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ASX Release

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BREAKTHROUGH IN GALLIUM & GERMANIUM RECOVERY

- **Highly successful initial testing:** very high recovery rates (~90% for Gallium (Ga) and ~80% for Germanium (Ge)) from semiconductor metal refining waste using proprietary Flash Joule Heating (FJH) technology.
- **Recovery rates match or exceed traditional methods**, but FJH technology offers a much more simple, sustainable, and streamlined alternative with no acid use and faster processing[1].
- **Filling a Critical Industry Gap:** No cost-effective domestic methods currently exist in the U.S. or globally for Ga / Ge recovery from waste. MTM is positioned at the leading edge of solving this supply chain vulnerability.
- **Geopolitical Significance:** The achievement comes amid China's further tightens export restrictions on Ga and Ge, reinforcing the need for independent and scalable U.S.-based recovery solutions.
- **MTM's breakthrough positions it at the forefront of a multi-billion-dollar market** as industries and governments seek sustainable, onshore critical metal supply solutions.
- Access to **ultra-high value scrap** containing up to **20% (200,000 ppm) In**, **15% (150,000 ppm) Ga**, and **18% (180,000 ppm) Ge** – all critical technology metals that have recently experienced substantial price increases.
- **Strategic Partnerships:** Discussions ongoing with industry partners regarding commercial business models for maximising critical metal recoveries and optimising value for large-scale application of this technology.

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MTM Critical Metals Limited ("MTM" or the "Company") (ASX: MTM; OTCXB: MTMCF) is pleased to announce a major technological milestone, achieving successful recovery of gallium & germanium from semiconductor industry waste using its proprietary FJH technology at its lab in Houston, Texas USA. This positions MTM as a leader in sustainable, high-efficiency recovery solutions for these ultra-high-value technology metals.

MTM's advancement in gallium and germanium recovery is bolstered by its previously announced strategic partnership with **New York-headquartered Indium Corporation[2] ("Indium")**, one of the Western world's largest suppliers of refined specialty technology metals. This collaboration has been instrumental in assisting with the sourcing of the high-value feedstock used for this testing. This partnership strengthens MTM's access to critical materials and accelerates the pathway towards commercialisation.

Indium's Business Unit Manager, Metals Markus Roas remarked: *"MTM's latest test results are very meaningful and could be an industry game-changer for the recycling of critical "technology metals" as this development path continues. The ability to recover Gallium and Germanium from waste streams represents an important opportunity to establish a circular supply chain for materials that are essential to semiconductors, defence, and renewable energy industries. The integration of MTM's technology could reshape how these metals are sourced, reducing dependence on foreign-controlled supply chains. Indium Corporation fully supports this pioneering effort and looks forward to working alongside MTM in advancing this transformative initiative.*

MTM Managing Director & CEO, Michael Walshe, commented: *"We're thrilled with FJH technology's versatility across multiple metals, and the latest test results for ultra-high-value technology metals couldn't be timelier given the current geopolitical landscape. Ga & Ge are indispensable to semiconductors and defence applications, yet their supply chains remain highly vulnerable due to overwhelming dependence on imports—particularly from*

[1] Ignacio R et. al 2024. *"Recovery of Lesser-Known Strategic Metals: The Gallium and Germanium Cases"* Processes 12, no. 11: 2545. https://doi.org/10.3390/pr12112545.
[2] ASX:MTM announcement dated 29/11/2024, *'Strategic Collaboration with Major Gallium & Germanium Firm'*

China. MTM's proprietary process offers a commercially viable, environmentally friendly solution to secure domestic supplies of these strategic materials, creating a major economic opportunity for the Company".

Comparison of Traditional Recovery Methods vs. FJH Technology

The global demand for gallium and germanium has surged due to their critical roles in semiconductors, defence applications, and renewable energy technologies. However, existing recovery methods for these metals remain inefficient, environmentally harmful, and cost-intensive. Traditional processes, such as acid leaching, solvent extraction, and smelting, often involve high reagent consumption, toxic waste production, and significant energy costs with resultant low selectivity and metal recovery efficiency.

MTM's proprietary FJH technology represents a revolutionary alternative. By using rapid, high-energy pulses to volatilise and recover metals, FJH eliminates the need for hazardous chemicals, significantly reduces processing times, and achieves high metal recoveries (~90% for Ga and ~80% for Ge). This not only provides an economically viable and environmentally sustainable solution but also strengthens domestic supply chains by reducing reliance on foreign-controlled sources.

