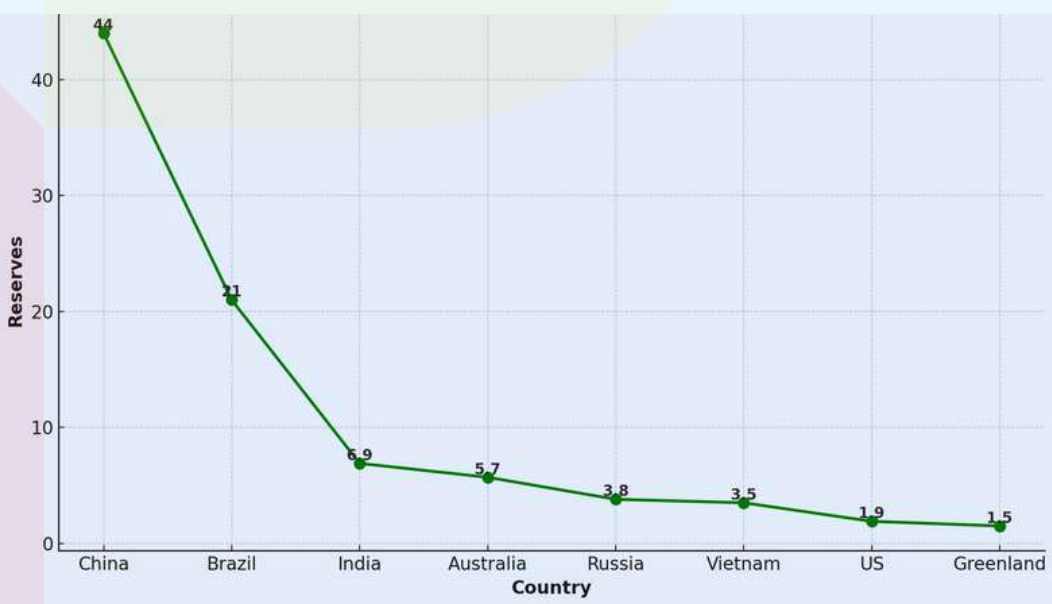
Total Global Reserves

0.4 Million Tonnes

Total 2024 Production

The total mine production of REEs projected for 2024.

Rare Earth Reserves



What is the "Rare Earth" Paradox?

Rare earths are 17 metals with unique properties, including the 15 lanthanides (a row in the periodic table). They were discovered relatively recently: the first ore, Yttria, was found in 1794, and the last element, promethium, in 1945.

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info@petrotexpulse.com

What are Rare Earth Elements (REEs)?

The eight rare earths that are produced in India

Light Rare Earths (LREEs)

- La Lanthanum
- Ce Cerium
- Pr Praseodymium
- Nd Neodymium
- Pm Promethium
- Sm Samarium
- Eu Europium

Heavy Rare Earths (HREEs)

- Gd Gadolinium
- Tb Terbium
- Dy Dysprosium
- Ho Holmium
- Er Erbium
- Tm Thulium
- Yb Ytterbium
- Lu Lutetium
- Y Yttrium

Transition Metal

Sc Scandium

Some Uses of Rare Earths

CATALYSTS
In automobile exhausts & industries.

PERMANENT MAGNETS
In EVs, electronics, etc.

BATTERIES
For EVs and gadgets

HIGH-STRENGTH ALLOYS
For aircraft engines, etc.

SEMICONDUCTORS
For semiconductor production.

CONTROL RODS
In nuclear reactors

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info@petrotexpulse.com

Rare Earth Elements

The Global Supply Chain Challenge

The Equipment & Knowledge Hurdle

- Refining is like "finding a needle in a haystack."
- Major challenge: "the corrosive nature of rare earth chemistry."
- Western projects failed; pipes corroded, costing millions.
- US/West lost tech leadership; 1970s/80s experts are retired.
- China mastered corrosion-resistant tech and now "firmly guards it."

Rare Earths and the China Challenge

The US-China trade war truce means Chinese rare earth exports will resume, but China's historical use of its monopoly power makes the calm misleading.
India is struggling, with production stuck at 2,900 metric tons, due to lack of technology, unlike the US.
Both countries are focused on reducing reliance on China's indispensable rare earth elements (REEs)

How China Monopolised REE Production

> *"There is oil in the Middle East, and there is rare earth in China."*
> *— Former Chinese President Deng Xiaoping, 1992*

The Strategy & The Dominance

The Strategy

Vast reserves (44mn tonnes) and a 1970s well-thought-out strategy to lower production costs. Used low prices to undercut foreign companies, forcing them to close and achieving a monopoly by 2002.

The Dominance

Today, controls 61% of REE mining (the 'easy part') and 92% of processing (the 'real challenge'). Acquired key tech, like GM's Magnequench, for $70mn.

Market Challenge: China Sets the Pace

China's reserves (44m tonnes) are ~6.4x India's. Prices, supply, and demand are set by China, leaving India a "price-taker."

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info@petrotexpulse.com

Problem: Chinese Dominance

- REEs are in everything: EV motors, jet engines, phones, computer chips.
- China can "cripple manufacturing" in any country.
- Used as leverage: Curbed supplies to Japan (2010), threatened US (2019).
- China may not have enough quotas to supply others, focusing on its own factory.

India's Untapped Potential

With the world's third largest reserves of ore — primarily LREs like lanthanum, cerium, neodymium, praseodymium and samarium — and cheap labour, India should be able to do better.

