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# The Government of Brazil Mining Sector Technical Support and Cooperation 2020-2023

## Final Report

**Prepared for:**
Office of Energy Programs
Bureau of Energy Resources
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**Prepared by:**
Deloitte & Touche LLP
1919 N. Lynn Street
Arlington, VA 22209

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## Acronyms

| | |
|---|---|
| AMD | Acidic Mine Drainage |
| ANM | Brazil's National Mining Agency |
| ARD | Acidic Rock Drainage |
| ASM | Artisanal and Small-Scale Mining |
| BPA | Blanket Purchase Agreement |
| CAGR | Compound Annual Growth Rate |
| CAPEX | Capital Expenditure |
| CBMM | Brazilian Metallurgy and Mining Company |
| CFEM | Financial Compensation for Mineral Resource Exploitation |
| CPRM | Geological Survey of Brazil |
| CTAPME | Inter-ministerial Committee for the Analysis of Strategic Mineral Projects |
| DOE | Department of Energy |
| DOS | Department of State |
| DRC | Democratic Republic of Congo |
| EMGP | Energy and Mineral Governance Program |
| ENR | Bureau of Energy Resources |
| EoR | Engineer of Record |
| ESG | Environment, Social, and Governance |
| EV | Electric Vehicles |
| GDP | Gross Domestic Product |
| HPAL | High-pressure-acid-leaching |
| IAA | Impact Assessment Act |
| IEA | International Energy Agency |
| GHG | Greenhouse Gas |
| GIS | Government Information System |
| GISTM | Global Industry Standard on Tailings Management |
| GTR | Global Tailings Review |
| HSE | Health, Safety, and Environment |
| IEA | International Energy Agency |
| IBAMA | Brazilian Institute of Environment and Renewable Resources |
| IBGE | Instituto Brasileiro de Geografia e Estadística / The Brazilian Geographical and Statistical Institute |
| IBRAM | Brazilian Mining Association |
| ICA | Investment Canada Act |
| ICMM | Brazil's International Council on Mining and Metals |
| IGF | Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development |
| IPT | Institute for Technological Research |

| | |
|---|---|
| IRENA | International Renewable Energy Agency |
| IRR | Internal Rate of Return |
| LME | London Metal Exchange |
| METC | Mineral Exploration Tax Credit |
| MME | Ministry of Mines and Energy |
| NDC | Nationally Determined Contribution |
| Ni-Co | Nickel Cobalt |
| NPV | Net Present Value |
| OEM | Original Equipment Manufacturer |
| PGE | Platinum Group Elements |
| PNM | National Plan for the Brazilian Mineral Sector |
| PPI | Investment Partnerships Program (PPI) |
| REE | Rare Earth Elements |
| REO | Rare Earth Oxides |
| REPM | Rare Earth Permanent Magnet |
| SIF | Strategic Innovation Fund |
| SME | Society for Mining, Metallurgy, and Exploration |
| SOE | State-Owned Enterprise |
| T&D | Transmission and Distribution |
| TAH | Annual Tax per hectare |
| Ti | Titanium |
| TiO2 | Titanium Dioxide |
| TDF | Tailings Disposal Facility |
| TFC | Tailings Facility Closure |
| TFRM | Control, Monitoring, and Supervision of Research Activities, Mining, Exploration and Exploitation of Mineral Resources Fee |
| TSF | Tailings Storage Facility |
| TSM | Towards Sustainable Mining |
| UNEA | United Nations Environment Assembly |
| UNEP | United Nations Environment Programme |
| UNFC | United Nations Framework Classification |
| USGS | United States Geological Survey |
| $V_2O_5$ | Vanadium Pentoxide |
| $V_2O_3$ | Vanadium Oxide |

# 1. EXECUTIVE SUMMARY

## 1.1. Introduction and Background

Under *Call 08: The Government of Brazil Mining Sector Technical Support and Cooperation* (the Project) the Deloitte team provided technical support to the Government of Brazil's Ministry of Mines and Energy (MME), the Geological Survey of Brazil (CPRM), and the National Mining Agency (ANM). The Deloitte team delivered this Project under the U.S. Department of State (DOS) Energy Governance, Reform, and Development II (EGRD II) Blanket Purchase Agreement (BPA) in support of the Bureau of Energy Resources (ENR) Energy and Mineral Governance Program (EMGP). Technical assistance under this Project focused on promoting international leading practices that are relevant to the Brazilian context and strengthening the governance of Brazil's mineral sector to both, protect its environment and local communities, while maximizing the potential economic benefit from its extractive industries.

*Deliverable 4: Final Report* (this Report) summarizes key findings and recommendations for this Project. The Period of Performance for this work is 29 months, beginning on September 28, 2020 and ending on April 30, 2023.

Project activities included three (3) task areas that provided MME and CPRM with expertise, analysis, and capacity building via the following:

I. **Task 1: Mine Closures and the Use of Tailings.** This task focused on building the capacity of MME and CPRM for the development and execution of safe, sustainable, and effective procedures for mine closures and use of tailings, including method of tailings sampling and characterization;

II. **Task 2A: Economic Viability and Global Market Competitiveness of Specific Minerals.** This task provided an analysis and recommendations on the economic viability and global market competitiveness of nine Brazilian critical minerals;

III. **Task 2B: Structure of a Brazilian Nickel-Cobalt (Ni-Co) Inventory**. This task provided leading practice recommendations for how to structure a Brazilian Ni-Co inventory; and

IV. **Task 3: Technical Trainings**. As part of the capacity building efforts, the Deloitte team provided two (2) virtual trainings to the Government of Brazil. Specific topics for the trainings included: (i) methods of tailings sampling and characterization; and (ii) an analysis of the economic viability and global competitiveness of specific Brazilian minerals.

The Deloitte team produced one Work Plan, 11 Technical Reports, two Appendices, 32 Biweekly Reports, 5 Quarterly Reports, and one Final Report during the Period of Performance.

## 1.2. Approach and Methodology

Under this Project, the Deloitte team provided a flexible and responsive approach to working with the Government of Brazil. Activities in the three task areas noted above and the technical support provided under this Project, focused on supporting the Government of Brazil as they seek to improve their ability to:

- Develop safe, sustainable, and effective mine closure procedures and use of tailings, including methods of tailings sampling and characterization, based on international leading practices, to protect and improve the legacy of ongoing and future projects, thereby realizing sustainable benefits from the extractives industry;

- Manage a growing mineral sector and compete effectively in the global market, given a growing market and accelerated demand for critical minerals that are essential to the development of innovative technologies to advance the global clean energy transition (electric vehicles, batteries, and battery storage systems, etc.); and
- Streamline the structure of Brazil's Ni-Co data inventory, so Brazil can improve its understanding and increase development of critical minerals.

Given restrictions on international travel due to COVID-19, Deloitte executed the work virtually. The Deloitte team worked with MME, CPRM, and other counterparts to facilitate and align mobilization timeframes, scopes of work, access to, and commitment from counterparts. The Deloitte team consisted of the following advisors:

Deloitte Leadership and Project Management Team

1. Richard Longstaff, Engagement Director
2. Donald Hulse, Team Lead
3. Juli Cara, Project Manager
4. Christian Tiernan, Data Analyst

Deloitte Advisors

5. David Bird, Mineral Commodity Markets Analyst
6. Rex Bryan, Critical Mineral Geologist
7. Kirk Adams, Mining Project Financial Analyst
8. Chris Emanuel, Mining Engineer
9. John Craynon, Mining Closure / Legal and Regulatory / Mine Closure Engineer

## 1.3. Conclusion and Immediate Next Steps

As Brazil focuses on increasing investment in the mining sector, building a long-term sustainable mining industry, and increasing social and economic benefits for its population, the Government of Brazil should take immediate next steps to:

- **Incorporate leading practices into the Government of Brazil's mine development and management regulatory framework.** The framework should include:
    - Risk assessments of Tailings Storage Facilities (TSFs) and waste rock storage that reduce the risk of Acid Rock Drainage (ARD), failure of TSF, and other geotechnical instabilities of mine operations;
    - Global Industry Standard for Tailings Management (GISTM) recommendations on transparency for regulating tailings facilities and using these recommendations for industry as a template for future regulatory efforts. The Government of Brazil would also benefit from using GISTM as a benchmark for evaluating proposed, operational, or legacy TSFs and their risks to the public and the environment;
    - Leading practices to expand opportunities for tailings reuse and tailings reduction developed by industry and academia to reduce the volume of materials that require long-term storage and management;

- Effective mine water management (both surface and groundwater) to make mine operations safe, ensure adequate water supply to local ecosystems and communities, and mitigate water quality impacts;
- Early and periodic review of biodiversity at mining operations;
- Continued attention to cultural heritage issues, with assessments, rescue, and/or avoidance of sites with significant archeological or cultural importance; and
- Additional investments in local communities so that they receive direct benefits from co-located mining projects, with particular attention to local livelihoods. The government should enhance outreach to, and the capabilities of, potentially impacted people and communities to understand and participate in the evaluation and decision-making processes related to Tailing Disposal Facilities (TDFs) for future, existing and closed tailings facilities.

- **Develop a market competitiveness framework for Brazilian critical minerals to (i) help the government understand where and how Brazil could compete most effectively in the market, based on global market trends and challenges to mineral resource development, that may inhibit Brazil's overall market competitiveness; (ii) inform the government's long-term strategic planning for mineral commercialization, specifically, their National Plan for the Brazilian Mineral Sector (PNM 2050), and other future policy actions.** To support the Government of Brazil, the Deloitte team developed a series of nine critical mineral market reports, including, graphite, lithium, nickel, cobalt, rare earth elements (REEs), titanium, vanadium, tantalum, and copper; and two appendixes. *Appendix 1: Renewable Energy and the Use of Critical Minerals* discussed the growing impact of climate change on the commodity markets (including the market for the critical minerals noted above), as countries around the world (including Brazil), implement plans to accelerate their clean energy transition. *Appendix 2: Leading Practice Critical Mineral Policy Initiatives* focused on specific measures Western Australia and Canada have implemented to effectively compete in the market. These leading practices provide lessons learned for MME, CPRM, and other government entities in Brazil involved in the mining sector.
- **Increase access to, and circulation of, up to date mineral resource data to domestic and international exploration to promote mineral development in Brazil.** Increasing access to data may require gathering and distributing more extensive information from those regions that are considered to have significant mineral potential. Legacy CPRM geological data, reports, and studies should be made more broadly available online in a range of languages. Brazil should also undertake appropriate marketing of these documents to expand their circulation and increase their impact.
- **Incorporate leading practices into the Government of Brazil's Ni-Co inventory framework, via:**
  - **Including Environment Social and Governance (ESG) information in the Ni-Co inventory report generally, and promoting the ESG advantages of Brazilian nickel and cobalt projects in particular, to accelerate access to development finance and facilitate regional investment.** Nickel-cobalt projects in Brazil have systemic ESG advantages relative to (for example) Democratic Republic of Congo (DRC) copper-cobalt and Indonesian nickel-cobalt producers. For example, Brazil's access to low-cost, low-emissions hydroelectricity would give local nickel-cobalt producers a competitive advantage in both operating costs and carbon footprint vs. other locations.

This advantage could potentially lead to better mine offtake terms, improved access to ESG-focused sources of development finance, and similarly enabled downstream regional investment in cathode- or lithium-ion battery manufacturing facilities.

- **Including information on Brazil's use of "prior informed consent"** (the right of a community to be informed about mining operations on a full and timely basis, and to approve such operations prior to commencement). Brazil should aim for robust public participation as part of an open and informed impact assessment process. Engaging members of the public in matters that affect their community enables local citizens to better understand the costs and benefits of resource development, while simultaneously enabling them to participate in the planning process. When planning new projects, mining companies should look for opportunities that align with local communities' priorities. If there are opportunities for a community to benefit from mining infrastructure, such as a road, railway, or energy facility, discussions between industry and communities should happen as far in advance as possible to determine that the development of a mining project addresses the communities' needs and priorities.
- **Publishing Updates to Infrastructure Developments.** Natural resource development potential can often be closely tied to extant level of infrastructure near a prospective mine. This may include the existence of highway, power, and rail grids, all of which have the potential to enhance the attractiveness of a given project. An integrated approach to infrastructure planning may also enable national and regional governments to prioritize the scheduling and financing of new infrastructure projects, potentially via public/private partnerships.
- **Providing Education and Labor Information.** Mineral reports included in the Ni-Co inventory framework should also describe the availability and skills of the local workforce. Understanding the capacity of the local/regional population is a key factor in the successful development of the sector, and in negotiating appropriate local community hiring commitments.
- **Continuing to conduct basic scientific research, and outlining current and planned research, in future CPRM's mineral inventory reports.** Knowledge about regional geological factors, new research into potential Ni-Co sources (including seafloor sulfide nodules), and the potential for efficient mineral processing (bulk laterite leaching) will help to attract the attention of other innovative parties and investors.

## 2. OVERVIEW OF SUBMITTED DELIVERABLES

The Work Plan for this Project contained a detailed description of each deliverable, timelines for project work by deliverable, and key objectives for the engagement. Table 1 below provides the up-to-date status for each deliverable under this Project.

**Table 1: Project Deliverables**

| Deliverables/Reports | Task | Finalized Date |
|---|---|---|
| **1. Detailed Work Plan** | All | August 17, 2021 |
| **2. Quarterly Reports (QRs) Including a Summary of Activities** | All | 1. Q1: May 28, 2021<br>2. Q2: October 6, 2021<br>3. Q3: December 1, 2022<br>4. Q4: December 1, 2022<br>5. Q5: August 15, 2022 |
| **3. Bi-Weekly Status Reports (32)** | All | Final: March 18, 2022 |
| **4. Final Report with Summary of Activities and Outcomes** | All | April 20, 2023 |
| **5. Report on Mine Closures and the Use of Tailings (Task 1)** | Task 1 | March 14, 2023 |
| **6. Report on the Economic Viability and Global Market Competitiveness of Specific Minerals (Task 2A)** | Task 2A | 1. Graphite: November 22, 2021<br>2. Nickel: May 31, 2022<br>3. REE: June 2, 2022<br>4. Copper: September 27, 2022<br>5. Cobalt: October 28, 2022<br>6. Tantalum: December 1, 2022<br>7. Vanadium: December 1, 2022<br>8. Lithium: December 6, 2022<br>9. Titanium: April 11, 2023<br>10. Appendix 1: January 15, 2023<br>11. Appendix 2: March 21, 2023 |
| **7. Report on the Structure of a Brazilian Ni-Co Inventory (Task 2B)** | Task 2B | April 21, 2023 |
| **8. Virtual Training** | Task 3 | 1. Training 1: January 12, 2023<br>2. Training 2: October 21, 2022 |

# 3. TASK 1: REPORT ON MINE CLOSURES AND THE USE OF TAILINGS

## 3.1. Introduction

*Task 1: Report on Mine Closures and the Use of Tailings* (this Report), outlined key findings and leading practice recommendations to support MME, CPRM, and ANM in the development of safe, sustainable, and effective procedures for mine closures and the use of tailings, including methods of tailings sampling and characterization. As part of Task 1, the Deloitte team conducted a review of Brazil's existing policies and regulations, comparing them with international leading practices for the sustainable management of mine closures and the use of tailings; analyzed leading practices for tailings management; and provided case studies of countries (*e.g.,* Peru, Chile, Portugal, Colombia) that have implemented beneficial use and reuse of tailings methods.

## 3.2. Key Findings

- **The Government of Brazil has taken steps to eliminate the upstream construction of tailings dams through its implementation of Resolution 13 (2019),[1] Resolution 68 (2021),[2] and other administrative actions (*e.g.,* ANM Ordinance[3] and the Minas Gerais 2017 policy[4]).** Upstream construction, while widely used in mining, has been implicated in many tailings dam failures, and is now prohibited in several countries, including Brazil. Tailings dams store water and waste from the mining process. When tailings dams fail, they can release a powerful wave of waste and contaminated water that destroys communities and ecosystems. The Government of Brazil has worked closely with the owners of existing upstream dams to develop plans to eliminate the dams and reduce residual risks. By 2035, the government plans to eliminate the existing tailings dams, which are designed to contain mining waste. Additionally, through Resolution 68, the Government of Brazil has strengthened requirements for mine closure plans, to enhance planning and design for TFC, post-closure monitoring, and remediation.
- **The Government of Brazil has been working with industry and academia to develop specific projects in Brazil that incorporate leading practice principles related to tailings management, such as those outlined in the GISTM [5].** These leading practices include guidelines to reduce the volume of tailings, and to beneficially reuse tailings. CPRM noted that there are a few tailings reuse and reprocessing projects under development in Brazil, primarily involving tailings from iron ore production. CPRM has been working closely with industry, academic researchers, and other government entities, such as MME and ANM, to bring these projects to fruition. One of these projects, the Pico Block plant became operational in November of 2020, as Vale opened the Pico Blocks

[1] Resolution 13 banned the construction of mining dams using the upstream construction method and provided a deadline for all existing upstream construction dams (September 15, 2021) to be removed from service and decommissioned.

[2] Resolution 68 requires all mines in Brazil to submit updated mine closure plans before June 1, 2022. The resolution includes specific requirements for the information required, and particularly focuses on mining dams and other facilities that may need to be decommissioned at mine closure. The resolution also addresses temporary closure and the need for regular updates to the closure plan.

[3] This ordinance outlines specific criteria for dam construction, evaluating the risks of mining dams, requirements for emergency action plans, schedules and contents of dam inspections, and related issues.

[4] This policy provides additional details to allow the industry to comply and the regulators to evaluate that compliance.

[5] Provides recommendations on the transparency of regulation of tailings storage facilities.

