

Global Rare Earth Supply Chains

Beyond Extraction: Processing, Qualification & Strategic Control

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Earths Conference**

Australasia's key meeting place for the mineral sands and rare earths industries

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Why rare earths are strategic inputs

- Economically viable deposits are geographically limited.
- Processing and refining carry high technical and environmental barriers.
- Applications are essential in defence, energy transition and advanced technology.
- Supply disruption risk is amplified by long development timelines.

A small market can still have very large system consequences.



Where value and control sit in the supply chain

Mining

Low margin and scalable. Ore extraction is high volume and relatively commoditised.

Processing & separation

Physical, chemical and solvent separation are the technical bottleneck and the control point.

Metals, alloys & magnets

Highest value and most embedded in end-use system design.

Rare Earth Supply Chain - Where Value and Control Sit

Mining (Low margin, scalable)

Ore extraction (monazite, bastnäsite, ionic clays)

High volume, commoditised supply

Processing & Separation (High complexity, high control)

Physical → chemical → solvent separation

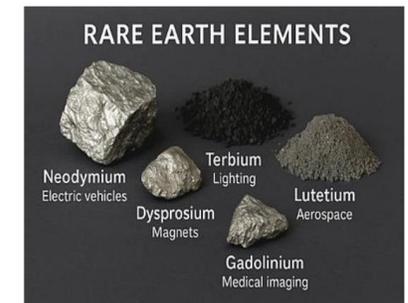
Solvent extraction = true bottleneck

Environmental + technical barriers

Metals, Alloys & Magnets (High value, strategic control)

NdPr, Dy, Tb → magnet alloys

Embedded in system design (EVs, wind, robotics — hard to substitute)



Processing control = market power

Source: p. 5

- China dominates separation and magnets.
- Policy-driven supply chains and resource nationalism are reshaping market access.
- Mine → separation → metal → magnet: separation is the leverage point.
- Value is not in the ore alone; it is in separated, qualified product.

Separation is the point where tonnes turn into qualified product — and where pricing power starts.

Rare Earths & Geopolitics

Processing Control = Market Power

Geopolitical Forces

- China dominates separation & magnets
- Policy-driven supply chains
- Resource nationalism rising

Value Chain

- Mine → Separation → Metal → Magnet → EV/Wind
- Separation = Control Point

Market Implications

- High Volatility
- Policy > fundamentals
- Split Pricing emerging

Value is not in the ore — it is in the separation and qualification.

The timing of Australia's proposed fund coincides with escalating trade tensions between major economies and growing recognition of rare earth elements as strategic resources essential for modern technology and defense applications.



Nolans Rare earths

Rare earths: small market, high strategic leverage

Source: pp. 14–15

Market structure

≈ US\$9–10bn baseline market, with growth increasingly defined by downstream refining and products.

Demand concentration

Permanent magnets are the fastest-growing demand segment, with NdPr, Dy and Tb central to performance.

Policy signal

Governments want downstream capability and supply-chain resilience, not just new mines.

Implication

The real battle is less about geology than chemistry, manufacturing and qualification.

Rare Earth Market Overview

Strategic Context

- Critical minerals designation (AU, US, EU, Canada)

Market Structure

- ~US\$9–10bn market (2020 baseline); ~US\$12bn by 2030.
- Refining growth (4–5%) > mine supply (1–2%)

Demand Concentration

- Total REE demand ~4% p.a.
- Permanent magnets ~6–9% p.a.
- NdPr, Tb, Dy driven by electrification

Magnet Segment Imbalance

- Production ~5–6% p.a. (2022–2035).
- Demand ~8–9% p.a., accelerating post-2021.

Policy Signal (Australia)

- ~\$1.7bn in support mechanisms.
- Increasing emphasis on downstream processing and supply chain resilience.
- **Governments want downstream capability, not just mines.**

“Rare Earths: The Real Battle Is Not in the Mine.”

