BUSINESS SWEDEN
THE SWEDISH TRADE & INVEST COUNCIL

EXECUTIVE GLOBAL INSIGHT
APRIL 2024

REINVENTING THE FUTURE OF MINING

A global overview and mapping of the innovation landscape in mining

EXECUTIVE SUMMARY

OPPORTUNITY AWAITS IN MAJOR MINING MARKETS

MOMENTUOUS CHANGE GETS UNDERWAY

The global mining sector's optimism is at an all-time high, with growing recognition of its importance and societal impact. Despite challenges, the market continues to grow steadily.

The focus is shifting towards critical raw materials due to the increasing demand for energy transition technologies, set to triple by 2030. While Asia leads in production, Latin America and Asia have the largest reserves. This demand will elevate regions with significant reserves to production leadership.

Geopolitics significantly influence the industry, with over 75% of minerals produced in countries deemed unstable in 2021 according to World Mining Data. This highlights the need for stable countries with significant reserves, fostering resource nationalism and strategic alliances. Major markets are prioritising critical raw materials through strategies, policies, and partnerships with sustainability at the top of the agenda.

Global mining giants are investing in automation, digitalisation, and electrification to meet greenhouse gas (GHG) reduction goals and enhance efficiency, safety, and sustainability. Mine operators, under pressure from the green transition, seek innovative technology yet to be developed, emphasising the need to harness existing technologies from other sectors and closer collaboration with original equipment manufacturers (OEMs) and technology providers.

"The mining industry can become part of the solution. Instead of being perceived as part of the problem, more metals, more electric vehicles, and more wind turbines will be needed."

Area Manager, Iron ore operations, Kiruna, LKAB, Swedish state-owned mining company

KEY MINING MARKETS FOR SWEDEN

Sweden's mining sector is among the most innovative and sustainability-focused in the world, and companies are likely to thrive in the following foreign markets where there is strong mining activity, a robust innovation landscape and clear prioritisation of the shift to sustainable practices.

Canada leads in global innovation and sustainability, producing over 60 minerals and metals. With a focus on increasing critical material production, Canada's reliance on innovation creates opportunities for Swedish solutions.

The United States (US), a significant gold and copper producer, with plans for 40 critical materials operations to secure the domestic critical raw materials supply chain. Due to the outsourcing of research and development (R&D), the Swedish industry can leverage partnerships with US players for joint R&D efforts and demonstration projects.

Chile is the top copper producer and also has the largest lithium reserves globally, aims to become a major critical raw materials producer. With sustainability goals set by the mining sector, Chile presents opportunities for Swedish companies as key partners in the pursuit of decarbonisation.

Brazil, an emerging market for critical raw materials, ranks third globally in rare-earth elements reserves and is a major iron ore producer. The growth of underground mining in Brazil presents opportunities for Swedish mining suppliers.

South Africa, a major gold and platinum group metals producer, faces challenges from aging mines and increased mining depths. With a focus on environment, social and governance (ESG) and sustainability, South Africa seeks collaboration with Sweden for innovative digital platforms.

Australia, a leader in mining automation and innovation, is poised to expand its role in critical raw materials production as the world's top lithium producer, offering opportunities for Swedish OEMs to contribute to its evolving mining industry.

KEY TERMS AND DEFINITIONS

In the context of this report, the following terminology and key terms are defined as outlined unless otherwise specified in the text

MINERAL GROUPS	
Critical raw materials	Refers to those materials deemed critical based on economic, strategic, and resource supply/demand factors. Regions and countries have developed unique critical material lists, though globally this typically includes materials vital to the energy transition, such as: lithium, cobalt, nickel, manganese, copper, rare earth elements (REE), and graphite.
Non-fuel minerals	Includes metals (e.g., gold, silver, copper, tin, lead, zinc, iron, nickel, chromium, aluminium), metal alloys, and non-metals (e.g., sand, gravel, gypsum, halite, uranium, dimension stone).
Fuel minerals	Includes coal, uranium, oil/ petroleum, and natural gas.
Iron and ferro-alloy metals	Includes Iron Ore, Cobalt, Manganese, Molybdenum, and Nickel.
Non-ferrous metals	Includes Bauxite, Copper, Lithium, REE, and Zinc.
Precious metals	Includes Gold, Platinum, Palladium, and Silver.
Industrial minerals	Includes Diamonds (gems/ industrial), Graphite and Potash.

KEY TAKEAWAYS

- The global mining market shows no signs of declining, forecasted to reach USD 2,775 billion in 2027 driven by vast long-term demand.
- Sustainability is top of mind amidst rising impacts of climate change and resource scarcity – mining companies are under pressure to mine quickly yet sustainably.
- All eyes – and investments – are focused on critical raw materials as the energy transition generates exponential demand for the minerals integral to key technologies.
- Global labour shortages and demand for increased mining productivity drive rising innovation and adoption of mine automation and electrification solutions.
- Recent supply chain challenges, geopolitical tensions and power rivalries have highlighted the risks of the current distribution of global mineral production, leading to a rise in resource nationalism, but also to friendshoring with new partnerships and alliances.
- The potential is rising for Swedish solutions in six key markets to meet demand for efficiency, sustainability, technology innovation and sourcing of critical raw materials.
- Investments in mining projects have recently seen an upswing globally and OEMs are emerging as mining owners. Automotive OEMs are increasingly entering long-term supply agreements or partially acquiring mines to secure supply chain needs.
- Australia and Canada stand out for opportunities in innovation and sustainability, Australia and Chile for critical raw materials, while Brazil, the US and South Africa offer strong growth potential in high reserve volumes.

Executive Global Insight is published by Business Sweden to give Swedish business leaders a regular deep-dive into the most important trends in cross-border trade. The report series helps decision-makers break down risks and opportunities and provides actionable insights, drawn from the knowledge and expertise of Business Sweden's global advisors based in more than 40 markets.

SWEDEN IS SET TO DRIVE GLOBAL GREEN INITIATIVES

EUROPE'S LEADING MINING NATION

Mining in Sweden has long traditions, and the industry holds a pivotal position in the country's economy. With a history spanning over a thousand years, mining has been a cornerstone of Sweden's prosperity contributing to economic growth, a well-developed road network and extensive mining expertise.

Sweden is one of Europe's leading mining nations and the continent's primary ore and metal producer. It is home to 12 highly productive metal mines accounting for 93% of the iron ore production in the European Union (EU). Additionally, Sweden produces 9% of the copper and 24–39% of the continents' zinc, lead, silver, and gold.

The Swedish mining ecosystem is characterised by its unique collaboration between government, academia, and industry to co-develop cutting-edge technologies essential for mining at great depths while ensuring the future sustainability of mining operations. Sweden is among the markets at the forefront of sustainable mining practices, minimising environmental impact along the value chain, and driving the development of mining technology. Mine operators in Sweden serve as testbeds or partners in this ongoing development. The country is home to global leaders in mining equipment such as Sandvik, Epiroc, and ABB, renowned as the world's largest providers. Additionally, it offers cutting-edge solutions for the global mining industry through many small-medium-enterprises (SMEs) like RockSigma, GreenIron H2 AB, and Flasheye.

The growing importance and global demand for minerals and metals, driven by the green transition and the global strategies to achieve self-sufficiency, further highlight the pivotal role of mining. Sweden and the Swedish Government continues to prioritise this sector, by recognising its significance in contributing to a cleaner, greener, and more sustainable future globally. To achieve this, Sweden needs to expedite permitting processes. The country's leading positioning in sustainable mining and the recent discovery of the largest known deposit of rare earth metals in Europe may not only strengthen the industrial value chains in Europe but also holds the potential to supply responsibly mined raw materials and encourage sustainable mining practices globally. Consequently, as the adoption of clean technologies continues to grow, mining is expected to thrive globally to meet these evolving needs.

INTERNATIONALISATION REMAINS A PRIORITY FOR SWEDEN

The Strategic Innovation Program Swedish Mining Innovation (SMI) is part of a joint investment in strategic innovation areas (SIP) by the Swedish Agency for Innovation Systems (Vinnova), the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas) and the Swedish Energy Agency. The aim of SMI is to strengthen the competitiveness of the Swedish mining and metal extraction industry.

SMI is a member of the Team Sweden Mining group led by Business Sweden, along with eleven other members.* Team Sweden Mining is coordinating international mining activities and efforts to promote Sweden as a leading mining nation and to facilitate the internationalisation of Swedish companies and organisations.

In collaboration with SMI, Business Sweden has conducted a study to build an understanding of the global mining market, its challenges, and opportunities including an in-depth analysis of key mining markets such as Canada, the US, Brazil, Chile, South Africa, and Australia.

This report reflects the industry's commitment to sustainability and innovation in response to evolving demands for responsibly sourced raw materials. The aim is to outline trends, challenges, key implications and opportunities for Sweden and Swedish companies as well as provide input for Team Sweden to support in prioritising future mining internationalisation efforts.

* Members of Team Sweden Mining: Geological Survey of Sweden (SGU), the Swedish Association of Mines, Mineral and Metal Producers (Svemin), Government Offices of Sweden, the Swedish Export Credit Agency (EKN), Sweden's Development Finance Institution (Swedfund), Vinnova, International Council of Swedish Industry (NIR), Environmental Protection Agency, Luleå University of Technology (LTU), Swedish Export Credit Corporation (SEK), and the Swedish International Development Cooperation Agency (Sida).