The following table compares traditional, yet rarely employed recovery methods with MTM's FJH technology, highlighting why this breakthrough represents a paradigm shift in critical metal recycling.

TABLE: 1: ***Comparison of Existing Gallium & Germanium Recovery Methods vs. FJH Technology***

Recovery Method	*Process*	*Typical Efficiency*	*Environmental Impact & Issues*	*Other Challenges*[3]
Traditional Acid Leaching	*Dissolves metals using strong acids (e.g., HCl, H_2SO_4)*	*50-80%*	*High acid consumption, toxic waste;*	*Low selectivity & recovery; Expensive, hazardous waste disposal (Zhang et al., 2023)*
Solvent Extraction	*Selectively extracts metals using organic solvents*	*50-75%*	*High waste generation, solvent losses*	*Complex separation, high solvent costs, requires CAPEX & OPEX intensive pretreatment; (Raja et al., 2022)*
Electrowinning	*Uses direct electric current to deposit metals from solution*	*60-75%*	*Requires CAPEX & OPEX intensive chemical pre-treatment, energy-intensive*	*High energy demand, limited to specific feedstocks (Chen & Li, 2021)*
Pyrometallurgical Smelting	*High-temperature processing to extract metals*	*50-75%*	*High CO_2 emissions, slag waste*	*Requires high energy input, not suited for fine waste streams (Jones et al., 2020)*
MTM's Flash Joule Heating (FJH)	*Rapid thermal processing with proprietary chlorination & catalysts to volatilise & recover metals*	***90% (Ga), 80% (Ge)***	***No acid use, minimal waste, low emissions***	***New technology***

[3] See References in Appendix

Industry Impact and Market Opportunity

Gallium, Germanium, and Indium are classified as critical minerals by the U.S. Department of Defense, with no primary domestic production of gallium or indium, and over 50% of U.S. germanium demand met through imports. The geopolitical implications of China's export restrictions on Ga and Ge—which took effect in 2024—underscores the urgent need for alternative supply solutions[3].

- **Gallium Prices:** Surged by over 50% in 2024, driven by supply disruptions & export bans[3].
- **Germanium Market Tightness:** U.S. and EU nations actively investing in alternative sources to reduce reliance on China.

MTM's breakthrough unlocks a **multi-billion-dollar addressable market** as governments and industries seek sustainable, onshore solutions for securing these materials.

Geopolitical Metals - Critical importance in high-tech industries and concentrated production in China