Factory at its Mina de Pico mining facility in Minas Gerais. The goal of the factory is to turn 30,000 tonnes of tailings annually into 3.8 million pre-molded construction products. Vale's sandy tailings at Mina de Pico have high silica content and very low iron content, making them particularly attractive for this type of use.[6]

- **The Government of Brazil is taking steps to incorporate leading practices into its mine development and management regulatory framework.** Following the severe impact caused by accidents at two tailings dams, first at Mariana and then at Brumadinho, the government is requiring mining companies to align more closely with international standards around Health, Safety, and Environment (HSE) and ESG. For example, Sigma Lithium represents one of the largest and highest-grade hard rock lithium spodumene deposits in the Americas and has been at the forefront of environmental and social sustainability in the EV battery materials supply chain. The Grota do Cirilo project developed by Sigma, includes a state-of-the-art green-tech processing plant that uses 100 percent renewable energy, 100 percent recycled water, and 100 percent dry-stack tailings. Sigma collaborated with communities of Itinga and Araçuaí to design transformative new social initiatives, which allocates funding to build 2,000 rainwater collection systems and to empower 10,000 women through microcredit.[7] In addition, the Government of Brazil has participated in several partnerships and discussions to further advance the development of mine closures, use of tailings, and overall ESG standards. Specific examples include: (i) the U.S. – Brazil Critical Mineral working group, which is expected to support the advancement of bilateral diplomatic engagement and technical cooperation on critical minerals, including stimulating investments and promoting technological innovation in critical minerals in a sustainable manner; and (ii) the United Nations Environment Programme (UNEP) discussions on a new governance framework for the extractive sector known as the "*Sustainable Development License to Operate*" for mining, which includes consensus-based principles, policy options, and leading practices that are compatible with the Sustainable Development Goals (SDGs) and other international policy commitments on climate change.[8]
- **Currently, Brazil has mining and environmental laws and regulations at the federal, state, and municipal level.** At the federal level, there are four primary authorities that implement mining and environmental laws and decrees including the following: National Council for the Environment; Institute of Environment and Renewable Natural Resources; Chico Mendes Institute of Conservation and Biodiversity; and the Brazilian Forestry Service. In addition, MME, through ANM, also implements specific requirements for licensing and environmental performance of mining operations. Although federal agencies, such as ANM, establish the legislation and overarching mining regulations for the country, Brazilian states have the authority to establish secondary regulations on certain aspects of mining activities including environmental standards, environmental

[6] https://im-mining.com/2020/11/22/vale-opens-pico-block-plant-produce-civil-construction-products-iron-ore-tailings/

[7] https://batteriesnews.com/sigma-lithium-successfully-initiates-commissioning-greentech-plant-schedule-budget/

[8] The "*Mineral Resource Governance in the 21st Century Report*", published by UNEP in 2020, outlines a plan for creating a "*Sustainable Development License to Operate*" for mining. As part of this plan, the report encourages the public and private sector and local communities to work collaboratively to enhance the contributions of the extractive sector to sustainable development.

impact assessments (EIA), safety, and labor requirements[9]. As a result, there are overlapping roles and responsibilities between different entities at the federal, state, and local level, which increases the complexity of enforcing these standards. Moreover there are no formal procedures in place for coordination between different entities involved in the mining sector. This can sometimes lead to lengthy licensing procedures and widely varied institutional capacity among governmental agencies. Reducing risks related to tailings and mine closure requires a focused effort by the government to successfully address challenges related to tailings risk governance and strengthen the overall safe management of tailings in the country.[10]

### 3.3. Key Recommendations

To increase the safety, sustainability, and effectiveness of procedures for mine closures, and the use of tailings, the Deloitte team recommends that the Government of Brazil considers the following:

- **Incorporate leading practices into the Government of Brazil's mine development and management regulatory framework.** The framework should include:
    - Risk assessments of TSFs and waste rock storage that reduce the risk of ARD, failure of TSF, and other geotechnical instabilities of mine operations;
    - GISTM recommendations on transparency for regulating tailings facilities and using these recommendations for industry as a template for future regulatory efforts. The Government of Brazil would benefit from using GISTM as a benchmark for evaluating proposed, operational, or legacy TSFs and their risks to the public and the environment;
    - Leading practices to expand the opportunities for tailings reuse and tailings reduction developed by industry and academia to reduce the volume of materials that require long-term storage and management;
    - Effective mine water management (both surface and groundwater) to make mine operations safe, ensure adequate supply to ecosystems and communities, and mitigate water quality impacts;
    - Early and periodic review of biodiversity in areas with critical natural habitat;
    - Continued attention to cultural heritage with assessments, rescue, and avoidance of significant archeological resources; and
    - Additional investments in communities so that they receive direct benefits from these projects, with particular attention to the restoration of livelihood of vulnerable people. The government should enhance the outreach to, and the capabilities of, potentially impacted people and communities to help them understand and participate in the evaluation and decision-making process related to TDFs for future mining and for existing and closed tailings facilities.

[9] https://www.oecd-ilibrary.org/sites/89a72df8-en/index.html?itemId=/content/component/89a72df8-en.
Sometimes state mining regulations may be more stringent than the federal regulations as it is the case of the regulations of mining activities in the state of Minas Gerais.

- **Build the capacity of MME, CPRM, and ANM (e.g., appoint an "Engineer of Record" – EoR) to review and evaluate TSFs based on international standard requirements.** These standards include the GISTM standards on transparency for regulating tailings facilities, and the life-cycle approach included in the Society for Mining, Metallurgy, and Exploration (SME) *Tailings Management Handbook* (SME, 2022) for design, construction, operation, monitoring, and closure of tailings facilities.
- **Implement formal coordination mechanisms between federal, state, and local government, and clearly define the benefits of intergovernmental coordination in helping to mitigate risk, lower cost, and improve investor confidence.** Formal processes to support intergovernmental coordination, working relationships, and regulatory decision-making would help to create a more open, transparent, and predictable environment for mining investment. Such processes would also harmonize work activities and instill greater investor confidence than decisions reached through the current reliance on informal arrangements. Through the Pro-Strategic Minerals policy (*Decree No. 10,657, of March 24, 2021, the Policy for Supporting the Environmental Licensing of Investment Projects for the Production of Strategic Minerals)*, the government is focusing on easing the licensing process by facilitating, for example, the dialogue between the environmental agency responsible for conducting the environmental licensing process and authorities, such as the managing bodies of Conservation Units, the National Indian Foundation (Funai), the National Institute for Colonization and Agrarian Reform (Incra), and the National Institute of Historic and Artistic Heritage (Iphan). The government should move to formalize these arrangements, and develop a framework agreement between MME, ANM, CPRM, state, and municipal entities to integrate existing activities and standardize TDF, TFC, TSF and ESG requirements. The Government of Brazil should consider establishing a single entity with the lead responsibility to: (i) convene regular coordination between different entities; (ii) establish/review/update formal policies to reduce risks associated with tailings; (iii) discuss leading practices and their application in Brazil, the impact of climate change and extreme weather events on the prevention of accidental water pollution from tailings; and (iv) design action plans on how to best enhance safety at different types of sites, including legacy sites.
- **Evaluate the presence of valuable constituents in coal wastes.** The relatively acidic conditions and high metals concentrations in coal wastes can have benefits. Over the past decades, the U.S. Department of Energy (DOE) has funded significant research that has demonstrated that the coal tailings and acidic mine drainage (AMD) created by coal mining and TSFs are a potential beneficial resource of rare earth metals and other critical materials. The Government of Brazil should consider evaluating the presence of valuable constituents in coal wastes. While the chemistry and geologic depositional environment of Brazilian coals may be different from the United States, there is an opportunity for further research of coal tailings and base metals tailings, as they are economically and technically viable sources of rare earth metals and other critical materials.

# 4. TASK 2A: REPORT ON THE ECONOMIC VIABILITY AND GLOBAL MARKET COMPETITIVENESS OF SPECIFIC MINERALS

## 4.1. Introduction

Under *Task 2A: Economic Viability and Global Market Competitiveness of Specific Minerals*, the Deloitte team developed a series of reports focused on nine minerals including, graphite, lithium, nickel, cobalt, REEs, titanium, vanadium, tantalum, and copper. The purpose of these reports was to provide recommendations to the Government of Brazil on where and how Brazil could compete most effectively and inform their long-term strategic planning for commercialization of minerals based on global market trends and challenges to mineral resource development that may inhibit Brazil's overall market competitiveness. The Deloitte team's recommendations will also inform the National Plan for the Brazilian Mineral Sector 2050 and future policy actions for the Government of Brazil.

In addition to the market and competitiveness analysis for the nine critical minerals noted above, the Deloitte team is also preparing two appendices to support Task 2A. *Appendix 1: Renewable Energy and the Use of Critical Minerals* discussed the growing impact of climate change on the commodity markets (including the market for the critical minerals noted above), as countries around the world (including Brazil), implement plans to accelerate their clean energy transition. *Appendix 2: Leading Practice Critical Mineral Policy Initiatives* (this Report) will focus on specific measures Western Australia and Canada have implemented to effectively compete in the market. These leading practices provide lessons learned for MME, CPRM, and other government entities in Brazil involved in the mining sector.

In the subsequent sections, the Deloitte team summarized the key findings and recommendations from these individual reports.

### 4.1.1. Graphite

#### 4.1.1.1. Key Findings

Key findings contained in this Report include:

- **Brazil has significant graphite resources and reserves**. Brazil is the third largest producer of graphite in the world (following China and Turkey), and the second largest high-quality flake graphite producer outside of China. The country is home to three graphite suppliers that produced 95 kt of graphite in 2020, approximately 10 percent of total global supply. Activity is focused within five operating mines in the country's graphite belt, which runs between Bahia and Minas Gerais. The mining operations of Nacional de Grafite (one of the two companies that dominate domestic graphite production) are the highest-margin graphite operations in the world, and have significant reserves with the potential for expansion based on Deloitte's analysis (*see Section 10 of the Graphite Report for details*). According to the U.S. Geological Survey (USGS), Brazil, China, and Turkey have the largest recognized graphite reserves, which account for around 72 percent of the world's total.[11] Madagascar, Mozambique, and Tanzania also hold significant reserves, which account for 21 percent.
- **When analyzing existing mines, Deloitte observed that Brazilian mining operations in Minas Gerais are among the most profitable operations in the world**. Deloitte analyzed data from 54 active graphite projects around the world to assess the economic viability and competitiveness of the market (*see Section 10 of the Graphite Report for*

[11] USGS, Mineral Commodity Summary of Graphite, January 2021.

*more details*). Deloitte compared graphite basket prices, operating costs, capital expenditures and capital intensity, and planned output across the 54 projects to create a benchmark of economic competitiveness. This analysis indicates that mining assets in Brazil appear to have significant potential for expansion.

- **Brazil has opportunities and potential for graphite development**. The financial viability of green mineral mining projects, including graphite, rely on global market trends and supply/demand dynamics. These dynamics depend on technological advancements (e.g., more efficient use of minerals), policy decisions (e.g., Brazil's commitment to its Nationally Determined Contribution - NDC), and supply-chain disruptions and/or risks (e.g., the COVID-19 pandemic and/or strategic initiatives to diversify mineral supply arrangements[12]). These trends may boost, or reduce, the attractiveness of Brazil's mineral assets in the near-term. However, as summarized in the table below, in the long-run, Brazil provides attractive opportunities for graphite exploration and development, due mainly to its significant geological resources, reflected by the fact that Brazil is the third largest producer of graphite in the world, and the second largest producer of high-quality flake graphite used in EVs.
- **There are currently limited expectations of any significant expansion of graphite production in Brazil.** The two domestic companies who dominate graphite production (Nacional de Grafite and Extrativa Metalquimica) have no known plans of growing their operations further[13]. Currently, there is only one project at an advanced exploration stage, Santa Cruz in southern Bahia owned by South Star Battery Metals, although there are other prospects in the early stages of exploration. Graphite is a strategic mineral under the Brazil's Pro-Strategic Minerals Policy, which is designed to streamline approvals and permitting procedures to accelerate production. Nevertheless, new activity has been limited despite having some 386 properties with graphite mineral rights, located mostly in Bahia, Minas Gerais, and Ceará.

#### 4.1.1.2. Key Recommendations

Brazil has a large graphite endowment, existing low-cost graphite mines, experienced personnel, and is a globally significant graphite producer, but will have to continue to compete globally to maintain its position in the market. Without increasing output, Brazil's share of global production is likely to decline as other countries continue to develop their resources. Brazil should therefore build on its inherent competitive advantages to support future production expansions by:

- **Increasing access to, and circulation of, up-to-date graphite resource data to domestic and international exploration companies to encourage exploitation and promote graphite development in Brazil**. In 2020, CPRM estimated that Brazil's total graphite resources were 43.8 Mt. Brazil's main graphite deposits are found in Minas Gerais, Bahia, Ceará, Rio de Janeiro, and Mato Grosso, but the government and mining industry believe that the Amazon Craton in the Sunsás Province may also have significant potential. Increasing access to up-to-date graphite resource data will require gathering and distributing more extensive information for those regions that are considered to have significant potential, and/or encouraging investment by exploration companies. Currently, legacy CPRM geological data, reports and studies are available in hardcopy; digitization of, and online access to, these records will greatly expand their impact and circulation. However measured potential (i.e., detailed resource delineation and metallurgical testing)

[12] China is currently the dominant global producer of graphite, and is responsible for nearly 62 percent of global production. The development of Brazil's graphite resources could help to diversify this concentrated supply.
[13] CPRM

may be unknown to the mining community until additional studies are completed. As new data becomes available and the results of additional CPRM studies are finalized (for example detailed resource delineation and metallurgical testing on individual deposits), these should also be published online as a matter of record, thereby helping to accelerate broader industry access to, and interest in, Brazil's graphite potential.

- **Considering financial incentives (e.g., lower royalties, preferential tax rates) to companies to encourage the expansion of existing graphite projects and new investment.** Without increasing output, Brazil's share of global production is likely to decline to just 3 - 4 percent by 2030 (from its current level of 9-10 percent) when other graphite mines come on stream (see Table 4 in the Graphite Report). Currently, Brazil has limited plans for increasing production beyond the exploration project in Santa Cruz. The government should fast-track the progress of graphite opportunities to avoid being crowded out by other graphite mine developments around the world, and before other countries with large resources, but a low level of projects – like Turkey, Russia, and India – decide to fast-track their own opportunities. The government should also encourage both international and domestic graphite companies (e.g., Nacional de Grafite and Extrativa Metalquimica) to participate in the development of new projects through financial incentives such as lower royalties, preferential tax rates, and assistance in capital financing.
- **Undertaking a comparative review of Brazil's exploration and mining policies vs. other graphite-producing countries.** This review should analyze whether the government can encourage graphite exploration and mine development through legal, regulatory, and ESG improvements. Such improvements may include simpler licensing and permitting processes, lower royalties, preferential tax rates, and a continued focus on environmental policy. The ultimate objective of such improvements should be to encourage development and stability for investors looking to develop the Brazil's mineral sector as a whole, and graphite in particular.
- **Developing downstream processing facilities to capture more of the graphite value chain.** Downstream graphite processing is currently concentrated in China, but given its graphite resources of approximately 43.8 Mt, growing worldwide demand, and the natural tendency for global supply chains to seek diversification, Brazil has an opportunity to become a leading downstream player in the graphite industry.

### 4.1.2. Lithium

#### 4.1.2.1. Key Findings

- **Brazil does not have significant lithium resources and reserves**. Based on current estimates, Brazil has a relatively low level of lithium reserves and resources, and accounts for just 0.5 percent of global total (see Table 1 in the Lithium Report). According to USGS, Brazil has lithium reserves of 95 kt Li and resources of 470 kt Li in 2020. Brine deposits are the main source of lithium resources in South America, but Brazil has predominantly hard-rock ('Mineral') deposits. This has limited economic implications, but each require a different extraction and processing method. A report published by CPRM in 2020 found that Brazil had 92 lithium occurrences, deposits, or mines, with 59 percent occurring in Minas Gerais State and 25 percent in Ceará State. Brazil currently has about 315 mineral rights for lithium issued covering almost 400 kha[14].

[14] One thousand hectares (kha) is equivalent to 2,471 acres.

- **Brazil is a relatively small, but low-cost producer of lithium.** Brazil currently has two mines producing lithium, Mina da Cachoeira (operated by Cia Brasileira de Lítio) and Mibra (operated by AMG Brazil), which account for about 1.5 percent of global output. The country also has one project (Grota do Cirilo operated by Sigma Lithium Resources) at an advanced stage of development.[15] Domestic industries, such as the aluminum industry are the main consumers of the existing lithium production (although the new Grota do Cirilo project will export its spodumene concentrate to South Korea for lithium chemical production). The country's lithium production is relatively low cost. Mibra produces lithium as a by-product, while Mina da Cachoeira sits at the bottom of the cost curve for Mineral producers (see Figure 23 in the Lithium Report) giving it a higher operating margin than its peers.
- **Producers are looking to expand production in Brazil.** The two lithium mines Mina da Cachoeira and Mibra, and the Grota do Cirilo project are all planning to expand mining capacity but have not provided a specific timeframe. If these expansions occur, this will double Brazil's output from these three operations from approximately 50 kt/y LCE to 100 kt/y LCE. In the meantime, global capacity is growing at approximately 6-7 times over the same period. As a result, Brazil will remain a relatively small producer of lithium over the next decade. Brazil currently has three recognized lithium exploration projects, but these remain in a very early stage of development. While current production of lithium in Brazil is low, the government lists lithium as a strategic mineral under their Pro-Strategic Minerals policy, which will allow for an acceleration of development procedures to reach lithium/critical mineral production, mainly by easing the licensing process of newly listed strategic mineral projects[16,17].

#### 4.1.2.2. Key Recommendations

The lithium market is expected to be in deficit over the next decade and, if prices continue their upward trajectory, the lithium market could offer robust returns to both miners and host countries. Brazil should therefore look to maximize its lithium output over the next few years and further develop its resources. Brazil's production at the two operating lithium mines (Mina da Cachoeira and Mibra) are slated to expand, and a third mine at Grota do Cirilo is anticipated to begin production. The exact timeline for these increases is not yet fully clear. Brazil should therefore look to accelerate the growth of its lithium industry over the longer term by:

- **Encouraging its existing lithium producers to pursue faster and larger expansions.** Brazil should have discussions with existing lithium mine operators (CBL and AMG Brazil) about the timing and scale of their planned expansions, with the aim of accelerating timelines and increasing production levels. Any expansion would need to be done on an economically sustainable basis, but the Government of Brazil could assist by

[15] Sigma Lithium Resources are the developers of Grota do Cirilo. They also are expected to bring a new mine into production in 2022 for lithium exportation

[16] Through the Pro-Strategic Minerals policy, the Government of Brazil has issued a list of specific critical minerals it aims to boost production of, and that are deemed of special interest to the country. Resolution No. 2 of June 18, 2021 defines the list of strategic minerals for the country. https://www.in.gov.br/web/dou/-/resolucao-n-2-de-18-de-junho-de-2021-327352416

[17] Through the Pro-Strategic Minerals policy, the Government of Brazil is focusing on easing the licensing process by facilitating, for example, the dialogue between the environmental agency responsible for conducting the environmental licensing process and authorities such as the managing bodies of Conservation Units, the National Indian Foundation (Funai), the National Institute for Colonization and Agrarian Reform (Incra) and the National Institute of Historic and Artistic Heritage (Iphan).

implementing measures, such as credit guarantees, higher capital allowances, and tax reductions, as required and appropriate.

- **Pursuing higher production levels for Phase 1 of the Grota do Cirilo project.** This development project is currently planning for a capacity of 220 kt/y of spodumene concentrate in Phase 1, with 440 kt/y planned for Phase 2 at some stage in the future. As outlined in the competitiveness analysis in Section 10 of this Report, Grota do Cirilo's has a high (43%) Internal Rate of Return and relatively low capital intensity, (Net Present Value [NPV]/Capital Expenditure [CAPEX]). As such, Brazil should prioritize discussions with Sigma Lithium Resources, the developers of Grota do Cirilo, to start / accelerate the project to Phase 2 production levels as soon as possible. As noted above, any expansion would need to be done on an economically sustainable basis, but the Government of Brazil could assist by implementing measures, such as credit guarantees, higher capital allowances, and tax reductions as required and appropriate.
- **Streamline access to, and circulation of, up-to-date domestic lithium resource data to domestic and international exploration companies to encourage exploitation and to promote lithium development in Brazil.** This may require gathering and distributing more extensive information for the regions considered to have significant lithium potential. Legacy CPRM geological data, reports, and studies should be more broadly published online and in a range of languages. Brazil should also 'market' these documents to expand their circulation, use, and impact.
- **Developing downstream processing facilities to capture more of the lithium value chain.** Currently, most downstream lithium processing takes place in China. Nevertheless, Brazil could become a midstream processor of lithium chemicals as part of a greater strategy to develop a downstream lithium-ion battery industry. Brazil could achieve this by constructing a facility to process the spodumene ore produced by Sigma Lithium Resources into lithium carbonate and/or lithium hydroxide (Brazil currently plans to export this ore unprocessed). This type of venture may also help to encourage the construction of cathode-manufacturing facilities and lithium-ion battery manufacturing. Discussions with existing global lithium-ion battery companies about investment in Brazilian initiatives, such as 'Colossus Cluster Minas Gerais', which aims to build a 35 GWh battery Gigafactory, may help to accelerate the business case for commercial lithium processing. In addition, Brazil does not necessarily need to wait for new domestic mines to come in line for it to achieve scale in lithium processing; the country could choose to import primary resources from neighboring producers.
- **Undertaking a comparative review of Brazil's exploration and mining policies/initiatives versus other lithium-producing countries.** Such a review, taking approximately 12 to 18 months, would analyze and prioritize how Brazil's government could encourage and accelerate lithium exploration and mine development through potential legal, regulatory, and ESG improvements. Such improvements could include simpler licensing and permitting processes, lower royalties, preferential tax rates, and a coordinated approach to environmental policy.

