ASX Release 25 August 2025

Metallium Strengthens Rare Earth Element (REE) Strategy – Rice University Collaboration to Advance Next-Generation Separation

HIGHLIGHTS

- **Proven today & traditional flowsheet compatible – FJH upgrades REE intermediates (e.g. monazite, MREC) into high-grade solvent extraction (SX)-ready product, unlocking higher payables and avoiding foreign-owned toll refineries[1].**
- **New innovation pathway - beyond SX –** Metallium is now collaborating with Rice University to test whether FJH can go further and **directly separate individual REEs**. This research aims to simplify or even bypass SX altogether.
- **Why it matters – Strengthens current refining today while building a pathway to reduce reliance on China, which controls over 90% of global rare earth refining[2].**
- Creates potential for **licensing & partnerships** with REE miners, developers, magnet makers and other REE participants.
- **Strategic role –** Aligns with nearly US$1B in new U.S. Department of Energy funding for rare earth supply chain security[2].
- **Fast & scalable** – Modular FJH units deployable in <12 months, far quicker than constructing new SX facilities.
- **Future REE Testing targeting waste streams and highly strategic heavy REEs - Planned evaluation of hard-rock ores, waste tailings, NdFeB scrap, and heavy REE-rich intermediates, further broadening applications for REE extraction.**

Metallium Limited ("Metallium" or the "Company") (ASX: MTM; OTCQX: MTMCF) provides an update on its rare earth element (REE) processing strategy. Flash Joule Heating (FJH) technology has already demonstrated breakthroughs in upgrading REE feedstocks across traditional flowsheets. Unlike conventional sulphuric-acid circuits, FJH delivers a more elegant and efficient solution, producing high-value intermediates that are directly compatible with existing solvent extraction (SX) separation plants. This provides Western developers with a plug-in midstream solution today, while building a pathway to reduce reliance on China in the future[1].

Today, REE separation is dominated by SX → huge industrial plants with very large footprints, high capital and operating costs, and commissioning timelines that can stretch for years. Over 90% of this capacity is in China. Recent Chinese export restrictions on magnet alloy exports forced automakers to suspend production, underlining the fragility of supply chains and the urgency of alternatives[3]. Metallium's patented FJH technology addresses this problem on two fronts:

1. **Today – improving existing flowsheets:** FJH upgrades REE feedstocks into SX-ready products, removing unfavourable and low-value elements while enriching high-value magnet metals. This strengthens existing refining and improves payables without relying on Chinese toll refining[1]. See *Appendix* for extra details.
2. **Tomorrow – reducing reliance on SX:** Through its collaboration with **Rice University**, Metallium is evaluating the potential for FJH to separate individual REEs. If successful, this could dramatically reduce or even replace the need for large SX plants, giving Western projects a domestic refining solution.

Metallium Managing Director & CEO, Michael Walshe, commented: *"FJH has already demonstrated its ability to upgrade multiple REE feedstocks into SX-ready products, giving Western supply chains a midstream solution today. In parallel, our Rice University collaboration is tackling the next frontier: using FJH to separate individual REEs directly, potentially bypassing solvent extraction. With SX plants taking years, vast capex and footprint, and massive solvent use, even partial success would be transformative. This positions Metallium for near-term revenues from partnerships and licensing, and long-term leadership in REE refining".*

Tony Hadley, Non-Executive Director, added: *"Having spent over 20 years in rare earth metallurgy, I know the scale, cost, and complexity of solvent extraction plants.* ***Metallium's FJH technology is the first credible midstream solution I've seen that improves existing flowsheets today while opening the door to entirely new separation methods****. This is exactly the kind of innovation needed to reduce reliance on China".*

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[1] A: ASX: MTM announcements dated: 25/11/2024, '17/06/2025 & 06/05/2024. See also page 7.
[2] U.S. Department of Energy, 2025, *'Energy Department announces actions to secure American critical minerals and materials supply chain'*
[3] Business Insider 2025, 'China is flexing its supply chain muscles — and the auto industry is freaking out'.

Introduction

Metallium's patented **FJH is a multi-metal platform:** already proven in REEs, with parallel applications in Ga, Ge, In, gold, copper and red mud. Its dual business model - Build-Own-Operate in recycling and Licensing/Royalties in mining - provides both near-term revenues and scalable long-term growth.

Rare earth metals are the fundamental backbone of modern technology – essential for electric vehicles, wind turbines, defence systems and electronics. But separating them is extremely challenging: they always occur together in nature (orebodies) and have near-identical chemical and electrical properties. Today, separation is dominated by **solvent extraction (SX)** – enormous plants with large footprints, very high capital & operating costs, and commissioning timelines measured in years. **>90% of global SX capacity currently resides in China, leaving Western projects dependent on foreign refiners.**

Metallium's patented FJH technology has already **proven a breakthrough for traditional flowsheets**[1]. By removing contaminants and concentrating high-value rare earths, FJH produces high-grade chloride products that plug directly into SX plants, making them faster, cleaner, and more efficient.