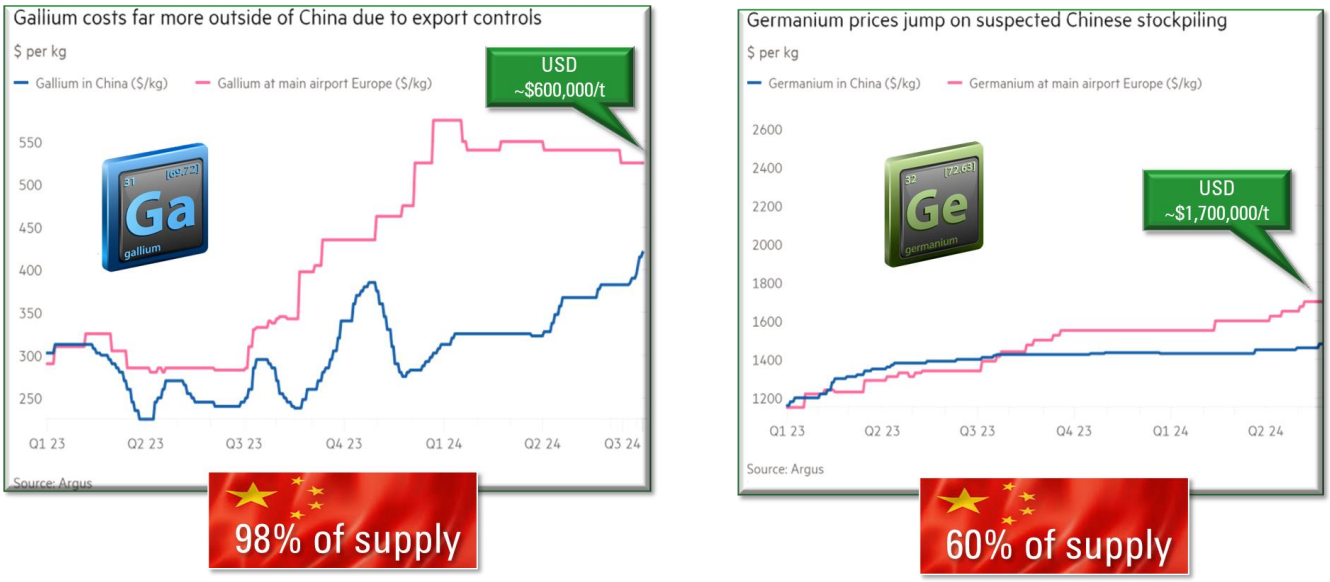

FIG. 1: Gallium & Germanium Recent Price Trends (to Q3 2024 – does not include more recent price increases since Q4 2024)[4]

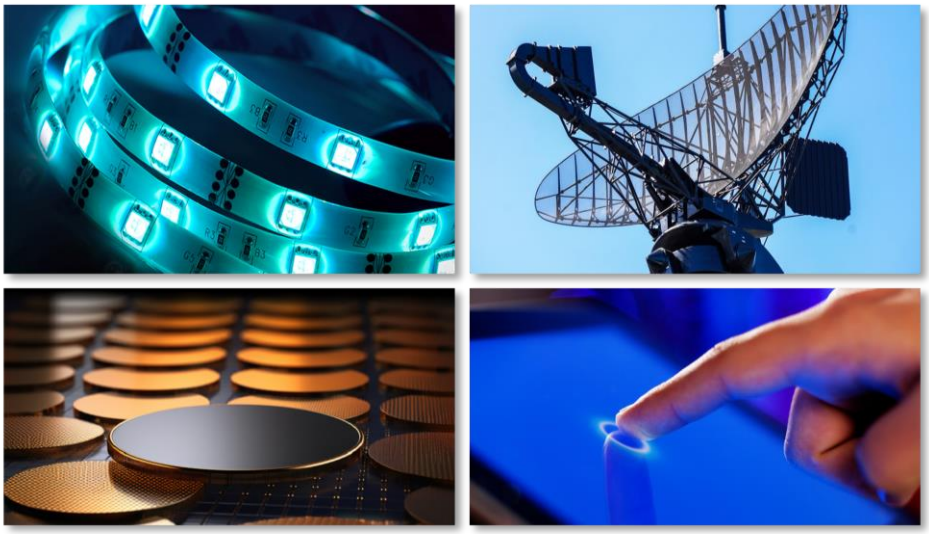

FIG. 2: Ubiquitous uses i.e. Semiconductors (e.g., NVIDIA gallium nitride & arsenic chips); Military Technology (e.g., radar systems, advanced communication); Renewable Energy (e.g., solar panels).

[4] Dempsey, H. and White, E. (2024). China's export curbs on semiconductor materials stoke chip output fears. Financial Times, 27 August 2024. https://www.ft.com/content/9cd56880-4360-4e11-8c22-e810d3787e88; Lucas, L. (2024). Overcoming China's dominance in gallium will not be easy. Financial Times, 31 August 2024. https://www.ft.com/content/20819d8e-5d2b-4a12-9a50-edbfd07336ef.

Supply Chain Disruptions & Risk for Western Nations

The semiconductor and other associated manufacturing industries are expected to face disruptions, leading to potential shortages and significant price increases for gallium-dependent technologies. **Several western nations are 100% reliant on gallium imports from China (see *Fig. 3* below)[5].**

China's recent export controls on critical minerals, particularly germanium and gallium, have significantly disrupted global supply chains. Effective August 1, 2023, China imposed restrictions on these metal exports, citing national security concerns. Given that China produces over 95% of the world's gallium and around 70% of its germanium, these measures have led to substantial supply constraints.

The United States, which relies entirely on imports for these minerals, has been notably affected, especially in sectors like semiconductors and defence technologies. Following the implementation of these export controls, gallium prices surged by 27% within a week, with a cumulative increase of 68% by December 2023. In a further escalation, on December 3, 2024, China expanded its export bans to include antimony and superhard materials, intensifying global concerns over the stability of critical mineral supplies[6].

