IBRAM
BRAZILIAN MINING

CONTRIBUTION OF THE MINING INDUSTRY TO THE G20

BUILDING A FAIR WORLD AND A SUSTAINABLE PLANET

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BUILDING A FAIR WORLD AND A SUSTAINABLE PLANET

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SHIS QL 12 Suite 0 (zero) House 04, Lago Sul.
Zip Code [CEP]: 71.630-205 – Brasília/DF
Phone: (61) 3364-7272
Electronic address:
http://www.ibram.org.br

IIBRAM - BRAZILIAN MINING INSTITUTE

- Aline Nunes
- Cinthia de Paiva Rodrigues
- Cláudia Franco de Salles Dias
- Julio Cesar Nery Ferreira
- Renata Motta

DESIGN AND GRAPHIC PRODUCTION

Pablo Fiori

TECHNICAL CONTENT, IMAGES AND GRAPHICS

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PRESENTATION

The mining industry and its production is a strategic ally to support the fulfillment of the G20 agendas, especially in relation to sustainable socio-economic development, the energy transition, and mineral security, i.e. ensuring an abundant supply of mineral resources. Promoting this industry will mean paving the way for achieving the goals set by the G20, especially the necessary and urgent transition to a green economy and the formation of supply chains.

This publication addresses crucial issues for sustainable development and technological innovation, and the Brazilian Mining Institute (IBRAM) presents a detailed analysis of the importance of critical and strategic minerals (CSMs) for the global economy and the energy transition. The reader is presented with the challenges facing the mining sector, and IBRAM proposes a series of initiatives to strengthen the mining industry, including investments in technology, sustainability and professional training.

There is a growing need demonstrated by several countries to guarantee a stable and accessible supply of these minerals, in relation to sectors such as renewable energies and digital technologies. CSMs are essential for various purposes, such as the manufacture of batteries and solar panels, key components for the energy transition and environmental sustainability.

To make this transition a success, this publication highlights three major risks: supply risks, since there is, for example, a concentration of production in a few countries; challenges in purchasing agreements; and macroeconomic risks, such as fluctuations in commodity prices.

If the world is in a hurry to achieve decarbonization and the energy transition, another critical point highlighted in this publication is the long time needed to develop mining projects. On average, it takes 10 years for a project to move from the exploration phase to production. This long development period limits the market's ability to react quickly to increased demand, creating supply bottlenecks. The publication suggests that public policies and investments in research and development are essential to reduce these delays and increase the sector's efficiency.

In short, the IBRAM publication offers a comprehensive overview of the challenges and opportunities facing the mining industry in Brazil, with a special focus on critical and strategic minerals. Mining's contribution to G20 Brazil 2024 is highlighted as an opportunity to promote fairer and more sustainable development, in line with the global goals of energy transition and technological innovation.

Raul Jungmann, Chief Executive Officer - Brazilian Mining Institute (IBRAM)

IBRAM
MINERAÇÃO DO BRASIL

01 G20 Background

The G20 was created in 1999 as a forum for finance ministers and central bank presidents from the main developed and emerging economies. In 2008, after the global financial crisis, the G20 was elevated to the level of a summit of leaders, including presidents and prime ministers.

It is made up of 19 countries - South Africa, Germany, Saudi Arabia, Argentina, Australia, Brazil, Canada, China, South Korea, the United States, France, India, Indonesia, Italy, Japan, Mexico, the United Kingdom, Russia and Turkey - and two regional bodies, the African Union and the European Union. The members of the group represent around 85% of the world's economy, more than 75% of global trade and around two thirds of the world's population.

The Summit Meetings are held annually and bring together the leaders of the member countries to discuss global issues and coordinate policies. Each meeting is organized by the country holding the G20 presidency that year.

In 2024, Brazil will play a central role in leading global discussions. The meeting, which will bring together leaders of the world's largest economies, will allow Brazil to lead debates on crucial issues such as the fight against hunger, poverty and inequality, as well as addressing fundamental issues such as the energy transition, financing for sustainable development and the reform of global governance.

The Global Mobilization against Climate Change and the creation of the Global Alliance against Hunger and Poverty will also be important focuses, reflecting Brazil's commitment to a more inclusive and sustainable global agenda. As president of the G20 in 2024, Brazil has the right to call on other countries and organizations. Among the guests are Angola, Bolivia, Egypt, the United Arab Emirates, Spain, Nigeria, Norway, Paraguay, Portugal, Singapore and Uruguay. In 2025, the G20 will be chaired by South Africa.

The highlight of the Brazilian presidency will be the meeting of heads of state and government on November 18 and 19 in Rio de Janeiro.

02 The mining sector and its role as an ally in the G20 agenda

The mining sector plays a crucial role in the global economy and is a strategic ally for the G20 agendas of sustainable economic growth, energy transition and resource security. In this context, the mining sector is essential for achieving the goals set by the G20, especially with regard to the transition to a green economy and ensuring resilient supply chains.

The mining sector is one of the oldest and most fundamental in the global economy. It is responsible for extracting essential raw materials for energy production, the manufacture of technological products and the construction of infrastructure. Mining not only supplies key industries, electronics and automotive, but also plays a vital role in the production of inputs for agriculture and the energy transition, such as critical and strategic minerals (CSMs) used in batteries and renewable technologies.

Figure 1: Mining in Brazil - Potential

Global Player Exporter	Exporter	Self-sufficient	Importer/ Producer	External Dependence
Niobium (1st)	Tin	Limestone	Copper	Coal
Iron ore (2nd)	Nickel	Diamond	Sulphur	Metallurgy
Vermiculite (3rd)	Magnesite	Industrial	Titanium	Potassium
	Manganese			
Graphite (4th)	Chromium	Tungsten	Phosphate	Rare Earths
Vanadium (4th)	Gold	Talc	Diatomite	
Bauxite (4th)	Rock		Zinc	
Kaolin (8th)	Ornamental			
Lithium (5th)				

STRATEGIC MINERALS FOR BRAZIL'S TRADE BALANCE AND ENERGY TRANSITION

Global mineral production is dominated by countries such as China, Australia, Brazil, Russia and the United States. Brazil is one of the world's largest producers of iron ore, bauxite (aluminum), niobium and other strategic minerals. In 2023, the Brazilian mineral sector generated revenues of approximately USD 49.7 billion (BRL 248 billion), with iron ore accounting for around 59.6% of this total.