### 4.1.3. Nickel

#### 4.1.3.1. Key Findings

**Brazil has significant reserves and resources of nickel and it is a top 10 global nickel producer.** Brazil has nearly 17 percent of reserves and almost 6 percent of resources of

nickel in the world. The country also produces 3.6 percent of the world's nickel.[18] Brazil has five nickel mining operations (Barro Alto, Onça Puma, Santa Rita, Codemin, and Americano do Brasil – see Table 6 in the Nickel Report) that produced over 85 kt of nickel in 2021, three advanced stage development projects (Araguaia, Piauí, and Jaguar – see Table 9 in the Nickel Report), and four promising earlier stage exploration projects (Itapitanga, Vermelho, Jacaré, Morro Sem Bone - see Table 9 in the Nickel Report). In Brazil, nickel mining takes place from both sulfide and laterite projects. Global growth in nickel mine supply in recent years has primarily come from laterite ore sources, particularly from Indonesia (see Section 4.3 in the Nickel Report), which has recently grown over the last decade to account for over a third of global production capacity.[19] The second largest producer is the Philippines (13 percent), followed by Russia (9 percent), and New Caledonia (7 percent).[20] Nickel mines in Brazil produce Class II nickel (74 percent) or concentrate that is exported to be processed into Class I nickel (26 percent).[21]

- **The nickel market has the potential to be balanced out until 2030, with a slight deficit expected in 2029 and 2030[22] (excluding any impacts created by the Russian invasion of Ukraine).** Deloitte analysis shows that demand for nickel is expected to increase from 2.4 Mt/y in 2020 to 3.8 Mt/y – 4.5 Mt/y by 2030 due to its rising use in lithium-ion batteries in EVs. At the same time, new capacity coming online could increase supply to approximately 4.5 Mt/y by 2030, potentially balancing the market. The large increase in supply would mostly come from nickel pig iron (NPI) and high-pressure acid leach (HPAL) projects in Indonesia processing large resources of local laterite ores. In addition, the nickel market could also be affected by Russia's invasion of Ukraine. Although the scale of possible sanctions to this output are not yet fully clear, they have the potential to result in major supply disruptions (see Section 1.3 of the Nickel Report). As noted above, Russia is major producer of nickel, accounting for 9 percent of global production in 2021. The Russian invasion of Ukraine caused the international nickel price to rise. This resulted in the covering of short positions by a Chinese nickel company Tsingshan, due to margin calls, and in March 2022 the price briefly spiked to over $100,000/t, which resulted in a halt in trading on the London Metal Exchange (LME).[23] The price remains elevated, but is gradually declining.
- **Brazil is mainly an exporter of commodity nickel.** Brazil exports 85 percent of its nickel production—with China being its largest market (45 percent of exports)—and consumes just 13 kt/y of nickel for domestic stainless-steel production.[24] If Brazil decides to develop downstream battery facilities, it is likely that battery grade nickel would be available, or could potentially be produced, by Brazil's nickel industry. Piauí and Jaguar, Brazil's late-

[18] U.S. Geological Survey (USGS) and Nickel Institute.

[19] Estimates for global nickel reserves and resources are substantial, with Australia, Indonesia, South Africa, Russia, and Canada accounting for more than 50 percent globally.

[20] Additional information on the scale of possible sanctions in Russia (as a result of Ukraine invasion) are discussed in Section 1.3 and Section 11 of this Report.

[21] Globally, there are two main types of nickel produced, Class I and Class II. Class I nickel generally describes a group of nickel products including nickel metal, powders, and briquettes. These nickel products are mainly used to make metal alloys and nickel sulphate for batteries. The majority of nickel produced from nickel laterites is Class II nickel and is mixed with iron (ferronickel and nickel pig iron - NPI) and is mainly used to make stainless steel.

[22] Roskill forecast

[23] LME. https://www.lme.com/en/metals/non-ferrous/lme-nickel

[24] Inseego Corp (INSG) Insight No.35.

stage nickel development projects are both planning to produce Class I nickel, with domestic conversion facilities for battery-grade nickel sulphate.

- **Brazil has competitive advantages over Indonesia in producing nickel.** Growth in global mine supply in recent years has principally come from laterite ore sources, particularly from Indonesia (using HPAL, ferronickel, and NPI processing methods). Meanwhile, there has essentially been no growth in mine supply from sulfide deposits. As noted above, Brazil has a robust nickel industry, with five mining operations (Barro Alto, Onça Puma, Santa Rita, Codemin, and Americano do Brasil – see Table 6 in the Nickel Report), three advanced stage development projects (Araguaia, Piauí, and Jaguar – see Table 9), and four promising earlier stage exploration projects (Itapitanga, Vermelho, Jacaré, Morro Sem Bone - see Table 9 in the Nickel Report). Three of the five mining operations ( Barro Alto, Codemin, and Santa Rita) have operating costs below the market average (Table 10 in the Nickel Report), partly due to favorable labor and energy costs in Brazil.[25] The use of hydroelectricity in Brazil compared with the use of coal in Indonesia to supply energy to the nickel market, also means that Brazil has a competitive advantage in terms of carbon footprint (Figure 8 in the Nickel Report). This is becoming increasingly important to manufacturers of lithium-ion batteries and original equipment manufacturers (OEMs) when sourcing raw materials.
- **New processing routes could ease the projected deficit of Class I nickel:** Until recently, analysts expected an oversupply of Class II nickel, due to the forthcoming development of large new nickel laterite projects in Indonesia, and a shortage of Class I nickel due to strong demand from the battery industry. However, this outlook changed in March 2021 when Chinese producer Tsingshan announced plans to convert NPI into a nickel matte that can be refined to produce Class I nickel for battery grade chemicals.[26] Conversion of NPI to nickel matte could satisfy marginal demand for Class I nickel. A stable market provides opportunities for nickel producers in the long-term, including mines and projects in Brazil.

#### 4.1.3.2. Key Recommendations

The nickel market will likely remain balanced through 2030, with the possibility of a slight deficit in 2029 and 2030, excluding any impacts created by the Russian invasion of Ukraine. This offers opportunities for continued supply growth to mines and projects, including those operating and planned in Brazil. The Government of Brazil should continue to further develop its resources to meet global demand and encourage investment in the longer term by:

- **Streamlining access to, and circulation of, up-to-date domestic nickel resource data to domestic and international exploration companies to encourage exploitation and to promote nickel development in Brazil.** This may require gathering and distributing more extensive information for those regions considered to have significant nickel potential, including Goiás, Pará, Bahia, and Minas Gerais. Legacy CPRM geological data, reports, and studies should be broadly published online and in multiple languages. Brazil should also actively 'market' these documents to expand their circulation, use, and impact.

[25] The data for the other two mining operations, Onça Puma and Americano do Brasil is not available.
[26] https://www.spglobal.com/marketintelligence/en/news-insights/blog/profit-margins-key-to-tsingshans-battery-nickel-supply-plans

- **Providing nickel producers with access to Brazil's low-cost and low-emissions hydroelectric power.** In 2020, 66 percent of Brazil's electricity generation came from hydropower. Access to low-cost and low-emissions hydroelectricity in Brazil gives nickel producers a competitive advantage in their operating costs and carbon footprint. The nickel market is increasingly focused on the carbon footprint of nickel producers, feeding into the lithium-ion battery market, particularly given the high carbon footprint of Indonesian nickel producers. Figure 8 shows a global comparison of nickel production carbon footprints based on tonnes of $CO_2$ per tonne of nickel production, with Brazil having a low to medium carbon footprint, and Indonesia showing the highest carbon footprint. Addressing ESG challenges related to mining, smelting, refining, and tailings management in nickel production is becoming increasingly important to OEMs. Tesla has reportedly signed contracts with Vale in Canada, BHP in Australia, and Talon Metals in the United States for the supply of low-carbon footprint nickel. It is critical for nickel producers in Brazil to demonstrate to OEMs that these challenges are being addressed successfully throughout the value chain.
- **Ensuring Brazilian nickel projects achieve timely production by 2030 to capture potential higher returns of the forecast tight market.** Deloitte anticipates that three of the late-stage development projects (Araguaia, Piauí, and Jaguar) could come into production by 2030. If this is the case, these projects will likely benefit from the forecast tight nickel markets and the likely higher prices anticipated by the end of 2030. To ensure that these four projects come into production by 2030, the Government of Brazil should encourage these companies to apply for assistance under the Policy for Supporting the Environmental Licensing of Investment Projects for the Production of Strategic Minerals (Decree No. 10,657 of March 24, 2021)[27]. For example, the Government of Brazil recently selected three mining projects to receive accelerated environmental licensing support. Jaguar, was one of projects selected by the government.[28]
- **Developing downstream processing facilities to capture more of the nickel value chain domestically.** A portion of Brazil's nickel production could be refocused from direct exports towards the downstream development of domestic cathode-manufacturing and lithium-ion battery production. Proactive marketing by the Government of Brazil with existing global lithium-ion battery companies about investment and construction of battery Gigafactories in the country, may help to increase the consumption of domestic nickel production. The 'Colossus Cluster Minas Gerais', which aims to build a 35 GWh battery Gigafactory, an initiative between the Minas Gerais Investment and Trade Promotion Agency and US-based Bravo Motor Company, is the first such project under way.

[27] The Pro-Strategic Minerals Policy has been qualified under the Investment Partnerships Program (PPI), which is a government entity dedicated to expanding and accelerating the implementation of projects with the participation of the private sector in Brazil. Accordingly, if it meets specific criteria, the company that has a project of a mineral deemed strategic, may request that their project be qualified as a PPI project.
[28] The projects, all in northern Pará state, are considered by the Government of Brazil as strategic for the expansion of aluminum, nickel, and copper production. The selected projects include: Novas Minas, owned by Mineração Rio do Norte (aluminum), Centauros Níquel's Jaguar (nickel), and Pantera of Avanco Resources Mineração (copper).

### 4.1.4. Rare Earth Elements

#### 4.1.4.1. Key Findings

- **Brazil's existing REE production is low, but the country has significant potential to expand production.** Existing production of REEs in Brazil is limited, and production currently only comes from the Buena Industrial Unit, which is a monazite operation. The mine is currently in the decommissioning phase and monazite is only recovered from tailings reprocessing. The limited scale of current production notwithstanding, according to USGS, Brazil has the third largest reserve base (21 Mt – approximately 17 percent) of REEs in the world, and ANM reports REE resources (measured, indicated, and inferred) at 25.0 Mt[29]. Approximately 88 percent of these resources are in Araxá in Minas Gerais, where there is potential to extract REE from new and existing niobium mining operations. At present, Brazil has two advanced REE projects in development – Serra Verde (expected to commence production in 2022) and Morro do Ferro (at the pre-feasibility stage). There is also one earlier-stage exploration project (Bahia) which has the potential to produce the rare earth oxides (REO) from monazite contained in marine placers. This project is being acquired by U.S.-based Energy Fuels.[30]

- **Brazil has limited data available on its potential REE projects.** Deloitte evaluated potential REE operations worldwide, including in Brazil. Deloitte aggregated the production and economic details of 27 other projects (Figure 19 in the REE Report); however, a full comparative analysis was not possible because most project details were unavailable. Accurate data on the REE market is difficult to find, given the industry's relatively small size. Much of the REE mining, and most downstream processing and consumption takes place in China, which does not make industry data readily available. Consistent availability of geological data will be crucial to generating sustainable investor interest in REE in the mid-term to long-term.

- **China dominates the REE value chain.** China currently controls 61 percent of global REE mining capacity, 86 percent of the REO processing facilities, 93 percent of the rare earth metals processing operations, and 67 percent of rare earth permanent magnet (REPM) production. The future REE market outlook is very sensitive to the level of REE mine production in China. The lack of transparent Chinese supply figures therefore creates investor uncertainty, which slows the development of new mines in locations such as Brazil and, in turn, serves to solidify the competitive position of China.

- **REE demand is expected to expand dramatically over the next decade due to the increased use of REPMs.** The REPMs are critical inputs for EVs and wind turbines, among other low-emissions energy technologies. As a result, the rate of demand growth for REPMs out to 2030 is expected to be 6 to 8 percent annually. Brazil should be able to capture upstream (mine production) market share in the extraction of REE, but the country is unlikely to capture downstream growth in REPMs without significant investment and industrial development. As such, Brazil may need to purchase REO from China, unless it develops its own REO processing industry. Figure 11 provides a simplified overview of this REO process, from the mining of REO concentrate to the production of final components.

[29] This information is based on the old DNPM/ANM methodology.

[30] Energy Fuels Secures Major Rare Earth Land Position in Brazil - May 19, 2022

- **The current market supply-demand balance looks to remain tight until 2030, given that few new mines are likely to come on stream (see Section 9 in the REE Report)**. Market consensus is that neodymium and praseodymium (which are used in REPMs) will experience supply shortfalls toward the end of the decade, and prices will likely increase. Deloitte's analysis of the REE market (see Section 9 in the REE Report) shows that from a supply perspective, few new mines will likely come on stream before 2030, and demand will likely outpace supply. Capacity expansions from the two currently operating mines in the U.S. (Mountain Pass operated by MP Minerals) and Australia (Mt. Weld operated by Lynas Rare Earths), along with prospective expansion projects elsewhere in the world, will be needed to meet demand and balance the market by 2030. If the market moves into a deficit and REO prices remain strong, as forecasters project out to 2030, this higher price environment should help to encourage further REE exploration and development, including in Brazil.

#### 4.1.4.2. Key Recommendations

Brazil has a window of opportunity to ramp up its REE output over the next few years. The REE market is expected to be in deficit over the next decade, and if prices rise as a result (as is currently the case), the REE market could offer attractive returns for investors. The Government of Brazil should therefore look to further develop its resources and encourage investment in the longer term by:

- **Increasing access to, and circulation of, up to date REE resource data to domestic and international exploration companies to promote REE development in Brazil.** Increasing access to data may require gathering and distributing more extensive information from those regions that are considered to have significant REE potential. Legacy CPRM geological data, reports, and studies should be made more broadly available online in a range of languages. Brazil should also undertake appropriate marketing of these documents to expand their circulation and increase their impact.
- **Pursuing a faster and larger expansion of its existing REE production.** Brazil should accelerate discussions with the country's two REE proposed projects, bring forward the timing, and expand the scale of their planned operations.[31] Any expansion should satisfy economic return requirements, but the Government of Brazil could help expedite the projects by providing streamlined approvals, infrastructure support, workforce capacity building support, credit guarantees, higher capital allowances, and tax reductions, if required and appropriate.
- **Expediting the assessment of the potential of the Araxá region.** Brazil has the potential to produce REE as a by-product from an existing niobium mine in Araxá in Minas Gerais. The Brazilian Metallurgy and Mining Company (CBMM), a private entity, has been exploring the feasibility of producing REE from an existing niobium mine in Araxá in Minas Gerais for several years.[32] The status of this project is currently unknown, but Brazil should verify whether it can become a significant source of future REE production. Again, the project should satisfy economic return requirements, but

[31] Brazil has two advanced REE projects – Serra Verde (expected to begin production in 2022) and Morro do Ferro (at the pre-feasibility stage).

[32] CBMM is a private company and has not disclosed their expansion plans. As such access to additional information on their expansion plans is limited.

the Government of Brazil could assist by providing credit guarantees, higher capital allowances, and tax reductions. In addition, in 2018, Minas Gerais inaugurated the laboratory-factory for rare earth magnets (LabFab ITR), which is being developed by Brazilian Research Centers and Federal Universities.

- **Developing downstream processing facilities to capture more of the REE value chain.** Downstream REE processing is currently concentrated in China, but Brazil could process REO concentrates as part of a strategy to develop a downstream REPM industry. Processing REO concentrates would capture more of the REE value chain, provide skilled employment, and allow Brazil to produce REPMs. These are a key input into electric motors for EVs and wind turbines, and could be part of a strategy to also develop these industries further. Brazil could begin to achieve this by building a facility to process REO concentrate to produce REE. CBMM has also been working with the Institute for Technological Research (IPT) to assess the possibility of processing REO into REPM powders.
- **Undertaking a comparative review of Brazil's exploration and mining policies versus those of other countries with REE projects.** This review should analyze whether the Government of Brazil can encourage REE exploration and mine development through legal, regulatory, and ESG improvements. Such improvements may include simpler licensing and permitting processes, lower royalties, preferential tax rates, and more robust environmental policy.[33] The ultimate objective of such policy improvements should be to encourage development and stability for investors looking to develop Brazil's mineral sector as a whole, and REE specifically. The Pro-Strategic Minerals policy which focuses on simplifying the environmental licensing process by facilitating a dialogue between different environmental agencies in the country, is a right step in this direction.

### 4.1.5. Titanium

#### 4.1.5.1. Key Findings

- **Brazil is a relatively small producer of titanium.** In 2021, Brazil produced 66 thousand tonnes (kt) of titanium dioxide ($TiO_2$), which accounted for 0.7 percent of global $TiO_2$ production.[34] The largest global producers of $TiO_2$ are China (33 percent), South Africa (12 percent), Mozambique (11 percent), and Australia (8 percent). In Brazil, there are currently two producers of $TiO_2$: Tronox Pigmentos do Brasil (operating the Paraíba mine), and Indústrias Nucleares do Brasil (operating the Bueno mine). The Paraíba mine is scheduled to close at the end of 2023 due to resource depletion.[35]

[33] Effectively mitigating and managing the environmental impact of REE projects is challenging. It is a complicated process to isolate individual REEs into nearly-pure metal oxides due to their complex physio-chemical properties. Techniques, such as dry processing (dry processing techniques include gravity methods for separation of REEs and pilot techniques such as separation from coal ash and tailings) cause less harm to the environment; though the potential to create radioactive particles (e.g., uranium and thorium) as a by-product would require strict dust control measures to mitigate exposure risks to workers and surrounding communities.

[34] United States Geological Survey (USGS).

[35] The main use of titanium feedstock is to produce titanium pigments (90 percent of global TiO2 demand) for use in paints and plastics, principally as an opacifier. Some 6 percent of global output is used to make titanium metal for use in aerospace and defense, and in chemical processing plants. The balance is used for direct use in products, principally as a flux.