PAVING THE WAY FOR A GREENER FUTURE

A POSITIVE TRAJECTORY IN THE GLOBAL MINING MARKET

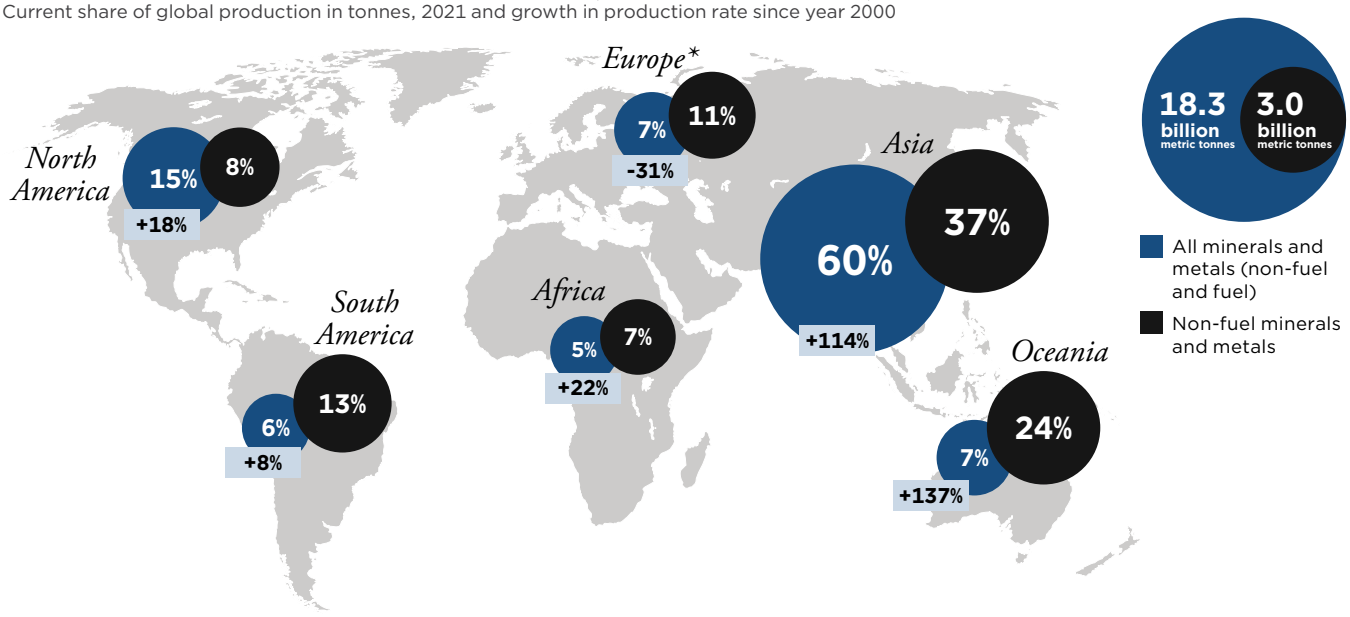
The global mining market is continuously growing and reached a value of USD 2,145 billion in 2023. Despite the COVID-19 pandemic and geopolitical turbulence, the global mining market shows no signs of decline. On the contrary, the global mining market is expected to grow at a CAGR of 6.7%, reaching USD 2,775 billion in 2027, primarily due to the vast long-term demand. [1]

Total global mining production amounted to approx 18 billion tonnes in 2021, of which 3 billion tonnes were non-fuel minerals[2]. At 60%, Asia holds the largest share of total global production of all minerals and metals in 2021, followed by North America at 15%. China and the US are key markets in terms of overall mining output. Over the last few decades (2000–2021), production rates have increased across all regions, apart from Europe[3] (-31%) and is expected to continue to rise to meet the exponential demands of modern – and future – society.

Global output remains dominated by fuel minerals with coal as the largest revenue contributor. In 2021, Asia, Oceania, and South America dominated global production of non-fuel minerals with a market share of 37%, 24% and 13% respectively. [4] Australia, China, and Brazil are key non-fuel output markets, while China dominates output primarily consisting of fuel minerals.

China (17%), US (13%) and Russia (10%) lead in global share of production value (USD). [5] While fuel minerals continue to dominate production value globally, South Africa and Australia are exceptions, with their production value stemming primarily from iron and ferro-alloy metals.

PRODUCTION OF ALL MINERALS AND METALS (NON FUEL AND FUEL)
Current share of global production in tonnes, 2021 and growth in production rate since year 2000

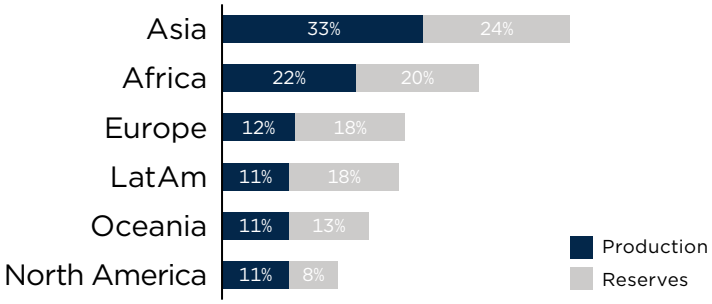


* Note that Europe includes Russia

Source: World Mining Data 2023, PWC Report 2023

[1] Business Research Company
[2] World Mining Data 2023
[3] Europe statistics include Russia
[4] Ibid
[5] Ibid

SHARE OF PRODUCTION AND RESERVE VOLUMES FOR ALL SELECTED MINERAL GROUPS
By total share in %, by world region



Source: Statista 2022, Euromonitor

Global coal production is expected remain stagnant at a 0.7% CAGR to 2030, as demand decreases in response to expanding renewable energy capacities.[6] As western nations scale clean energy infrastructure, Asia's share of coal demand is growing, now outpacing the US and the EU for the first time. A significant driver of Asia's growth is expected to come from India, whose coal production is forecasted to grow at 4.9% CAGR by 2030.[7]

PRODUCTION VS. RESERVES

Production of key metal and non-metal minerals is geographically dispersed, with Asia[8] and Africa accounting for the largest shares of leading selected mineral groups: iron and ferro-alloy metals, non-ferrous metals, precious metals, industrial minerals, and mineral fuels. Africa leads in output of iron and ferro-alloy metals and precious metals, with significant output from Democratic Republic of Congo (DR Congo) in cobalt, and South Africa in manganese, platinum, and palladium. Asia dominates production of non-ferrous metals, industrial minerals, and mineral fuels, primarily attributed to China's output in rare earth minerals, zinc, graphite, and coal, along with the Middle Eastern countries' share of oil output.

While mineral reserves are vast across the globe, the complete volumes of specific reserves remain unknown. Amongst known mineral reserves, Asia and Africa remain leading regions overall, and for precious metal and mineral fuel reserves. However, from this lens, Oceania, Latin America[9], and Europe emerge as more prominent regions, with Australia topping volumes of key iron and ferro-alloy metals, Chile and Peru with non-ferrous metals, and Russia with industrial fuels.

The shift of leading markets between production and reserves, particularly for critical raw materials, draws a map of the likely future dynamics of the industry as countries with high reserves are tapped to mitigate supply risks.

CRITICAL RAW MATERIALS IN HIGH DEMAND

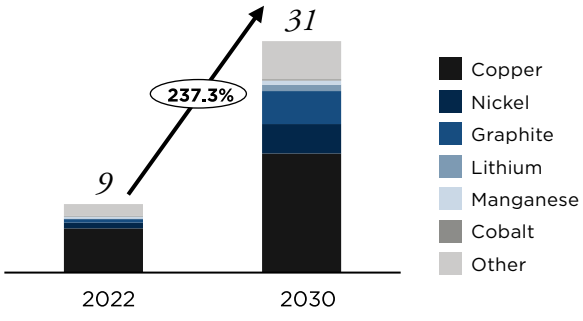
All eyes are on critical raw materials in the global mining industry. Growing demand for energy transition technologies is expected to create mirrored demand for the materials critical to their development. Materials identified as critical vary by country, depending on economic, strategic, and resource supply related factors – cobalt, nickel, manganese, copper, lithium, graphite, and rare earth elements (REE) are among those most consistently prioritised globally.

Demand for critical raw materials is forecasted to more than triple by 2030 to reach net-zero emission goals and grow substantially over the next three decades, estimated to reach USD 400 billion by 2050.[10] As it stands, current production levels of critical raw materials will not be sufficient to satisfy exponential demand of a net-zero society by 2050 – with an increase in production of between 93% (copper) to 910% (lithium) required to achieve objectives.[11] As technological innovation continues, the materials deemed critical may shift in response to new developments, leading to further uncertainty around the demand for production levels. For example, overproduction of certain materials is also a possible outcome.

"For the first time, we are openly discussing how to exclude certain markets."

Svemin, The Swedish Association of Mines, Mineral and Metal producers

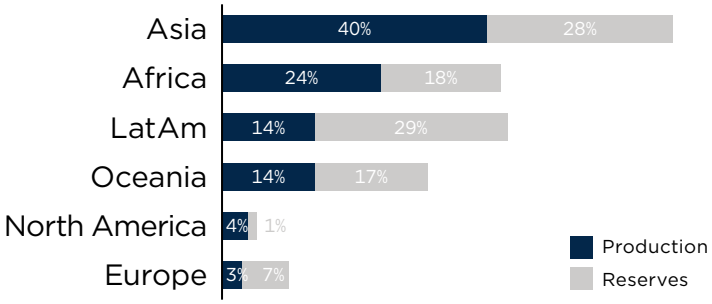
DEMAND FOR CRITICAL MATERIALS 2022 AND 2030
By critical material, million tonnes



Source: International Energy Agency

[6] GlobalData; International Energy Agency
[7] Ibid
[8] Asia includes East Asia, the Middle East and Türkiye
[9] Latin America includes Mexico (excluded from NA)
[10] International Energy Agency 2023, Statista 2022
[11] Ibid

SHARE OF PRODUCTION AND RESERVE VOLUMES FOR ALL SELECTED CRITICAL MATERIALS
By total share in %, by world region



Source: Statista 2022, Euromonitor

Currently, Asia produces the largest share of critical raw materials globally, while Latin America narrowly leads alongside Asia by share of known reserves. Chile, Indonesia, and DR Congo emerge as top markets to consider in critical raw materials production alongside consistent leaders Australia, China, and South Africa.

Recent challenges with global supply chains, exacerbated by the COVID-19 pandemic and further complicated by the Russia-Ukraine war, have highlighted the risks of the current distribution of mineral production and encouraged nations to act swiftly to ensure sufficient supply.

GEOPOLITICAL LANDSCAPE

Given the concentration of resources, commodity prices and regulatory processes, access to materials is facilitated – or blocked – by the state of international relations. Political tensions and major power rivalries impact markets' ability to ensure supply of critical raw materials.