Figure 2: Annual turnover - Brazilian mining (Billions BRL)

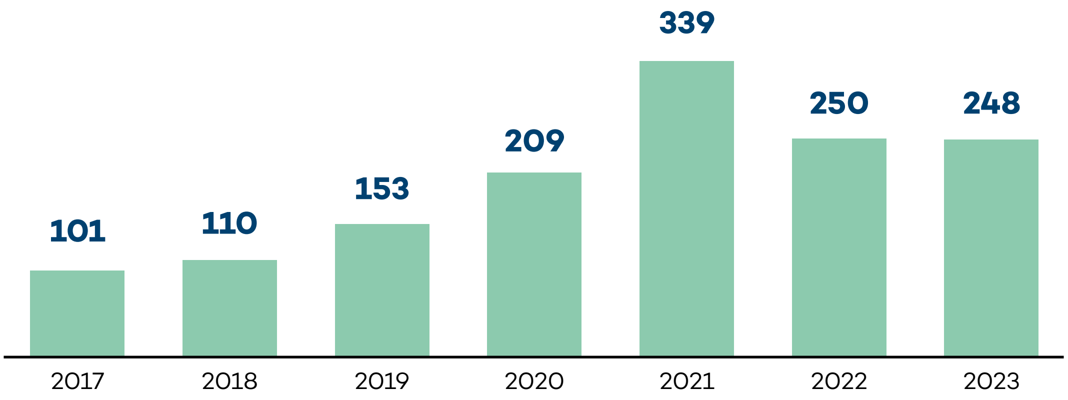
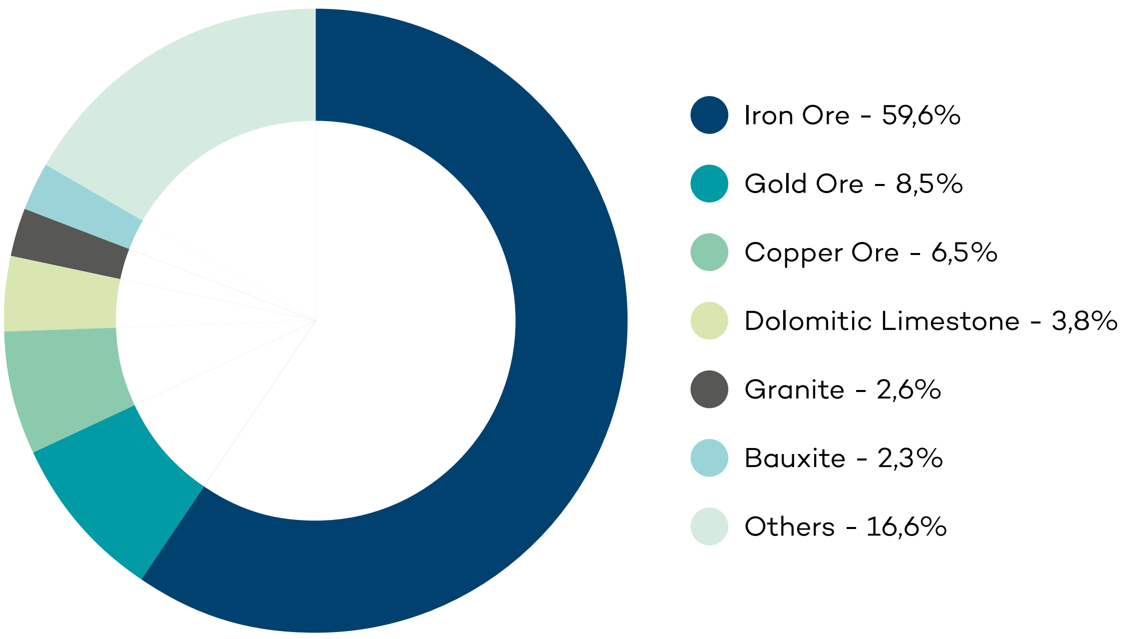
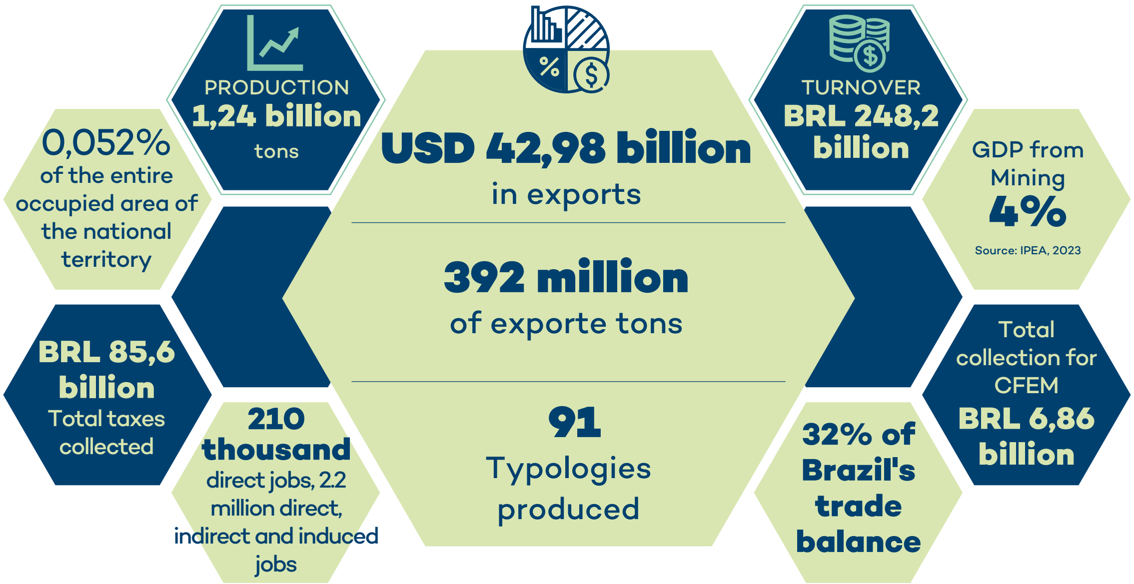


Figure 3: Substance share of turnover - 2023



Source: ANM, IBRAM determination, 2024

The extractive industry currently occupies approximately 0.052% of the national territory, and in this area the extractive industry produces the equivalent of 4% of Brazil's GDP (IPEA), moving 1.24 billion tons of minerals on the domestic and foreign markets. The sector's turnover in 2023 was BRL 248.2 billion, maintaining a scale of production similar to that of 2022, when it had a turnover of BRL 250 billion.



