Report: AusIMM Critical Minerals Research and Development Policy Forum

Table of Contents

Executive Summary

The Australasian Institute of Mining and Metallurgy (AusIMM) and Australian Critical Minerals Research and Development Hub (Hub) hosted a Policy Forum on Monday 1 September to gather insights on research and development priorities for the nation's critical minerals sector.

The Forum, which took place in Perth alongside AusIMM's Critical Minerals Conference, had three goals – namely, to:

1. Define opportunities and priorities for future research, development and investment in the critical minerals sector, focussing on the next five to ten years.
2. Engage stakeholders from across the research and development ecosystem, to promote alignment between industry, government and academia.
3. Generate a suggested pathway and highlight further engagement priorities for AusIMM to take forward with the Hub and sector partners.

AusIMM and the Hub asked delegates to focus on three technical areas:

1. Enabling geoscience: How public and private geoscience programs can be calibrated to support targeted critical minerals exploration and development.
2. Mine waste and tailings: The opportunity to 're-mine' waste and tailings, particularly as geological understanding and extraction techniques mature.
3. Processing and byproduct recovery: Opportunities for Australian industry to exploit genuine competitive niches along the critical minerals value chain, considering both 'mid' and 'downstream' opportunities.

Forum outcomes

The key outcomes from the Critical Minerals R&D Forum are:

An 'Exploration Investment Matrix' is needed to allocate capital and capability

Public and private geoscience investment decisions should be based on an 'Exploration Investment Matrix' that balances the 'criticality' of a given mineral with the 'commerciality' of its production and refinement in Australia.

A long-term analysis of the various market, technological and geopolitical drivers impacting demand for specific commodities and products will help public and private investors to make informed decisions that balance these factors.

This is a function where government can play a key role convening and contributing relevant intelligence, but delegates emphasise that any minerals pricing initiative will rely on the data, expertise and insights of private miners and academic institutions.

Beyond the 'investment matrix' and a prospective long-term demand analysis, delegates highlighted public-private partnerships and incentives for explorers to complete comprehensive geoscientific studies as a major opportunity area.

The science needs to mature to make mine waste and tailings economic.

The potential to extract valuable critical minerals from mine waste material, particularly at so-called 'legacy' mine sites is significant but further effort is required to understand the co-location of historical primary and secondary (i.e. critical) mineralisation.

The role for research and development here is to deliver new, efficient extraction technologies, and to deepen Australia's expertise in and knowledge of chemical flowsheets and processes suited to mine waste and tailings. While, for example, there are technologies that allow significant volumes of copper and lithium to be extracted from waste material, the related processes are energy intensive and therefore difficult to integrate into existing industrial hubs.

At this stage, delegates describe this as a priority for universities and industry-linked research programs. The focus should be on the chemistry of mineral extraction, and the energy efficiency of the technology used to do it.

Australia's opportunity is to move to the 'midstream' of critical minerals processing, and work with global partners to strengthen the downstream market.

This is especially true for relatively small-scale minerals with niche (but highly strategic) technological applications, where relevant chemical processing, flowsheets and manufacturing 'know how' is either highly concentrated or absent altogether.

In other words, for many minerals, the sector does not have the knowhow needed to move downstream at scale. This presents a substantial opportunity for Australia to carve out genuine technical and commercial niches. Doing so requires a high degree of coordination between industry and government to develop a long-term view of 'strategic' demand drivers and their impact on project viability.

Where to next?

Forum findings will now form the basis for ongoing sector-wide engagement led by AusIMM with the continued support of Hub and other industry partners. AusIMM will test and refine Forum findings, define opportunities on a regional and jurisdictional basis, and incorporate findings from separate engagement activities focussed on:

- Building critical minerals workforce capability, particularly in mid- and downstream processing, refinement and manufacturing.
- Building Environmental, Social and Governance capability to enhance Australia's position as a partner of choice to industry and like-minded governments, supporting the establishment of integrated cross-border supply chains.
- Enhancing regional economic development outcomes, particularly through First Nations investment and commercial partnerships.