Now, through a new collaboration with Rice University, Metallium is testing whether FJH can go further. If successful, FJH could perform direct separation of REEs, removing large parts of the highly capital- and energy-intensive SX process — a potential "missing piece" in Western rare earth supply chains. See *Appendix* for extra details

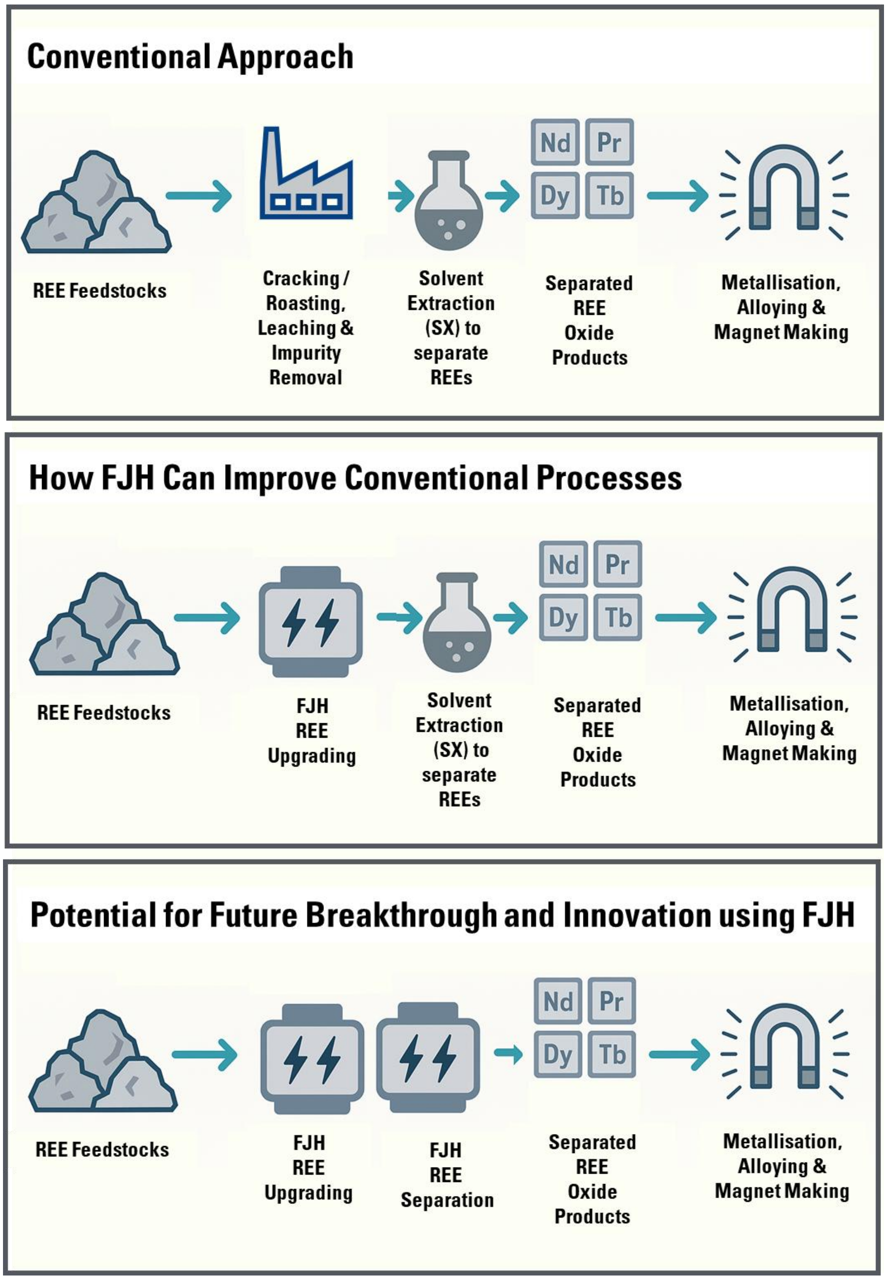


Figure 1: Simplified illustration of traditional REE vs. FJH potential flowsheets for REE enrichment and separation

Strategic Context

China's dominance of rare earth refining remains one of the greatest vulnerabilities in global supply chains. In June 2025, China restricted NdFeB magnet alloy exports, forcing automakers like Ford and Suzuki to suspend production. Such disruptions underscore the urgency of establishing Western alternatives[4].

The U.S. has responded with nearly US$1B of new DOE[5] funding to build domestic REE refining capacity, demonstration plants, and recycling programs. Metallium's FJH technology directly aligns with these priorities: it provides a rapid, modular, low-footprint way to turn raw and secondary REE sources into SX-ready intermediates, creating the missing midstream link needed to secure supply.

Technology Advantage

FJH applies direct electrical energy to feedstock in the presence of proprietary chlorination or carbochlorination chemistry. This enables:

- **Selective impurity removal** (Fe, Al, P, alkalis and radionuclides) improving downstream separation efficiency.
- **High recoveries and purity** across a wide range of feedstocks as already demonstrated in pilot-scale tests.
- **Sustainability** – reduced reagent use, no large liquid waste streams, and potential for co-product recovery.
- **Future potential** – under fluorine atmospheres, FJH could potentially produce REE metals directly from intermediate feedstocks, potentially bypassing separation bottlenecks.

Why Solvent Extraction (SX) is the Bottleneck

- **Only commercial option today:** SX is the sole method currently used to separate individual REEs at industrial scale.
- **China dominates:** Over 90% of global SX capacity is located in China, leaving Western projects dependent on Chinese refineries.
- **Slow and capital intensive:** SX plants require **hundreds of mixer-settler stages (often > 1,000**,) very large CAPEX, and take **years** to reach nameplate capacity / equilibrium operation.
- **High operating costs:** Large consumption of solvents, acids, and bases; significant waste management burden.
- **The result:** SX is a costly chokepoint, slow to scale, and controlled by China; any innovation that reduces SX reliance is strategically transformative.