Sources: ANM, CAGED, Comex Stat, IPEA, IBRAM.

Brazil's trade balance reached exports of USD 339.67 billion, 1.6% higher than the previous year. Mineral exports reached USD 42.98 billion, 3% more than in 2022, and in quantity this increase was 9.5%, totaling 392 million tons. Brazilian imports fell by 11.7% compared to 2022, reaching USD 240.8 billion. Imports of minerals, on the other hand, fell more significantly, by 34% to USD 11 billion. Brazil's trade balance was USD 98.8 billion, and the mineral sector's was USD 31.9 billion, equivalent to 28% of Brazil's balance.

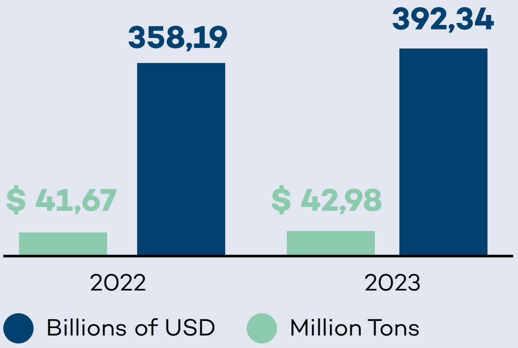
Table 1: Brazilian trade balance - Billions USD

	2022	2023	2022 x 2023
Brazilian Exports	USD 334.46	USD 339.67	1.6%
Mineral Exports:	**USD 41.67**	**USD 42.98**	**3.1%**
Brazilian Imports	USD 272.70	USD 240.83	-11.7%
Mineral Imports	**USD 16.75**	**USD 11.02**	**-34.2%**
Balance of Brazil	USD 61.76	USD 98.84	60.0%
Mineral Balance*	**USD 24.91**	**USD 31.95**	**28.3%**

* Mineral balance is equivalent to 32% of Brazilian balance in 2023

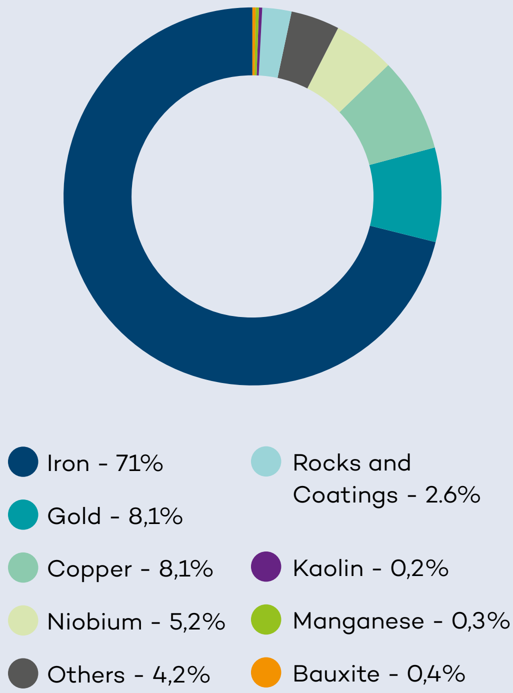
Source: Comex Stat, determination IBRAM

TOTAL MINERAL EXPORTS

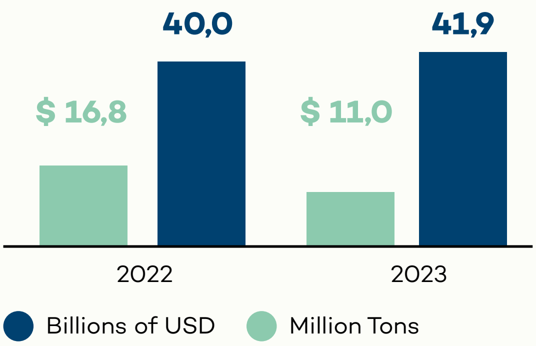


	Variation 2022 x 2023
Billions of USD	**3,1%**
Million Tons	**9,5%**

EXPORTS SHARE BY SUBSTANCE

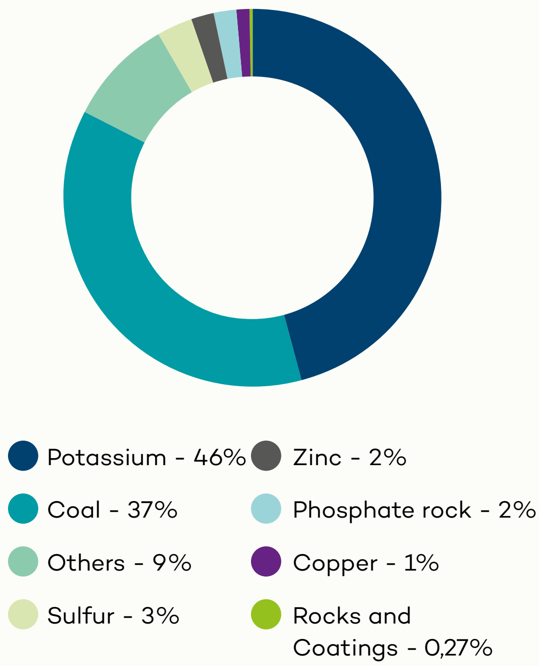


TOTAL MINERAL IMPORTS



	Variation 2022 x 2023
Billions of USD	**-34,2%**
Million Tons	**4,7%**

IMPORTS SHARE BY SUBSTANCE



Fonte: Comex Stat, apuração IBRAM

The mining sector accounts for a significant portion of the Gross Domestic Product (GDP) in countries such as Australia (13.6% of GDP)[1] , Canada (7.9%)[2] Brazil, and South Africa (6.3%)[3]. It also generates more than 210,000 direct jobs and 2.2 million direct, indirect and induced jobs, and is a vital source of income for many communities.

The social impact of mining, however, is twofold: on the one hand, it promotes economic development and, on the other, it presents environmental and social challenges that need to be managed sustainably.

2.1 The mineral Sector on the G20 agenda

Within the G20 agenda, the mining sector plays an important role in the **transition to a low-carbon economy**. The extraction and processing of critical minerals, needed for technologies such as lithium-ion batteries, solar panels and wind turbines, are important for achieving climate goals. In addition, the sector contributes to global energy and food security, being essential for the production of fertilizers and the development of energy infrastructure.