“In the rare earth industry, geology may start the supply chain, but chemistry & manufacturing ultimately determine who captures the value.”



<https://universe-review.ca>

The new demand engine: data → electricity → materials

Source: pp. 10, 28



- AI and hyperscale data centres lift firm electricity demand.
- Grid expansion and power quality requirements pull through more processed materials.
- Countries that can pair energy, materials and policy stability gain strategic advantage.



Ex-China supply chain capacity is forming

- Capacity is forming across concentrate, MREC and oxides/metallisation.
- But the chain remains fragmented and limited outside China.
- Integration and qualification still determine who can actually supply customers.

Supply is forming — but without integrated processing and qualification, not every tonne can serve a customer.



Premium sits downstream

Source: p. 12

Refinement

Converts raw material into a higher-purity product that commands a premium.

Separation

Isolates the specific elements the market needs — including NdPr and Dy/Tb.

Qualification

Confirms the product meets customer specifications and can enter end-use supply chains.

That is where margin sits.

Tonnes do not create value — *Rare earths reminder*

Refinement does.

Converts raw material into higher-purity product that commands a premium.

Separation does.

Isolates the specific high-value elements the market needs. **NdPr, Dy/Tb**

Qualification does.

Confirms the material meets exact specifications to enter supply chains.

That is where margin sits.

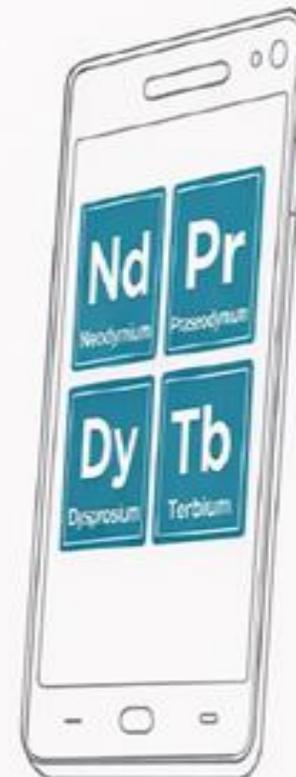
“Oceans of grapes ≠ premium wine”

Premium reminder

Heavy REEs are a quiet bottleneck

- Heavy REE separation — especially Dy and Tb — is a quiet bottleneck in the chain.
- Small supply constraints can have outsized market impact.
- Performance-critical systems depend on a narrow, hard-to-replace supply base.

These elements are not just minor additives — they keep modern systems operating under stress.



Neodymium

High-strength permanent magnets
Speakers • Vibration unit • Miniature motors



Praseodymium

Enhances magnet performance
Motor efficiency & strength



Dysprosium

Improves high-temperature stability
Critical for sustained motor performance



Terbium

Thermal resilience in magnets
Performance under stress

These are not battery metals. They enable motion, efficiency, and control.

Dysprosium: small addition, major magnet performance

- Dysprosium helps high-performance NdFeB magnets resist demagnetisation.
- That matters at temperature, under load and over extended operating periods.
- It is one reason Dy matters in EV drive units, wind turbines, defence systems and other high-reliability magnet applications.

In other words: Dy is performance insurance for magnets that must keep working when conditions get tough.

Dysprosium
THE REAL ★ RARE EARTH STAR

EV MAGNETS DEFENCE TECH

IONIC CLAYS RICH IN HEAVY RARE EARTHS	&	RICH IN Nd/Pr LIGHT RARE EARTHS
Dy/Tb <ul style="list-style-type: none">• high temperature stability for NdFeB magnets• essential for EVs, defence, smart phones and wind turbines CRITICAL & SCARCE		Nd/Pr <ul style="list-style-type: none">• torque & power• light & heavy rare earths• key magnet metals HIGH VOLUME

★ 90% of rare earth magnet supply
Focus on sale of finished products for value capture

CRITICAL SUCCESS FACTORS INCLUDE:

✓ easy to process ionic clays	✓ low-cost ESG production
✓ tier-1 location	✓ large mine life
✓ high-grade resource	✓ simple low-cost flow sheet
✓ little or no radioactivity	✓ MREO customer samples

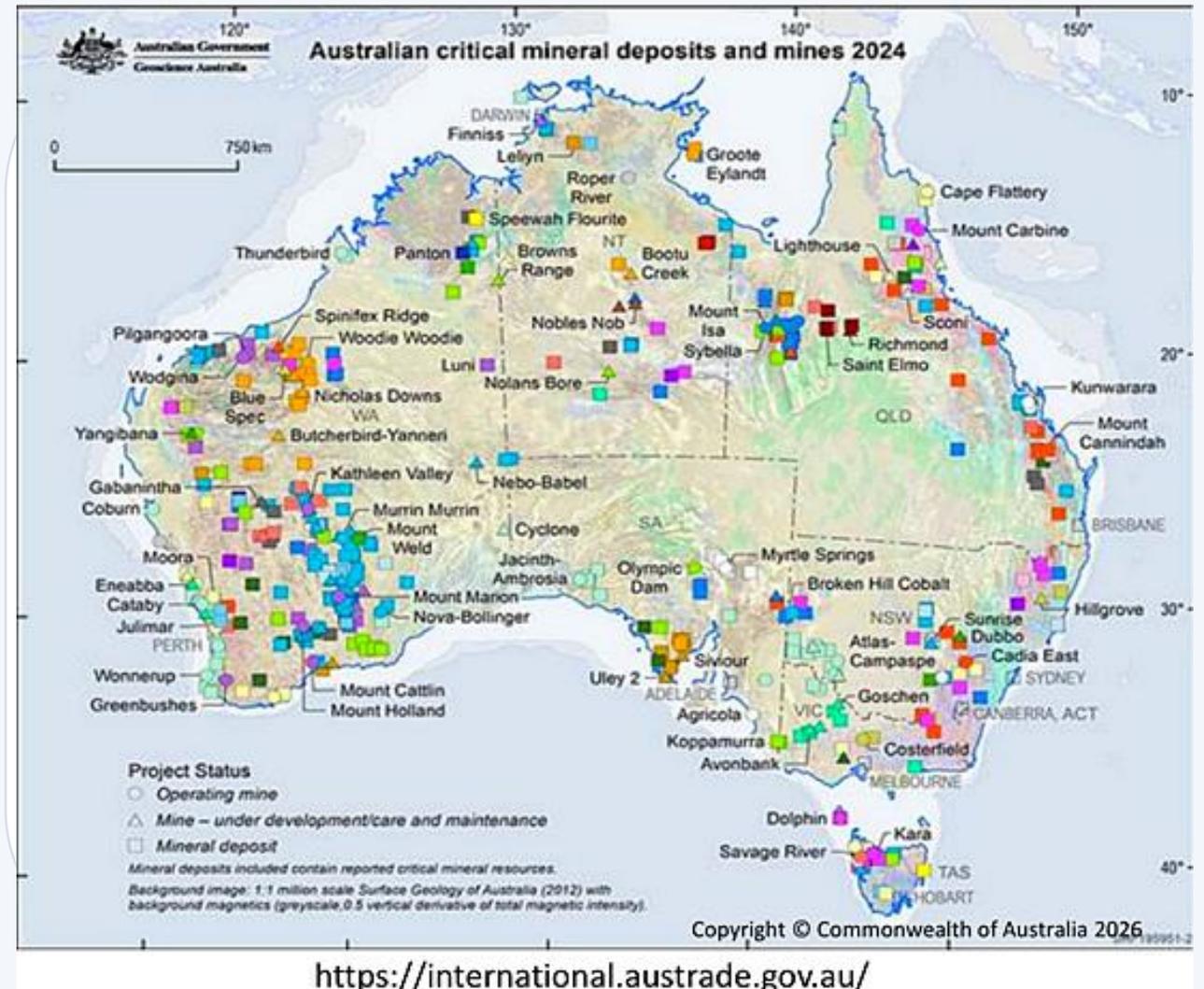
#RAREEARTHS #CRITICALMINERALS #AR3

Graphic attributed to Alister MacDonald at TCMS

Australia: resource-strong, processing-constrained

Source: pp. 21, 34

- Australia has a deep, globally significant resource base.
- The development pipeline is active, but fragmented.
- Separation scale remains limited outside Lynas and Iluka.
- Magnet manufacturing is emerging, but not yet scaled.