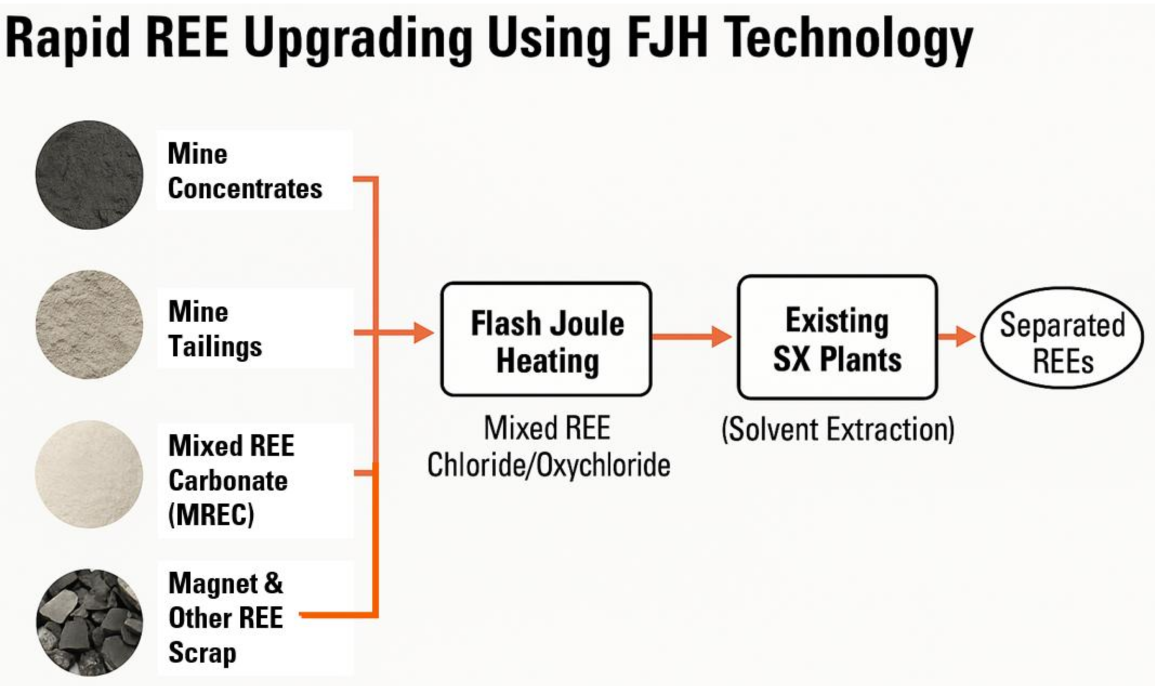


Figure 2: Illustrative Example of FJH's Versatility in Treating REE Feedstocks and Producing SX-compatible intermediates

[4] Business Insider 2025, 'China is flexing its supply chain muscles — and the auto industry is freaking out'.
[5] U.S. Department of Energy, 2025, 'Energy Department announces actions to secure American critical minerals and materials supply chain'

Metallium has already demonstrated that FJH can deliver SX-ready products across multiple feedstocks[1]:

- **Monazite concentrate** – 93% REE conversion into >90% mixed REE chloride in one flash, removing the need for acid baking and multi-stage leaching.
- **MREC (mixed rare earth carbonate)** – >80% La/Ce removed, high-value magnet REEs enriched, and 81% terbium recovered in a single flash, without solvents or acids. Metallium is collaborating with Meteoric Resources (ASX: MEI) to apply this pathway to Brazil's Caldeira Project.
- **Future testing** – Planned expansion to hard-rock ores, SEG intermediates and other challenging sources.

This confirms that FJH can improve existing flowsheets by producing cleaner, higher-value feedstock that integrates directly into current SX plants.

Beyond SX – A Separate Innovation Track

Metallium is investing in the **longer-term breakthrough of direct REE separation using FJH**.

Through a **sponsored collaboration with Dr. James Tour at Rice University**, Metallium is supporting research to selectively separate Nd, Pr, Dy, Tb, Y, and Eu by flash processes, with additional work on Nb–Ta separation.

- **Funding contribution by MTM** – US$379,000 over 12 months, with first tranche paid.
- **Scope** – Modelling and experimental validation on tailings and intermediates; benchmarking against SX in cost and lifecycle impact.
- **IP** – Metallium retains first rights to new patents, which can be integrated into its current global FJH commercialisation licence.

This program not only accelerates technical development but also strengthens Metallium's intellectual property position, while leveraging U.S. academic expertise to qualify for DOE-backed demonstration programs.

If successful, this work could provide the *"missing piece"* for Western supply chains - a pathway to magnet metals that would shorten or even replace parts of the SX-dominated flowsheet. This would position Metallium to one day compete directly with China's refining capability and support U.S. and allied independence in magnet metals.