In 2021, over 75% of global materials were produced in countries deemed unstable or extremely unstable.[12] Critical raw materials are at risk with most cobalt, manganese, nickel, and REE supply originating from politically unstable countries as well as at least half of copper and graphite supply. This will bring into focus the more stable countries with significant reserves of critical raw materials and encourage mining nations to make new friends – fast.

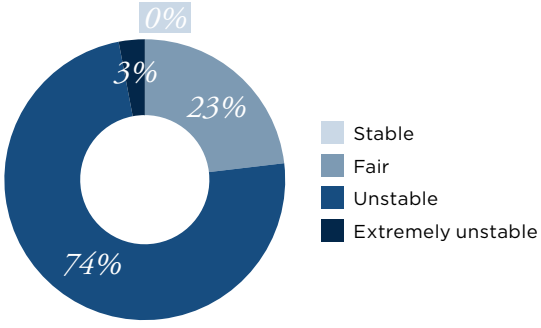
FRIENDSHORING AND RESOURCE HOTSPOTS

A key priority of global mining markets is to ensure domestic security of supply to meet anticipated demand – leading to a rise in resource nationalism and friendshoring. In response to the geopolitical landscape, leading markets are increasingly implementing strategies, policies and partnerships focused on critical raw materials. At the forefront of this push are the EU, Canada, the US, and Australia, each of which have launched national critical raw materials strategies and incentives (e.g., *EU Critical Raw Materials Act, US Inflation Reduction Act, Canada's Critical Minerals Tax Credit*) and agreements with other key mining countries to strengthen supply chains. This includes the recently launched Minerals Security Partnership (MSP) lead by the US, and Sustainable Critical Minerals Alliance, which span multiple regions, as well as bilateral agreements between specific nations, such as the US – Japan Agreement on Strengthening Critical Minerals Supply Chain and the Australia – India Critical Minerals Investment Partnership.

For Europe specifically, the Critical Raw Materials Act aims to review how Europe supplies raw materials and how to strengthen Europe's position with a strong emphasis on efficient permitting processes.

Many countries are dependent on a select few countries for many materials – Europe sources over 70% of nine critical raw materials from five supplying countries, while for example, the US is 100% dependant on imports for 12 of their identified critical raw materials, and 50% reliant for another 31.[13] Most major economies are dependent on a significant share of critical material imports from China, DR Congo, and Chile.

GLOBAL PRODUCTION BY POLITICAL STABILITY OF COUNTRIES
By production volume (thousand tonnes)



Source: World Mining Data 2023

"The Critical Raw Materials Act signals that the EU is open for business."

The Geological Survey of Sweden

[12] World Mining Data 2023
[13] European Council of the EU 2023, US National Mining Association

Countries globally are strategically positioning themselves for success within the critical raw materials supply chain. While some countries focus on building alliances (primarily consumer nations) many supply countries are endeavouring to facilitate growth of domestic capabilities – Indonesia has banned the export of raw nickel, and Namibia of raw lithium.

RAMPING UP INVESTMENTS

Investments in mining projects are growing globally with a 52% increase since 2020.[14] Exploration activities and spending for non-ferrous minerals has increased (USD 2.6 billion in 2023) with Canada (21%) and Australia (18%) accounting for the largest share of global investments, driven by significant growth in lithium exploration, copper and nickel.[15] Exploration spending is also rising in Brazil and Africa led by a growing focus on critical raw materials, while it has decreased in Russia and China due to international sanctions and pandemic restrictions.

While volume of mining M&A deals globally has declined, the value of deals has risen – and focus has shifted towards early-stage projects. Consolidation of the mining industry is forecasted to continue as companies reposition commodity portfolios to address evolving demands for critical raw materials and replenish reserves – though the complex regulatory, geopolitical landscape and general price inflation is likely to slow down deal-making.

Automotive OEMs are increasingly entering long-term supply agreements or partially acquiring mines to secure supply chain needs. In 2022, the Vale and General Motors Long-Term Nickel Supply Agreement was signed in Canada. This trend creates a risk that less raw material will be available on the open market as significant quantities of mine output are likely to be pre-allocated to these OEMs.

MINING 4.0 ON THE HORIZON

While adoption of innovative technologies may be less rapid in the mining industry than others, integration of advanced solutions is rising signalling that mining is diversifying. Driven by emission reduction targets, efficiency optimisation and safety, global mining giants are investing in mine automation, digitalisation, and electrification to maintain focus on security, sustainability, and productivity.

Significant investments are also being directed towards sustainable mining technologies, primarily led by OEMs. To keep pace with emerging technologies, it's crucial that policies evolve alongside advances to avoid reliance on outdated technologies.

Australia is at the forefront of automation in the mining sector due to its focus on productivity driven by the high cost of mining operations. Canada has made sustainability a primary focus, and is second globally in automated vehicle deployment and the global leader in mine electrification with 40% share of electrified truck fleets.[16]

Other innovation trends include employing smart sensing tech in exploration studies (e.g. BHP), development of green explosives aimed at reducing emissions, and beneficiation and valorisation of lower-grade raw materials (e.g. Shougang Mining Company). Increased innovation involves substantial challenges in ensuring recruitment, retention, and training of qualified skilled labour. Mine operators, pressured by the green transition, require innovative technology that has yet to be developed. Greater collaboration with equipment manufacturers and technology developers is required to bridge this gap, as well as to harness existing technologies outside of mining.

Smaller mine operators tend to be more forward-leaning when it comes to proactively engaging in innovation projects. Conversely, large mine operators often prioritise their core business and focus on production and profitability, while running more slow-phased development programmes on the side. Canada and Australia are exceptions to the rule. In these markets, large mining houses boast substantial innovation departments.

ALL EYES ON SUSTAINABILITY

The mining industry finds itself in the challenging position of being both a facilitator and a barrier in the green transition. Critical raw materials are imperative to achieve green transition goals – but current critical material mining techniques are often unsustainable. A key challenge for the global mining industry will be value chain transparency and the ability to increase production without compromising sustainability.

The tone and consensus of the mining sector is more positive than ever before, as global perception of its importance and societal impact improves. Alongside this positivity comes increased responsibility, particularly in communication efforts aimed at fostering understanding and trust within the communities where mining operations are located.

MARKETS TO WATCH FOR SWEDISH COMPANIES

As one of the world's most innovative and sustainability-focused mining sectors, Swedish companies across the value chain are likely to thrive in foreign markets where there is strong mining activity, a robust innovation landscape, clear prioritisation of sustainable mining and contribution to the green transition.

In alignment with this criteria, six markets across the globe stand out as high-potential mining markets for Swedish companies: *Brazil, Canada, Chile, the US, Australia and South Africa*.

Each market presents unique opportunities and challenges for Swedish companies to leverage and navigate.

"More investments will go into existing mines – it's a shortcut to recover more minerals."

Luleå University of Technology, Swedish School of Mines

[14] GlobalData Mining Intelligence Centre
[15] International Energy Agency 2023
[16] GlobalData Mining Intelligence Centre

MARKET OUTLOOK: CANADA

TAKING INNOVATION TO THE NEXT LEVEL

MARKET OVERVIEW

Canada is the 2nd largest nation in the world by land mass, spanning from the Atlantic to the Pacific Ocean and Arctic Sea, and is home to diverse landscapes, resources, skills and opportunities. Canada produces 60+ materials and metals at 198 underground and mining sites across the North American continent.[22]

As the world leader in potash production and ranking among the top five global producers of diamonds, gold, platinum, titanium and uranium, mining is among Canada's oldest and most important industries.

Canada is a preferred location for mining companies due to its transparent and fair legal and political system, well-developed expertise, and talent pool. For decades, the Toronto Stock Exchange's Venture arm, a public venture capital marketplace for emerging companies, was known for junior funding opportunities.

Canada's political system grants significant autonomy to local governments including indigenous groups holding specific land and resource rights. This decentralisation allows companies to use multiple mining incentives, e.g, federal Mineral Exploration Tax Credit, and the provincial Ontario Junior Exploration Program.

Government policies generally support mining but demand high environmental, social, and governance standards which can create extensive (and growing) approval processes and require communication with various government agencies.

Despite a long-standing mining tradition, the industry faces challenges. Canada's north, home to vast unexplored landscapes, lacks infrastructure and homes a smaller population than southern Canada requiring fly-in fly-out employment and less choice in service providers.

In recent decades, Canadian mining companies have been purchased by and absorbed into

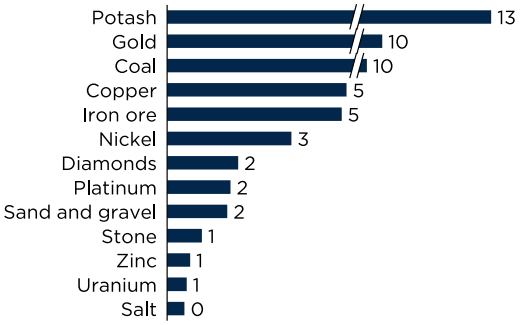
MAJOR PLAYERS IN CANADIAN MINING

NAME	MATERIALS MINED[23]
Glencore	copper, coal, nickel, zinc
Vale	nickel, copper, cobalt, PGM, gold, silver
Agnico Eagle	gold
Nutrien	potash
Rio Tinto	aluminium, titanium dioxide, diamonds, iron
Newmont	gold
Teck Resources	zinc, copper, coal

[22] Natural Resources Canada, 2023
[23] Company websites

LEADING MINERALS BY PRODUCTION VALUE IN 2022

USD, billion



Source: Natural Resources Canada

larger networks of international mining conglomerates. Industry experts note that this has prompted a 'branch plant' mentality in Canadian companies, which may put less emphasis on Canadian-specific innovation and process development. Companies remaining Canadian-owned are expected to consolidate in coming decades and therefore grow. Other trends include a rising interest in:

- *Precious metal mining, specifically in exploration*
- *Tailings management and waste valorisation, including novel biotechnology and bioremediation strategies*
- *Zero-carbon or carbon neutral materials, processes, and products*

INNOVATION LANDSCAPE AND ECOSYSTEM

Canada's business culture is often risk averse, reflected in a mining industry well-known for its conservatism. Consequently, mining projects ranging from geoscience to processing may not employ recent technological advances. An industry expert noted that during high commodity prices, Canadian mines focused on tonnage extraction, rather than innovation. The "If it isn't broken – don't fix it!"-mentality is common.