About AusIMM

The Australasian Institute of Mining and Metallurgy (AusIMM) is the peak body and trusted voice for professionals working in the resources sector.

Established in 1893 and operating under Royal Charter, we exist to advance the resources sector for the benefit of the community. Representing a community of more than 15,000 professionals working across 110 countries, our members are active at all levels of the sector; in fields ranging from engineering and geoscience through the processing, manufacturing, environmental management and social performance; and can be found at the senior-most levels of industry, government and academia.

We fulfil our purpose of advancing resources for the community's benefit through our role developing and upholding technical standards, delivering world-class professional development and convening our industry's leaders to shape policy and provide balanced, credible insights as part of well-informed public dialogue.

The Policy Forum initiative described in this report is a core element of our advocacy and policy-making function, designed to convene subject matter experts to provide specific and actionable recommendations on the strategic priorities that define the future of the resources sector.

AusIMM's focus at these Forums reflects the defined priorities and insights of our members, and the six pillars of our Advocacy Framework, namely:

1. The future of the sector, including its workforce and technical capability.
2. Community and environmental sustainability.
3. Professional best practice.
4. Professional recognition and mobility.
5. Diversity, equality and opportunity.
6. Health and safety leadership.

About the Australian Critical Minerals Research and Development Hub

The Australian Critical Minerals Research and Development Hub (the Hub) was announced on 21 October 2022 by the Prime Minister The Hon. Anthony Albanese and the Minister for Resources and Minister for Northern Australia, The Hon. Madeleine King. The initiative is part of the Government's plan to unlock Australia's potential in the sector, as outlined in the Critical Minerals Strategy 2023-2030.

Hosted by CSIRO and delivered in partnership with Geoscience Australia and ANSTO, the Hub brings together the nation's leading science agencies to address technical bottlenecks, unlock downstream value and build sovereign capability across the critical minerals value chain. Under this initiative, the three agencies are undertaking collaborative research projects that are delivering Australian-owned intellectual property (IP), infrastructure, data and knowhow needed to scale up and commercialise Australia's critical minerals potential. The Department of Industry, Science and Resources (DISR) through the Critical Minerals Office support and guide the Hub's activities.

The Hub is working with industry, universities and the research community to address technical challenges and drive collaborative research across the critical minerals value chain needed to support clean energy and Australia's net zero policy agenda

The Hub focuses on four key streams of work:

1. **Scaling and commercialising R&D:** moving research breakthroughs towards industrial application through pilot projects and demonstration facilities.
2. **Supporting international partnerships:** strengthening Australia's role in global supply chains through collaboration with likeminded countries.
3. **Coordinating and prioritising R&D:** aligning research efforts across government, academia and industry to reduce duplication and maximise impact.
4. **Connecting industry and government with R&D:** ensuring scientific knowledge is disseminated as a public good, informing policy and offering trusted technical advice.

Under workstreams 3 and 4 the Hub delivers and sponsors targeted stakeholder activities and tailored events, provides leadership and seeks to elevate the national conversation around R&D priorities across Australia's critical minerals research community.

Comment from the convenors

Stephen Durkin FAusIMM, CEO AusIMM

We have arrived at a pivotal moment for the Australian resources sector and its role in advancing the national interest. The race to secure and process critical minerals is accelerating amid a complex geopolitical, policy and industrial landscape.

At the same time, resources professionals working across government, industry and the research sector are delivering scientific and technological breakthroughs that allow us to 'move down the value chain' and embed our sector's role as the anchor-point for diversified Australian industry.

This is a once in a generation opportunity for the resources sector to again play a foundational role in shaping and strengthening Australian industry, its workforce and its sovereign position in a complex world.

As the Trusted Voice for resources professionals over more than 130 years, AusIMM has played a vital role connecting leaders and decision-makers to chart a course through many major transitions for our sector. From the initial development of our gold sector, into the conflict and disruption of the early twentieth century, through the long iron ore boom, and into the technological advancement of recent decades, AusIMM has provided leadership that advances our sector for the benefit of the broader community.