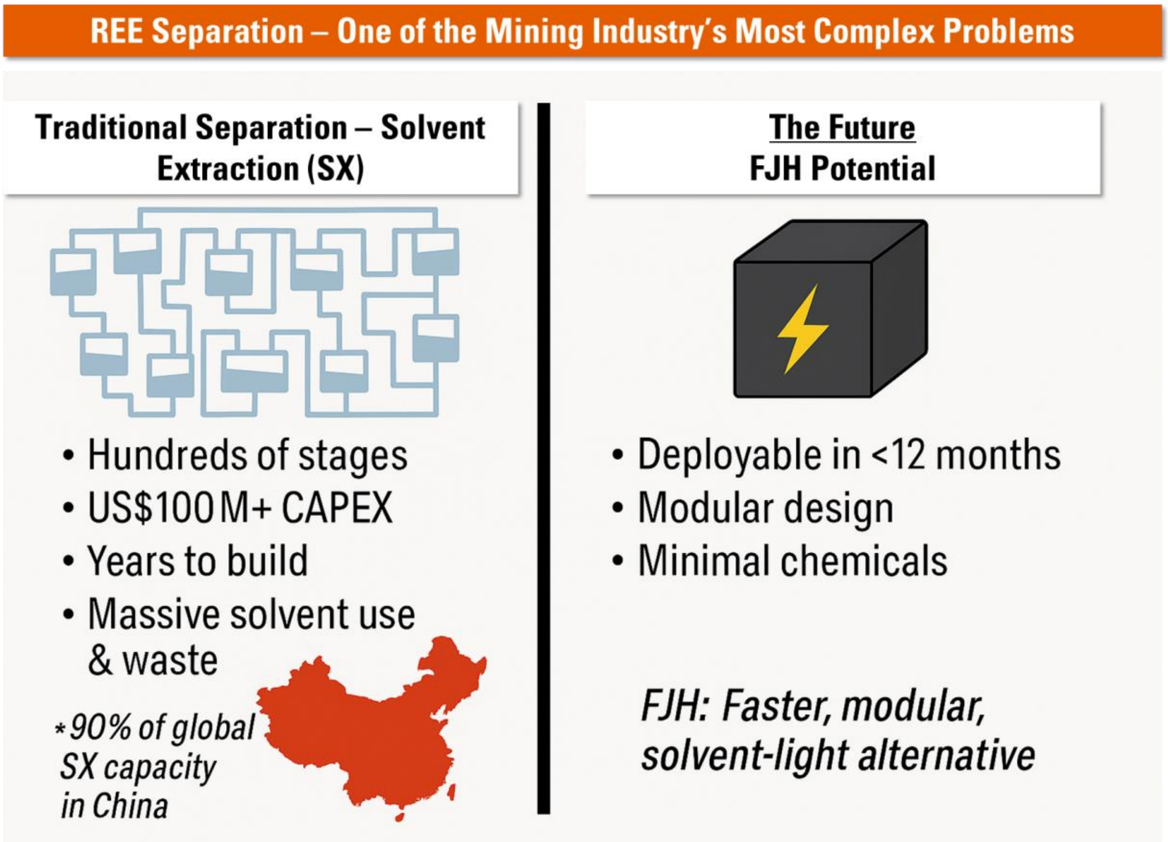


Figure 3: Future REE Separation Potential of FJH under new collaboration with Rice University

Mixed Rare Earth Carbonate (MREC) – and How Metallium's FJH Unlocks New Pathways

What is MREC?

Mixed Rare Earth Carbonate (MREC) is an intermediate product that contains a mixture of REEs in carbonate form, typically grading 40-60% total rare earth oxides (TREO). It is produced after the initial ore cracking and impurity removal stage for hardrock ores, or after leaching of ionic clays, but before the costly and complex solvent extraction (SX) separation stage.

In most REE projects, producing MREC is seen as a lower-risk, lower-cost route to market because it:

- Avoids the high capital and operating costs of building a full SX plant.
- Allows earlier production and revenue.
- Uses proven process steps already established in commercial flowsheets.

The Catch – China's Market Dominance

While MREC is easier and cheaper to produce, it creates a dependency problem: China is currently the only large-scale, commercially viable buyer and refiner (or toll treater) of MREC. This means developers outside China have limited options, and it creates significant geopolitical exposure for Western REE supply chains.

Where MREC Fits in Traditional Flowsheets (See *Appendix* for extra details)

Almost all REE processing routes for hard rock ores (like monazite, xenotime and bastnaesite) and ionic clays pass through an MREC stage:

1. Ore is beneficiated to a concentrate.
2. Concentrate is chemically cracked and impurities removed.
3. The resulting MREC is either fed into an SX plant to produce separated REE oxides, or shipped (often to China) for further refining.

How Metallium's FJH Changes the Game

Metallium's Flash Joule Heating (FJH) technology offers a rapid, solvent-free upgrade path for MREC that:

- Removes unwanted contaminants such as radionuclides, iron, aluminium, and phosphorus.
- Selectively rejects low-value REEs (e.g., Ce & La) that make up the bulk of MREC mass but add little or no value.
- Enriches high-value magnet REEs like Nd, Pr, Dy & Tb into a cleaner intermediate product.

The upgraded product can then be fed directly into existing chloride-based SX plants for separation into individual REEs - meaning developers can capture more value domestically without building their own full SX facility and without having to sell to China.