The proposal for a Global Alliance against Hunger and Poverty, a topic on the G20 agenda, finds in mining activities a way to reduce poverty and hunger, since the so-called agro-minerals, such as potassium, phosphate and nitrogen components, are relevant for optimizing planting areas.

Support and coordination between G20 member countries is key to ensuring that the mining sector contributes effectively to a more sustainable and prosperous future.

1 Available at https://www.trade.gov/country-commercial-guides/australia-mining
2 Canada GDP - https://mining.ca/flippingbooks/mac-report-2023/1
3 RSA - https://www.mineralscouncil.org.za/reports/2023

03 Global Context on Critical and Strategic Minerals (CSMs)

The critical and strategic minerals (CSMs) play a fundamental role in the global economic and geopolitical scenario, especially in a context of energy transition and increased demand for green technologies. In recent years, the need to ensure a stable and affordable supply of these minerals has become a priority for many nations, covering sectors such as renewable energies and digital technologies.

The global CSMs landscape is shaped by geopolitical, economic and technological factors. These minerals are essential for many modern industries and technologies, particularly in the process of transitioning to an economy with a lower environmental impact. The growing demand for these resources, driven by technological advances and the search for clean energy, has raised concerns about security of supply and the need for effective policies to manage these resources.

3.1 Risks in the Supply of Minerals

The challenges related to the supply of minerals critical to the energy transition, such as reliability, accessibility and sustainability, are clear, but they can be managed. The response of policymakers and industry will be decisive in determining whether these minerals will facilitate or hinder the energy transition. The main supply difficulties and price volatility of these minerals can be explained by the following factors:

1. **Geographical Concentration:** Most critical minerals are extracted in just a few countries, which increases the risk of supply interruptions. For example, China and the Democratic Republic of Congo dominate the production of cobalt and rare earths, which are essential for batteries and solar panels.

2. **Long-term Development:** On average, it takes 16.5 years for a mining project to move from the exploration phase to production. This long period limits the market's ability to react quickly to increased demand, creating supply bottlenecks.

3. **Decreasing Quality and High Cost:** The quality of minerals such as copper is decreasing, requiring more energy to extract. This results in increased costs and higher carbon emissions, impacting both the economy and the environment.

4. **Environmental and Social Issues:** Growing pressure for sustainable practices can disrupt poorly managed mining due to environmental or social impacts, affecting supply and local communities.

5. **Climate Risks:** Mining regions are increasingly vulnerable to extreme weather events, such as water shortages and natural disasters, which threaten the ability to extract minerals reliably and sustainably.

3.2 The Importance of Minerals in the Energy Transition

As the energy transition progresses, security of supply of minerals becomes as essential as security of supply of oil was in the past. However, unlike oil, the scarcity of minerals could directly impact the production of electric vehicles and renewable technologies such as solar and wind power plants. To avoid these bottlenecks, it is crucial to align demand with technological innovations and ensure the resilience of supply chains. Clear public policies and incentives to open new mines are fundamental, as well as seeking alternatives for the most efficient use of these resources.

3.2.1 Solutions and Recommendations

- **Encourage Recycling:** Recycling can reduce the demand for new minerals, especially from 2030 onwards, with the increased disposal of electric vehicle batteries and renewable technologies. This could reduce the need for extraction by around 10% by 2040.

- **Regular Market Evaluations:** Measures such as stress tests and strategic stocks can strengthen the resilience of supply chains, ensuring more efficient management in times of crisis.

- **Environmental and Social Regulations:** It is vital to establish clear and effective rules for sustainable mining in order to mitigate risks such as poor waste management and the violation of human rights, guaranteeing environmentally responsible practices throughout the life cycle of projects.

3.2.2 Opportunities and Challenges

Governments and companies face both opportunities and challenges in the transition to a low-carbon economy. The benefits include the creation of new supply chains, job creation and increased revenue. However, the challenges include managing environmental impacts, security of supply and adapting governance structures. To ensure the success of this transition, three major risks need to be addressed:

1. **Supply Risks:** The concentration of production in a few countries, the depletion of resources and the replacement of materials with new technologies pose considerable risks.

2. **Challenges in Purchasing Agreements:** Problems such as price volatility and geopolitical instability can complicate purchase agreements.

3. **Macroeconomic Risks:** Currency crises, fluctuations in commodity prices and the "Dutch disease" phenomenon can damage the economy.

A diversified approach is essential to ensure security in the supply of critical minerals. This includes encouraging investment, technological innovation, recycling and international cooperation. Such measures will help build more robust supply chains, minimizing negative impacts and maximizing economic and environmental benefits.

The current global scenario highlights the growing importance of critical and strategic minerals for the economic and technological development of nations. These minerals are fundamental to the energy transition, which seeks to replace energy sources based on fossil fuels with renewable, low-carbon alternatives. With the increase in demand for resources such as lithium, cobalt, nickel and rare earths, countries are reviewing their security and sustainability policies for the supply of these minerals.

04 Competitiveness of Critical and Strategic Minerals

The competitiveness of the mining sector is mainly determined by the quality of natural resources, such as the ratio between the quantity and content of its reserves. Countries with better reserves have greater potential to dominate world production of certain minerals. However, factors such as the volume of ore and the depth of the reserves are unalterable by public policy and, in the long term, the quality of the ore can vary, despite efforts in geological research.

Underground mines generally have higher production costs compared to open-cast mines. However, even in open-cast mines, increasing depth can increase absolute costs. In addition to natural competitiveness, there is also planned competitiveness, which involves economic income and implementation costs, both of which are impacted by political risks. These risks directly influence the decisions of mining companies, highlighting the importance of public policies for the sector.

Geopolitical and geo-economic factors are increasingly present in the decision-making process for mineral exploration, extraction and transformation, redesigning the global mining landscape. Forecasting demand for critical and strategic materials, however, remains a complex goal, especially given the relationship between energy generation and consumption of mineral resources, which increases the ecological footprint.

Although cost structures and extraction techniques are similar globally, the competitiveness of mining is influenced by local conditions and policies, such as inflation, exchange rates, the labor market and the regulatory environment. Production tends to move to regions with lower costs and greater legal certainty. According to Peck et al. (1992), the natural competitiveness of mining outweighs attempts at public intervention, due to unexpected consequences and contradictory policies.