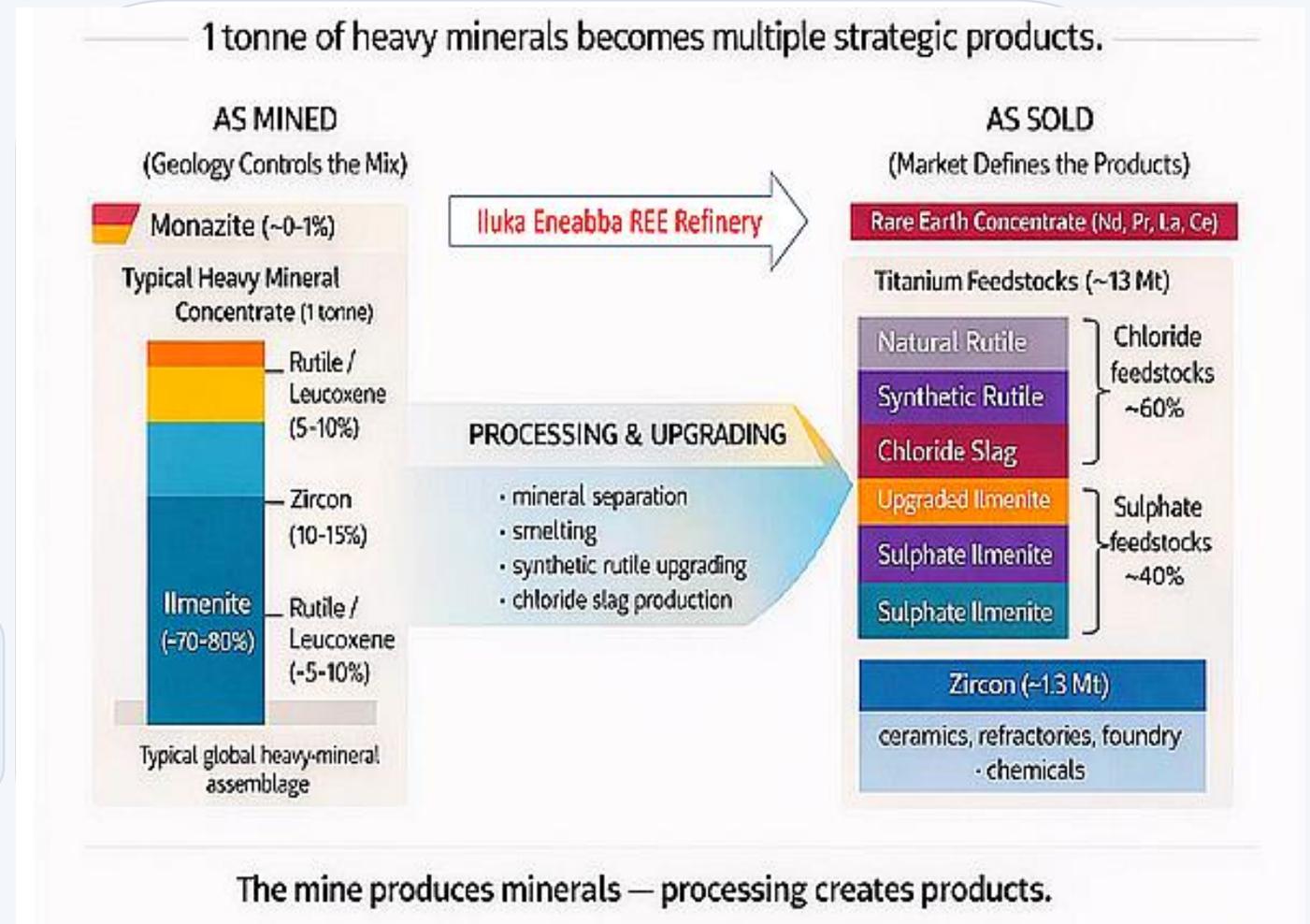


Example: Eneabba / Iluka shows why processing matters

Mineral Sands: From Geological Deposits to Global Feedstocks 2025

- Mine output becomes valuable only after separation and upgrading.
- Processing turns mixed heavy mineral feedstocks into strategic products.
- The mine produces minerals; processing creates products.

This is the core move downstream: from geology to chemistry, specifications and saleable product.



The current model still leaves most value capture downstream



- Australia has mastered extraction.
- Most pricing power sits after concentrate, where chemistry, specifications and qualification matter.
- Tonnes build revenue; specifications build pricing power.

Value capture migrates downstream as products become more specific, qualified and hard to replace.



The real bottleneck by 2030 is downstream

Value-chain layer	Indicative China share	Strategic risk	Implication
Mining	~59%	Moderate	Replaceable relative to downstream
Separation & refining	~77%	High	Control point for qualified product
Magnet manufacturing	~85–90%	Critical	Hardest layer to replace quickly

As you move downstream, supply becomes more concentrated — and harder to replace.

China is losing tonnes faster than it is losing control

- New upstream supply is emerging from Australia, the US and Africa.
- But downstream processing and demand remain concentrated in China.
- Mine share may erode; refined share and integrated magnet ecosystems remain the real control points.

Upstream diversification does not automatically create downstream independence.



AI infrastructure runs on processed materials

Material	System role
Silicon	Chips
Copper	Power & signal wiring
Rare earths	Motion & control (magnets)
Ga / Ge	Semiconductor functionality

Control of processed inputs shapes control of systems.



Australia's strategic leverage is downstream

What Australia already has

Political stability, ESG credibility, allied alignment and a strong resource base.

What still needs scale