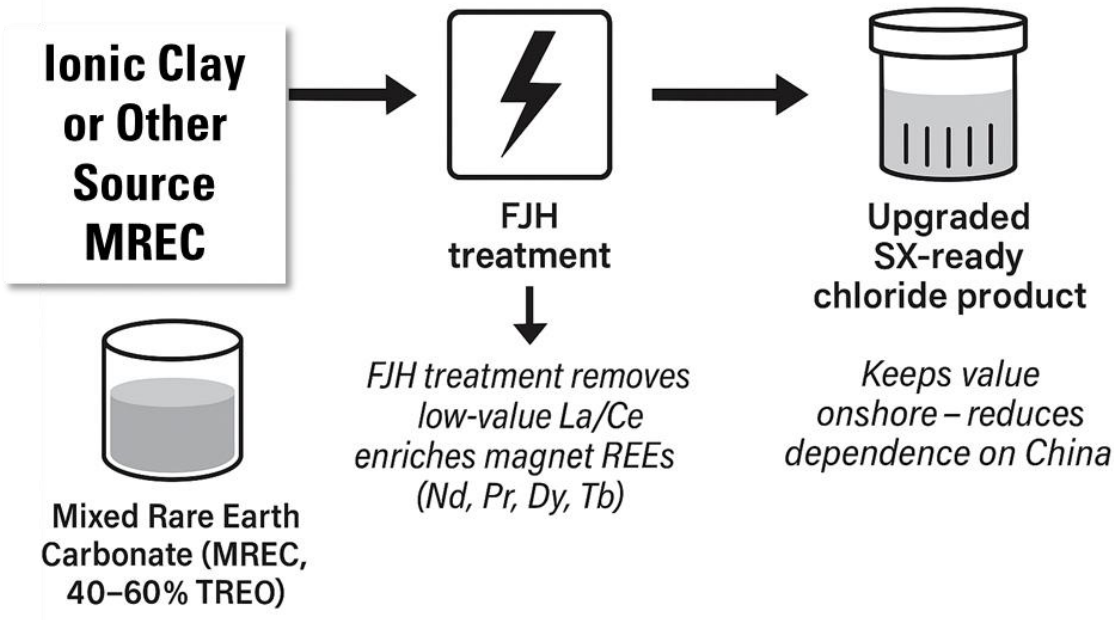


Figure 4: MREC Upgrading ("super concentrating") utilising FJH

See *Appendix* for extra details

This opens a pathway for:

- Western REE developers – to monetise production without relying on Chinese buyers.
- Government-backed supply chain initiatives – to integrate more domestic REE upgrading capacity.
- Investors – to participate in a technology that removes one of the largest bottlenecks in the non-Chinese REE supply chain.

Metallium's FJH enables developers to upgrade MREC by:

- Selectively removing contaminants (Fe, Al, P, radionuclides),
- Rejecting low-value REEs (La, Ce),
- Enriching magnet REEs (Nd, Pr, Dy, Tb) into a cleaner product.

The upgraded product can then be processed domestically in existing SX facilities, creating a new pathway for non-Chinese developers to monetise REEs without building their own SX plants or selling to China.

Next Steps - Building Out Metallium's Rare Earth Program

Metallium's dual-track strategy focuses on:

- **Track 1 – Proven Today:** FJH as a plug-in midstream step, upgrading feedstocks into SX-ready products that capture higher payables and reduce reliance on Chinese toll refining.
- **Track 2 – Future Innovation:** Rice University collaboration to test direct REE separation, unlocking a potential breakthrough that could reduce reliance on SX and provide the missing piece for Western supply chains.

Near-term programs target multiple feedstocks:

- **Mining ores** – Scale-up testwork to validate cost and efficiency versus conventional acid-bake flowsheets.
- **Industrial residues & mine tailings** – Pilot testing with partners; aligned with recent U.S. federal funding initiatives.
- **MREC (ionic clay and other potential projects)** – Ongoing Meteoric Resources Ltd collaboration, optimising La/Ce removal and magnet REE enrichment.
- **Magnet scrap & recycling** – Planned programs will replicate successful magnet REE recovery efforts undertaken by Rice University, extending FJH into high-value recycling applications and supporting U.S. EV and defence supply chains.
- **Heavy REE intermediates (SEG) and other potential heavy REE-rich feedstocks** – Planned trials to unlock higher-value heavy REEs (Sm, Eu, Gd, Y) plus the highly strategic heavy magnet REEs Dy & Tb.

Path forward: Deliver case studies across these feedstocks to secure licensing and partnership revenues in the near term, while Rice University research builds long-term upside from direct separation.

This announcement has been authorised for release by the Board of Directors.

For further information, please contact:

Michael Walshe
Managing Director & CEO
Metallium Ltd
info@MetalliumInc.com | +61 8 6391 0112

Andrew Keys
Investor Relations & Corporate Communications
Keys Thomas Associates
Andrew.keys@keysthomas.com | +61 400 400 380

ABOUT METALLIUM LIMITED

Metallium Ltd (ABN 27 645 885 463), is pioneering a low-carbon, high-efficiency approach to recovering critical and precious metals from mineral concentrates and high-grade waste streams. The company's patented **Flash Joule Heating (FJH)** technology enables the extraction of high-value materials - including **gallium, germanium, antimony, rare earth elements, and gold** - from feedstocks such as refinery scrap, e-waste, and monazite.