High-volume minerals such as iron, coal and aluminum depend on low production costs to be competitive, while high-value minerals such as gold and lithium have a higher unit value but are more susceptible to management and market fragmentation. Competitiveness therefore depends on the scale of production, available logistics and added value, requiring appropriate strategies for each type of mineral.

05 The energy transition agenda and the CSMs

The global energy transition, essential for combating climate change and reducing greenhouse gas emissions, depends heavily on access to critical and strategic minerals (CSMs). These minerals are essential for the production of clean energy technologies such as batteries for electric vehicles, wind turbines and solar panels. The energy transition agenda and CSMs are connected, and it is unlikely to achieve a decarbonized economy without ensuring an adequate supply of these resources.

5.1 Importance of CSMs in the Energy Transition

CSMs, such as lithium, cobalt, nickel, rare earths, among others, are essential inputs for the production of technologies that drive the energy transition. For example, lithium and cobalt are key components of lithium-ion batteries, which power electric vehicles and energy storage systems. Rare earths, meanwhile, are indispensable in the manufacture of permanent magnets, used in high-performance electric motors and wind turbines.

With the growing demand for clean energy technologies, the demand for these minerals has also increased exponentially. According to the International Energy Agency (IEA), global demand for these minerals could increase sixfold by 2040, depending on the pace of the energy transition. This scenario places CSMs at the center of countries' energy and industrial strategies, making their exploitation and processing an economic and geopolitical priority.

5.2 5.2 CSMs Supply Chain Challenges

The geographical distribution of CSMs is uneven, concentrated in a few countries. China, for example, dominates the production and processing of various rare earths, while Chile and Australia are leaders in lithium production. This concentration creates vulnerabilities in the global supply chain, which can be exacerbated by geopolitical factors such as trade tensions or conflicts.

To mitigate these risks, many countries are seeking to diversify their CSMs sources and invest in recycling and material substitution technologies. In addition, international initiatives are being launched to increase the transparency and sustainability of supply chains, ensuring that the exploitation of these resources does not cause environmental or social damage.

5.3 Brazil's Role in the Energy Transition

Brazil, with its predominantly renewable energy matrix and vast reserves of CSMs, has a strategic position in the global energy transition. The country is one of the largest producers of niobium, as well as having significant reserves of graphite and rare earths. The development of a National Policy for Critical and Strategic Minerals (PNMCE) is crucial if Brazil is to harness its potential and make a significant contribution to the global energy transition.

The PNMCE should integrate sectoral policies and promote the sustainable development of mineral resources, in line with the goals of decarbonization and technological innovation. Brazil also has the opportunity to position itself as a leader in the production and export of green technologies, adding value to its natural resources and promoting the country's reindustrialization in strategic sectors.

The energy transition agenda places critical and strategic minerals at the center of global energy policies. Ensuring safe and sustainable access to these minerals is essential for the decarbonization of the world economy. Brazil, with its abundant reserves and industrial capacity, has a key role to play in this process. The formulation of a robust and integrated PNMCE is a crucial step for the country to establish itself as a leader in the new green economy, contributing to both global energy security and sustainable development.

06 Critical and strategic minerals for the energy transition

6.1 Lithium

6.1.1 Data, Resources and Reserves

Lithium is one of the critical minerals essential for the energy transition, especially in the production of batteries for electric vehicles and electronic devices. The world's main lithium resources are found in brines, especially in South America. Brazil, however, has smaller reserves of lithium contained in spodumene, a hard rock ore. In 2023, Brazil had 1.4% of global lithium reserves, with 390 kt of contained lithium.

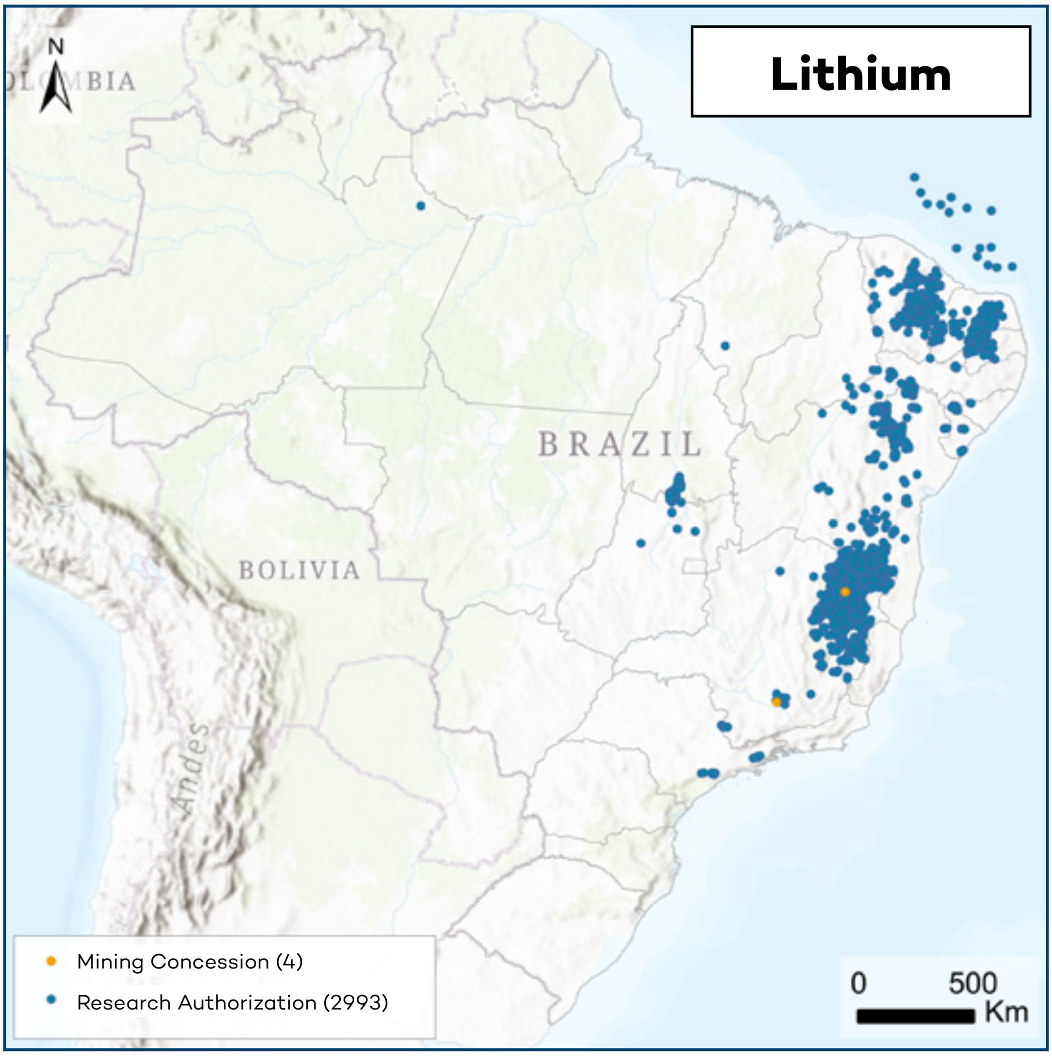
Li reserves and production in 2023 (USGS)