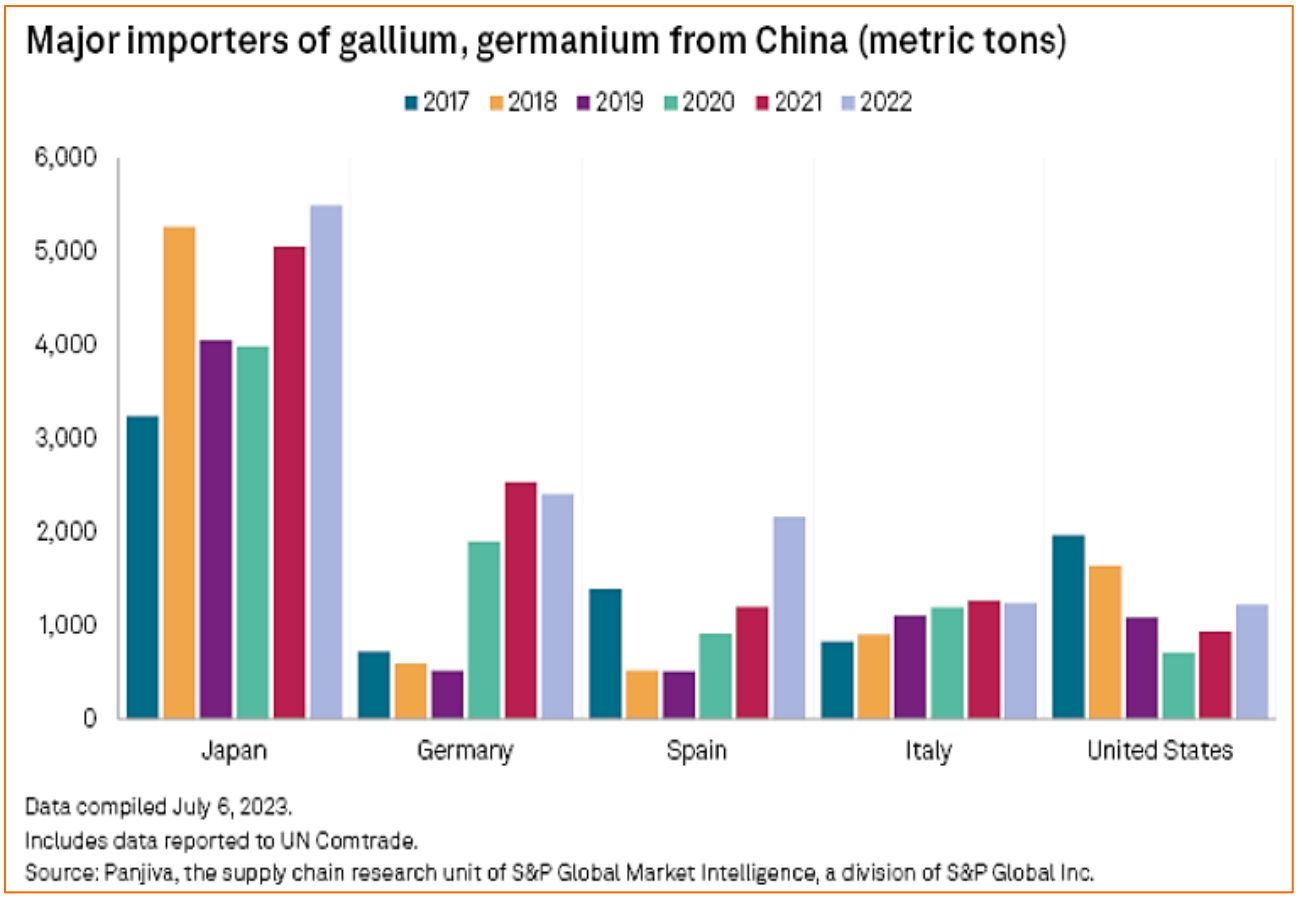

FIG 3: Major Gallium & Germanium Importers. Source: S&P Global (2023)

[5] S&P Capital IQ 2024, 'Uncertainties abound around China's gallium, germanium export controls', Commodity Insights – Gallium
[6] Reuters, 2024. *China bans exports of gallium, germanium, and antimony to the US.* https://www.reuters.com/markets/commodities/china-bans-exports-gallium-germanium-antimony-us-2024-12-03

Breakthrough Technology & Recovery Process

The testing utilised Flash Joule Heating technology at MTM's lab in Houston, Texas, USA to process Ga & Ge waste supplied by semiconductor metal refining partner.

KEY RESULTS:

- **Gallium Recovery:** Approximately **90%** of the gallium (by mass) was successfully extracted and captured, with opportunities for further optimization.
- **Germanium Recovery:** Approximately **80%** recovery (by mass) was achieved, with opportunities for further optimization.
- **Minimal Metal Losses:** Only trace amounts of Ga and Ge were found in wash solutions, confirming high capture efficiency within the closed system.