Previously, companies retained competitive relationships and were unlikely to collaborate, but formalised innovation initiatives have recently become more common. In the last 20 years, innovation initiatives including the Centre for Excellence in Mining Innovation (CEMI) and ReThink Mining / Canada Mining Innovation Council (CMIC) were established.

The innovation ecosystem that has emerged in recent decades tends to favour outsourcing, with companies focused on purchasing – rather than developing – innovative technologies. Given the diversity of mine sites and minerals, interest in site-agnostic and industry-agnostic products is growing. Investors are currently more incentivised to fund startups as this system presents a natural path to a return on investment.

Canadian startups are generally young companies, well-funded (due to government policies specifically supporting small and medium sized enterprises) and focused on large-scale technology development.

Exploration has historically been the focus of mining innovation in Canada. The country remains one of the most attractive exploration markets worldwide. Emerging Canadian startups like Novamera create opportunities to explore and extract with higher efficiency. Collaboration between Canadian and Swedish organisations in exploration is common, with Canadian companies such as Lundin owning mine sites in Sweden and vice versa. Canadian and Swedish researchers often collaborate or partner in Arctic, deep and high-stress mining initiatives such as MinErAl at Laval University.

Exploration and geology are prioritised in academic research. At Laurentian University, the Mineral Exploration Research Centre (MERC) is dedicated entirely to geoscience research. MERC, located in Sudbury Ontario, is considered the heart of Canadian mining with vast mineral deposits, an extensive mining suppliers' network, several operating mine sites (by KGHM, Glencore etc.), and test mine operated by startup incubator NORCAT (co-owned by mining giant Vale).

Given declining ore grades and the increasing age and depth of mines, technologies increasing and improving ore mined are becoming attractive to companies looking for a competitive edge. In response, novel transport (e.g. RIINO) and processing systems (e.g. MineSense) were developed by Canadian startups.

Canada is currently a world leader in mine electrification, with flagship mines such as Borden Gold and Onaping Depth mines partially or fully electrified due to stricter environmental regulations and requirements of deeper mining. Further digitalisation of mining, including telecommunications improvements for automation and remote mining are expected.

Mining companies funding startups or adopting their technology typically have access to significant capital and capacity to integrate new technologies. Certain mining companies, like Vale and BHP, are creating accelerators and venture funding arms for startups.

"Canada has an adoption and integration – not an innovation – problem. Companies that can come and prove that they are suitable for the Canadian environment will win."

Mining Industry Expert

Given commodity price fluctuations, a changing landscape for fuel products and social attitudes, Canadian mining is looking to reposition itself as a leader in the green transition. This includes a focus on critical raw materials and other green technologies.

ACADEMIC, GOVERNMENT AND RESEARCH LANDSCAPE

Canada's academic emphasis on energy, waste, tailings, water, and resource management supports the mining industry in achieving environmental goals.

Industry collaboration with academia including research projects at university facilities is encouraged via financial incentives and a well-developed educational system.

Companies may also work with educational institutions to develop programmes meeting industry demands. The Battery Electric Vehicle technician course at Cambrian College is just one example. Canadian government policy incentivises innovation via research grants and programmes, tax credits (including those available to multinational players, such as scientific research and development incentives) high-quality data availability, a mining-positive environment across the political spectrum and R&D support at government-owned facilities such as CanMet.

OPPORTUNITIES FOR SWEDISH COMPANIES

A small community of professionals, a healthy ecosystem of trade shows, events and sense of community characterises the Canadian mining environment. A product successfully adapted in a local context can be easily disseminated via word-of-mouth and employee knowledge transfer.

Companies looking to enter Canada may benefit from accepting less favourable terms to encourage initial adoption – e.g., technology pilots at no cost. Both relationship-building and negotiation skills are necessary for Canadian market penetration.

The need for innovation within Canadian mining is critical. The evolving social landscape and shifting priorities encourage domestic mining companies to increasingly explore novel mining technologies, opening the door for innovative Swedish solutions.

GYPSUM MINING, CANADA

MARKET OUTLOOK: USA

ENTERING THE ERA OF REINVENTION

MARKET OVERVIEW

The United States is a globally recognised economic powerhouse with 331 million people and a total GDP of USD 25.5 trillion, a significant lead compared to the EU's 448 million people and USD 16.6 trillion GDP. While mining only accounts for 2% of US GDP, the importance of this USD 109.2 billion sector cannot be overlooked. [29]

Despite its position as the world's leading economy, the US has faced challenges remaining competitive, especially in hard-to-abate sectors such as mining and heavy industrial manufacturing. The historic impact of globalisation on the outsourcing of skilled labour, and China's rise as a major competitor, prompted a reevaluation of complex supply chains and their inherent inefficiencies. Further exacerbated by the pandemic, the growing public concerns around environmental and social factors highlighted the drawbacks of complex supply chains – particularly the impact on economies lacking strong heavy industrial sectors. Longer lead times on orders, increased prices, and heightened social unrest marked a turning point for the US.

The economic approach under the Biden administration, "Bidenomics" continues the trend of reevaluating the US economy's interdependence, with a focus on implementing policies that boost domestic growth and reduce depencies on China. While these initiatives are sometimes perceived as an "America-first" stance, the objective is primarily to recalibrate relationships rather than achieving full independence.

The US has mineral reserves worth an estimated USD 6 trillion, but the country imported USD 6 billion of minerals from foreign countries in 2023. [30] Additionally, the US is a major producer of copper and gold, which account for a combined 61% of the US metallic minerals production value. The US is

MAJOR PLAYERS IN THE US

NAME	MATERIALS MINED
Freeport McMoRan	Copper, gold, molybdenum
Cleveland Cliffs	Iron ore
Grupo Mexico/ Asarco	Copper
Hecla	Silver
Albemarle	Lithium
Newmont	Gold, copper, silver, zinc, lead

Statista "Leading US Mining Companies based on revenue 2023". Albemarle added as a leading critical mineral operator.

[29] Federal Reserve Economic Data (FRED)
[30] National Mining Association, "2023 Mining Facts"

"In the US, the private sector sees university research as a product rather than an ongoing process. Consequently, mining companies rarely invest in long-term collaborations with academia. They only engage in small-scale partnerships to address immediate issues, leading to confusion within firms about the mismatch between academic education and industry needs."

Professor of Mining Engineering, Colorado School of Mines

ranked 5th globally in copper production.[31] With almost 50% of this domestic copper going to the construction industry, and Center for Strategic and International Studies (CSIS) projecting a 1,000% increase in demand for future energy tech, there is a concern that domestic supply may be insufficient for cleantech industries.

The US is reliant on imports for critical raw materials, including graphite, cobalt, manganese, nickel, and other rare earth metals (all 50% or more imports). In the pursuit of accelerating the green transition, one thing is clear – the US cannot stand alone.

This realisation prompted the US to establish and participate in multi-national initiatives such as the *Minerals Security Partnership (MSP)* and the *Sustainable Critical Minerals Alliance*, while pursuing bi-lateral agreements with 'friendly' countries to secure the critical raw materials supply chain, including Japan, Australia, and Canada.

Landmark domestic legislation such as the Inflation Reduction Act (IRA), the Bipartisan Infrastructure Law (BIL), and the CHIPS & Science Act all have an underlying theme of onshoring and "friendshoring" critical raw materials supply, with the recently adopted Fixing America's Surface Transportation (FAST-41) act aiming to streamline permitting. However, there has been notable criticism that the US lacks an adequately detailed strategy for ramping up critical raw materials production, especially compared to Canada's strategic outline.

PRODUCTION HUBS

The Appalachian states (West Virginia, Pennsylvania, and Kentucky) are the major coal producers and subsequently the primary recipients of abandoned mine reclamation grants.

For non-metal minerals, a similar trend can be seen in the Great Lakes region (Wisconsin, Michigan, Ohio, Pennsylvania, Indiana, Illinois) with a second smaller cluster in the southeast (North Carolina, Georgia, Florida, Alabama, Tennessee).

Metal mines are concentrated in the west (Nevada, Utah, Arizona, Colorado, and California), and the US expects 40 upcoming critical material operations including mines, extraction, and refinery facilities primarily in those western states and surprisingly, the southeast (North Carolina, South Carolina, Georgia, Alabama), that expect to be operational by 2026.

Additionally, some noted general trends observed in the US mining sector involve a delayed adoption of autonomous machinery, heightened investor emphasis on reducing emissions beyond regulatory requirements, and an upswing in the production of metallic minerals compared to pre-COVID levels.

INNOVATION LANDSCAPE AND ECOSYSTEM

To those unfamiliar with the US mining sector, it is likely surprising to note that the country is not at the forefront of mining innovation. However, with a history of outsourcing heavy industry processes, the US mining sector is looking to make up for lost time.

Large-scale mine operators in the US have distanced themselves from the innovation process, prioritising production output and the bottom line. These mine operators frequently offload R&D responsibilities onto OEMs and technology providers, perceiving R&D as a product rather than a dynamic collaborative process.

Newmont is a notable exception, openly disclosing significant R&D investments in financial reporting. Newmont's transparency and ESG proactivity is further demonstrated in recently announced USD 4.38 million project collaboration with the National Renewable Energy Lab in 2023, focused on carbon capture, utilisation, and sequestration solutions from waste rock and tailings.

On the other end of the private sector spectrum, startups struggle with a challenging landscape for technology solutions. The absence of mining-focused accelerator programmes leaves innovators to navigate the path alone. Faced with the uphill task of proving their technology's prowess to operators, startups often require demonstrations and joint R&D partners to fine-tune their solutions.