These are similarly exciting, but also complex and challenging, times for our sector.

That is why AusIMM and our partners at the Australian Critical Minerals Research and Development Hub partnered to deliver the Policy Forum on which this report focusses.

The insights, findings and recommendations tabled in this report reflect the expertise of leading professionals, state and federal government representatives, research leaders and industry experts on the pathway to unlock the full benefit of our critical minerals opportunity. Three priorities emerge:

1. Comprehensive, broad based geoscience and exploration.
2. A regionally integrated approach to 'moving downstream', where industrial hubs connect commodities, processing capability and a broader industrial base.
3. Continued investment in foundational science to develop knowhow and infrastructure needed to unlock downstream processing, byproduct and mine waste opportunities and enhance our environmental and social performance.

Most importantly, the findings outlined in this report again demonstrate the vital role professionals play in making a balanced, credible and evidence-backed contribution to public dialogue about our sector.

Thank you to the individuals who contributed their time and expertise to this inaugural R&D Forum. AusIMM looks forward to tabling the report with partners across the sector, shaping policy to advance mining and resources for the benefit of our community.

Stephen Durkin FAusIMM CEO

Dr Chris Vernon, Chief Research Scientist, CSIRO

Australia is well positioned to become a trusted supplier of responsibly sourced critical minerals, essential for clean energy technologies, defence, and high-tech manufacturing. We have abundant geological potential in critical minerals, world-leading science institutions with all of the necessary applied skillsets, excellent access to pre-competitive geoscience data, supportive policy settings to advance and a robust and innovative mining sector, underpinned by a skilled workforce and a strong regulatory environment.

Despite these strengths, the critical minerals industry remains fragmented. It is dominated by junior explorers with single-asset portfolios and limited capital, with barriers to moving beyond early-stage development. Unlocking Australia's potential will require a coordinated effort to overcome technical barriers, scale up downstream processing, and demonstrate capability to global partners.

Critical minerals pose new and complex challenges that differ from traditional commodities. New data, new technologies, and new capabilities are needed, not only to extract value, but to position Australia as a key player in reshaping global supply chains.

As the world races to secure critical minerals and materials, Australia needs to move quickly to innovate and leverage its advantages. Solutions require collaboration across research, industry and multiple agencies – no single organisation of government body can achieve this alone.

The Australian Critical Minerals R&D Hub is proud to partner with AusIMM on this Policy Forum. The Forum builds on the Hub's prior collaboration with AusIMM to deliver "Critical Conversations" at the 2023 and 2024 Critical Minerals Conferences. It is the next step in our shared interest in setting the direction for critical minerals research and advances on the findings of the Hub's National Symposium Critical Minerals Symposium held in Melbourne in February 2025. Together we are creating a shared vision that prioritises and targets research that unlocks value, addresses bottlenecks and ensures Australia is well positioned to capitalise on its comparative advantage.

Dr Chris Vernon, Critical Minerals Lead, CSIRO and
Chair of the Operations Group, Australian Critical Minerals R&D Hub

Prioritising research and development in the Australian critical minerals sector

Delegates to the Critical Minerals Research and Development Policy Forum discussed priorities across three focus areas:

1. Enabling geoscience: The role of broadly based geoscience and exploration in unlocking new discoveries, and the opportunities to develop new professional and technical capabilities to achieve this outcome.
2. Mine waste recovery: The pathway to move along the technological maturity curve and build knowledge in this area, shifting from what is currently a largely 'academic' field of endeavour to pilot and demonstrate viable, commercial waste related projects. Delegates also discussed opportunities to manage new mine sites in a way that preserves future value and takes advantage of 'co-mineralisation' both for current products, and potential future products.
3. Downstream processing and by-product recovery: The key elements of a 'minerals investment matrix' to balance the commercial viability and strategic significance of new critical minerals projects, along with priorities for investment in new processing capabilities based on regional strengths and linkages with an expanded global customer base.

Key findings across each area are tabled in the sections that follow.