TEST SETUP:

- Chlorination in the presence of proprietary MTM catalysts was performed within the reactor to enhance metal recovery.
- Super-cooled proprietary outgas recovery systems used to condense reaction products.

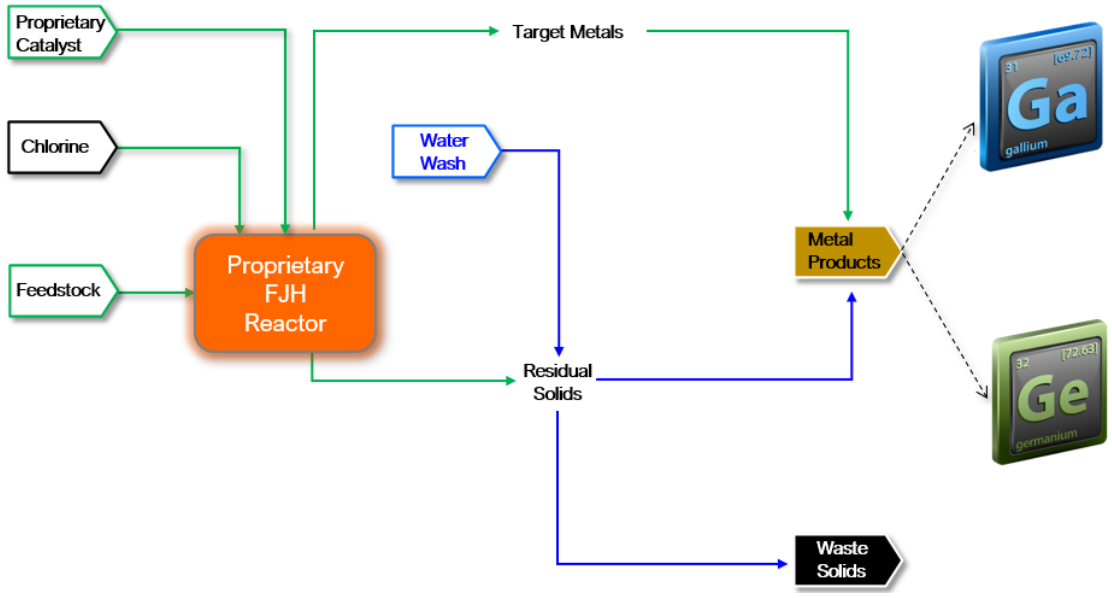

FIG. 4: conceptual flowsheet for testwork employed

ANALYSIS METHODOLOGY:

- Scanning Electron Microscopy with Energy Dispersive Spectroscopy (SEM/EDS): Used to analyse the solids collected from the reactor and downstream systems.
- Inductively Coupled Plasma Mass Spectrometry (ICP-MS): Employed to quantify the metal content in the captured chlorides, co-products, and residual materials.
- Thermogravimetric Analysis (TGA): Used to assess the decomposition and transformation of recovered critical metals under proprietary FJH conditions.
- TotalQuant Inductively Coupled Plasma Mass Spectrometry (ICP-MS)[7] was used to quantify the metals in the water wash solutions.

[7] TotalQuant refers to a mode in ICP-MS where all measurable elements are detected and quantified in a single run without prior specific selection of elements. This is particularly useful for complex samples where a comprehensive elemental profile is required. It is considered qualitative (or semi-quantitative) (±20% accuracy) because, in the TotalQuant mode, it provides a broad overview of the elements present in a sample without the rigorous calibration that would be needed for fully quantitative results & does not account for possible elemental interferences between various metals.

The Hidden Resource: Large-Scale Waste Potential

Millions of tons of semiconductor production waste and electronic scrap containing gallium, germanium, and indium is currently landfilled, representing a massive untapped resource[3, 5].

Preliminary assessments suggest that:

1. Millions of tonnes of semiconductor waste containing Ga, Ge, and In have been disposed of globally.
2. Potential secondary resources in industrial landfill sites could rival primary deposits in scale.
3. MTM plans to initiate studies to quantify and validate this waste-derived metal inventory, opening the door for future resource classification.

Additional "Technology Metal" Opportunities

Indium (In) and **Bismuth (Bi)** represent a high-value market opportunity for MTM, as these metals are critical in advanced electronics, solar panels, and specialty alloys. Indium is primarily used in indium tin oxide (ITO) coatings for displays and touchscreens, while Bismuth is increasingly replacing lead in environmentally friendly applications, including pharmaceuticals and low-melting alloys.