- **Brazil has unexploited titanium resources.** Brazil holds 90 million tonnes, or about 3.7 percent, of global titanium reserves and resources, as reported by S&P Global Intelligence. World titanium reserves and resources are concentrated in Australia (23 percent), Paraguay (16 percent), and South Africa (13 percent). Mozambique, Russia, Canada, and the United States also hold significant resources (See Table 2 in the Titanium Report for more details). Titanium reserves in Brazil are mainly located on the northeast coast of Paraíba.[36] Other important ilmenite deposits[37] have not yet been fully evaluated and occur along the Brazilian coastline in the form of beach placer deposits or marine terraces.
- **Two companies are seeking to expand titanium production in Brazil.** New titanium capacity is expected from Largo Resources [TSX: LGO], which is planning to begin constructing an ilmenite concentration plant in 2024 at its existing Maracás Menchen vanadium mine and a $TiO_2$ pigment processing plant in Camaçari. In addition, Jangada Mines [LSE: JAN] completed a feasibility study of the Pitombeiras project in Ceará in April 2022. The planned Pitombeiras mining operation is expected to focus on the direct extraction/export of a high vanadium-content iron ore, although Jangada Mines are also assessing the potential to extract $TiO_2$ from the tailings (*See* pg. 9 in the Titanium Report for more details).
- **Currently, there are limited opportunities for Brazil to expand titanium production.** As noted above, Brazil has significant titanium prospectivity, but there appears to be insufficient activity to bring the majority of those potential resources through the exploration process towards commercial viability. The only recent report of titanium exploration in Brazil was in May 2022, when U.S.- based Energy Fuels [NYSE: UUUU] announced an agreement to acquire the Bahia heavy mineral sands project, located on the coast in the State of Bahia. Energy Fuels stated that it planned to perform exploration work during 2022, and a preliminary economic assessment (PEA) is anticipated to be developed in the first half of 2023.[38]

#### 4.1.5.2. Key Recommendations

The titanium market is not large in size or value (compared with other major commodities), but it is a commodity important to consumer markets, as a pigment in paints, plastics, enamels and paper. The Government of Brazil should continue to allow the development of existing titanium assets and should encourage the development of further titanium resources in the longer term - either on a stand-alone basis or as a by-product in association with another commodity, such as vanadium. Given titanium's importance to consumer markets, local consumption of $TiO_2$ pigment is likely to continue rising as Brazil's gross domestic product (GDP) per person rises, the use of $TiO_2$-related products expands, and the per capita consumption of $TiO_2$ correspondingly increases. Brazil should be able to meet this new demand domestically, rather than rely on imports. Indeed, if higher living standards raise Brazil's titanium consumption closer to U.S. levels, it will require over 400 kt/y more of TiO2; an increase of over 500% above current levels of domestic production.

[36] S&P Global Intelligence

[37] Titanium minerals are found in hard rock deposits and in mineral sands deposits. Mineral sands are the most abundant class of economic titanium deposits and contain heavy minerals including titanium minerals. The most important, naturally occurring minerals that are mined to produce $TiO_2$ feedstock are ilmenite and rutile. Ilmenite is the most common titanium-rich mineral in the Earth's crust and accounts for 92 percent of the world's titanium mineral production.

[38] Energy Fuels has not released any publicly available information on the status of the Bahia project since May 2022.

Brazil should consider enhancing titanium-related investment in the longer term by:

- **Examining the potential of Largo Resources upgrading its planned $TiO_2$ pigment plant from a sulfate plant to a chloride plant.**[39] While the choice of plant is partly dependent on the quality of ilmenite and the $TiO_2$ pigment demands of the end-market, it may be possible to install a titanium slag upgrading plant and a chloride pigment operation, instead of a sulfate pigment plant. The sulfate process is older, less efficient, and produces a number of waste products that are difficult to treat, while the chloride process uses high grade feedstock to produce high quality $TiO_2$ pigment. The chloride process offers waste disposal, energy, and quality advantages over the sulfate process. Switching to a chloride plant may result in higher capital costs and additional technology requirements, but the benefits include significantly lower environmental footprint and a higher quality $TiO_2$ pigment, which is in strong global demand.[40]
- **Increasing access to, and circulation of, up to date titanium resource data to domestic and international exploration to promote titanium development in Brazil.** Increasing access to data may require gathering and distributing more extensive information from those regions (*e.g.,* Paraiba) that are considered to have significant titanium potential. Legacy CPRM geological data, reports, and studies should be made more broadly available online in a range of languages. Brazil should also undertake appropriate marketing of these documents to expand their circulation and increase their impact.

### 4.1.6. Cobalt

#### 4.1.6.1. Key Findings

- **Brazil has limited cobalt reserves and no production.** Brazil has not produced cobalt since 2016. The country's cobalt reserves are small, at 430 thousand tonnes (kt)[41]. This represents 1.7 percent of the 25 million tonnes (Mt) of global cobalt resources in 2021 estimated by USGS. The DRC accounts for 46 percent of global reserves and approximately 72 percent of mine production. China is the largest cobalt concentrates and chemicals processor, refining 67 percent of global cobalt supply.
- **Brazil has a limited number of new cobalt development projects underway.** The Deloitte team assembled a database of 30 global brownfield and greenfield cobalt projects that could potentially come onstream by 2030. Of these projects, 80 percent include planned brownfield expansions[42], are under construction, or are at final investment decision stage. However, due to financing, permitting, or other issues, it is possible that some of these projects may not reach the production stage by 2030.

  The above analysis includes one Brazilian advanced-stage nickel-cobalt exploration project (Piauí), which has a small, targeted average production level (0.9 kt/y) that is scheduled to start in late 2024. The analysis does not include Brazil's two earlier-stage nickel-cobalt exploration projects (Vermelho and Jacaré) because these are unlikely reach production by 2030. These projects look prospective, although the primary target commodity is nickel, and only small amounts of cobalt are expected to be recovered as a by-product.

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[39] The Largo Resources $TiO_2$ pigment plant not yet been built.

[40] Titanium dioxide pigments are produced from two chemical processes: the sulfate and the chloride process. China, the main producer of sulphate pigment, is recently building predominantly new chloride plants.

[41] See Table 2, in Section 3.1

[42] A brownfield expansion refers to the expansion of an existing mine.

- **Strong demand for lithium-ion batteries is driving up cobalt demand.** Roskill forecasts cobalt demand to increase to 258 kt by 2030. This represents a compound annual growth rate (CAGR) of 6.7 percent, from the Cobalt Institute's estimate of 135 kt consumption in 2020. Cobalt is primarily used in manufacturing batteries, which accounted for 57 percent of global cobalt consumption in 2020. Other major cobalt uses include nickel-base alloys mainly used in turbine engine components (14 percent of consumption), and hard materials used in carbides for cutting tools (8 percent). Brazil's imports of cobalt are relatively small, in line with its limited battery manufacturing capacity.
- **Forecasters project cobalt prices to decline from their current highs as the market moves into surplus by 2030.** The Deloitte team's analysis shows that cobalt supply from mine production and recycling could increase to 311 kt by 2030, a CAGR of 8.1 percent, from 142 kt in 2020. Roskill forecasts demand of approximately 258 kt. These forecasts imply a significant surplus of 59 kt by 2030. Cobalt prices are expected to decline from their current high levels but remain around $57,000/t − well above historical average prices of $39,400/t since 2010. The impact on Brazil will be limited given that it does not currently produce cobalt, and new production out to 2030 will be small.
- **Cobalt consumers are concerned with ESG challenges surrounding cobalt production.** ESG is an important issue for cobalt consumers, given that the majority of production currently comes from the DRC (a country under the spotlight for its track record on human rights and child labor), and much new cobalt capacity is anticipated to come from Indonesia (where land clearance, habitat loss, and high energy consumption from coal-fired power stations also raise ESG concerns). Both DRC and Indonesia are attempting to address these challenges, but such ESG concerns may potentially provide a market opportunity for Brazil's cobalt projects to be developed in a more ESG-friendly manner. For example, Brazil's predominant use of hydroelectricity, compared to the use of thermal (coal) generation in Indonesia, means that Brazil's mining industry has an inherent competitive advantage in terms of its carbon footprint. This is becoming increasingly important to manufacturers of lithium-ion batteries and OEMs when sourcing raw materials, and it may provide an opportunity for Brazil to secure off-take agreements for cobalt and associated nickel products, potentially at a price premium.

#### 4.1.6.2. Key Recommendations

The Government of Brazil could look to further develop its resources and encourage investment in the longer term by:

- **Streamlining access to, and circulation of, up-to-date domestic cobalt resource data to domestic and international exploration companies to encourage exploration and to promote cobalt development in Brazil.** This may require gathering and distributing more extensive information for those regions considered to have significant cobalt potential. Legacy CPRM geological data, reports, and studies should be broadly published online and in multiple languages. Brazil should also actively 'market' these documents to expand their circulation, use, and impact.
- **Promoting the ESG advantages of Brazilian cobalt projects to accelerate access to development finance and facilitate regional investment.** Nickel-cobalt projects in Brazil have systemic ESG advantages relative to DRC copper-cobalt and Indonesian nickel-cobalt producers. Access to low-cost, low-emissions hydroelectricity in Brazil gives nickel-cobalt producers a competitive advantage in both operating costs and carbon footprint. This advantage could potentially lead to better mine offtake terms, improved access to ESG-focused sources of development finance, and similarly enabled

downstream regional investment in cathode-manufacturing facilities and lithium-ion battery manufacturing.

### 4.1.7. Copper

#### 4.1.7.1. Key Findings

- **Brazil's copper reserves[43] and resources[44] are relatively small, and the country is not a major copper producer.** Global growth in copper mine supply in recent years has primarily come from South America. Chile is currently the largest producer, accounting for 27 percent of global production in 2021, followed by Peru (11 percent), China (9 percent), DRC (9 percent), and the United States (6 percent). Brazil has 0.6 percent of global copper reserves and resources, and produces 1.6 percent of the world's mined copper[45] and 0.7 percent of global refined copper.[46] Brazil has eight operating copper mines (Salobo, Sossego, Chapada, MCSA Mining Complex, Pedra Branca, Antas, Celestra, and Serrote – see Table 6 in the Copper Report), which produced approximately 350 thousand tonnes (kt) of copper in 2021. Production is dominated by two mines, Salobo (145 kt/y) and Sossogo (82 kt/y), accounting for 65 percent of Brazil's 2021 production. The other mines are considered to be mid-to-small-scale. Brazil also has one active copper project at late-stage development (Boa Esperanza), and one project at prefeasibility stage (Alemao), although both are relatively small copper projects, compared with other global projects. Brazil does not have currently-identified large-scale copper resources (at least 100 kt/y potential – see Figure 7 in the Copper Report) that could be developed to support a new world class copper mine.
- **The copper market is forecast to be in deficit in 2030 (excluding the impacts of Russia's invasion of Ukraine).** The Deloitte team's analysis of the supply and demand outlook shows that new copper mine production and increases in scrap supply are unlikely to meet increases in refined copper demand from 2030. Supply in 2030 is forecast at 31.5 million tonnes (Mt) and demand is forecast at 34.1 Mt, suggesting a supply deficit of 2.6 Mt. This further suggests that more investment is required in greenfield and brownfield production, which will in turn likely require high copper prices (relative to history). Consensus currently expects copper prices to remain in a long-term range of $8,400/t to $8,900/t ($3.80/lb to 4.00/lb), compared with an average of $6,704/t ($3.04/lb) from 2010 to 2020. The industry currently faces cost pressures, particularly from higher energy prices, but at these price levels the copper industry would still be expected to make above average returns. The copper market could also be affected by the potential for continued restrictions on Russian exports, as a result of that country's invasion of Ukraine. Russia is the eighth largest producer of copper, accounting for 4 percent of global production in 2021.
- **The decarbonization of energy will play an important role in the future demand for copper.** Copper plays a central role in the ongoing decarbonization movement within energy markets. Copper enables renewable energy generation technologies, the implementation of EV battery technologies, and the construction of/interconnection with grid infrastructure. Geographically, China is likely to continue to be a major driver of global

[43] The amount of copper that could be economically extracted or produced at the time of determination, defined by a high level of exploration.

[44] The amount of copper that could potentially be economically extracted based on geological evidence but has a lower level of mineral exploration.

[45] U.S. Geological Survey (USGS) 2021.

[46] British Geological Survey 2019 (BGS)

copper consumption, given that China's demand accounted for 59 percent of global copper consumption in 2021.

- **Brazil is mainly an exporter of copper concentrate and importer of refined copper.** In 2020, Brazil exported $2.4 billion (3.9 percent of gloAbal trade) of copper concentrate and imported $1.25 billion (1.8 percent) of refined copper. Comparatively, it exported $126 million (0.2 percent) of refined copper and imported $480 million (0.8 percent) of copper concentrate. If Brazil further develops its downstream manufacturing capabilities for items such as renewable energy equipment and auto batteries, it may prove necessary to import additional refined copper or expand existing smelting and refining facilities to process more of its domestic copper concentrate to cathode copper.

#### 4.1.7.2. Key Recommendations

The Government of Brazil should continue to further develop its resources to meet global demand and encourage investment in the longer term by:

- **Streamlining access to, and circulation of, up-to-date domestic copper resource data to domestic and international exploration companies to encourage exploration and to promote copper development in Brazil.** This may require gathering and distributing more extensive information for those regions considered to have significant copper potential, including the Carajás district in the state of Pará. Legacy CPRM geological data, reports, and studies should be broadly published online and in multiple languages. Brazil should also actively 'market' these documents to expand their circulation, use, and impact.
- **Ensuring copper producers (currently 15 mines and projects) utilize Brazil's low-cost and low-emissions hydroelectric power or other renewables.** In 2020, 66 percent of Brazil's electricity generation came from hydropower, although most of the capacity is located in the north. Brazil has abundant wind resources, and wind capacity is increasing in the south, and solar is increasing rapidly from a low base. Access to low-cost and low-emissions hydroelectricity or other renewables in Brazil would give copper producers a competitive advantage in their operating costs and carbon footprint. The copper market is increasingly focused on the carbon footprint of copper producers.
- **Ensuring Brazilian copper projects achieve timely production by 2030 to capture potential higher returns of the forecast market deficit in 2030.** The Deloitte team anticipates that two development projects (Boa Esperanza and Alemao) could come into production by 2030. If this is the case, these projects will likely benefit from the forecast copper market deficit and higher prices noted above that are expected to occur by that date. These projects have already applied and received acceptance for assistance under the *Policy for Supporting the Environmental Licensing of Investment Projects for the Production of Strategic Minerals* (Decree No. 10,657 of March 24, 2021).[47] The Government of Brazil has already selected Boa Esperanza and Alemao, plus the early-stage Pantera exploration project owned by Avanco Resources[48], and a dozen other mining projects to receive accelerated environmental licensing support.

[47] The Pro-Strategic Minerals Policy has been qualified under the Investment Partnerships Program (PPI), which is a government entity dedicated to expanding and accelerating the implementation of projects with the participation of the private sector in Brazil. Accordingly, if it meets specific criteria, the company that has a project of a mineral deemed strategic, may request that their project be qualified as a PPI project.
[48] https://www.gov.br/mme/pt-br/assuntos/secretarias/geologia-mineracao-e-transformacao-mineral/ctapme

- **Developing downstream processing facilities to capture more of the copper value chain domestically.** A portion of Brazil's copper concentrate production could be refocused from direct exports towards the downstream development of facilities to produce more domestically refined copper. Proactive marketing by the Government of Brazil with existing global mining, smelting, and refining companies (including Vale S.A.) could then lead to the development of further copper cathode facilities in Brazil. Preferred access to clean hydropower has the potential to make such facilities, and the cathode copper they produce, particularly attractive to end users in the renewables industry.

### 4.1.8. Tantalum

#### 4.1.8.1. Key Findings

- **Brazil's tantalum reserves and resources are significant. Brazil is a relatively large tantalum producer globally.** Brazil has 40 thousand tonnes (kt) of tantalum reserves and produced 470 t of tantalum in 2020, equivalent to 23 percent of global mine production.[49] Based on company reported data, it has 20 percent of global reserves and resources, which are located mainly in the Pitinga tin mine and the Mibra lithium mine. Other occurrences of tantalum in Brazil have been reported, but there are currently no active Brazilian exploration or development projects that plan to produce tantalum directly or as a byproduct. World tantalum reserves and resources are concentrated in Australia, Brazil, Canada, China, DRC, Nigeria, and Rwanda. However, the scale of tantalum resources in central Africa have never been fully documented and remains an open question. This said, USGS considers the existing identified world resources of tantalum in Australia, Brazil, and Canada adequate to ongoing and projected needs.
- **The tantalum market is very small and opaque.** The tantalum supply chain is relatively complex and opaque, and detailed information on both production and consumption is limited. Supply side data is complicated by the fact that around 50 percent of production comes from artisanal and small-scale mining (ASM) in central Africa (the DRC, Rwanda, Uganda, and Burundi), and much of the balance is produced as a byproduct of bulk commodity mining operations. Furthermore, tantalum processors that buy and process ores and other concentrates maintain variable amounts of working inventory, in large part due to the uncertainty of supply, which can also distort annual supply chain data. On the demand side, there is a relatively small number of tantalum processors, who tend to be wary of antitrust issues and do not freely disclose volume and pricing information. These factors make analyzing and forecasting the tantalum industry difficult.
- **The Deloitte team expects new tantalum supply from lithium producers to move the market into surplus.** The Deloitte team anticipates that tantalum supply will increase over the next few years as the recent supply constraints due to COVID-19 unwind, as an increasing amount of byproduct tantalum is produced from the expansion of some existing lithium mines, and from several new lithium mines scheduled to come on-stream. Even if demand increases modestly (as expected), it is still likely that the market will be in surplus given the number of new projects scheduled to start operations, producing tantalum as a byproduct.

[49] USGS

- **There are limited opportunities for Brazil to expand tantalum production**. Other than the two existing mines (Pitinga and Mibra), there are no other known active tantalum exploration or development projects in Brazil. The Mibra mine is currently expanding lithium capacity, but it is unclear whether tantalum output will also be increased.

#### 4.1.8.2. Key Recommendations

The tantalum market is small in both size and value, and Brazil already provides a significant portion of that mined output. Expanding tantalum output by further developing existing assets is a logical step, but actively promoting and developing new tantalum-bearing resources in the short-to-medium term may not represent the best prioritization of MME's limited assets. Longer term, additional tantalum output is most likely to occur as a by-product in association with other commodities, such as niobium or lithium. Such longer-term investments could be encouraged by:

- **Increasing access to, and circulation of, up-to-date tantalum resource data to domestic and international exploration companies to promote tantalum development in Brazil:** It appears that no in-depth study of Brazilian tantalum resources has occurred in recent years, and MME should consider developing one. Increasing access to data may require prioritizing, gathering and distributing information from those regions that are considered to have significant potential. Such data should be made available online in a range of languages, and Brazil should appropriately market such materials to expand their circulation and increase their impact.

### 4.1.9. Vanadium

#### 4.1.9.1. Key Findings

- **Brazil does not have significant vanadium reserves and resources**. Brazil has a relatively low level of vanadium reserves and resources, accounting for 0.9 percent of identified global mineralization as reported by S&P Global Intelligence (Table 1). In 2020, Brazil had reserves of 0.12 Mt vanadium.[50] China holds 40 percent of global vanadium reserves, with Russia accounting for 22 percent, Australia 18 percent, and South Africa 15 percent.
- **Brazil is a relatively small but low-cost producer of vanadium.** Brazil is the fourth largest producer of vanadium in the world; however, its production accounts for only six percent of the global output. It currently only has one mine producing vanadium (Maracás Menchen operated by Largo Resources), and one vanadium project at an advanced stage of development (Pitombeiras operated by Jangada Mines). The largest producers of vanadium are China (60 percent), Russia (17 percent), and South Africa (7 percent). Brazil exports vanadium pentoxide ($V_2O_5$) in concentrate (6.6 kt vanadium), primarily to the Netherlands and South Korea, with smaller quantities sent to Canada, India, Japan, France, and the United States. Brazil's vanadium production is relatively low cost due to high grades and low levels of contaminants.
- **Producers are seeking to expand vanadium production in Brazil.** Largo Resources, the country's sole vanadium producer, producing 13.2 kt/y $V_2O_5$, is currently undertaking a project to additionally produce vanadium oxide ($V_2O_3$), and constructing a new ilmenite concentration plant. Largo is also considering the construction of a ferrovanadium plant. Jangada Mines, an exploration company, expects to bring the Pitombeiras project (an advanced stage project) online by 2024, producing 46.5 kt/y $V_2O_5$ as well as titanium dioxide.