Enabling geoscience

Advancing Australia's critical minerals sector relies on high-quality, comprehensive and precompetitive geoscience data. This data is required to inform exploration, and guide investment in new mining and industrial precincts.

Current national datasets, largely built around bulk commodities, lack the resolution and specificity required for critical minerals, which often occur in low concentrations and as secondary mineralisations to other deposits. Forum delegates therefore emphasised that private and public datasets should be combined to maximise both the range of quality data available to industry and research users, and its commercial value for new project proponents.

As part of a coordinated national endeavour, delegates identified four immediate opportunities to expand and make best use of existing geoscience data:

- Harness artificial intelligence to analyse existing core libraries, as part of a program combining private, commercial and state and federal government datasets. Data standardisation is a priority here, and the Forum identified a national Critical Minerals Portal as a potential end product.
- Map co-located minerals, to encourage joint exploration from multiple parties, potentially with support from state and federal governments, and inform priorities for major programs such as Resourcing Australia's Prosperity Initiative.
- Introduce incentives for junior explorers to undertake comprehensive mapping and in-situ assaying, looking beyond their target commodities to generate comprehensive datasets for use by public geoscience agencies.
- Undertake long-term price and demand forecasts to strengthen the case for investment in critical and strategic mineral deposits that do not currently attract substantial commercial investment.

Forum delegates noted the significant impact that Geoscience Australia's Resourcing Australia's Prosperity Initiative will have in meeting the need for comprehensive geoscience data.

A balanced approach is required to maximise the impact of these broad public geoscience programs with more targeted exploration activities, to support commercial projects while ensuring a broader public benefit is maintained. In practice, delegates indicated this would involve two primary factors that can be balanced as part of an 'Exploration Investment Matrix':

- The 'criticality' of the minerals or mineralisations being explored for, meaning the strategic importance of the mineral to Australia's allies and trading partners, as well as major end-use customers in the energy, defence, space, automotive and advanced technology sectors (both domestically and abroad).
- The 'commerciality' of the mineral or deposit, referring to potential economic value and present commercial viability of projects to develop the relevant deposits. Here, delegates championed a comprehensive assessment of commerciality, accounting for the role of critical minerals mining within broader regional industrial ecosystems. For example, exploration might be prioritised in areas where public and private funds are already being allocated towards advanced manufacturing hubs or research and development facilities.

Delegates also recommended that criticality and commerciality be considered alongside secondary factors such as timeliness (that is, how quickly a region can be explored and developed), prospectivity (whether known deposits indicate a high likelihood that critical minerals will be present) and strategic maturity (being the timeline over which relevant minerals will evolve from 'strategic' to 'critical').

On the latter point, delegates emphasised that a lead-party, potentially a government or cross-industry organisation, is required to undertake the comprehensive techno-economic analysis that will support long-term (and not immediately commercial) investments in critical minerals geoscience.

This multi-factorial approach seeks to account for several challenges with the existing approach to geoscience and exploration investment, including that:

- The business case for junior companies to identify secondary mineralisation is constrained, whether by the explorers' own financial resources or investors and off-takers who provide capital based on narrowly defined target mineralisations.
- Poor transfer of proprietary data between commercial partners, or grant holders, which means significant capital and human resources are often deployed to 're-explore' known deposits rather than gather genuinely new datasets.
- Encouraging explorers to complete comprehensive datasets, with relevant exploration permits rarely requiring proponents to move from mineralogy (i.e. core sampling) to assaying (i.e. detailed in-situ analysis).

Mine waste and tailings

New technologies and processes could make mine waste a significant commercial supplement for Australian critical mineral miners, while also delivering enhanced environmental, health and social outcomes for the community.

Increasing investor and community interest in circular economy and resource sustainability means mine waste and tailings represent a genuine competitive and capability niche for Australian critical minerals operators, with potential 'spillover' benefits for the broader resources sector.

Forum participants referenced a range of emerging technologies developed with backing from major mining houses globally, which support the extraction of valuable minerals from mine tailings and waste materials. The potential upside for new Australian industry is significant, given the stockpiles of waste material accumulated (and managed) over decades of mining activity.