KABIL: Hope for New Capabilities

The govt set up Khanij Bidesh Nigam Ltd (Kabil) with three state-run companies:

- National Aluminium Company
- Hindustan Copper
- Mineral Exploration and Consultancy

Purpose: To ensure supply of critical and strategic minerals and also step up mineral security.

How India Squandered a 75-Year Head Start?

A Promising Beginning: 1950 vs The Current Reality (2025)

The Potential

Should have been India's spearhead. Rare earths are at the heart of EVs, electronics, and defence supply chains.

The Reality

A laggard, hobbled.
Stuck in permits, outdated technology, and board vacancies.
Now under the Department of Atomic Energy.

Why? Governance & Capability Gaps

Governance Gaps

IREL is hobbled by basic management gaps. Since Nov 2024, there has been no full-time CMD. All four independent director seats are vacant. Board strength is half the sanctioned 12.

Permitting Gaps

Expansion is slowed by bureaucratic delays and permitting issues. In IREL's Tamil Nadu unit, not a single mine has been allotted since 1998, forcing the plant to run at 50% capacity.

Technology Gaps

The PSU cites technology and manpower constraints. Dated technology and a state-controlled operating space have eroded its competitiveness, even as it supplies key sectors.

A View from the Inside

"In our Tamil Nadu unit, from 1998 onwards, not a single mine has been allotted. The plant is running at 50% capacity because the mine is not allotted."

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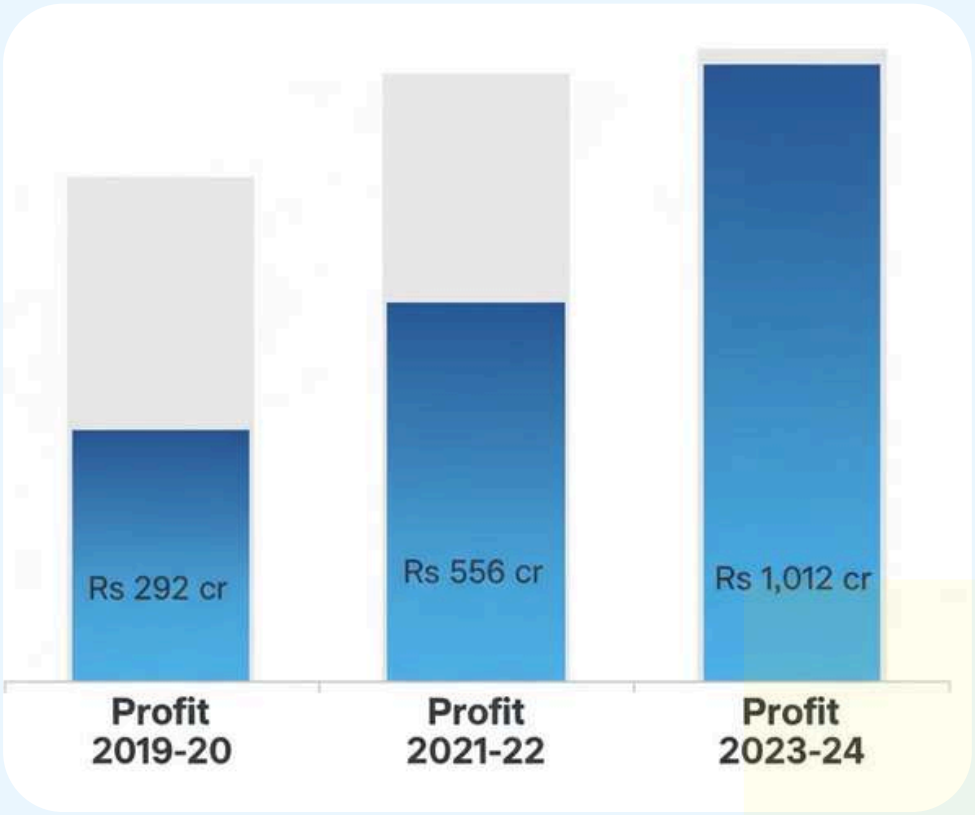

The Financial Paradox: Strong Profit Growth

Despite deep operational issues, IREL has remained highly profitable, with Profit After Tax (PAT) more than tripling in four years. Revenue also doubled from Rs 1,039 cr to Rs 2,105 cr.

The Path Forward: Upgrades "On a Fast Track"

- IREL (under Dept. of Atomic Energy) has 7 Plants, 5 Projects, and an R&D Lab.
- It supplies critical materials to nuclear, defence, space, and MSEs.
- Removal from the US Entity List should ease access to new equipment.
- A senior official states that upgrades are now "on a fast track."

IREL: India's Production & Profits

IREL Production rose from 445 KTPA (FY20) to 532 KTPA (FY24).
India produces 8 of 17 rare earths, mainly from monazite (beach-sand minerals).
Profits hit by market conditions; FY25 estimates down nearly 20%.
Challenge: High-value steps (separation, magnets) are thin; value 'leaks abroad'.

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The Way Forward

Strategic Tie-ups: Partnering with Oil India, Coal India, and NLC to chase critical mineral assets.

Capacity Goal: Internally aims to triple capacity by 2031-32 to meet domestic demand.

Key Requirements:

- Time-bound mine allotments, board and leadership fixes.
- Fast-tracked procurement of gear.
- Clear targets for separations and magnet-grade output, not just ore.

Breaking the Stranglehold

The Comeback

The US (former leader) and allies (Lynas, Solvay) are "getting back in the game." But starting new mines takes years.

Alternative: Fly Ash

Residue from burnt coal. REEs are concentrated 6-10x. The US has over 2 billion tonnes, a potential supply for "years.

Alternative: Recycling

There is also a growing move to recycle REEs from old devices to secure the supply chain.

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