[50] U.S. Geological Survey

#### 4.1.9.2. Key Recommendations

The global vanadium market is relatively small and is expected to be in deficit from 2021 to 2023, followed by a surplus in 2024 to 2029, and again a deficit in 2030, according to Roskill. It is therefore unlikely that new vanadium production is likely to benefit from sustained appreciation of commodity prices. As such, the Government of Brazil might want to consider supporting the further development of its vanadium industry, and encourage downstream opportunities, by:

- **Streamlining access to, and circulation of, up-to-date domestic vanadium resource data to domestic and international exploration companies to encourage exploitation and to promote vanadium development in Brazil.** This may require gathering and distributing more extensive information for those regions considered to have significant vanadium potential, including Bahia and Ceará. Legacy CPRM geological data, reports, and studies should be broadly published online and in multiple languages. Brazil should also actively market these documents to expand their circulation, use, and impact.
- **Undertaking a comparative review of Brazil's exploration and mining policies/initiatives versus other vanadium-producing countries.** Such a review would take approximately 12 to 18 months and would analyze and prioritize how Brazil's government could encourage and accelerate vanadium exploration and mine development through potential legal, regulatory, and ESG improvements. Such improvements could include simpler licensing and permitting processes, lower royalties, preferential tax rates, and a coordinated approach to environmental policy. The ultimate objective of such policy improvements should be to encourage development and stability for investors seeking to develop Brazil's mineral sector generally, and vanadium in particular. Brazil's 2021 Pro-Strategic Minerals Policy[51], which focuses on simplifying the environmental licensing process by facilitating a dialogue between different national environmental agencies, is a right step in this direction.
- **Developing downstream vanadium redox flow batteries (VRFBs) to capture more of the value chain.** Brazil could consider becoming a VRFB producer by leveraging the experience of Largo Resources, its main vanadium producer. Largo Resources manufactures VCHARGE, a VRFB system, in the United States. The Government of Brazil may wish to encourage Largo Resources to expand its battery manufacturing activities into Brazil by offering credit guarantees, higher capital allowances, and tax reductions. This would then allow Largo Resources to use the vanadium mined in Brazil to produce domestic VRFBs, or manufacture VRFBs for export, rather than exporting the run-of-mine commodity itself.

[51] Through the Pro-Strategic Minerals policy, the Government of Brazil has issued a list of specific critical minerals it aims to boost production of, and that are deemed of special interest to the country. Resolution No. 2 of June 18, 2021, defines the list of strategic minerals for the country. https://www.in.gov.br/web/dou/-/resolucao-n-2-de-18-de-junho-de-2021-327352416. Through the Pro-Strategic Minerals policy, the Government of Brazil is focusing on easing the environmental licensing process by facilitating, for example, the dialogue between the environmental agency responsible for conducting the environmental licensing process and authorities such as the managing bodies of Conservation Units, the National Indian Foundation (Funai), the National Institute for Colonization and Agrarian Reform (Incra) and the National Institute of Historic and Artistic Heritage (Iphan).

## 4.2. Appendix 1: Renewable Energy and the Use of Critical Minerals

#### 4.2.1.1. Key Highlights

- The global levelized cost of energy (LCOE) for renewables has decreased over the past 15 years, and in many places, wind and solar are cheaper than thermal power generation (natural gas and coal).[52] According to Lazard, between 2009-2018, the price of solar dropped by 86 percent.[53] This drop in cost has catalyzed the adoption of utility-scale renewable energy and shifted planned new generation capacity towards wind and solar, and away from gas and coal.
- The most important technologies expected to dominate the clean energy market are wind, solar, hydrogen, and smart electric grids [transmission and distribution (T&D) networks]. Lithium-ion batteries for both electric vehicles (EVs) and battery energy storage systems (BESS) are also a key technology. Building out these technologies and industries will require a substantial increase in the supply of certain commodities (some of them critical minerals, such as REE, lithium, cobalt, nickel, platinum, and others) over the coming decades[54]. Lithium, nickel, cobalt, manganese, and graphite are currently crucial to lithium-ion batteries; REEs are essential for permanent magnets in wind turbines and EV motors; non-critical minerals, such as copper, silicon, and silver, are used in solar panel applications; vanadium is used in renewable energy technology for stationary energy storage in vanadium redox flow batteries; titanium (and tantalum, although in smaller amounts) are inputs to wind turbines; and T&D networks need a large amount of copper and aluminum.
- The Russian invasion of Ukraine has increased global uncertainty around the availability and price of oil and natural gas. Many governments, especially in Europe, which has been particularly impacted by fuel shortages and price increases, are reconsidering their energy policies and implementing plans to accelerate the clean energy transition. In addition, Russia is a major producer of a number of critical minerals and metals including aluminum, nickel, palladium, and vanadium. The Russian invasion of Ukraine has increased global uncertainty and triggered supply constraints and price spikes for multiple commodities. The price of aluminum and nickel reached 10-year highs in February 2022; similarly, the price of palladium and vanadium have seen rapid spikes since January 2022. This type of volatility in commodity prices can cause problems for producers and consumers; it could, for example, encourage buyers to take a more conservative, risk-averse approach, which means a preference towards longer-term contracts with less spot trade. Some primary consumers may also consider expanding vertical integrating their supply chains once the uncertainty subsides.
- The acceleration of the pace of renewable energy deployment, will be dependent on robust and transparent critical mineral supply chains. Key risks to such supply chains will include: the geological availability of specific critical minerals; the time required to develop mines and processing plants to recover commodities; the geopolitical energy landscape (with focus on China's market dominance in the processing and refining of critical minerals); and the social and environmental impacts of mining projects. As countries

[52] Levelized Costs of New Generation Resources in the Annual Energy Outlook 2022 (eia.gov)

[53] Solar Power Cost Rapidly Decreasing, Chart Shows (businessinsider.com)

[54] Critical Minerals & Materials | Department of Energy.

focus on expanding their domestic mining, production, processing, and recycling[55] of critical minerals, they will also have to address the growing issues of labor standards, environmental justice, and community engagement.

Table 2 below summarizes market trends and green uses for the nine critical minerals analyzed under Task 2A.

**Table 2: Green Uses for Select Mineral Commodities Analyzed Under Task 2A**

| Group | Clean Technology Applications/Green Uses | Market Overview and Potential |
|---|---|---|
| **Graphite** | • Key input for batteries and electrodes (anodes for lithium-ion battery), in the development of EVs.<br>• Fuel-cell applications utilizing graphite plates in battery storage may require increased graphite demand. | • Growing, long-term demand for EVs and energy storage continues to drive the demand for graphite<br>• Drawbacks include middlemen and the need for long-term offtake agreements. China dominates the production and processing of graphite. |
| **Lithium** | • Key component on all traction batteries currently used in EVs as well as consumer electronics (mobile phones, laptops, and portable tools).<br>• Lithium-ion batteries are widely used in many other applications as well, from energy storage to air mobility. | • It will be challenging for lithium supply to keep up with demand growth over the next decade. Current forecasts all suggest that the lithium market will remain in deficit, even with timely financing and the development of new capacity.<br>• Attempts to accelerate demand are becoming visible with some planned mining projects and new chemical plants increasing in size. Consequently, the market will need to develop new types of lithium sources such as clays and evaporites to meet demand. |
| **REEs** | • Key roles as inputs to green energy generation, storage, and control systems, magnets in motors and generators, and the IC chips in control systems from cell phones to EVs. | • Positive market demand and outlook to 2030 and beyond.<br>• Supply is limited, and few mines operate at scale outside China. |
| **Cobalt, Nickel, Copper** | • Key inputs to wind power, solar cells, and EV battery production.<br>• Nickel and cobalt hold roles in the next wave of EV battery and battery storage development, often substituting for each other in various types of technologies. | • Predicted near-term demand (and price) for copper, nickel, and cobalt expected to increase through 2040.<br>• Increased EV demand and over-dependence on DRC causing a surge in exploration for new deposits or sources of cobalt. |
| **Titanium and Vanadium** | • Key input to wind power turbines, geothermal piping, catalytic | • Long-term, steady demand for titanium due to China's increase in imports. |

[55] According to the Institute for Sustainable Futures (ISF), recycling of metals from end-of-life batteries has the greatest opportunity to reduce primary demand for battery metals, including demand for cobalt, lithium, nickel, and manganese.

| Group | Clean Technology Applications/Green Uses | Market Overview and Potential |
|---|---|---|
| | converters for EVs and grid energy storage capabilities.<br>• New redox battery technology may support increased use of vanadium. | Competitive market, with over eight major producers.<br>• Vanadium demand likely to grow, tied to steel production and energy storage technology. |
| **Tantalum** | • Though small amounts needed, tantalum are inputs to wind turbines and solar arrays. | • Projected steady growth for tantalum; new opportunities with 5G technologies may absorb current over-capacity. |

## 4.3. Appendix 2: Leading Practice Mineral Policies in Western Australia and Canada

### 4.3.1. Introduction

The Deloitte team reviewed the policy initiatives for both Canada and Western Australia impacting the following key areas: (i) historical production and development of critical minerals; (ii) investment opportunities and incentives; (iii) policy, legal, regulatory, and governance framework development; (iv) fiscal regime incentives; and (v) ESG requirements. Table 3 below provides a high-level analysis of specific policy initiatives from Western Australia and Canada, and summarizes lessons learned from these countries that Brazil should consider implementing into their overall framework for regulating, developing, and managing their critical minerals.

#### 4.3.1.1. Key Highlights

**Table 3: Comparative Case Studies**

| Country | Leading Practice Analysis and Lessons Learned |
|---|---|
| **Western Australia** | **1. Historical Production and Development of Critical Minerals**[56]<br>• **Summary:** Western Australia is a major supplier of critical minerals. It accounts for around 50 percent of global lithium production and is a major exporter of nickel, cobalt, manganese and REEs. Western Australia has 127 high-value mining projects, with hundreds of smaller projects totaling to almost 1,000 operational mine sites. These projects combined produce over 50 commodities, including iron ore, gold, nickel, lithium, and base metals.[57] Western Australia's lithium producers are some of the lowest cost producers in the world. Western Australia produces lithium at less than half the cost of Chile, the world's second largest producer, and at around a quarter of the cost of US production.<br>• **Key Developments Impacting Production and Development of Critical Minerals in Western Australia include:**<br>○ Three of the **world's largest lithium producers**—Tianqi Lithium (China), Albemarle (United States) and SQM (Chile) have partnered with Australian companies like IGO[58], Mineral Resources, and Wesfarmers to build and operate battery-grade lithium |

[56] https://www.wa.gov.au/system/files/202207/220630_Battery%20and%20Critical%20Minerals_Prospectus-Web.pdf

[57] Microsoft Word - 000718.Elliot.SAMSON (dmp.wa.gov.au)

[58] IGO is a leading ASX-listed exploration and mining company focused on discovering, developing and operating high quality assets focused on metals critical to enabling clean energy.

| Country | Leading Practice Analysis and Lessons Learned |
|---|---|
| | hydroxide facilities in Western Australia. Tianqi Lithium has achieved commercial production of the Kwinana lithium hydroxide refinery located in Western Australia.[59]<br>○ BHP Nickel West commenced operations at its battery grade nickel sulphate plant in Kwinana, Western Australia, in 2021.[60]<br>○ The Lynas Mt Weld mine in Western Australia is one of the world's premier rare earths deposits. It is established as an **ethical and environmentally responsible producer of rare earth materials**. It is the world's only **significant producer** of separated rare earth materials **outside of China**.[61]<br>○ Iluka is building Australia's first fully integrated REE refinery, which will have the capability to produce both light and heavy rare earth oxides. This provides customers with **a new source of REE products** sourced directly from one producer, **operating as an independent market participant**.[62] |
| **Western Australia** | **2. Investment Opportunities and Incentives**<br>• **Summary:** Since the mid-2010s, Western Australia has attracted more than $9 billion of investment for a range of battery and critical mineral projects, including the establishment of globally significant mineral processing facilities.[63] An increase of government support of mining exploration has stimulated investment in Western Australia, leading to new mineral and energy discoveries.<br>• **Key Developments Impacting Investment in Critical Minerals in Western Australia include:**<br>○ **The *Exploration Incentive Scheme (EIS)* is a government initiative that aims to encourage exploration in Western Australia for the long-term sustainability of Western Australia's resources sector**. This initiative was funded in July 2019, giving $10 million per year for exploration activities using funds collected through Mining Tenement Rents.[64] This was increased to $12.5 million per year since then. The increased knowledge of the State's geology and resources will support further investment, increasing employment opportunities and state revenue. A recent independent economic impact assessment found that **every $1 million invested in the EIS generates $31 million in benefits to the State**. EIS covers five areas: exploration drilling, geophysical surveys, encouraging exploration through cover, 3D prospectivity mapping, and promoting strategic research with industry. There are numerous programs under EIS to refund a portion of exploration costs and a Junior Minerals Exploration Initiative that allows smaller companies to convert their tax losses into a tax credit that can be used to attract new investors, encouraging new greenfield exploration. The EIS **offers up to a 50 per cent refund for innovative exploration drilling projects**. Funding support is available through the Co-funded Exploration Drilling Program and the Co-funded Energy Analysis Program.<br>○ **Western Australia launched the *Future Battery and Critical Minerals Industries Strategy* in 2019**. This strategy outlines the government's vision to **grow Western** |

[59] https://www.nsenergybusiness.com/news/kwinana-lithium-hydroxide-refinery-commercial-production/

[60] https://www.wa.gov.au/system/files/2022-07/220630_Battery%20and%20Critical%20Minerals_Prospectus-Web.pdf

[61] https://lynasrareearths.com/

[62] https://iluka.com/operations-resource-development/operations/western-australia#:~:text=Iluka%20is%20building%20Australia's%20first,range%20of%20third%20party%20suppliers.

[63] Charging up investment in WA's battery and critical minerals industries (www.wa.gov.au)

[64] Exploration Incentive Scheme (EIS) (dmp.wa.gov.au)

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| | **Australia's participation in global battery and critical mineral supply chains,** with the primary goal of increasing domestic value-add manufacturing.[65] The initiative aims to match the strong mineral reserves, specifically in metals required for batteries, such as lithium, nickel, cobalt, manganese, and alumina, while growing Western Australia's battery industry into a prominent sector, source of new jobs, economic development, and diversification. The 2020-2022 revision of the strategy[66] included five elements, including: 1) Growing participation in global supply chains for both minerals and battery technology; 2) Highlighting investment opportunities in Western Australia across the value chain, including in mining, processing, and advanced manufacturing to promote value-add products; 3) Developing a certification scheme for their critical minerals to increase transparency of the ESG standards across the supply chain; 4) Promoting the use of energy storage and battery project development across rural communities and different industries; 5) Strengthening the local workforce capability to be prepared for job requirements for value-add opportunities in the battery and critical mineral sectors and identify skill gaps and training plans. |
| **Western Australia** | **3. Policy, Legal, Regulatory, and Governance Regime**<br>• **Summary:** The legal and regulatory frameworks for mineral development in Western Australia include the following key legislation, amongst others: Mining Act 1978, Mining Regulations 1981, and Offshore Minerals Act 2003. Mining Act 1978[67] outlines the law relating to mining and covering the land area of Western Australia and the first three nautical miles of the territorial sea. Mining Regulations 1981 outlines the standards, processes, and procedures for obtaining licenses and conducting mining operations. The Offshore Minerals Act 2003 formalizes the Offshore Constitutional Settlement, which outlined an Australia-wide common minerals legislative framework applicable to all of the territorial sea. Mining tenements and applications that touch this area are under the jurisdiction of the Offshore Minerals Act and not the Mining Act.[68] Investors can rely on **stability and predictability of the legal and regulatory regime**. The government's focus on **streamlining business, policy, and investment processes combined with their record of environmental, social, and legal stability** allows for mutually exclusive and successful foreign investment.<br>• **Key Developments Impacting Policy, Legal, Regulatory, and Governance Regime for Critical Minerals in Western Australia include:**<br>○ **New National Critical Minerals Strategy 2022:** The updated strategy was published in March 2022[69] to focus on **developing the Western Australian critical minerals sector, expand downstream processing, and help meet future mineral demand globally**. The strategy was **developed in consultation with industry and community stakeholders**, including traditional owners.<br>○ **Fast Tracking Mining Approvals Strategy**: The focus of this strategy is to **streamline regulatory approvals for mining to fast-track mining projects to production**. These changes will not affect environmental, safety or heritage standards, and construction of |

[65] https://www.wa.gov.au/system/files/2021-01/Future%20Battery%20and%20Critical%20Minerals%20Industries%20Strategy%20Update%202020_1_0.pdf

[66] Western Australia's Future Battery and Critical Minerals Industries (www.wa.gov.au)

[67] Mining Act legislation (dmp.wa.gov.au)

[68] Mining Act legislation (dmp.wa.gov.au)

[69] Critical Minerals Strategy 2022 | Department of Industry, Science and Resources

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| | the projects cannot occur until the **mining proposal is assessed and is environmentally acceptable**.[70]<br>○ **The Foreign Investment Review Board:** The board **reviews proposals individually**, so that they can verify that they align with national interest. Because of a clear, well-established framework, investors can meet expectations for an acceptable proposal. As a result, most proposals can be considered in 30 days, with only three (3) resource-related proposals rejected since 2001.<br>○ **The Geoscience Data Transformation Strategy:** The $10.6 million strategy will transform the State's billions of dollars' of geoscience information into intelligent data suitable for machine learning and artificial intelligence. It will **stimulate mining exploration and unlock billions of future wealth initiatives**.[71]<br>○ **The Greenhouse Gas Storage and Transport Draft Bill:** This bill provides Western's Australia's mining, LNG, and natural gas industries with access to opportunities to decarbonize, such as mineral carbonation and carbon capture, utilization and storage.[72] |
| **Western Australia** | **4. Fiscal Regime and Incentives**<br>• **Summary:** Western Australia has a **straightforward, tiered royalty system that applies a rate depending on the state of the mineral** at the time of sale. Most mining projects are subject to percentage rates according to the value of the mineral in its sale state. The royalty system is based on the **idea that mineral resources are owned by the community**, the royalty is the purchase price for the mineral resource, and as such, the **community expects a fair return for the exploitation of its non-renewable mineral endowment**. A key factor in Western Australia's **low sovereign risk status** is its royalty system, which **provides the industry with a straightforward, transparent, stable, and predictable arrangement**. Western Australia requires prospecting and exploration licenses for the early stages of a project, as well as mining leases for operational mines. The royalty system is three-tiered and applies royalty rates depending on the form of the mineral when it is sold (e.g., ore, concentrate, or final form) and the level of processing. Western Australia uses two systems to collect mineral royalties: (i) Specific rate: a flat rate per tonne of mineral produced – generally applied to low-value construction and industrial minerals; and (ii) Ad valorem – proportion of the "royalty value" of the mineral (defined as the quantity of the mineral in the form in which it is first sold the multiplied by the price in that form, minus deductions)<br>• **Key Developments Impacting Fiscal Regime for Critical Minerals in Western Australia include:**<br>○ **Clear mining tax regime:** Mineral royalty rates were established by the Mining Act 1904 and Mining Act 1978, as well as additional State Agreements in Western Australia. This **structure was designed with equity, efficiency, adequacy, stability, transparency and simplicity** in mind to **encourage investment and proper management**. The basis of the royalty rates is to return about 10 percent of the value of the ore, excluding transportation and processing and is applied to the minerals when they are first sold. Royalties are applied on a specific material across an industry, opposed to evaluating on a mine-by-mine basis. The following three-tier royalty rates, introduced in 1981,[73] apply to the various stages of processing:<br>▪ Bulk materials (crushed and screened), 7.5 percent of free-on-board value, i.e. the value on a ship for export. |