At this stage, however, waste processing technologies only have applications for a narrow range of materials and minerals, where waste material is of a sufficient volume and quality to enable significant extraction – essentially, commercial waste processing is possible only for the 'highest grade of waste material'.

Delegates therefore described mine waste and tailings as an area that requires further scientific and technological development, before moving to commercial demonstration and expansion. Money, time and regulation are the key drivers here, with the most immediate priorities being to:

- Develop protocols and technical frameworks to define waste resources.
- Define standards for the safe and sustainable sampling of waste material.
- Lift capability and knowledge regarding mine waste characterisation through continued higher research investment.
- Invest in waste extraction technologies, particularly focussing on energy efficiency.

New technologies to process other materials from copper tailings were cited as one of the most technologically mature examples of the commercial waste processing opportunity.

Beyond the technological and capability questions, however, an additional challenge is to deal responsibly and commercially with the economic and environmental liabilities associated with mine waste and tailings. Almost by definition, waste and tailings contain a complex mixture of elements that require highly novel flowsheets and processing approaches to access residual value. These processes need to be safe, sustainable and secure, too. Many delegates highlighted the potential to engage with international counterparts to share knowledge and build capability in this area.

Forum delegates recommended further investigation of regulatory barriers, tax incentives or royalty arrangements that directly reward multi-element recovery and incentivise producers to actively preserve waste and tailings materials during the 'active' phase of the mining lifecycle, for future use and transfer. This may involve co-management of multi-company waste streams within a given industrial region, which should be considered as part of regionally based shared infrastructure planning.

Downstream processing and by-product recovery

Moving downstream into critical minerals processing and achieving greater field by-product recovery, presents opportunities for Australia to carve out genuine competitive niches and strengthen linkages with government and industry partners globally.

The commercial-strategic mismatch described in relation to enabling geoscience and waste reprocessing is similarly apparent when considering the downstream opportunity for Australia, according to delegates at the Forum.

Delegates emphasise that the challenge of moving downstream does not reflect a short-term or unduly commercial focus from the Australian sector. Rather, the simple reality is that 'going downstream' involves shifting into specialised areas of chemical processing and manufacturing where basic research, applied science and industrial capability is not so much lacking as completely absent in much of the world.

In other words, most of the global resources industry does not know how to operate, at scale, in niche downstream areas of the critical minerals value chain.

As new technologies and applications emerge, and even as new processing methods are developed, their application and commercialisation remain fraught. There are four corollaries to this assessment:

- Education and advanced research are essential to define and extend genuine competitive niches: In Australia, investing in industry-linked postgraduate research to build capability is an imperative. The sector should actively prioritise research that 'intersects' with developments in the energy, defence, space and advanced manufacturing sectors, and prioritise opportunities to deploy researchers and professionals currently working in areas where long-term demand is expected to fall. Developing processing capability, especially in metallisation and high purity metals, remains a key opportunity
- Common user facilities and a 'regional hub' approach are key: Common road, energy and port infrastructure has played a fundamental role in supporting industry development historically, and a coordinated approach to develop new facilities can likewise help to crowd-in a range of industry parties, researchers and utility services in the future.
- Shared facilities can help individual operators overcome challenges of scale, especially around the energy intensive nature of most critical minerals processing. Facilities also need to be designed to accommodate a range of distinct technical requirements, with processing methodologies varying substantially between different commodities, mineralisations and end-use applications.
- The broader industrial and R&D ecosystem can be leveraged to support demand for Australian critical minerals, and build the case for increased domestic beneficiation. This opportunity is particularly strong in areas of advanced manufacturing relevant for the defence and energy sectors.

A focus on by-product recovery 'makes sense': Building capability to process secondary mineralisation and by-products is a natural place to start for Australian industry, reflecting circular economy principles around efficient mineral extraction for all new land disturbances. In many cases this will require a degree of coordination between commercial and non-commercial parties, particularly where secondary mineralisations (and their downstream applications) are strategically significant but commercially unviable.