While there are certain platforms such as The Society for Mining, Metallurgy, and Exploration's *The MINEXCHANGE Annual Conference & Expo* that bring US players together for networking, US operators and OEMs won't necessarily engage in dialogues beyond standard sales tactics or entertain cutting-edge solutions.

Across the industry, stakeholders face challenges with a shortage of talent to fill corporate, engineering, and skilled labour roles. While there are collaboration initiatives from academia, they are often addressing niche, company-specific problems.

[31] USGS Mineral Commodities Summary 2023

These universities stand at the centre of upskilling the mining industry, often hosting training programmes, conferences, and integrated research projects that try to bridge the gap between industry and the incoming workforce. However, with a lack of industry-consortium driven projects and initiatives, the gap between what the companies need and what academia can provide is likely to persist.

It should be noted that there are certain schools that are at the epicentre of innovation. The Colorado School of Mines Earth Mechanics Institute, for example, works directly with industry to solve current issues that are pragmatic and immediate. This is a fantastic opportunity on its own, however, with industry consortiums and support, these programmes can help drive innovation towards larger-scale strategic industry issues.

To address the workforce shortage, a global industry issue, the Mining Safety and Health Administration has been funding mining engineering programs, allocating USD 15 million directly from the federal government in 2023. State governments are obligated to fund the remainder for public institutions to ensure up-to-date curriculums, experienced faculty, and successful job placements.

Hopefully, the new federal bill will be passed that aims to mandate the Department of Energy, now linked to the mining sector, to establish a substantial grant programme for universities, providing crucial funding for mining engineering programmes. In general, the federal scope for involvement in the mining industry is restricted to regulatory guidelines on worker safety, environmental issues and tailings management, and to set the strategic direction for the industry.

Meanwhile, state governments hold more power in implementing strategic initiatives and support for innovation. For example, the Arizona Corporation Commission aims to intertwine their energy and mining ecosystems to promote innovation, while Nevada's economic development programme has set up small business support programmes focused on innovation based economic development (IBED) with mining as a key industry.

In conclusion, the US innovation ecosystem is quite fragmented and short-sighted, with each stakeholder focused on their own areas. As a result, the US continues to rely heavily on foreign companies to bring innovative solutions to the market.

"The opportunities for Swedish companies are strong because we do not count on the US for innovation, but when you can walk into a Scandinavian mine and eat off the ground, that says something."

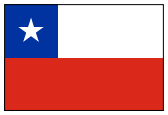
Chief Engineer, Leading US Mining OEM

OPPORTUNITIES FOR SWEDISH COMPANIES

Through roundtables and knowledge-exchanges, Swedish policymakers and academia can lead by example on how to best implement new technologies. Swedish industry stakeholders can partner with startups and build consortiums with US players to engage in joint R&D efforts and demonstration projects especially for underground mining equipment, as there has been emerging projects and need for these solutions.

Sandvik and Epiroc are already leading the way in underground mining autonomy and electrification with Sandvik's Battery Center for Excellence in Camarillo, California, and Epiroc's Regional Application Center in Denver, Colorado. These demonstrate how Sweden is at the forefront of mining innovation in the US and can serve as a blueprint to other Swedish technology specialists on how to position themselves as innovation leaders in the US market. Swedish companies should target western and southeastern states in the US, leading the critical raw materials push by leveraging the Swedish reputation for resilient, sustainable, and innovative solutions.

UTAH, USA



MARKET OUTLOOK: CHILE

LEADING THE WAY IN COPPER AND LITHIUM

MARKET OVERVIEW

Mining stands as one of Chile's primary economic drivers, constituting 10% of employment, 12% of the GDP, and 56% of exports. [24] Presently, Chile leads globally in production of copper – as well as reserves – and is the second-largest producer of lithium and molybdenum, and top producer of iron and silver.

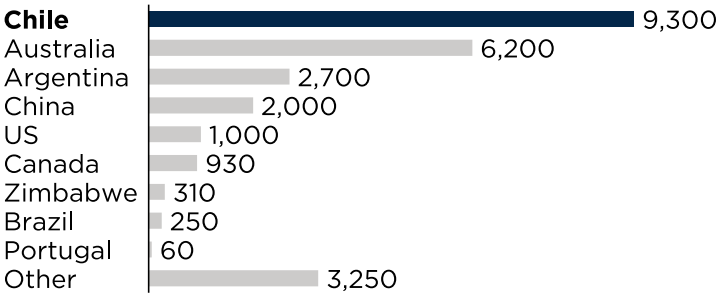
While 80% of copper production in Chile is sourced from open-pit mines, operations are trending towards a shift to underground mining to ensure continued production. For example, Chuquicamata Subterraneo is transforming one of the largest open pit mines into an underground operation, ensuring production for an additional 40 years.

Key players in the Chilean mining sector include Codelco (state-owned), Antofagasta for Minerals, Anglo American, and BHP. Codelco accounts for 27% of the country's copper production. [25] Due to the complex regulatory landscape and limitations of foreign control within the mining sector in Chile, most private companies pursue joint ventures to operate mines. Japanese investment corporations are commonly key stakeholders within these mining joint ventures, given Japan's policy of securing its sourcing of key materials.

In recent years, Chile has emerged as a significant player in the lithium industry, boasting the largest proven reserves. Currently, two private companies, SQM and Albemarle, exploit lithium while Codelco is pursuing a state-led exploitation strategy. Chile aims to position itself as a major producer of several critical raw materials including cobalt, of which Chile has the potential to become a major global producer according to Invest Chile.

[24] Consejo Minero, Mining in numbers 7th edition
[25] Consejo Minero, Mining in numbers 7th edition

IDENTIFIED LITHIUM RESERVES
In thousand tonnes of contained lithium, 2022



POLITICAL LANDSCAPE

Chile maintains a stable geopolitical environment in the region, enhancing its capacity to attract long-term investments. Certain industry stakeholders stress the importance of legal certainty and striking a balance in mining regulations and taxes to sustain a competitive investment landscape. For example, the political uncertainty generated by a 4-year long process to change the constitution to put large investments on hold, and a new bill that increases royalty for copper production is seen as a potential obstacle to increase production within the mining sector.

Despite having decreased since 2012, FDI in Chile's mining sector is now on an upswing. In 2022, FDI reached USD 5 billion, the highest value since 2016[26]. A significant portion of foreign investments are within copper.

Furthermore, with the recent announcement of the National Lithium Strategy, there is growing anticipation for increased investments in the lithium sector. The strategy provides a defined framework for the industry's development. Under this initiative, public-private partnerships are mandated for new projects, requiring the state to hold a majority ownership stake in each project. While this requirement has encountered resistance from stakeholders, a rapid agreement between Codelco and SQM has contributed to a more optimistic outlook.

While Chile remains the largest copper producer in the world by a margin, its output has decreased by 2% over the last 5 years[27]. This is primarily attributed to decreasing ore grade, rising operational cost and challenges – including a diminishing workforce and low productivity. Disruptions in the supply chain, as well as Codelco's falling production (-15% since 2017) are also contributing factors.

The mining sector in Chile is facing major sustainability challenges. Governments, shareholders, and communities alike are increasingly demanding ambitious environmental and decarbonisation targets, as the mining sector's impact is scrutinised. Being a water-intensive industry, the mining sector is further challenged by water scarcity. This lack of access to fresh water is prompting mines to utilise desalinated water, which requires larger investments.

INNOVATION LANDSCAPE AND ECOSYSTEM

Despite its robust mining industry, Chile is a net importer of technology. In the absence of a clear and concise strategy, whether for internal development in collaboration with OEMs or to continue importing from abroad, Chile lacks the coherent state-level approach required to boost local production and R&D.

Currently, Chile has the technical and theoretical knowledge to develop a strong local R&D ecosystem. However, the limitation of incentives and shared strategies hinders collaboration between academia, industry and the government. These stakeholders acknowledge that collaboration is crucial for achieving common goals, but the challenge lies in allocating resources and establishing long-term trust. The transition from collaborative intent to successful implementation remains an obstacle, fuelled by a reluctance to generate formal, structured, and efficient collaborative initiatives without the confidence and support of incentives. Within the mining culture, stakeholders – especially operators – tend to view each other as competitors rather than potential collaborators.

Moreover, although universities such as Advanced Mining Technology Centre (AMTC) are recognised as potential influential players, a significant gap exists between mining companies and academia. While academia tends to focus on slower-paced theoretical research, mining companies prioritise proven solutions for immediate implementation. This often results in a symbolic display of collaboration, given the divergence of the actors' incentives and priorities. The gap between mining entities and academic institutions is widened by misaligned interests, obstacles in information transfer, and funding disparities. Bridging this gap is imperative to fostering synergistic relationships between the mining industry and academia.

In the private sector, startups and scale-ups recognise that despite its many opportunities, Chile's mining sector still faces extensive challenges. Entrepreneurs are faced with a complex market with high investment costs, substantial entry barriers, and limited financing opportunities, along

"Chile is more innovative than we think, but the open innovation process is not as developed to move to the next level. It is necessary to build more trust and be willing to give more and expect less, but with long-term benefits."

Director of Technology Contracts and Partnerships, Codelco Chile

[26] Chile's Central Bank, FDI report
[27] Sernageomin, yearbook 2023

with obstacles in accessing mining operations and an aversion to risk among mining stakeholders. Additionally, the lengthy processes of research, development, and testing required for a solution to be commercially viable further hinder the survival and growth opportunities for startups.

Major mining operators in Chile typically lean towards implementing established solutions that have undergone testing in similar conditions. However, at present, they may not allocate specific areas within their operations for conducting these tests, often relying on solutions that have already been proven abroad. This is a barrier for both small-and-medium-sized enterprises as well as OEMs that are continually developing new products.