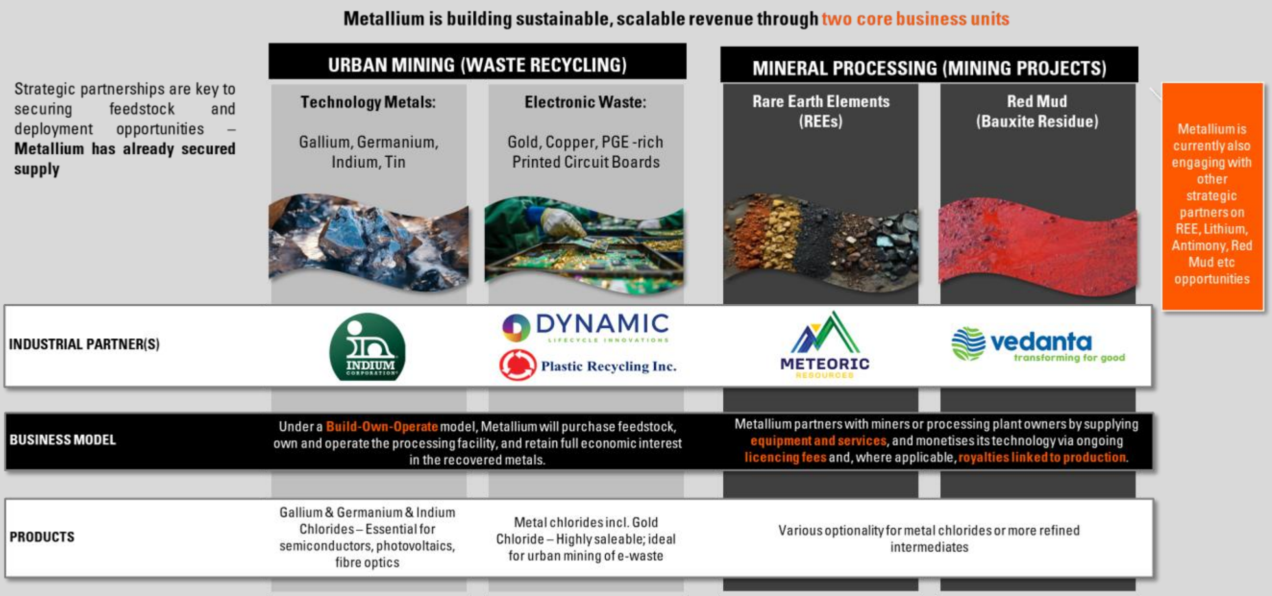
Aligned with U.S. strategic supply chain objectives, Metallium has recently secured its first commercial site in Texas via its wholly owned subsidiary, **Flash Metals USA Inc.**, marking a major step toward near-term production and revenue generation.

To learn more, visit:

Website:	metalliuminc.com
Contact:	info@metalliuminc.com | *+61 8 6391 0112*
Investor Hub:	investorhub.metalliuminc.com
X	x.com/Metallium_MTM
in	www.linkedin.com/company/metalliumltd
USA Office:	*12 Greenway Plaza, Suite 1100, Houston, Texas USA 77046*
Australia Office:	*Unit 4, 22 Railway Road, Subiaco, Western Australia*

METALLIUM's BUSINESS MODEL

Metallium's FJH technology is a true multi-metal platform. In waste recycling ('urban mining'), Metallium can recover high-value metals such as gallium, germanium, indium, gold and copper under a Build–Own–Operate model. In mineral processing, FJH upgrades complex feedstocks including rare earths and red mud, with revenues driven by technology licensing and royalties linked to production. This dual business model provides diversified exposure across multiple critical and high-value metals, positioning Metallium as a scalable and sustainable leader in clean-metals processing.



REFERENCED Metallium ASX Announcements:

ASX: MTM announcement dated 25/11/2024, '*Breakthrough in Rare Earth Element (REE) Processing*'.

ASX: MTM announcement dated 17/06/2025, '*MTM & Meteoric Sign MOU After Successful REE Testwork*'.

ASX: MTM announcement dated 06/05/2024, '*Flash Joule Heating Prototype Tests Increase REE recovery*'.

Appendix - Additional Technical Information

RARE EARTH ELEMENTS – INTRODUCTION AND TERMINOLOGY

- **Rare Earth Elements (REEs)** are a group of metals essential to modern technologies, from electric vehicles to renewable energy and advanced electronics. They are usually sold and traded as rare earth oxides (REOs), the purified form of each element used in downstream processing.

- The first step in the supply chain is typically **MREC (mixed rare earth carbonate)**, an intermediate product from mining that contains all REEs blended together and requires further refining.

- Because REEs occur together in nature, with very similar chemistry, they are difficult to separate and are often found with radioactive elements like thorium and uranium.

- Within the REEs, the magnet REEs (Nd, Pr, Dy, Tb) are especially valuable for high-performance permanent magnets.

- Another grouping is **SEG (samarium–europium–gadolinium),** which lies between the light and heavy REEs; most processing and separation options for SEG today are concentrated in China, underscoring Western reliance on Chinese refining capacity.