Priorities for future engagement

The Forum and previous consultation undertaken by both AusIMM and the Hub have identified a series of areas requiring further engagement, particularly including:

1. Long term workforce planning and skills development, which AusIMM is pursuing through its Professional Pathways Whitepaper process.
2. ESG Capability, on which AusIMM is again leading via a multi-year research partnership with the Queensland Government.
3. Market expansion, on which delegates called for peak bodies and government agencies to coordinate foreign investment attraction and export promotion initiatives, particularly to broaden and diversify the market for 'end-use' consumers of Australian minerals and value-added materials. Connecting Australian projects and products to export markets is critical to achieve commercial scale.
4. Research infrastructure assessment and uplift, for which delegates recommended a broad-based review to identify existing research and development facilities, and develop an agreed plan for future R&D and commercial infrastructure investments.

Priorities and opportunities to advance critical minerals capability

Focus area 1: Enabling Geoscience

Opportunity	Lead	Breakthrough idea	Sequence
Apply a Critical Minerals Investment Matrix to all research and development investments	Industry, government and academia	Balance 'criticality' and 'commerciality' when making decisions about new research and development, accounting for technological maturity, known deposits and reliable analysis of future demand and price	Short-term
Harness AI and other technologies to reassess existing geological datasets	State and federal geoscience agencies Commercial parties	Establish Critical Minerals Portal housing all state, federal and private geoscience data. Centrally manage and facilitate data access to balance privacy, commercial sensitivity and public interest considerations.	Short-term
Commence long-term economic and political analyses to better understand the demand (and price) profile for key commodities	Coordinated program leveraging industry, government and academic capability.	A Critical Minerals Pricing Program to better predict the long-term demand profile for key Australian minerals and value-added products, which can guide trade missions led by government organisations and industry peak bodies.	Short-term
Map co-located minerals and secondary deposits	Federal science agencies	This should continue to be a core focus for the Geoscience Australia Resourcing Australia's Prosperity Initiative, with technical support from ANSTO, CSIRO and universities to undertake detailed mineral studies.	Medium-term
Introduce an exploration incentive program that encourages commercial parties to acquire comprehensive datasets	State and federal governments, working directly with junior explorers.	Tax incentives and streamlined processes could be considered to ensure comprehensive datasets are in the commercial interests of junior explorers.	Medium-term

Focus area 2: Mine waste and tailings management

Opportunity	Lead	Breakthrough idea	Timeline
Develop protocols and technical frameworks to define waste resources	Cross-industry group convened by peak standards and professional bodies, with input from industry, science and government organisations.	Australian-developed Global Mine Waste Taxonomy to demonstrate Australian technical leadership.	Medium-term
Define standards for safe and sustainable sampling of waste materials	Cross-industry group convened by peak standards and professional bodies, with input from industry, science and government organisations.	Waste materials processing standards to support Australia's technical leadership position.	Medium-term
Higher research investment in mine waste tailings.	Universities and industry-aligned research organisations including Cooperative Research Centres.	University and industry investments in new extraction technology demonstration plants.	Long-term
Develop new Australian waste extraction technologies and capabilities	Industry and academia		Long-term

Focus area 3: Downstream processing and byproduct recovery

Opportunity	Lead	Breakthrough idea	Timeline
Take a region-first approach to develop common infrastructure and leverage local strengths	State and federal governments, working with industry, university, peak body and community representatives.	Establish regional coordinators with a mandate to coordinate state and federal approvals, facilitate engagement and connect industry, research and other partners.	Medium-term
Invest in education and industry-linked research	Cooperative research centres and industry-funded research centres.	Establish centres of excellence for downstream processing and by-product recovery, based on existing and planned industrial ecosystems.	Medium-term
Develop new by-product recovery capability and processing pathways	Industry and academia	Science agencies (CSIRO, ANSTO and Geoscience Australia) build on research methodologies established under the Hub to develop processing pathways needed to extract by-products.	Medium-term