[70] https://www.dmirs.wa.gov.au/sites/default/files/atoms/files/227494_about_dmirs_2022_web_0.pdf
[71] https://www.dmirs.wa.gov.au/sites/default/files/atoms/files/227494_about_dmirs_2022_web_0.pdf
[72] https://www.dmirs.wa.gov.au/sites/default/files/atoms/files/227494_about_dmirs_2022_web_0.pdf
[73] Mineral Royalties (dmp.wa.gov.au)

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| | ▪ Mineral concentrates, 5 percent of the value.<br>▪ Metallic form, 2.5 percent of the value<br>○ **Industry centered approach:** The *Future Battery and Critical Minerals Industries Strategy* was launched in January 2019 to increase cooperation across government agencies with the mining industry. This initiative provides a framework for government agencies to coordinate a clear message to investors to focus on investment attraction, project facilitation, research and development, and adoption of new battery technologies. Increased incentives supporting the construction of local infrastructure across the entire battery value chain helps attract investors and the government focus on facilitating strategic project planning by serving as a partner, to enable access to industrial land, common-user infrastructure, resources, supplies, and a workforce. This industry centered and holistic approach has increased investment in local mining and processing projects, while expanding their contribution to the battery supply chain.<br>○ **Temporary assistance to maintain production:** A royalty rebate scheme was introduced for by the State Government at the end of 2020 to three lithium mineral producers in Western Australia: Galaxy Resources' Mt Cattlin operations, Pilbara Minerals' Pilgangoora operations and Altura Mining's Pilgangoora operations. Spodumene – the mineral from which lithium is derived – has seen a fall in prices over the last two years, putting these companies' operations at risk. The mining company will receive a **50 per cent royalty rebate on spodumene concentrate** for up to 12 months for operational mines, **where the employee count does not drop significantly from current numbers**. If prices improve significantly (equal to or greater than $550 per tonne for a given quarter), the rebate will not be provided. This industry supported measure is **designed to assist in preventing the loss of more than 600 jobs and save more than $20 million in annual royalty revenue** over the coming years. At the conclusion of the assistance period, the companies will fully repay the rebates over a period of two years, so that there is no cost to the State Government. This indicates to potential investors that the government is dedicated to the success of mining activities and will intervene to support if needed. |
| **Western Australia** | **5. ESG Regime Requirements**<br>• **Summary:** Western Australia is a **leader in environmental regulations for mining** with a strong regulatory regime for environmental and community impacts, and for geotechnical, physical, and geochemical stability of mining projects from their inception to reclamation, and closure. Western Australia places a **high importance on protection of biodiversity**, **indigenous communities**, and **archeological resources**. Western Australia takes a holistic approach in their governance structure, considering the environmental, Aboriginal community, and worker's right. This **approach engages all stakeholders of potential mining projects** and outlines clear expectations and guidelines so that projects are completed in an expected and responsible manner so that all stakeholders benefit.<br>• **Key Developments Impacting the ESG Regime for Critical Minerals in Western Australia include:**<br>○ **Work Health and Safety (Mines) Regulations 2022:** Western Australia's mining regulatory regime includes a strong, well-defined mining health and safety regulatory framework governed by the *Mines Safety and Inspection Act of 1994* and *Mines Safety Regulations 1995*, and executed by *Department of Mines, Industry Regulation, and Safety (DMIRS), Safety Regulation Group*.[74] In 2022, the Government of Western |

[74] Government of Western Australia Department of Mines, Industry Regulation and Safety, "Minerals safety legislation", Historical Legislation and compliance, accessed October 20, 2022, http://www.dmp.wa.gov.au/Safety/Minerals-safety-legislation-8321.aspx

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| | Australia amended its safety programs with the new Work Health and Safety Act, which strengthened protections for workers and auditing processes. DMIRS is the safety regulator for the minerals, petroleum, and dangerous goods industries in Western Australia, and executes its safety functions through the Safety Regulation Group. The government formed the Group in 2017; the Group engages with the mining industry in two ways: (i) raising awareness of safety roles and health matters in the workplace; and (ii) seeking compliance with and enforcement of safety legislation when necessary. DMIRS has six groups which coordinate and regulate mining sector-related activities under the umbrella of a Director General, including the Safety Regulation Group, which is the principal enforcer of mine health and safety. Western Australia demonstrates its **commitment to health and safety regulatory operations through comprehensive strategic objectives**. For example, the Safety Regulation Group reports their progress and conducts their operations to drive the *Towards 2020 Regulation Strategy*, goals for world-leading regulation, smarter systems, and well-informed industry. Western Australia is an **excellent example of a government mining regulator that performs a variety of safety functions, reports often, and uses their revenue in a strategic way to streamline and conduct operations on a regional level**. Its safety and health regulatory functions are important in that Western Australia's government reports annually to maintain regulatory effectiveness, transparency, and achieve an overall goal of improved mine health and safety.<br>○ **Protect and support indigenous peoples**. Western Australia began a review of the Aboriginal Heritage Act of 1972 in early 2018 to identify issues and their corresponding gaps in legislation through **consultation of industry representatives, Aboriginal people, cultural professionals**. As result of this research, the Aboriginal Cultural Heritage Bill was passed to provide greater protections of the Aboriginal community and their heritage. They will be able to better negotiate how their lands can be used for mining.<br>○ **Address challenges in employee's working environment**. The State Government released a risk management framework in April 2019 to address the psychosocial hazards of fly-in, fly-out labor, which is common for many extraction projects in Western Australia. The framework aims to **foster strong mental health for these workers** through a supportive culture, appropriate accommodations with time for breaks and recreation. Additionally, the Work Health and Safety Action replaced previous legislation to not only address physical health, but also mental wellbeing.<br>○ **Evaluate environmental impacts as it relates to current climate change goals**. Australia's Environmental Protection Agency released updated guidelines for the evaluation of greenhouse gas emissions to be included in the environmental review process. Proposals for new projects or significant expansions that undergo environmental review will be subject to evaluation on how the specific project will hinder or enable the government to meet their net zero goal by 2050. Western Australia's specific climate goals reference a focus on decreasing emissions from the mining industry and leverage the Net Zero Emission Mining projects which is led by the Minerals Research Institute of Western Australia. This program offers up to $1.5 million of co-funding to reduce energy use of mining projects, potentially through improving mining and processing mechanisms, as well as additional funding for small to medium mining equipment, technology and services businesses. |
| **Canada** | **1. Historical Production and Development of Critical Minerals**[75]<br>• **Summary:** Canada is one of the leading mining countries in the world and one of the largest producers of minerals and metals. Canada currently ranks fifth globally in the production of nickel, it's a key global producer of copper and cobalt, and hosts advanced mineral projects |

[75] https://www.canada.ca/en/campaign/critical-minerals-in-canada/canadian-critical-minerals-strategy.html

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| | for REE, lithium, and vanadium. Valued at $102 billion in 2020, mineral exports accounted for 21 percent of Canada's total domestic exports. Canada is seeking to build more resilient critical mineral global supply chains by working with international partners to align policies; raise economic and ESG standards; advance joint research and development; and encourage new investment opportunities.<br><br>• **Key Developments Impacting Production and Development of Critical Minerals in Canada include[76]:**<br>○ **The Canada-U.S. Joint Action Plan on Critical Minerals** is focused on advancing bilateral interest in securing supply chains for the critical minerals needed for strategic manufacturing sectors, including clean technology, aerospace and defense, and communication technology.<br>○ **The Canada-EU Strategic Partnership on Raw Materials** is focused on engaging the European Commission and European Union Member States on Canada's critical mineral and battery value chains. The objective of the partnership is to advance the value, security and sustainability of trade and investment into the critical minerals and metals needed for the transition to a green and digitalized economy.<br>○ **The Canada-Japan Sectoral Working Group on Critical Minerals** is focused on facilitating commercial engagement between Canadian and Japanese businesses across the critical mineral value chain, strengthen government-to-government information sharing, and encourage cooperation on international standard setting for critical minerals.<br>○ **Multilateral Engagements:** Canada is pursuing other initiatives on critical minerals to support the global transition to green energy and more resilient supply chains. Notable multilateral organizations and initiatives include the G7/G20; the International Energy Agency (IEA); the World Bank; the International Renewable Energy Agency (IRENA); the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF); and the Energy Resource and Governance Initiative (ERGI).<br>○ **Other Developments**: At the end of 2022, citing national security concerns, the Canadian government ordered **the divestiture of three Chinese investors in Canadian critical minerals companies**. The approach in Canada is closely aligned with the U.S. and Australia, which have implemented similar frameworks to place greater regulatory scrutiny on foreign investments in the critical minerals sector. |
| **Canada** | **2. Investment Opportunities and Incentives**<br>• **Summary:** *Investment Canada Act* (ICA), is Canada's federal legislation that regulates foreign direct investments into Canada. On Dec. 9, 2022, Canada published its new *Critical Minerals Strategy*.[9] The Strategy has as its key objective for Canada to become a global supplier of choice for critical minerals and the clean digital technologies they enable. It outlines the following priorities for the government: increase investment, boost extraction, enhance regulatory oversight, and harmonize policies with allies, all while being mindful of growing national security considerations tied to critical mineral supply chains.<br>• **Key Developments Impacting Investment for Critical Minerals in Canada include:**<br>○ As part of the Critical Minerals Strategy, the government developed the **Strategic Innovation Fund (SIF)** to **support critical mineral projects** and a **new 30 percent critical mineral exploration tax credit (METC)** that will be introduced and become available to investors under certain flow-through share agreements to support |

[76] https://www.canada.ca/en/campaign/critical-minerals-in-canada/our-critical-minerals-strategic-partnerships.html

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| | specified exploration expenditures in Canada. The overarching objective of the SIF investment (government budget for 2021 and 2022 includes a $1.5 billion for SIF) is to help **build a world-class critical mineral supply chain** that can **lighten the dependency** of Canada on foreign supply chains.[77]<br>○ The Federal Government proposed to provide up to **$3.8 billion from its FY22 budget** to support over eight years the **implementation its new Critical Minerals Strategy**. The budget notes that the government's investment focus will be on "priority critical mineral deposits" and that the government will **work closely with affected Indigenous groups** and through **existing regulatory processes**. A key focus of this strategy is making critical mineral mining projects less risky: The budget outlines the following:<br>▪ "Up to **$1.5 billion over seven years**, starting in 2023-24, for **infrastructure investments that support the development of the critical minerals supply chain**s, with a focus on priority critical mineral deposits.<br>▪ **$79.2 million over five years**, starting in 2022-23, for Natural Resources Canada to provide public **access to integrated data sets to inform critical mineral exploration and development.**<br>▪ **$144.4 million over five years**, starting in 2022-23, to Natural Resources Canada and the Natural Resource Council to support **research, development and the deployment of technologies and materials to support critical mineral value chains**. These investments aim to make Canada an attractive country for investments to develop these supply chains.<br>▪ **Investments** aimed at **facilitating existing regulatory processes**, including those applicable to critical minerals projects, such as:<br>▪ $**10.6 million over three years**, starting in 2024-25, to Natural Resources Canada to **renew the Centre of Excellence on Critical Minerals**. The Centre works with provincial and territorial governments and other partners to **provide direct assistance to help developers navigate regulatory processes** and existing support measures; and<br>▪ Up to $**40 million over eight years**, starting in 2022-23, to **Crown-Indigenous Relations** and Northern Affairs Canada to **support Northern regulatory processes**.<br>▪ **$70 million over eight years**, starting in 2022-23, to Natural Resources Canada to **advance Canada's global leadership on critical minerals**, in particular to meet its responsibilities under the *Extractive Sector Transparency Measures Act*, and aim to make Canada a trusted partner in the global critical minerals supply chain."[78]<br>○ On October 28, 2022, the government adopted the *Policy Regarding Foreign Investments from State-Owned Enterprises (SOEs) in Critical Minerals under the Investment Canada Act. The Policy was issued due to concerns related to* some investments into Canada by SOEs being motivated by non-commercial imperatives that are contrary to Canada's interests. The purpose of the Policy is **to attract responsible investments that support Canada's national security objectives**.[79] |

[77] https://www.jdsupra.com/legalnews/canada-s-new-critical-minerals-strategy-7118171/

[78] https://www.torys.com/our-latest-thinking/publications/2022/04/federal-budget-2022-invests-in-critical-minerals-development-in-canada

[79] https://mcmillan.ca/insights/foreign-investment-in-canada-minerals-are-critical-and-annual-report-released/

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| **Canada** | **3. Policy, Legal, Regulatory, and Governance Regime**[80]<br>• **Summary:** Canada is a federalist state with responsibilities and powers split between the Federal Parliament and the ten provincial governments. The provincial legislatures have legislative jurisdiction over the natural resources and so are primarily responsible for regulating the exploration and extraction of minerals. The Constitution Act, 1867 outlines the federal government's legislative authority, including taxation and regulating trade and commerce, and anything not under the exclusive jurisdiction of the provinces. The 1982 amendments to the Constitution Act, 1867 explicitly define and recognize the provinces and territories' jurisdiction and rights to manage their own non-renewable natural resources.[81] Canada's three territories, the Yukon, the Northwest Territories, and Nunavut are under federal jurisdiction but governed by three territorial governments. The Yukon and Northwest Territories regulate mineral rights within their respective territories but mineral rights in Nunavut are under federal law.<br>• **Key Developments Impacting Policy, Legal, Regulatory and Governance Regime for Critical Minerals in Canada include:**<br>○ **The Canadian Minerals and Metals Plan was established in 2020**, with annual action plan released every year. The **six strategic goals** of this plan provide additional government resources to support economic development and competitiveness, indigenous participation, the environment, innovation, local communities, and global leadership. Each goal focuses in on discrete actions that are published in the annual action plan. Federal, provincial, and territorial governments led the development of this pan-Canadian plan in collaboration with partners and stakeholders to set a forward-looking strategy to solidify Canada's position as a global mining leader.[82]<br>○ On Dec. 9, 2022, Canada published its new **Critical Minerals Strategy** to "increase the supply of responsibly sourced critical minerals and support the development of domestic and global value chains for the green and digital economy."[83] The Strategy includes **five key focus areas**, including: support economic growth, competitiveness, and job creation; promote climate action and environmental protection; advance reconciliation with Indigenous peoples; foster diverse and inclusive workplaces and communities; and enhance global security and partnerships with allies.<br>○ Applicable federal laws still apply to all mining projects, including laws regarding the environment, indigenous peoples, and imports and exports.<br>○ **Territorial governments provide regulations for mining activities**, unless on federal lands or if it involves uranium, of which the Canadian government oversees. Canada has **separate regulatory bodies** in each of the ten provinces, three territories, and the federal government to provide oversight of mining activities in each jurisdiction. Each province has different ministerial bodies, legislation, and regulations for mining activities, including mineral rights, ESG requirements and standards, workplace protections, etc. For example, in British Columbia, the Ministry of Energy, Mines, and Petroleum Resources is responsible for the mining sector, but the Ministry of Environment and Climate Change Strategy, the Environmental Assessment Office, and the Ministry of Forests, Lands, Natural Resource Operations and Rural Development provide additional oversight of mining operations. |

[80] Mining in Canada: overview | Practical Law (thomsonreuters.com)

[81] Roles and Responsibilities of Governments in Natural Resources (nrcan.gc.ca)

[82] What is the Canadian Minerals and Metals Plan? (minescanada.ca)

[83] Introducing Canada's Critical Minerals Strategy - Canada.ca

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| | ○ The federal government has indicated **plans to align its laws closer to the United Nations Declaration on the Rights of Indigenous Peoples**. This has been echoed by some provinces, including British Columbia, which has enacted its Declaration on the Rights of Indigenous Peoples in 2019.[84] Canadian current law does not include the right of Indigenous veto, which exists in the United Nation Declaration.<br>○ From a regulatory enforcement perspective, British Columbia is **proposing an amendment to its Mines Act** to **separate the responsibility for the permitting of mines from the oversight, health, safety, and enforcement responsibilities**. The Chief Inspector of Mines currently is responsible for both functions. The proposal would create a **separate Audit Unit** headed by a Chief Auditor focused solely on compliance and enforcement.[85] The goal of these changes is to **increase permitting efficiency** and **improve decision-making timeframes** while providing **regulatory and safety oversight to prevent environmental disasters, especially related to tailings management**. |
| **Canada** | **4. Fiscal Regime and Incentives**<br>• **Summary**: In additional to income tax, mining companies must pay mining taxes and/or royalties to the corresponding jurisdiction of their mining operation. Most providences evaluate the mining and processing operations profit, with many providences deducting a processing allowance, capital depreciation, and exploration expenses to end up with the taxable income. Key fiscal incentives include:<br>○ **Mineral Exploration Tax Credit (METC):** 15 percent to enable exploration companies to gather equity funds in addition to the regular tax deduction associated with flow-through share (see below) investments.<br>○ **Canadian Exploration Expense**: 100 percent deductible in the year that they occur and used to offset pre-product development expenses;<br>○ **Foreign Resource Expense and Foreign Exploration and Development Expense Claims**: 10 – 30 percent for exploration and development expenses incurred abroad by Canadian mining companies.<br>○ **Flow-Through Shares**: Corporations can issue flow-through shares on certain expenses to the share purchases to reduce taxable income with a 100 percent tax deduction for the amount invested in the shares and a 15 percent tax credit for any eligible expenses.<br>• **Key Developments Impacting the Fiscal Regime for Critical Minerals in Canada include:**<br>○ **Territorial mining royalties are defined by the territories:** The Quartz Mining Act[86] defines the Yukon mining royalties. The Northwest Territories Lands Act[87] legislates the Northwest Territories mining royalty rates, and the Nunavut Mining Regulations[88] outline the Nunavut mining royalty scheme. There are multiple financial mechanisms to support the mining industry, including support of exploration activities. Because of the mining industries cyclical and capital intensive natural, with long timelines until revenue generations, the income and mining tax systems aim **to help mining companies** |

[84] Mining in Canada: overview | Practical Law (thomsonreuters.com)
[85] Mining in Canada: overview | Practical Law (thomsonreuters.com)
[86] Quartz Mining Act (yukon.ca)
[87] Mining Regulations (gov.nt.ca)
[88] Nunavut Mining Regulations (justice.gc.ca)