Reserves*	3 Li Lithium	Production	Conversion**
28 Mt (Li)		**180 Kt (Li)**	**180 Kt (LCE)**
(1) Chile = 33%		(1) Australia = 48%	(1) China = 78%
(2) Australia = 22%		(2) Chile = 24%	(2) Australia = 5.1%
(3) Argentina = 13%		(3) China = 18%	(3) Chile = 13%
(4) China = 11%		(4) Argentina = 5.6%	(4) Argentina = 3.0%
(5) USA = 3.9%		**(5) Brazil = 2.7%**	(5) Portugal = 0.5%
(6) Brazil = 1.4%		(6) Canadá = 1.9%	**(6) Brazil = 0.16%**
Others = 16%		Others = 22%	Others = 0.24%

*Resources = 105 Mt.** Estimate from Eng. Renato Costa from Ionic Lithium

In Brazil, reserves are still modest, but the country ranks fifth in the world for production, with 2.7% of global lithium production, representing 4.9 kt of lithium in 2023.

Figure: Map for Lithium Exploration Authorization and Mining Concession in Brazil (2024)



Elaboration: Jazida.com, ANM database May 2024

6.1.2 Value Chain

The lithium value chain involves several stages, from extraction to battery production. In Brazil, lithium mining is concentrated in Minas Gerais, which stands out for its production of spodumene concentrate. Three main mines are in operation:

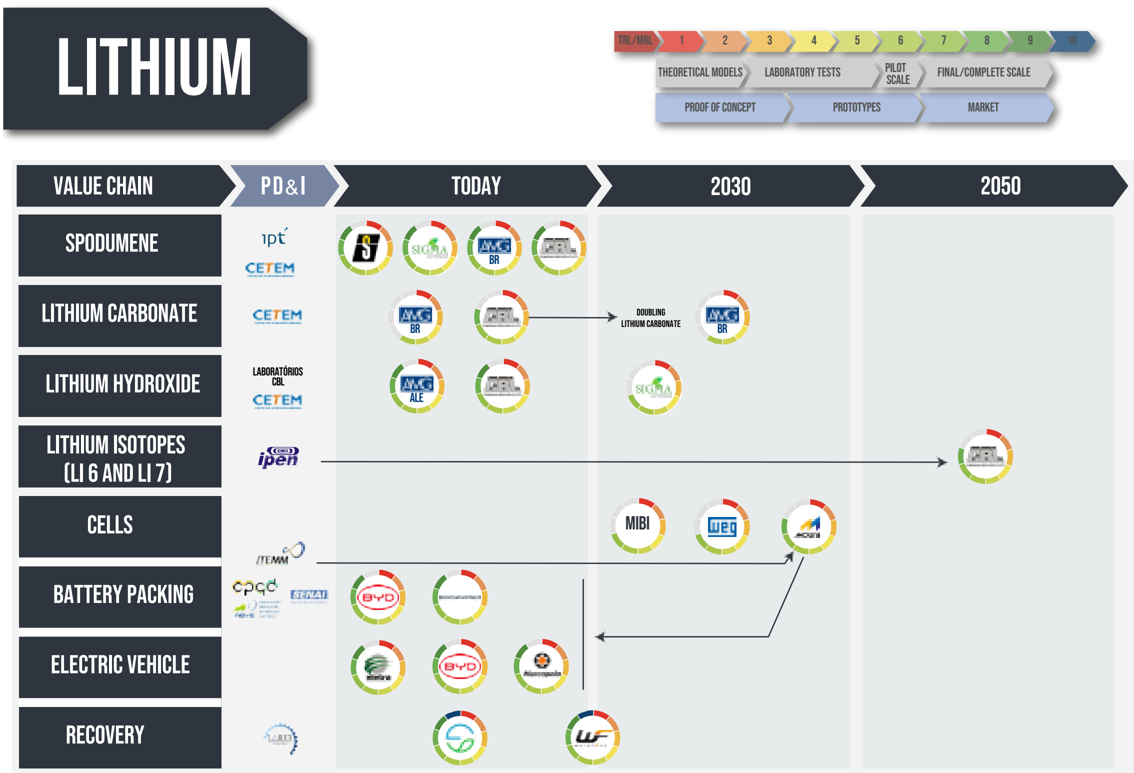
- **Cachoeira Mine:** Operated by CBL, a pioneer in the production of lithium carbonate for the domestic market.
- **AMG Brazil mine:** It exports spodumene concentrate, with lithium being a by-product.
- **Grota do Cirilo Mine:** Operated by Sigma Lithium, it began operations in 2023 and focuses on the export of concentrate.

- ## Technology Routes

The future of lithium production in Brazil lies in the verticalization of the production chain and advances in recycling. It is estimated that by 2050, around 60% of lithium demand could be met by recycling. Companies such as WF Baterias and Baterias Moura are already focused on recovering secondary materials and developing smaller, more efficient batteries.

The **Jequitinhonha Valley** in Minas Gerais is standing out as a hub of innovation in lithium production, known as Lithium Valley, attracting investment in the chemical conversion of lithium concentrates to battery-grade lithium carbonate and hydroxide. This initiative has the potential to add more value internally, as well as attracting electric vehicle manufacturers.

Lithium Technology Roadmap that maps the value chain and the stages of production, recycling and recovery of lithium by 2050.



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https://invest.mcti.gov.br/blog/projeto-de-cti/projeto-nicoli/

6.2 Rare Earths

Brazil has significant potential in the field of rare earths, with estimated reserves of 21 million tons of rare earth oxides (OTR), ranking third in the world. However, the country's current production is still minimal, accounting for just 0.02% of global production, which is largely dominated by China (69%). This contrast between reserves and production reveals a strategic opportunity for Brazil to further explore and develop its rare earths sector.