More separation, product qualification, metals and magnet capability.

Strategic choice

Move downstream — or miss the value.



Australia's strategic shift

Stage	Today	Future
Mining	Strong	Strong
Processing	Constrained	Scaled
Magnets	External dependence	Domestic capability
Value capture	Low	High

Australia moves from bulk supplier to strategic materials partner.

Australia's Strategic Position
From Resource Leader to Value Chain Player

Move downstream – or miss the value

Mine → *Separation* → Metal → Magnet

Because the value sits here—in separation... and ultimately in magnets.

Australia's position is stronger than it appears

- Resource base is not the constraint.
- Processing is the leverage point; magnet manufacturing remains the downstream gap.
- Policy and capital are starting to align across Australia, the US, Japan and Europe.
- Australia can move from supplier to system enabler by capturing more processing and downstream capability.

Australia's Position Is Stronger Than It Appears

- **Resource base is not the constraint**

World-class deposits, including heavy REE potential

- **Processing is the leverage point**

Value and control sit in separation and downstream processing

Downstream gap = strategic opportunity

Magnet manufacturing still largely offshore

- **Policy + capital now aligned**

Momentum building (US, Japan, EU)

Australia can move from supplier to system enabler — but only by capturing processing and downstream capability.

Australia already has the resources — that's not the constraint.

The real opportunity is capturing processing and moving downstream — where value and control sit

Strategic takeaways

- Geological scarcity is not the only constraint — processing scale is.
- Separation capability remains structurally concentrated.
- Heavy REEs disproportionately amplify risk.
- Value retention requires downstream capability.
- The next chapter is selective processing scale.



“It’s a small market — but small changes have very large consequences.”