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| | **recover their initial capital investment before significant taxes**. There are also **expense claim structures for exploration and development activities**.<br>○ **Special tax treatments under income tax laws incentivize mining investment across the entire value chain**. These programs include adjustments to capital cost allowances, with a 25 percent depreciation rate on qualifying mining capital assets and an even further accelerated rate assets for assets acquired before commercial production or major expansions greater than 5 percent of the mine's gross income. There are also **stipulations that allow for loss carry-over to reduce the impacts of price fluctuations**.<br>○ **Unique financing options allow mining companies to raise capital from investors to support projects**. One such instrument is **flow-through shares, which allow a company to obtain financing for development and exploration activities tax free**. The expenses flow-through to the investor, who then gains tax advantages, including tax deductions. In addition, there is METC that allows for a **15 percent credit to enable exploration companies to gather equity funds** in addition to the regular tax deduction associated with flow-through-share investments. The METC was extended in 2018 so that it is active until March 31, 2024. This tax credit can be applied against federal income tax obligations a company has in the year the investment was made. The credit if flexible and can be carried back three years and carried forward 20 years. Taxpayers can also claim the Canadian Exploration Expense (CEE) deduction at the same time, which applies to both federal and provincial or territorial income tax liabilities. |
| **Canada** | **5. ESG Regime Incentives**<br>• **Summary:** Canada has numerous initiatives to facilitate comprehensive ESG, including the following: Impact Assessment Act of 2019 (replacing the Canadian Environmental Assessment Act of 2012); Towards Sustainable Mining Initiative; and Green Mining Initiative.<br>• **Key Developments Impacting ESG Regime for Critical Minerals in Canada include:**<br>○ A focus on innovation to improve more environmentally friendly mining practices: Canada's Green Mining Initiative fosters innovation to enhance mine productivity, minimize water usage, manage mine waste, and improve energy efficiency. CanmetMINING, a branch of the Natural Resource Canada, manages the research plan and performance monitoring for these goals. Attaching research efforts to targeted goals to establish a greener mining industry will enable Canada to best meet their climate change goals and make mining a more environmentally friendly industry.<br>○ **Clear impact planning**: In 2019, Canada enacted the Impact Assessment Act (IAA), replacing the Canadian Environmental Assessment Act (2012). This updated framework continues to **provide clear, comprehensive expectations for applicants and expanded the mechanisms to consider the environment, impacted communities, and Indigenous peoples**. The IAA focuses on both the positive and negative aspects of a major project, like mines, roads, or dams, on the economy, environment, people, and communities. The goal of the Act is to **identify and understand potential impacts during the project development phase and to outline mitigation strategies to address potential negative impacts**. The IAA created the Impact Assessment Agency of Canada, which leads the federal impact assessments. The Agency is responsible for managing the process but multiple parties participate, including: the proponent, who must submit project plans, studies, and potential impacts and mitigation measures; experts, including scientists and representatives from other government agencies to provide information across the scope of the project, including social, health, economic, and environmental factors and mitigation measures; indigenous groups, including First Nations, Metis, and Inuit communities, who provide expertise on the project impacts and highlight potential impacts on their communities from the projects; and the general |

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| | public, including both individuals and community groups, who provide local knowledge and insights and share how projects might impact communities.<br>○ **Active public participation:** Canada aims for **robust public participation as part of an "open, informed, and meaningful impact assessment process."** Engaging the public in matters that affect their community enables them to not only voice concerns related to a project, but also better understand the benefits. Their input can lead to design changes that lead to improved outcomes. With the focus of identifying potential problems before they occur, impact assessments require plans to mitigate these harms if the project moves forward, for which public input is crucial and valuable. Requirements for public participation plans also clearly communicate the activities that companies can take to engage communities about their projects.<br>○ **Focus on involvement of indigenous communities in the impact assessment process:** The Canadian government outlined a specific **indigenous engagement plan to gather input from indigenous communities and allow them to establish the level of involvement** they would like in the assessment process with the agency. The applicant is responsible for compiling a list of potential impact communities, as well as information on how they plan to include these communities in the different phases of the impact process. In addition, the new legislation includes funding for the public and indigenous peoples to participate in the assessment process. These programs **provide reimbursements to applicants** for staff salaries, administrative costs, external third-party fees, and travel expenses for individuals, non-profit organizations or indigenous groups when contributing to an impact assessment.<br>○ **Meeting climate commitments:** Canada enacted the *Strategic Assessment of Climate Change* in August 2019. The IAA introduces new requirements focused on a project's environmental, health, social, and economic effects, which are reviewed during the federal impact assessment. The expressed purpose of the *Strategic Assessment of Climate Change* is to support the Government of Canada to meet their commitments regarding climate change for the Paris Agreement, Canada's individual 2030 target, and their overall goal of achieving net-zero emissions by 2050. Each new requirement provides clear methodologies and review procedures to support project proponents to convey to regulators how a specific project will affect Canada's climate commitments. The new requirements also provide for engaging projects throughout the impact review process, with early engagement as a first step. Quantifying and describing net greenhouse gas emissions, upstream greenhouse gas assessments for potentially large emissions projects, and transparent review criteria are integral parts of this legislation.[89] In addition, aligning with the increased climate commitments in the future years, regulators also tighten stipulations and focus on impact throughout the project timeline.<br>○ **A clear framework with public key performance indicators helps mining companies communicate their benefit to communities while meeting societal expectations:** In 2004, the *Towards Sustainable Mining (TSM)* initiative began requiring site-level reporting on 30 indicators of social and environmental performance, leading to annual assessments from C through AAA. The individual indicators detail assessment criteria categorized into eight (8) protocols: biodiversity conservation, climate change, crisis management, indigenous and community relationships, child and forced labor, safety and health, tailings management, and water stewardship. For example, the biodiversity protocol has three (3) performance indictors: corporate biodiversity |

[89] Government of Canada, "Strategic Assessment of Climate Change", Canada.ca, October 2020, accessed October 7, 2022, https://www.canada.ca/en/services/environment/conservation/assessments/strategic-assessments/climate-change.html

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| | conservation commitment, facility level biodiversity planning and implementation, and biodiversity conservation reporting. For the biodiversity conservation reporting indicator, the criteria are listed for each assessment level, with AAA requiring management review these biodiversity reports that are independently verified on a regular basis and community feedback on the report is sought out and reported to the public. The criteria are updated every few years to incorporate new information and standards, with the last update occurring in 2019. |
| **Brazil** | **1. Historical Production and Development of Critical Minerals**<br>• **Summary:** Similarly to Western Australia and Canada, Brazil has a long mining history and has grown as a critical mineral producer. Brazil is **third largest producer of graphite in the world**, and the **second largest producer of high-quality flake graphite; the sixth largest lithium producer and the eighth largest nickel producer**.[90] The Government of Brazil is taking strategic steps to increase critical mineral production in the country. Through the **Pro-Strategic Minerals policy, the government has issued a list of specific critical minerals it aims to boost production of, and that are deemed of special interest to the country.** These minerals include lithium, graphite, nickel, cobalt, vanadium, tantalum, copper, REE, and titanium, amongst others. Similarly to Western Australia, Brazil is also a **low cost producer for lithium. In addition, Brazil is also a low cost producer of vanadium.** Brazilian **graphite mining operations** in Minas Gerais are among the **most profitable operations** in the world. Brazil's existing REE production is low, but the country has significant potential to expand production.<br>• **Key Development Impacting Historical Production and Development for Critical Minerals**<br>  • Unlike Western Australia and Canada, Brazil has only a small electric vehicle industry and does not have facilities to process lithium, so it can be used for batteries. **Exports are seen as a good solution to advance the country's lithium sector**. Specifically, Sigma Lithium Resources' **Grota do Cirilo project production is earmarked for South Korean battery company LG Energy Solution Ltd**., a partnership that may further increase the role of Brazil in the market. Brazil could become a midstream processor of lithium chemicals as part of a greater strategy to develop a downstream lithium-ion battery industry. Brazil could achieve this by constructing a facility to process the spodumene ore produced by Sigma Lithium Resources into lithium carbonate and/or lithium hydroxide (Brazil currently plans to export this ore unprocessed). This type of venture may also help to encourage the construction of cathode-manufacturing facilities and lithium-ion battery manufacturing. Discussions with existing global lithium-ion battery companies about investment in Brazilian initiatives, such as 'Colossus Cluster Minas Gerais', which aims to build a 35 GWh battery Gigafactory, may help to accelerate the business case for commercial lithium processing.<br>  ○ Brazil exports 85 percent of its nickel production. If Brazil decides to **develop downstream battery facilities**, it is likely **that battery grade nickel would be available or could potentially be produced by Brazil's nickel industry**. Recently, the US Government announced investment of $30 million in the mining company TechMet (in Piaui) for processing strategic minerals nickel and cobalt in Brazil.<br>  ○ The Government of Brazil **has developed a number of key national initiatives** (discussed below) to further **develop its critical mineral sector, participate, and collaborate in diversifying the supply chain**. "There is interest from Brazil to **import minerals from Latin America and collaborate in the industrialization chain**. Brazil is in the transition to low-carbon energy and this is a good opportunity to **strengthen** |

[90] S&P Global

| Country | Leading Practice Analysis and Lessons Learned |
|---|---|
| | **relations with neighboring countries** as well as to jointly **develop new technologies**," said the Director of the Department of Mineral Transformation and Technology, Ministry of Energy and Mining, Brazil.[91]<br>○ **Lessons Learned:** The Government of Brazil should **encourage its existing producers to pursue faster and larger expansions** for specific mines such as the lithium mines operated by Companhia Brasileira de Lítio (CBL) and AMG Brazil. The government should also encourage that certain **projects, such as the nickel projects achieve timely production by 2030** to capture potential higher returns of the forecast tight market. Any expansion would need to be done on an economically sustainable basis, but the government could assist by **implementing measures, such as credit guarantees, higher capital allowances, and tax reductions**, as required and appropriate. In addition, the government should focus on **developing downstream processing facilities to capture more of the nickel value chain domestically.** A portion of Brazil's nickel production could be refocused from direct exports towards the downstream development of domestic cathode-manufacturing and lithium-ion battery production. **Proactive marketing** by the Government of Brazil with existing global lithium-ion battery companies about investment and construction of battery Gigafactories in the country, may help to increase the consumption of domestic nickel production. |
| **Brazil** | **2. Investment Opportunities and Incentives**<br>• **Summary:** The Government of Brazil has taken strategic steps to attract responsible investors in the country. Such steps include **easing its mineral leasing laws** in order to attract foreign investment for lithium, nickel, and copper mines**; streamlining the licensing process** of newly listed strategic mineral projects through the development of the Pro-Strategic Mineral Policy and **reducing restrictions on foreign ownership** of mining projects along Brazil's border area.<br>• **Key Development Impacting Investment in Critical Minerals in Brazil Include:**<br>○ The Government of Brazil issued ***Decree No. 11,120 of July 5, 2022***, which allows for **unrestricted foreign trade operations of lithium minerals, ores, and their derivatives**. According to this decree, Brazilian lithium imports and exports will no longer require preliminary authorization from government entities. This measure is expected to **attract lithium investments**.[92] This measure is "expected to move lithium investments in Eastern Europe and Asian countries towards Brazil"[93]. This measure could also **increase legal certainty and predictability for mining companies**, while reducing bureaucracy.<br>○ The Government of Brazil has also issued ***Decree No. 10,657, of March 24, 2021, the Policy for Supporting the Environmental Licensing of Investment Projects for the Production of Strategic Minerals (Pro-Strategic Minerals Policy)***. Pro-Strategic Minerals policy allows for an acceleration of development procedures to reach critical mineral production, mainly by **easing the licensing process of newly listed strategic** |

[91] https://www.igfmining.org/beps/blog/three-emerging-policy-trends-for-critical-minerals-in-latin-america/

[92] The Decree No. 11,120, of July 5, 2022, allows for foreign trade operations of lithium minerals, ores. and their derivatives. The measure promotes the opening and dynamization of the Brazilian lithium market, with the objective of positioning Brazil in a competitive way in the global chain and attracting investments for research and mineral production, and for the advancement of production capacity in the stages of processing and production of components and batteries.

[93] https://www.reuters.com/markets/commodities/brazil-eases-rule-lithium-exports-amid-rising-demand-2022-07-07/

| Country | Leading Practice Analysis and Lessons Learned |
|---|---|
| | **mineral projects**[94]. The Pro-Strategic Minerals Policy has been qualified under the **Investment Partnerships Program (PPI)**, which is a governmental body dedicated to expanding and accelerating the implementation of projects with the participation of the private sector in Brazil. The Decree also instituted the Inter-ministerial Committee for the Analysis of Strategic Mineral Projects (CTAPME), including representatives from the PPI, the Ministry of Mines and Energy (MME), the Ministry of Science, Technology and Innovations, the Institutional Security Office, and the Special Secretariat for Strategic Affairs of the Presidency of the Republic. CTAPME will **analyze projects** and select those considered highly important for the country's development. It will also serve as an **intergovernmental mechanism to help expand production of strategic minerals in an environmentally sustainable way**.<br>○ **The US – Brazil Critical Mineral working group** is expected to support the advancement of bilateral diplomatic engagement and technical cooperation on critical minerals, including improving critical minerals security in the United States and Brazil, promoting economically viable mining and production streams, stimulating investments, promoting technological innovation and increasing U.S.-Brazil interconnectivity throughout supply chains for critical minerals.<br>• **Lessons Learned:** The initiatives outlined above, show a willingness and commitment by the Government of Brazil to attract responsible foreign investment. Brazil should continue to focus on **building an investment framework** to support critical mineral projects. The government could assist by **implementing measures, such as credit guarantees, higher capital allowances, and tax reductions**, as required and appropriate. The government may also want to consider an **innovation fund similar to the SIF in Canada** to support exploration activities. The government should provide **specific financial incentives**, similar to those in Canada and Western Australia, **to support the implementation of its National Mining Plan (PNM) 2050.** |
| **Brazil** | **3. Policy, Legal, Regulatory, and Governance Regime**<br>• **Summary:** The main laws and regulations on mining in Brazil are the following: (i) Mining Code and its regulatory decree; (ii) Federal laws on specific mining regimes; (iii) National Policy on Dams Safety; and (iv) Regulations from the National Mining Agency (Agência Nacional de Mineração or ANM). In parallel to mining, environmental matters are subject to both federal, state and municipal laws. As certain aspects of mining activities are required to consider environmental matters, state and municipal laws on this regard also apply to mining, in addition to federal laws.<br>• **Key Development Impacting Policy, Legal, Regulatory, and Governance Regime include:**<br>○ **Similar to Western Australia and Canada, the Government of Brazil is enhancing its current policy, legal, regulatory, and governance framework to increase critical mineral production and responsible investment in the country.** Specifically, the development of key documents such as the **PNM 2050** which outlines long-term objectives for the mineral sector in Brazil, the **development of the Pro-Strategic Mineral Policy** which streamlines the licensing process, **the Lithium Decree** which allows for **unrestricted foreign trade operations of lithium minerals, ores, and their derivatives**, and the **establishment of CTAPME** tasked with analyzing projects in the mining sector and helping expand production of strategic minerals in an environmentally |

[94] Through the Pro-Strategic Minerals policy, the Government of Brazil has issued a list of specific critical minerals it aims to boost production of, and that are deemed of special interest to the country. Resolution No. 2 of June 18, 2021, defines the list of strategic minerals for the country. https://www.in.gov.br/web/dou/-/resolucao-n-2-de-18-de-junho-de-2021-327352416

| Country | Leading Practice Analysis and Lessons Learned |
|---|---|
| | sustainable way, and the **development of a draft regulatory framework for exploitation of REE** which is in progress, are examples of critical steps the government has taken to advance developments in a mining sector in line with leading practices. Furthermore, from a sector governance perspective, the creation of the **ANM** in 2017 as an **autonomous regulator** with the authority to ensure that mineral resources in Brazil are managed in a **socially sustainable** way represents an important institutional development for the country. Important regulations regarding **tailings dams' safety and mines closures have been developed or updated**, utilizing leading practice regulatory policy tools such as **regulatory impact assessment and stakeholder engagement**.<br>○ **Lessons Learned:** The Government of Brazil should continue to build on legal and regulatory reform. As part of this process, the government should consider the following to further advance the development of the mining sector and attract responsible investments include (i) **update key legislative pieces** governing the mining sector, such as the Mining Code (1967) and complementary regulations; (ii) **streamline access to and circulation of up-to-date domestic resource data** to domestic and international exploration companies to encourage exploitation and to promote critical mineral development in Brazil; (iii) **gather and distribute more extensive information** for the regions considered to have significant potential; (iv) **publish more broadly** online and in a range of languages legacy CPRM geological data, reports, and studies; and (v) '**market'** these documents to expand their circulation, use, and impact. Brazil would also benefit from **fostering the systematic collaboration and coordination between the federal and sub-national administrations** (states and municipalities) to ensure regulatory coherence, reduce overlaps and regulatory gaps, and to use resources more efficiently. |
| **Brazil** | **4. Fiscal Regime and Incentives**[95]<br>• **Summary:** In Brazil, there are **no special tax incentives for the mining industry**; the mining projects can use the general incentives provided for all other activities. Brazilian legislation **does not provide for any tax advantages or incentives** to persons engaged in mining activities, or their investors and lenders. Specifically:<br>○ The Brazilian corporate income tax (IRPJ) is levied at the rate of 15 percent on taxable profits;<br>○ A 10 percent surcharge is levied on the actual profits, presumed profits or profits determined by the tax authorities, in excess of 240,000 reais per year;<br>○ Brazilian legal entities are **allowed to carry forward losses indefinitely**, which is of paramount importance for companies that undertake exploration, development and later mining activities; however, such losses can only offset 30 percent of taxable profits, which can result in deferral of the utilization of the losses in the event that the legal entity sustains material losses and profits that are not substantial;<br>○ **Mining activities are subject to a statutory royalty known** as *Financial* Compensation for *Mineral* Resource Exploitation **(CFEM),** which is calculated based on the revenue arising from the sale of the mineral product. **Royalties from CFEM aim to mitigate negative impacts on mining regions**. The rate varies depending on the substance and, in most cases, the applicable rate is 2 percent. The highest rate currently is applicable to iron ore, at 3.5 percent (although it may be reduced to 2 percent for marginal projects). The rate for gold is 1.5 percent. The tax reform currently under Congressional review, may result in an increase of the CFEM rates; |