6.2.1 Data of Resources and Reserves

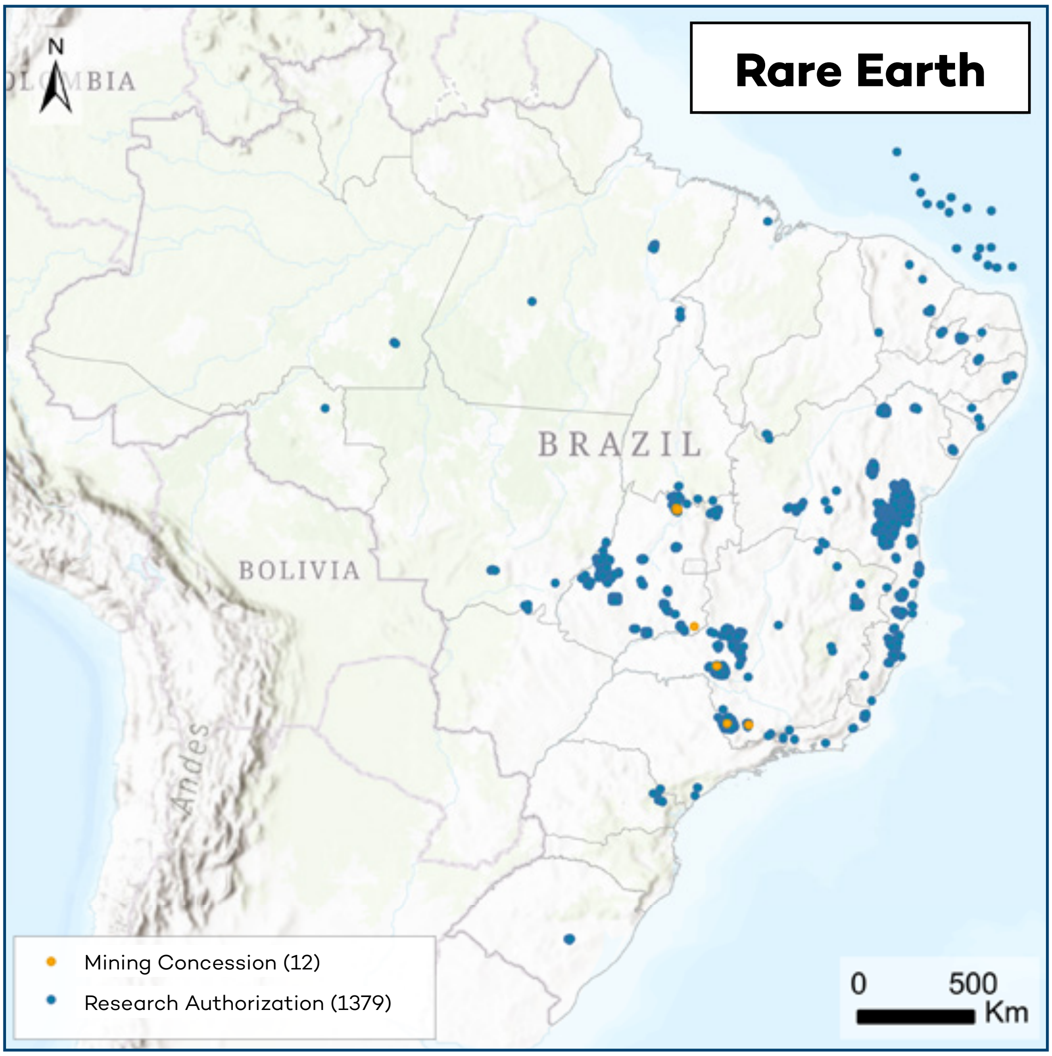
The image showing "Rare Earth Reserves and Production in 2023 (USGS)" highlights the global distribution of reserves and production of rare earth oxides. While China leads with 40% of reserves and 69% of world production, Brazil, with 19% of global reserves, plays an almost insignificant role in production, which highlights the need to invest in infrastructure and technology to increase its share of the global market. It is important to mention the start of production by Mineração Serra Verde (Minaçu - Goiás) in 2023, the first company to mine ionic clays, which has opened up great potential in Brazil, with important research in the Poços de Caldas - MG region.

Rare Earths Reserves and Production in 2023 (USGS)

Reserves*	**ETR** rare earth elements	**Production**
110 Mt (OTR)		**350 Kt (OTR)**
(1) China = 40%	21 **Sc** Scandium	(1) China = 69%
(2) Vietnam = 20%		(2) USA = 12%
(3) Brazil = 19%		(3) Burma = 11%
(4) Russia = 9.1%	39 **Y** Ithrium	(4) Australia = 5.1%
(5) India = 6.3%		(5) Thailand = 2.0%
(6) Australia = 5.2%	57 **La** Lanthanum	**(?) Brazil = 0.02%**
Others = 0.40%		Others = 5.9%

*Resources = N.D; OTR = rare earth oxides

Figure: Map for Rare Earths Exploration Authorization and Mining Concession in Brazil (2024)



Elaboration: Jazida.com, ANM database May 2024

6.2.2 Value Chain

The rare earth value chain includes several important stages, from the mining and concentration of the ore to the separation of oxides and the production of metals and alloys, culminating in the manufacture of high value-added products such as permanent magnets and catalysts. In Brazil, the value chain is still concentrated in the first stages of extraction, with raw materials being exported for processing abroad. To move forward, the country needs to develop its capacity to carry out the most profitable stages, such as the separation of oxides and the production of final components.

6.2.3 Technology Routes

The technological routes for the development of the rare earths sector in Brazil involve:

- **Mining and Concentration:** The initial stage of rare earth extraction and concentration, already in operation in Brazil, mainly uses ionic adsorption clays, as at Mineração Serra Verde in Goiás. This operation is a milestone in the production of ETR (rare earth elements) from ionic clays.

- **Separation of Oxides:** The separation of oxides is an advanced technological step that is essential for the processing of rare earths and is one of the main barriers for Brazil. This process uses chemical techniques, such as solvent extraction, to isolate the different rare earth elements, making it possible to produce pure oxides.

- **Production of Metals and Alloys:** Once the oxides are separated, the production of metals and alloys is crucial for the manufacture of magnets and other technological components. This stage is not yet consolidated in Brazil, which limits the development of the sector.