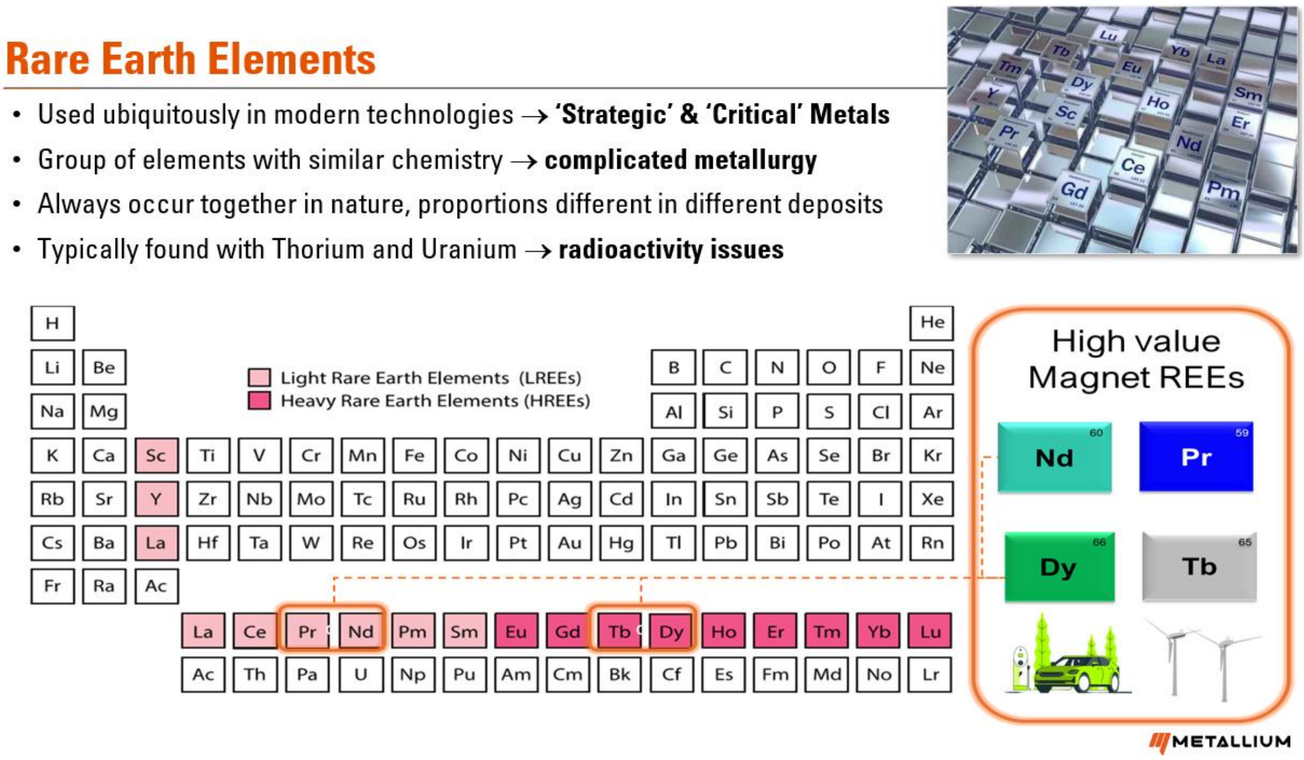


***Fig 5:** REE Overview*[6]

[6] Gupta, C.K. & Krishnamurthy, N. 2005, *Extractive Metallurgy of Rare Earths*, CRC Press, Boca Raton, p. 191; ASX: MTM announcement 17/06/2025, '*MTM & Meteoric Sign MOU After Successful REE Testwork*

RARE EARTH ELEMENTS – USES & STRATEGIC IMPORTANCE

- Broad and important applications in National Defense, Aerospace and Satellite Technology, High-tech Devices, Clean Energy Technologies, Catalysts and Metallurgy because of their unique chemical and physical properties.

MILITARY APPLICATIONS

***Fig 6:** REE Usage in Modern Economies*[7]

[7] Adamas Intelligence 2024, *Rare-Earths Market Outlook & Opportunities 2024-2035*, Adamas Intelligence, Toronto