[95] https://www.dentons.com/en/insights/newsletters/2022/january/17/dentons-global-mining-guide/dentons-global-mining-guide-2022/brazil#Taxes

| Country | Leading Practice Analysis and Lessons Learned |
|---|---|
| | ○ **Allowable deductions are restricted** only to those taxes that are levied on the sale of products. **External transportation and insurance costs are not deductible**, which **increases significantly the CFEM** payable by those producers that have logistics associated with their mining business. For those companies that use a mineral substance in their industrial process to create an industrialized product, the statutory royalty will be calculated based on current market prices or a reference price, both to be defined by the ANM;<br>○ **Control, monitoring, and supervision of research activities, mining, exploration and exploitation of mineral resources fee (TFRM)** is a fee charged by certain states (such as Minas Gerais, Pará, Amapá, Mato Grosso do Sul and Goias) **levied on the sale or transfer of the mineral resource for processing;**<br>○ **Annual Tax per hectare (TAH)** is an annual tax on mining rights to be paid to the National Department of Mineral Research by the holder of the prospecting authorization;<br>○ **Landowner Royalty is required to be paid on a monthly basis in the amount of 50 percent of the CFEM due** during the exploitation phase, under the concession system, if the land does not belong to the surface right holder; and<br>• Four states (Minas Gerais, Pará, Goiás, and Amapá) have created **inspection fees**. A close review of these state fees shows that they are actually **proportionate to the mine production and are tantamount to an additional royalty**.<br>• **Key Developments Impacting Fiscal Regime for Critical Minerals include:**<br>○ Brazil National Congress is considering changes to the country's fiscal regime. The National Congress is currently **reviewing a significant and comprehensive tax reform** with the main purpose of **rationalizing the tax system and easing tax management** both from the perspective of companies and the government. Streamlining the tax processes in a transparent way also has positive implications for responsible investment in the sector.<br>○ Brazil recently started using **auctions to award mineral exploration licenses** for copper and other minerals. This is a change from the usual first-come-first-served approach seen in the sector. The main challenge to auctioning mineral deposits is having sufficient geological information to design a competitive tender. This initiative has the potential to **maximize revenues** for the country. Bidders are often required to **compete on royalty rates**, **state equity shares**, and **pay signature bonuses** if they are successful. Brazil is auctioning previously approved mining projects that have returned to the ANM for various reasons, such as a rejection of application or expiry of titles.[96]<br>• **Lessons Learned**: The Government of Brazil should consider **developing a mining fiscal regime that is designed with equity, efficiency, adequacy, stability, transparency and simplicity** to encourage investment and proper management of mineral resources. The government should consider **adopting an industry-centered approach such as that of Western Australia** to increase cooperation across government agencies with the mining industry. This initiative should provide a **framework for the government to coordinate a clear message to investors to focus on investment attraction, project facilitation, research and development, and adoption of new technologies**. The government may also want to consider **special tax treatments** (such as those in Canada) and **temporary assistance to maintain production** (such as that being implemented in Western Australia) to relieve companies from operational risks during an economic downturn. |

[96] https://www.igfmining.org/beps/blog/three-emerging-policy-trends-for-critical-minerals-in-latin-america/

| Country | Leading Practice Analysis and Lessons Learned |
|---|---|
| **Brazil** | **5. ESG Regime Incentives**<br>• **Summary:** The *Indigenous and Tribal Peoples Convention 169 (ILO 169)* establishes states' obligations to **consult with indigenous peoples on decisions that affect their land, communities, and rights**. In the context of mining projects, this requires governments to relinquish power over key decisions to Indigenous populations if a project will impact their lands or rights—including decisions on whether or how the project should proceed. **The treaty has been widely ratified by states in Latin America, including Brazil**. From an electricity usage perspective, Brazil has an **inherent competitive advantage** in terms of its **carbon footprint**, because the country uses **mainly hydroelectricity**. This is becoming increasingly important to manufacturers of lithium-ion batteries and original equipment manufacturers (OEMs) when sourcing raw materials, and it may provide an opportunity for Brazil to secure off-take agreements for cobalt and associated nickel products, potentially at a price premium. Graphite produced in Brazil using hydropower (which encompasses 65 percent of Brazil's power supply) has the **potential to be marketed as 'green' graphite**, thereby aligning it with the efforts of many auto and battery manufacturers to enhance the green credentials of their own products.<br>• **Key Developments Impacting the ESG Regime for Critical Minerals include:**<br>○ Through the Pro-Strategic Minerals policy, the government is focusing on **easing the licensing process by facilitating**, for example, the **dialogue between the environmental agency** responsible for conducting the environmental licensing process and **authorities such as the managing bodies of Conservation Units,** the National Indian Foundation (FUNAI), the National Institute for Colonization and Agrarian Reform (INCRA) and the National Institute of Historic and Artistic Heritage (IPHAN).<br>○ Following the severe impact caused by accidents at two tailings dams, first at Mariana and then at Brumadinho, Brazil's **mining companies have aligned more closely with international standards around ESG** as reported by the *Brazilian* Mining Association (*IBRAM). For example,* ANM issued Resolution 13 on August 8, 2019. This resolution banned the construction of mining dams using the upstream construction method and provided a deadline for all existing upstream construction dams to be removed from service and decommissioned. The Resolution also set out timeframes for all other mining dams to follow standards for operation, maintenance, and inspection, based on the size of the impoundment. This resolution was the government's decisive action to prevent tailings dam failures. On April 30, 2021, ANM also published Resolution 68, which requires all mines in Brazil to submit updated mine closure plans. There are also requirements that information is tied to a geographic information system (GIS) per Brazilian standards, and that the professionals responsible be appropriately qualified. In addition, ANM issued Ordinance No. 70.389 on May 17, 2017, to address mining dams. This ordinance outlined in detail the requirements for permitting, construction, operation, and closure of mining dams. The ordinance was updated by ANM Resolution No. 32 of 2020. The standard includes specific criteria for dam construction, evaluating the risks of mining dams, requirements for emergency action plans, schedules and contents of dam inspections, and related issues.<br>○ Sigma Lithium represents one of the largest and highest-grade hard rock lithium spodumene deposits in the Americas. Sigma Lithium has been at the forefront of **environmental and social sustainability** in the EV battery materials supply chain. The Grota do Cirilo project developed by Sigma, includes a **state-of-the-art green-tech processing plant** that uses **100 percent renewable energy, 100 percent recycled water, and 100 percent dry-stack tailings**. Sigma collaborated with communities of Itinga and Araçuaí to design transformative new social initiatives, which allocates |

| Country | Leading Practice Analysis and Lessons Learned |
|---|---|
| | funding to build 2,000 rainwater collection systems and to empower 10,000 women through microcredit.[97]<br>• **Lessons Learned**: Brazil should continue to work with industry, local communities, research organizations, and other appropriate parties **to expand the opportunities for tailings reuse and tailings reduction**. Brazil should look to international examples of success and adopt approaches being developed by industry and academia to reduce the volume of materials that require long-term storage and management. Brazil has taken steps to improve the relationship with indigenous communities. In Brazil, the big mining projects are investing more in local infrastructure, educational programs, and local agenda development. Brazil should aim for **robust public participation as part of an "open, informed, and meaningful impact assessment process**." Engaging the public in matters that affect their community enables them to better understand the benefits, and also allows them to participate in identifying opportunities for improvement. A **clear framework with public key performance indicators** (similar to that of Canada) for mining companies, a **regulatory regime that includes a strong, well-defined mining health and safety regulatory framework** (similar to that of Western Australia), and a **focus on involvement of indigenous communities in the impact assessment process** (similar to that of Canada), helps mining companies communicate their benefit to communities while meeting community expectations . |

[97] https://batteriesnews.com/sigma-lithium-successfully-initiates-commissioning-greentech-plant-schedule-budget/

# 5. TASK 2B: REPORT ON THE STRUCTURE OF A BRAZILIAN NI-CO INVENTORY

## 5.1. Introduction

Under *Task 2B: Developing a Structure of a Brazilian Nickel-Cobalt (Ni-Co) Inventory* the Deloitte team provided: (i) a review and analysis of three mineral reports [graphite, REEs, and manganese] developed by CPRM, which form the current approach and methodology for the Ni-Co inventory report; (ii) a detailed inventory structure for CPRM's consideration, plus leading practice examples of how other countries develop and organize mineral inventories (with a focus on Ni-Co inventories), and; (iii) recommendations on how CPRM could develop the inventory framework in a manner that would address both Brazil's strategic concerns, and the investment/commercial needs of potential private sector developers.

## 5.2. Key Findings

Key findings contained in this Report include:

- **A number of national, state, and provincial governments such as, the United States, the state of Alaska, Western Australia, and Brazil publish mineral inventory reports.** The purpose of these reports is to: (i) document the country's/state's/province's geological and mineral resource occurrence information to support government's overall mineral policy; and (ii) make the information available to the public and industry to demonstrate a country's/state's/province's exploration potential, encourage mining development, and promote mineral-related economic growth. Leading practice mineral inventories generally include geological descriptions, locations, mineralogy, deposit types, work histories, resource and/or reserve statistics, analytical results on known mineral occurrences, and bibliographies. CPRM has produced several robust mineral inventory reports on the geological potential of various minerals in Brazil, including graphite, REE, and manganese. These reports generally align with leading practice requirements, such as those outlined in the McKelvey Framework[98] and the United Nations Framework Classification (UNFC)[99].
- **Addressing ESG challenges related to mining, smelting, refining, and tailings management in mineral production is becoming increasingly important to investors and OEMs.** Leading practice inventory reports such as those produced by the USGS[100] include specific ESG requirements in an effort to enhance transparency and accountability of the governments and the mining industry. These reports now include information on the possible environmental effects of mining and mineral processing to give a more complete picture of both the positive and negative potential impacts of mineral production. To date, CPRM's inventory reports have primarily focused on providing investors with reliable geological information and resource and/or reserve statistics. Given the ESG global trends noted above CPRM should consider adapting its inventory format to also

[98] McKelvey diagrams are used to describe a natural resource, such as in-situ mineralogy, based on the geologic certainty of its presence and its economic potential for recovery. The diagram is used to estimate the uncertainty and risk associated with the availability such a resource, illustrating that - as geological assurance and economic recoverability of a resource decreases - risk correspondingly increases.

[99] UNFC explicitly identifies three dimensions for assessing projects; (E) Economic and commercial viability; (F) Field project status and feasibility; and (G) Geological knowledge.

[100] https://www.usgs.gov/publications/cobalt

address ESG themes, thereby signaling to investors and OEMs that such requirements are now being integrated into long-term sector planning throughout the value chain.

- **CPRM staff are well trained in mineral resource assessment, possessing the relevant advanced educational qualifications (e.g., Master of Science or Doctoral degrees in different aspects of the geosciences), technical skills, and expertise required to produce robust geological reports.** As the Government of Brazil expands the production and development of critical minerals, CPRM should continue to expand its human and institutional capacity (with a focus on ESG) to support sector development and attract responsible sector investment for sustainable long-term industry growth.

## 5.3. Key Recommendations

To develop a Ni-Co inventory that addresses both Brazil's strategic concerns, and the investment/commercial needs of potential private sector developers, the Deloitte team recommends that the Government of Brazil considers the following:

- **Incorporate leading practices into the Government of Brazil's Ni-Co inventory framework, via:**
    - **Including ESG information in the Ni-Co inventory report generally, and promoting the ESG advantages of Brazilian nickel and cobalt projects in particular, to accelerate access to development finance and facilitate regional investment.** Nickel-cobalt projects in Brazil have systemic ESG advantages relative to (for example) DRC copper-cobalt and Indonesian nickel-cobalt producers. For example, Brazil's access to low-cost, low-emissions hydroelectricity would give local nickel-cobalt producers a competitive advantage in both operating costs and carbon footprint vs. other locations. This advantage could potentially lead to better mine offtake terms, improved access to ESG-focused sources of development finance, and similarly enabled downstream regional investment in cathode- or lithium-ion battery manufacturing facilities.
    - **Including information on Brazil's use of "prior informed consent"** (the right of a community to be informed about mining operations on a full and timely basis, and to approve such operations prior to commencement). Brazil should aim for robust public participation as part of an open and informed impact assessment process. Engaging members of the public in matters that affect their community enables local citizens to better understand the costs and benefits of resource development, while simultaneously enabling them to participate in the planning process. When planning new projects, mining companies should look for opportunities that align with local communities' priorities. If there are opportunities for a community to benefit from mining infrastructure, such as a road, railway, or energy facility, discussions between industry and communities should happen as far in advance as possible to determine that the development of a mining project addresses the communities' needs and priorities.
    - **Publishing Updates to Infrastructure Developments.** Natural resource development potential can often be closely tied to extant level of infrastructure near a prospective mine. This may include the existence of highway, power, and rail grids, all of which have the potential to enhance the attractiveness of a given project. An integrated approach to infrastructure planning may also enable national and regional governments to prioritize the scheduling and financing of new infrastructure projects, potentially via public/private partnerships.

- **Providing Education and Labor Information.** Mineral reports included in the Ni-Co inventory framework should also describe the availability and skills of the local workforce. Understanding the capacity of the local/regional population is a key factor in the successful development of the sector, and in negotiating appropriate local community hiring commitments.
- **Continuing to conduct basic scientific research, and outlining current and planned research, in future CPRM's mineral inventory reports.** Knowledge about regional geological factors, new research into potential Ni-Co sources (including seafloor sulfide nodules), and the potential for efficient mineral processing (bulk laterite leaching) will help to attract the attention of other innovative parties and investors.

Incorporating such information will depend on data availability, although much of this information is already available from the Brazilian Geographical and Statistical Institute (IBGE) online system and is therefore easily accessed.[101] Such information, coupled with the geological data already available on the CPRM website[102], provides a robust basis for attracting long-term responsible investment in the sector. Table 6 below outlines the information that is generally provided in leading practice mineral reports and compares this to the information currently provided in the inventory reports produced by the Government of Brazil. Of the reports noted below, the **Deloitte team recommends that the Government of Brazil use the USGS Cobalt report as a template** for Ni-Co inventory reports, and incorporate information on labor, education, and infrastructure developments to further enhance their mineral inventory framework to attract responsible investments in the country.

**Table 4: Leading Practice Mineral Report Comparison**

| | USGS Cobalt[103] | Alaska Platinum Group Elements[104](PGE) | Australia REE[105] | Australia Mineral Sands[106] | Brazil Graphite[107] | Brazil REE[108] | Brazil Manganese[109] |
|---|---|---|---|---|---|---|---|
| Introduction | **Y** | Y | Y | Y | Y | Y | Y |
| Objectives | **Y** | Y | Y | Y | Y | Y | Y |
| Commodity Uses and Demand | **Y** | | | | Y | Y | Y |
| Mineral Economics | **Y** | Y | | | Y | | Y |

[101] https://www.ibge.gov.br/en/home-eng.html

[102] https://geosgb.cprm.gov.br/

[103] Recommended format (with additional data on infrastructure) https://www.usgs.gov/publications/cobalt

[104] http://doi.org/10.14509/30468.

[105] https://www.ga.gov.au/scientific-topics/minerals/mineral-resources-and-advice/australian-resource-reviews/rare-earth-elements

[106] https://www.ga.gov.au/scientific-topics/minerals/mineral-resources-and-advice/australian-resource-reviews/minerals-sands

[107] https://rigeo.cprm.gov.br/handle/doc/21910

[108] https://rigeo.cprm.gov.br/handle/doc/16923

[109] https://rigeo.cprm.gov.br/handle/doc/20421

| | USGS Cobalt[103] | Alaska Platinum Group Elements[104](PGE) | Australia REE[105] | Australia Mineral Sands[106] | Brazil Graphite[107] | Brazil REE[108] | Brazil Manganese[109] |
|---|---|---|---|---|---|---|---|
| Ore Minerals | **Y** | Y | Y | Y | Y | Y | Y |
| Principal Deposit types | **Y** | Y | Y | Y | Y | Y | Y |
| Exploration Methods | **Y** | | | | Y | Y | |
| Exploitation Methods | **Y** | | | | Y | | |
| Known Deposits | **Y** | Y | Y | Y | Y | Y | Y |
| Unknown/Potential Resources | **Y** | | | | Y | | |
| Environmental and Social Considerations | **Y** | | | | | | |
| Updates to Infrastructure Developments | | | | | | | |
| Providing Education and Labor Information | | | | | | | |
| Ongoing/Future Research | **Y** | | | | Y | | |

# 6. TASK 3: TECHNICAL TRAININGS

The Deloitte team held two virtual Trainings under this Project. Table 5 summarizes these Trainings, including their purpose and takeaways.

**Table 5: Training Descriptions and Takeaways**

| Name of Training | Date | Purpose | Discussion Points and Takeaways |
|---|---|---|---|
| **Mine Closures and Use of Tailings** | April 13-15, 2022 | To support *Task 1: Report on Mine Closures and the Use of Tailings*, the Deloitte team developed a training course focused on how to characterize materials from tailings mineralogically and technologically. The training included case studies and leading practices from around the world on mine closures and tailings reuse.<br><br>The purpose of this training was to provide the Government of Brazil with (i) the proper knowledge and framework to evaluate materials from tailings and identify environmentally friendly ways to reuse these materials; and (ii) tools to implement mine and upstream dam closures leading practices to their mineral inventory.<br><br>Having the capacity to evaluate materials from tailings and identify environmentally friendly ways to reuse these materials will provide the Government of Brazil with the tools to implement these practices in the country. Mine and upstream dam closures in Brazil are prevalent and this training will prepare the MME, CRPM, and ANM to implement and apply leading practices from around the world for their own mineral inventory.<br><br>The Deloitte team designed and delivered a training course that reviews the process of identifying tailings, a deep-dive analysis on | • The Government of Brazil has worked diligently with the owners of existing upstream dams to develop plans for elimination of the dam and residual risks. Although the government has strengthened requirements for mine closure to enhance planning and design for tailings facility closure, post-closure monitoring, and remediation, they should focus on training those professionals who are responsible for reviewing tailings storage facilities on the appropriate international standards and current engineering approaches, such as GISTM, ICMM, UNEP and UNEA-4 Resolution 19. The Government of Brazil should also adopt the transparency recommendations of the GISTM, as a part of its program for regulating tailings facilities.<br><br>• CPRM and others in the Government of Brazil have been working with industry and academia to develop specific projects in Brazil to adopt leading practice principles related to tailings management, including approaches to reduce the volume of tailings and to beneficially reuse tailings. The government should build on these efforts and expand the opportunities for tailings reuse and tailings reduction by utilizing international examples of success specifically focused on reducing the volume of materials that require long-term storage and management. |

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| | | case studies of tailings reuse from around the world, and leading practices and processes for mine and upstream construction dam closures. The training was made available to all stakeholders within CPRM, MME, and ANM, specifically those who are connected to the mine closure process and interested in the beneficial uses of tailings. | |
| **Developing a Discounted Cash Flow Model for Critical Minerals** | October 4-6, 2022 | To support *Task 2A: Economic Viability and Global Market Competitiveness of Specific Minerals*, the Deloitte team developed a training course for key professionals within the Government of Brazil responsible for the countries mineral sector relating to leading practices on how to analyze investment opportunities and competitiveness in the sector, specifically with respect to the production of critical minerals. Specifically, this training focused on providing the Government of Brazil with the appropriate tools to evaluate a mining development project and building their capacity to produce accurate financial models for mining projects, with an emphasis on the renewable energy market's impact on mining commodities and the mining industry.<br><br>The training included examples and leading practices from around the world on mine valuation methodologies, factors impacting mine development, and an interactive case study on how fiscal terms affect investment decisions. The training utilized a conceptual Discounted Cash Flow (DCF) model that described the full-cycle cash flows of a mining project, incorporating standardized parameters related to reserve, C grade, production capacity, average prices, | • The Government of Brazil has worked diligently to assess, develop, and market the mineral resource potential of Brazil to investors. The ability to build and evaluate DCF models for mining projects will help the government to assess the investment potential of a mine, make insightful decisions relating to mine development, evaluate and analyze potential investment opportunities/projects in the country, and choose investments wisely so that they benefit the country and citizens of Brazil. |

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| | | operational expenditure (OPEX), and capital expenditure (CAPEX) as applied to a set of fiscal terms.<br><br>The purpose of this training was to build the capacity of the Government of Brazil in producing and evaluating DCF models, therefore providing them with the tools to better evaluate and analyze potential projects in the country. The training also demonstrated how standardized parameters such as reserve, C grade, production capacity, average prices, OPEX, and CAPEX – as applied to a set of fiscal terms (tax and royalty rates) affect investment decisions in the mining sector. | |

Deloitte & Touche LLP
1919 N. Lynn Street
Arlington, VA 22209
Phone: +1 571 882 5000
Fax: +1 571 882 5100