OPPORTUNITIES FOR SWEDISH COMPANIES

Chile is a major mining market, offering Swedish companies significant business opportunities, as reflected in an estimated value of USD 20–25 billion in local sales by mining suppliers in 2022.[28]

While the political landscape has been more turbulent than in previous decades, the country has showed resilience and capacity to solve its challenges in a democratic and institutional manner. Additionally, the new government has changed it original discourse and is more willing to promote private investments. In fact, mining investments are on the rise again and substantial CAPEX investment plans by companies like Anglo American, BHP and Lundin Mining suggest that Chile continues to be competitive. These investments are aligned with Chile's leadership in two relevant critical raw materials: copper and lithium. Existing copper supply agreements with countries like China, and lithium supply agreements with international OEMs such as Ford and LG, showcase global interest in Chile's potential as a competitive, democratic, and open strategic partner for critical raw materials.

Sustainability targets outlined by most mining companies offer further opportunity for Swedish companies, which are considered key partners in the race to decarbonise. Companies like Codelco, have made the ambitious commitment to incorporate 100% electric equipment for underground mining by 2030, with concrete steps being taken to achieve objectives.

Digitalisation and automation are two highly relevant trends for Swedish companies within the Chilean mining sector. In fact, Codelco's El Teniente, the largest underground mine in the world, recently purchased major orders from Swedish OEMs Epiroc and Sandvik. These orders included Epiroc's largest ever digital solution package while Sandvik sold a large fleet of automated underground loaders and trucks. Codelco was even an early adopter of autonomous vehicles.

Finally, Chile currently holds a ministerial-level Memorandum of Understanding (MoU) with Sweden, as well as an MoU between Codelco and the Swedish mining cluster through the Swedish Mining Innovation initiative. These agreements demonstrate the willingness of Chile to engage with Sweden and its mining ecosystem. In Chile, Sweden is widely recognised as a role model for modern mining methods and technology development. The Chilean mining ecosystem is perceived to be open for more collaboration and engagement, with significant interest in increased partnerships in R&D and technology development.

[28] Aprimin, Chile Mining Global Business Report 2023

CALAMA, CHILE

MARKET OUTLOOK: BRAZIL

A MAJOR HUB FOR CRITICAL RAW MATERIALS

MARKET OVERVIEW

Mining is a key sector in Brazil, generating USD 50 billion in 2022, accounting for 17% of industrial GDP and 2% of Brazil's total GDP.

Home to close to 9,000 mines, Brazil's mining industry consists of predominantly small-scale and non-metallic (sand and gravel) mines, concentrated in the southern regions of Minas Gerais, Rio Grande do Sul and São Paulo. With up to 500 metallic mines, Brazil produces a diverse range of materials, with iron ore leading at 61%. [17]

The vast majority of metallic mines are open pit and located in southeast region. Over the last five years, the Brazilian mining sector's annual average growth rate has been around 1% in production whilst the financial results have grown around 19% on average, mainly driven by commodity prices. [18]

With its varied geological landscape, Brazil is recognised globally for its extensive mineral potential. The nation boasts substantial reserves of key commodities such as iron ore, gold, nickel, potash, lithium, and niobium.

Brazilian mineral resources are crucial to the global green transition, with vast niobium reserves and growing lithium production in addition to a large current production base.

Given the ongoing green transformation in the global mining sector and rising geopolitical tensions with China, Brazil presents great opportunities considering its abundance of rare earth elements (REE). Brazil holds top production positions for several minerals such as:

1. *Niobium*
2. *Iron ore*
3. *Aluminium*
4. *Lithium*

Further, Brazil is as a major hub for REE exploration and holds the world's third largest REE reserves with 21 million tonnes. [19]

Global mining company and Brazilian born Vale, leads the domestic mining sector, followed by Reunited Brazilian Mining (*Minerações Brasileiras Reunidas*) and the UK's Anglo American.

[17] IBRAM
[18] IBRAM, Ministry of Mines and Energy
[19] IBRAM, InvestingNews

"Safety and risk management is a big challenge in Brazil. Society is changing and the generations XYZ don't want to work in mining."

General Manager, Hexagon Mining Brazil

POLITICAL LANDSCAPE

With federal, state and municipal authorities involved, Brazil's mining regulatory framework is complex. Key federal institutions include the Ministry of Mines and Energy (MME), the National Mining Agency (ANM), the Geological Service of Brazil (CPRM), and the National Mineral Policy Council (CNPM).

The MME considers the mineral sector essential for the growth of the Brazilian economy.

The global energy transition will be advantageous for Brazil, due to the country's critical resources and the large volumes of materials required for the transition to a low-carbon economy.

The main objective for the government is to discover new deposits and increase production, particularly for materials utilised in the energy transition. Several actions are being pursued to achieve this goal, including:

- *Expansion of geological knowledge to attract investments in research for new reserves*
- *Increase in public and private financing for mineral research*
- *Support from the MME for technological development and innovation*
- *Time reduction to obtain mining rights*

However, the general perception of the mining sector in Brazil is a key challenge, contributing to industry difficulties in attracting talent. In particular, illegal gold mining on indigenous lands in the Amazon rainforest poses significant concerns, including water contamination, disease spread among the indigenous population, and deforestation.

Mine waste management is also a key contributor to the less favourable public perception of the industry, following the recent high-profile failures of tailing dams. The Brumadinho incident in 2019, which caused 270 fatalities and the Mariana disaster in 2015, causing 19 fatalities, underscore the need for stricter monitoring of tailings dams and stricter regulations to prevent collapse and flooding. New laws were implemented in response to prohibit upstream dam construction.

The local mining sector also faces significant environmental challenges related to water, air, and noise pollution, as well as mine subsidence (vertical movement of ground).

To strengthen the Brazilian mining industry and its public image, the government's focus for the next coming years includes strengthening institutions, ensuring safety, and promoting socially and environmentally responsible practices among companies.

INNOVATION LANDSCAPE AND ECOSYSTEM

Mining companies are looking to increase efficiency, explore new energy sources, optimise processes, and minimise adverse community impacts through innovation. In response to the growing need for increased innovation, mining companies in Brazil are expected to raise their current average R&D investments from 0.26% to 4% by 2030. [20]

Generally, innovation in Brazil is carried out by mine operators with a focus on local challenges. An exception to this is the Mining Hub, launched in 2019 in Belo Horizonte, which is the world's first open innovation centre for the mining industry. The aim of the Mining Hub is to bring together mine operators, suppliers, start-ups, researchers, investors and other key players to network and develop opportunities and solutions to common challenges in the sector. Currently, 23 mining operators and 25 major mining suppliers are associated members, including Sweden's Lundin Mining, Epiroc and Hexagon.

In addition, the Mining Hub is available to support global mining startups. For example, in 2023, Swedish startup Clearwell qualified for proof-of-concept stage with mine operator Nexa Resources focused on how to sustainably adjust the sulphate concentration in industrial effluents.

Brazilian startups and SMEs also have access to financial support through government programmes such as, PRONAMPE, the National Support Program for Micro and Small Enterprises, and FINEP.

Brazil is also home to leading mining focused universities, including the University of São Paulo (USP) (ranked #30 globally in the 2024 QS Top Universities for mining engineering), focused on sustainability and exploration, as well as the Federal University of Minas Gerais (UFMG), University of Ouro Preto, and the University of Rio Grande do Sul (UFRG).

[20] IBRAM

OPPORTUNITIES FOR SWEDISH COMPANIES

Sweden and Brazil share mutual business opportunities and technological expertise in the mining sector. In October 2016, a Memorandum of Understanding (MoU) was signed between Sweden and Brazil aiming to strengthen cooperation within sustainable mining.

Swedish mining companies in Brazil have joined forces with Business Sweden and the Embassy of Sweden to create a Swedish Mining Alliance with the objective to strengthen the Brazilian mining industry, and to position Sweden and the Swedish Mining Alliance as the point of reference for innovative and holistic mining collaborations in Brazil.

The Swedish mining industry has already established a strong footprint in Brazil with players like Lundin Mining, SSAB, Epiroc, AFRY, Sandvik, Alfa Laval, SKF, Ericsson, Hexagon, ABB, Scania, Volvo Group, Quant, and LOTS.

Swedish mining companies can capitalize on opportunities in mining equipment and specialty mining services, and innovative technology for sustainable waste recycling, dam tailings and monitoring solutions. Additionally, as the underground mining equipment market is in its development phase, Swedish companies are well positioned to leverage an early market entry.

Though the Brazilian mining industry faces public image and environmental challenges, the outlook remains positive with outlined investments for the current planning period 2023–2027 estimated at USD 50.4 billion, an increase of USD 10 billion compared to previous investment cycle 2022–2026. Of the estimated investments, the largest share (USD 17 billion) is allocated towards iron ore, followed by social and environmental initiatives (USD 6.5 billion).[21]

For the upcoming future, Swedish companies can benefit by offering expertise and solutions advancing critical material mining, and sustainable mining, but also through early-stage participation in the transition to underground operations.

[21] IBRAM, Brazili Mining Overview 2023

MINING MACHINERY, BRAZIL

MARKET OUTLOOK: SOUTH AFRICA

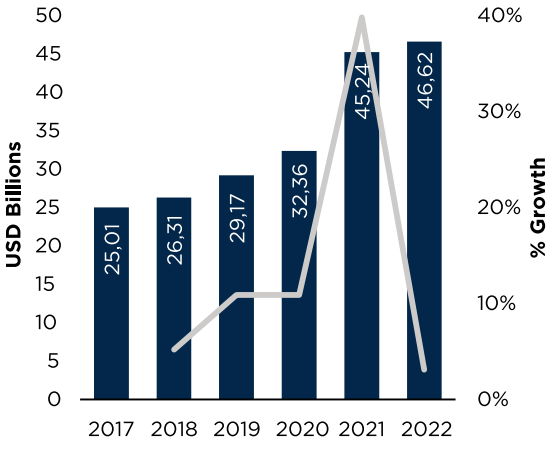
A WORLD LEADER IN GOLD AND PLATINUM

MARKET OVERVIEW

South Africa is known for its vast mineral resources, including precious minerals (gold, platinum, and diamonds), as well as coal (providing the majority of South Africa's energy), iron ore, manganese, and chrome. These resources have historically been the backbone of the country's mining industry. Despite being the world's largest producer of gold for a long time, aging mines and increasing depths have made it increasingly difficult for mining companies to achieve desired quantities. More recently, the country has also emerged as the world's leading producer of platinum group metals (PGMs).