CONVENTIONAL REE PROCESS FLOWSHEETS

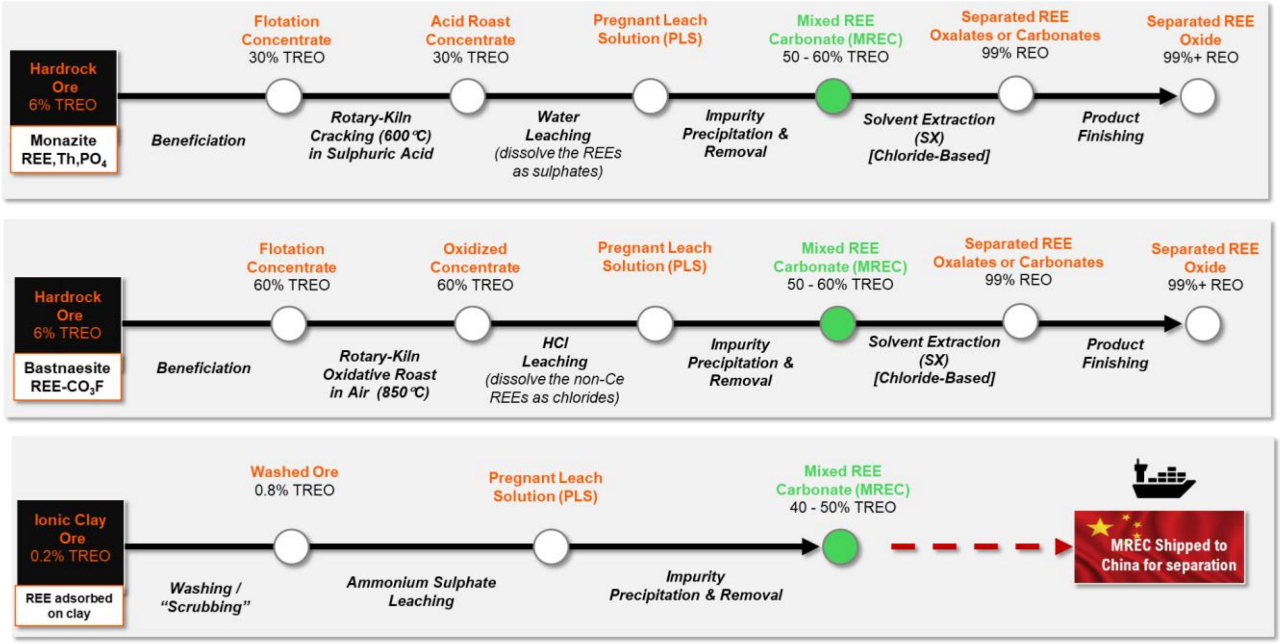


Fig 7: *Typical REE Flowsheets – Hard Rock Minerals & Ionic-Clay – and how all involve producing an intermediate product called MREC*[8]

WHY SEPARATE REEs?

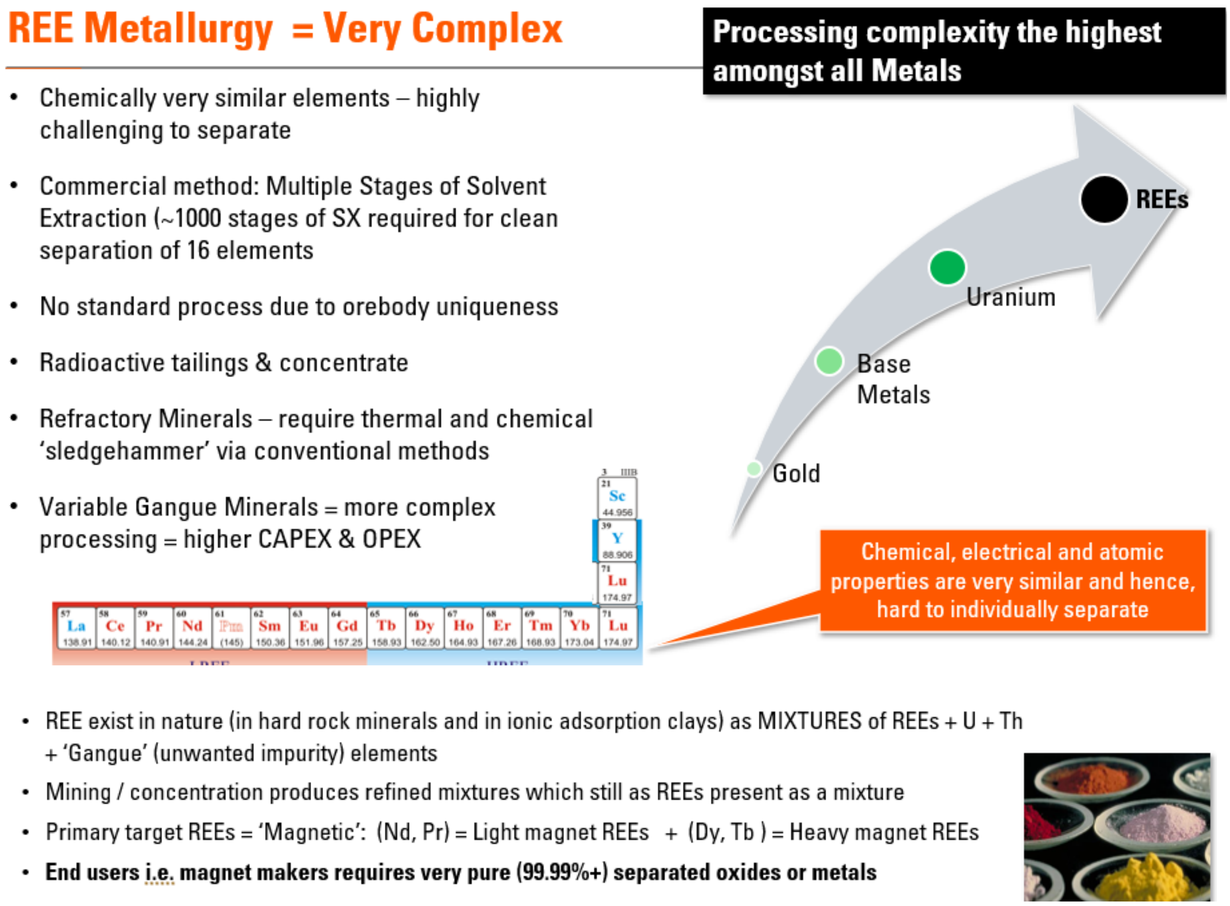


Fig 8: *Overview of REE separation*[8]

[8] Gupta, C.K. & Krishnamurthy, N. 2005, *Extractive Metallurgy of Rare Earths*, CRC Press, Boca Raton, p. 191; ASX: MTM announcement 17/06/2025, '*MTM & Meteoric Sign MOU After Successful REE Testwork*

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