Despite their strategic importance, Western supply chains remain vulnerable, with Indium supply dominated by China (~50% of global production) and Bismuth facing similar geopolitical risks[8]. Currently, Indium is largely recycled from ITO scrap in Japan and South Korea, but U.S. infrastructure for indium and bismuth recovery remains underdeveloped. MTM's FJH technology offers a unique opportunity to efficiently recover these metals from industrial and electronic waste, unlocking new potential supply sources and economic opportunities.

Next Steps & Commercialisation Pathway

MTM's breakthrough in gallium and germanium recovery represents a first-mover advantage in the development of scalable, cost-effective solutions for securing these essential materials. With rising geopolitical tensions, soaring demand, and an urgent need for domestic supply chains, MTM is ideally positioned to capture this growing market opportunity.

The next phase of testing will focus on optimizing reaction conditions to further purify Ga and Ge metal products, improving recovery yields, and expanding trials to other critical metal-containing feedstocks.

The path ahead:

1. **Expand Trials:** Testing additional waste feedstocks, including indium and bismuth-rich materials.
2. **Optimise Process Efficiency:** Refining FJH conditions to enhance metal purity and economic recovery.
3. **Strategic Partners:** Pursuing commercial business models with semiconductor & recycling industry stakeholders.
4. **Scale for Industrial Application:** Exploring pilot-scale implementation for high-throughput processing.

[8] Reuters 2025, *'What are the five critical metal exports restricted by China?',* https://www.reuters.com/markets/commodities/what-are-five-new-critical-metal-exports-restricted-by-china-2025-02-04/

FIG 5. Conceptual artist's impression of the FJH Demonstration Plant

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

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ADDITIONAL REFERENCES

- Chen, X. & Li, M. (2021) 'Advances in Electrowinning of Critical Metals: A Review', *Journal of Metallurgical Processes*, 34(2), pp. 97–115.
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ABOUT MTM CRITICAL METALS LIMITED

MTM Critical Metals Limited (ABN 27 645 885 463), is an ASX & OTCQB-listed company with management teams in Perth, Western Australia, and Texas, USA, and specialises in advanced metal recovery technologies. MTM's 100%-owned USA subsidiary **Flash Metals USA Inc** is based in Texas, USA. MTM possess exclusive licensing rights to the innovative *Flash Joule Heating technology*, a cutting-edge metal recovery and mineral processing method developed by esteemed researchers at Rice University, USA. Additionally, MTM holds exploration assets prospective for niobium (Nb), rare earth elements (REE), and gold, strategically located in Western Australia and Québec.

- Flash Joule Heating (FJH) is an advanced electrothermal process that enhances metal recovery and mineral processing compared to traditional methods. By rapidly heating materials in a controlled atmosphere, FJH efficiently extracts metals like lithium from spodumene, gallium from scrap, and gold from e-waste, among others. This technology has the potential to revolutionise metal recovery by reducing energy consumption, reagent use, and waste, offering a more economical and environmentally friendly alternative.
- MTM's West Arunta Nb-REE exploration assets are situated in one of Australia's premier exploration hotspots, where over $60 million has been invested by ASX-listed companies such as WA1 Resources, Encounter Resources, Rio Tinto (in JV with Tali Resources), and IGO Limited. MTM also holds tenements in other key mineral regions across Western Australia, including the Mukinbudin Nb-REE Project, East Laverton Gold & Base Metals Project, and Mt Monger Gold Project. In Québec, the Pomme Project is a highly promising carbonatite intrusion rich in REE and niobium, located near the world-class Montviel deposit.

To learn more, visit:

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PREVIOUS DISCLOSURE

The information in this announcement is based on the following MTM Critical Metals Limited ASX announcements, which are all available from the MTM Critical Metals Limited website www.mtmcriticalmetals.com.au and the Australian stock exchange (ASX) website www.asx.com.au.

Date	Description
29 November 2024	Strategic Collaboration with Major Gallium & Germanium Firm'

The Company confirms that it is not aware of any new information or data that materially affects the information included in the original ASX announcements and that all material assumptions and technical parameters underpinning the relevant ASX announcements continue to apply and have not materially changed. The Company confirms that the form and context in which the Competent Person's findings are represented have not been materially modified from the original ASX announcements.

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