The mining industry is a significant economic sector in South Africa employing nearly half a million people, generating more than USD 45 billion in revenues in 2022 and contributing over 6% of the country's GDP.[34]

MINERAL SALES AT CURRENT PRICES 2017–2022 (USD BILLION)



Source: STATSSA, 2023

[34] Statistics Department of the Republic of South Africa

South Africa is home to a mix of international and domestic players. Global giants such as Anglo American and Rio Tinto have been operating in South Africa for decades while local mining companies Sibanye Stillwater, Impala Platinum and Africa Rainbow Minerals dominate the local mining scene.

Since the COVID-19 pandemic, the South African mining industry has experienced high profit margins and significant returns on investment. However, the last year has been difficult for the industry; national growth nosedived, margins shrunk and productivity fell while infrastructure constraints and input costs increased.

Coupled with weakening of local currency, the local mining sector has benefitted from the continued improvement in specific commodity prices. The main contributor to the increased revenue was gold, followed by platinum group metals (PGMs) and non-ferrous metals. South Africa's mining sector is projected to remain stagnant for 2024 with infrastructure limitations (i.e. lack of power access, water, transportation issues), commodity price volatility and exchange rate fluctuations adding to the challenges mining companies face.

POLITICAL LANDSCAPE

As South Africa prepares for elections this year, issues around the high unemployment rates, corruption, labour disputes and slow economic growth prevail. As a result, delays in mine site openings and production disruptions are common. As one of the top employers in South Africa, hopes remain that the mining industry could absorb a significant percentage of the working age population, but full-time employment rates are somewhat depressed as mining companies favour hiring temporary contractors.

High levels of unemployment also spur significant and concerning levels of illegal mining activity, costing the mining industry up to USD 376 million annually (approximately 1% of revenue).[35] Illegal mining includes participation from organised crime and illegal entry into abandoned and/or closed mine sites.

The current ruling party is expected to hold onto power, likely with less political dominance. A decade ago, this same ruling party rejected a plan to nationalise the mining industry but introduced new mining taxes. Since then, the government position on mining has been described as "in a state of paralysis and inertia", with a historically high backlog of unapproved mining permits. Marginal improvements in legislation have included allowing mine operators to generate additional electricity (from 10MW to 100MW) to offset power outages. This creates opportunities for the implementation of green energy and is likely to improve South Africa's foreign investment outlook.

SUSTAINABILITY

To promote sustainable mining and circumvent environmental degradation beyond the lifespan of a mining project, the South African government has developed strict regulations and policies such as the Mineral and Petroleum Resources Development Act (MPRDA), Mining and Biodiversity Guideline, and the National Environmental Management Act. However, the successful implementation of these policies is heavily challenged by insufficient levels of monitoring.

Even in the absence of successful policy instruments, major world mining companies have set internal sustainability targets, e.g. AngloAmerican's goal to become carbon neutral by 2040.

INNOVATION LANDSCAPE AND ECOSYSTEM TRENDS

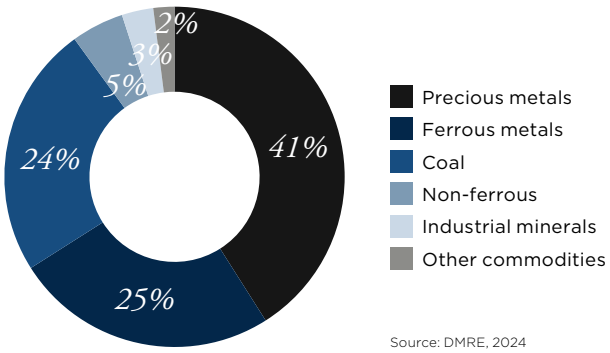
"Adoption for future mining capacity," is the phrase of the year, applying to mine operators, equipment manufacturers, and solutions suppliers alike.

The natural structure of South Africa's gold and PGM deposits creates difficulty in major mobile equipment use in confined, underground mines. This legacy of traditional mining presents significant opportunities to implement best practices, new technology and better methodologies.

Mining companies are also increasingly investing in clean technologies to minimise ecological footprint, including investments in renewable energy, water recycling systems, and introduction of basic safety systems such as steel netting in dangerous mining zones. Notable initiatives such as the Zero Harm Forum have successfully introduced mine safety best practices (introduction of bolting systems, system mechanisation, improvement of digital communication systems etc.) leading to a significant drop in fatality and injuries between 2022 and 2023 in South Africa.

Collaborations amongst research institutions such as the Mandela Mining Precinct, Council for Scientific and Industrial Research and Southern African Institute for Mining and Metallurgy are leading the implementation of technologies such as drones and satellite imaging to enhance geological and geotechnical surveys.

MINERAL PRODUCTION CONTRIBUTION BY COMMODITY IN 2022



Source: DMRE, 2024

[35] Al Jazeera, "South Africa turns to army in nationwide clampdown on illegal mining", 2023

OPPORTUNITIES FOR SWEDISH COMPANIES

Sweden has been a key partner in the development of the local innovation landscape and knowledge sharing platforms such as the South Africa-Sweden University Forum (SASUF).

Sweden remains a key partner for the South African mining industry through companies such as Sandvik, Atlas Copco, Epiroc, SKF, Volvo, and many others not only as suppliers, but also as key technology and research partners in the local market. Swedish companies such as Epiroc and Sandvik have acquired major local mining equipment manufacturing companies such as AARD to improve local manufacturing capacity and technology.

Presently, international mining companies lead innovation in South Africa by building on their experiences in other markets. Sweden, as a global leader in mining, is well-positioned to collaborate with local mining companies strategising to navigate current challenges and build a portfolio for the future.

COAL MINE, SOUTH AFRICA

MARKET OUTLOOK: AUSTRALIA

A BEACON FOR CONTINUOUS MINING GROWTH

MARKET OVERVIEW

Mining has long been a cornerstone of the Australian economy. In the 2022/2023 fiscal year, the sector generated almost USD 300 billion in revenue, accounting for 66% of Australia's export revenue, and 14.3% of total gross domestic product (GDP) [32].

Australia is a competitive hub for mining activity, home to global industry leaders such as BHP, Fortescue and Rio Tinto as well as junior miners like South32 and Northern Star Resources. A leading producing nation, Australia is the world's top lithium producer and ranks among the top five for gold, iron ore, lead, zinc, and nickel.

Furthermore, the nation has the world's largest reserve of uranium, all of which is exported since nuclear power has historically taken a backseat in favour of the more cost-effective alternative – coal. Since the disaster in Fukushima in 2013, the Australian government has been hesitant to endorse initiatives tied to uranium mining, however, there is a discernible shift in their stance. This change is primarily influenced by the recognition of the crucial role nuclear power plays in achieving climate change goals, and the trend of nuclear power adoption across Europe.

Drawing parallels between Sweden and Australia in the context of mining operations unveils the shared challenges and potential synergies in the industry. Both countries boast significant roles as producers of iron ore, precious metals, and base metals. The challenges faced in mine operations, such as extraction methods, safety protocols, and geological conditions are similar. This common ground presents a promising opportunity for the application of Swedish mining technology in Australia. The technology, initially developed to address the specific needs of the Swedish mining industry, aligns well with the analogous conditions found in Australia.

[32] Australia Bureau of Statistics

"With large deposits of critical minerals and rare earth elements, established technical expertise in mineral development and integration with global supply chains, Australia is well-placed to meet increased demand throughout the energy transition."

Department of Industry Science and Resources, Australian Government

With over 350 active mine sites, including quarries, Western Australia (WA), Queensland (QLD), and New South Wales (NSW) are the primary mining hubs. Approximately one-third of mines are in WA, one-quarter in QLD, and one-fifth in NSW[33].

Australia stands as a pivotal player in the global critical raw materials market, wielding a wealth of diverse resources crucial for the development of advanced technologies and the burgeoning energy transition. With an abundance of materials like lithium, rare earth elements, and cobalt, Australia serves as a cornerstone in the critical raw materials value chain. The nation actively engages in international agreements and partnerships to fortify supply chains and responsible sourcing. By strategically investing in exploration, extraction, and downstream processing, Australia aims not only to meet the escalating global demand but also to position itself as a leader in sustainable and ethical mining practices.

In June 2023, Australia released its updated Critical Minerals Strategy 2023–2030, providing added incentives worth USD 325 million on top of previous years' USD 1.3 billion Critical Minerals Facility and alongside various other initiatives. The Facility is managed by Export Finance Australia and provides financing to projects that are aligned with the Australian Government's Critical Minerals Strategy.

POLITICAL LANDSCAPE

In recent years, climate change has gained increasing importance among the Australian voter base. The 2022 federal election saw the Labor Party emerge victorious, attributing their win to a robust commitment to addressing climate issues. Despite this, the Labor Party's triumph did not signal a major policy shift for the mining sector. Their promises included supporting economically viable export-oriented coal projects and rejecting the imposition of carbon taxation. Instead, the focus has shifted towards reducing domestic coal consumption and promoting widespread decarbonisation across the economy.

However, the need to reduce environmental impact is expected to become more pressing. New approvals for coal mining are expected to slow down significanly due to stricter regulatory requirements, growing reluctance from investors to fund projects and strong pressure from communities as well as political entities. A case in point is the February 2023 decision by Environment Minister Tanya Pilbersek to reject the project proposed by Central Queensland Coal, citing concerns about potential harm to the Great Barrier Reef.

These trends are expected to accelerate the exit of major miners from coal. Companies such as Anglo American, Peabody Energy and Vale have already begun liquidating their Australian coal portfolios, while Rio Tinto has completely exited the coal market. More than 70 partners from industry and research are collaborating to find solutions to make Australian mine closures beneficial for communities and the environment via the Cooperative Research Centre for Transformations in Mining Economies.

INNOVATION LANDSCAPE AND ECOSYSTEM

In the face of technological disruption, the mining sector is at a crossroads – presented with the option to maintain traditional practices or embrace a transformative, sustainable future.

Australia with the likes of BHP, Rio Tinto, Fortescue Metals and Newcrest Mining, are known to be leaders in the adoption of innovative technology that reduces costs, improves efficiency, and enhances mine operations safety. With its strong network connectivity, reliable power supply, highly skilled labour force and government support, the Australian mining sector is well positioned for future innovation.

Australian mining benefits from incentives like the Exploration Development Incentive (EDI), encouraging investment in small mineral exploration. The government-backed EDI provides tax incentives for shareholders in greenfield exploration. Mining companies also use the R&D Tax Incentive to advance technology, collaborating for innovation and sustainability in the sector.

Australia's innovation landscape is further supported in academia and is home to leading universities with world class mining schools including the University of New South Wales, University of Queensland, Curtin University, University of Adelaide, Newcastle University and University of Western Australia.

The University of Western Australia's reputation as a world leader in resources research is founded on a depth and breadth of expertise in a wide range

[33] Minerals Council of Australia

of disciplines. As just one example, researchers are creating 3D mineral maps using integrated surface and subsurface sensing data. This work provides the mineral-mapping capabilities that better equip the industry for the challenges of sustainable exploration and mining. CRC Mining is a collaboration between industry giants and Australia's top universities in mining research—the Universities of Western Australia, Queensland and Newcastle and Curtin University. The organisation is responsible for developing many breakthrough technologies being used at mine sites around the world, from payload measuring to collision-detection systems to first-generation drill automation. Employee safety has been improved as a result of innovations such as the SmartCap, a baseball cap that continually monitors the wearer's brainwaves to determine their level of fatigue-induced impairment.

Western Australia truly is a global centre of technical innovation for the mining and exploration industry. It is home to the largest group in the world focused on innovative research and development in mineral exploration and resource management. The Centre for Exploration Targeting is a unique applied research enterprise working on cost-effective, high-quality mineral exploration. The centre is a collaboration between the mineral exploration industry, the University of Western Australia, Curtin University, and the Government of Western Australia. A diverse membership base of over 60 national and international companies integrates with the centre, providing a gateway to mining and minerals opportunities worldwide for students and early career researchers.

Additionally, CSIRO, Australia's premier scientific agency, is instrumental in advancing the mining sector through cutting-edge technologies, sustainable practices, and collaborative research. Notably, CSIRO has a history of research and collaboration with Swedish miners, highlighting their global engagement. This collaboration often involves joint initiatives, where CSIRO brings scientific expertise to address specific challenges or advance technological solutions within the mining industry. Their collaborative approach may include joint studies, field trials, and the exchange of insights to collectively enhance the efficiency and environmental sustainability of mining operations.

Australia has world-leading research organisations, yet there is a significant lack of robust commercialisation support for Australian OEMs and technology companies. A considerable number of successful startups are acquired by international companies before attaining substantial size. Government funding tends to favour mining companies addressing specific industry challenges, often neglecting to provide support for the more technology focused small-to-medium sized companies.

OPPORTUNITIES FOR SWEDISH COMPANIES

Australia offers abundant opportunities for Swedish mining OEMs. The heavy reliance on international OEMs to provide cutting-edge equipment and technology solutions creates a strong foundation for Swedish companies to enter the market and offer their expertise. Further, Swedish OEMs can capitalize on the gap in commercialisation support in the Australian market to explore potential acquisition targets. The synergy between Sweden's advanced mining technology and Australia's strong demand for such solutions positions Swedish OEMs strategically to meet the evolving needs of the Australian mining industry.

COOBER PEDY, AUSTRALIA

CONCLUSION

UNLOCKING THE TRANSITION: 4 OPPORTUNITIES

The potential is rising for Swedish equipment manufacturers, suppliers and technology experts in each of the mining markets explored in this report. The future of mining will be shaped by four key priority areas: *innovation, sustainability, political stability, and critical raw materials*. Below is an outline of why Swedish companies should look into these markets for their next investment.

INNOVATION TRAILBLAZERS

Australia and Canada are at the forefront of mining innovation adoption, as leaders in mine automation and electrification. While strong in adoption, both Australia and Canada lack the domestic strength in technological innovation that Swedish companies are well-known for. Moreover, both nations have attractive incentives that further support innovation, including Canada's *Critical Minerals Exploration Tax Credit* and Australia's *Junior Minerals Exploration Incentive*.

SUSTAINABILITY SUPERSTARS

When it comes to sustainable mining, Canada and Australia are often top of mind – each with stringent environmental regulations, strong social and community focus, as well as an emphasis on responsible resource extraction and safety. These markets are likely to be attractive to Swedish companies with innovative solutions that increase the sustainability of mining practices.

PRODUCTION POWERHOUSES

Already a mining powerhouse, Australia stands to grow even further as demand for critical materials accelerates. As a top producer of lithium and manganese, and with significant shares of reserves in these minerals as well as nickel, cobalt, and copper, Australia will be a high-activity and opportunity market.

Chile is a major producer of two high-demand critical materials – copper and lithium. As the global mining industry rushes to ensure production levels that can meet forecasted exponential demand, Chile is likely to be a key market of continued investment.

RISING STARS

Brazil is a market to watch when it comes to critical raw materials – with reserves in nickel, REE, and graphite, Brazil is likely to be a key growth market in the race to critical raw materials production. Swedish companies can leverage existing platforms (e.g., Swedish Mining Alliance) to enter the market.

Despite its traditional reputation as a gold and PGM nation, South Africa's leadership in manganese production and reserves puts it on the critical raw materials map.

With a significant share of copper and REE production, the US is pivoting from its traditional fuel mineral focus and investing in becoming a critical raw materials production hub. With new regulations and incentives, the US offers Swedish companies an opportunity to capture opportunities in this established market and leverage the infrastructure of the world's largest economy at a time of great momentum.

PILLARS OF POLITICAL STABILITY

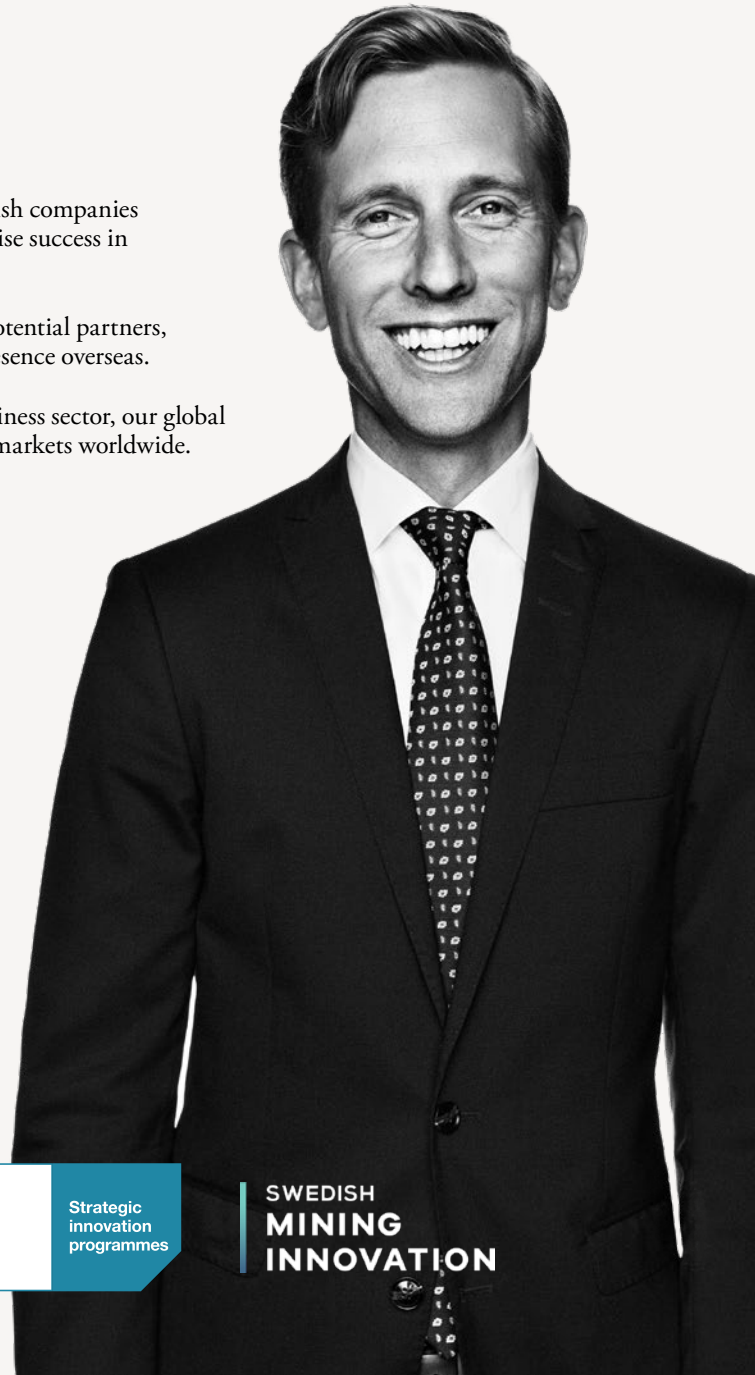
With geopolitical tensions running high across the globe, political stability and certainty are a key priority. Australia and Canada's stable political landscapes position the nations as highly attractive mining markets for investments. As the global mining industry looks to decentralise the mineral supply chain, both Canada and Australia are likely to be hot targets. Swedish companies looking for opportunities for long-term and sustainable growth in a new market are likely to find success in these two pillars of stability.

BUSINESS SWEDEN CAN SUPPORT YOU

Business Sweden's team of mining experts have helped many Swedish companies across the mining value chain to capture opportunities and maximise success in international markets.

We can help you analyse new market opportunities, reach out to potential partners, accelerate sales, develop go-to-market strategies, and build your presence overseas.

With a unique mandate from the Swedish government and the business sector, our global team offers strategic advice and practical support in more than 40 markets worldwide.



BUSINESS SWEDEN

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With support from
VINNOVA Sweden's Innovation Agency
Swedish Energy Agency
FORMAS
Strategic innovation programmes

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