- **Final Product Manufacturing:** The last stage of the value chain is the production of high-tech components, such as neodymium magnets, which are used in electric motors and wind turbines. Brazil still needs infrastructure to compete at this stage of the production chain.

6.3 Nickel

6.3.1 Data, Resources and Reserves

Nickel is an essential metallic element for the production of stainless steel and batteries, with a growing demand due to the expansion of electric vehicles. In 2023, Brazil **ranked 3rd** in world reserves, with **16 million tons** of contained nickel, which represents **12% of global reserves**, behind Indonesia (42%) and Australia (24%). The main areas with reserves in Brazil include Goiás, Piauí, Minas Gerais, Pará and Bahia

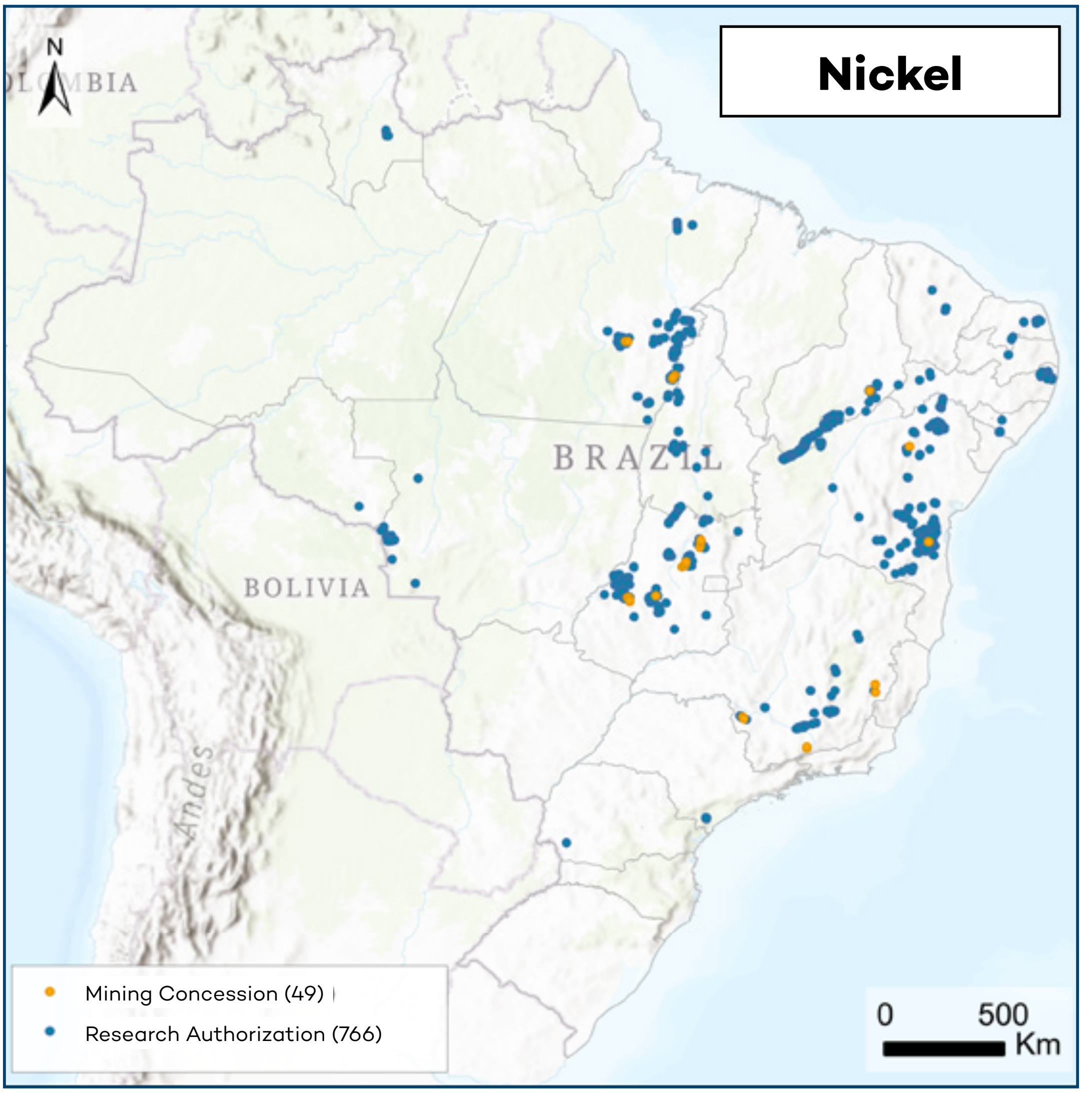
Nickel reserves and production in 2023 (USGS)

Reserves*	28 Ni Nickel	Production
130 Mt (Ni)		**3,600 Kt (Ni)**
(1) Indonesia = 42%		(1) Indonesia = 50%
(2) Australia = 24%		(2) Philippines = 11%
(3) Brazil = 12%		(3) N. Caledonia = 6.4%
(4) Russia = 6.4%		(4) Russia = 5.6%
(5) N. Caledonia = 5.5%		(5) Canada = 5.0%
(6) Philippines = 3.7%		**(8) Brazil = 2.5%**
Others = 6.4%		Others = 20%

*Resources = 350 Mt (54% in laterite and 35% in sulphides)

Despite its vast reserves, Brazil's production is relatively low, placing it in **8th place** with just **2.5% of global production**. World nickel production is dominated by Indonesia (50%), followed by the Philippines (11%).

Figure: Map for Nickel Exploration Authorization and Mining Concession in Brazil (2024)



Elaboration: Jazida.com, ANM database May 2024

6.3.2 Value Chain

The nickel value chain in Brazil is largely concentrated on the **extraction of sulphide and laterite ores**. Brazil mainly exports **Class II nickel**, which is a sulphide concentrate used to produce ferro-nickel and other metal alloys. This product is sent abroad, where it is processed into **Class I nickel**, used to make lithium-ion batteries.

Most of Brazil's production is concentrated in **five major operations**:

1. Barro Alto;

2. Codemin;

3. Santa Rita;

4. Onça Puma; and

5. Americano do Brasil.

However, the country still has a significant dependence on the export of raw materials, limiting the creation of added value in the domestic sector.

6.3.3 Technology Routes

To leverage the potential of its vast reserves, Brazil needs to invest in technological routes that go beyond simply extracting nickel. The technological routes include:

- **Mining and Processing of Laterite and Sulphide Ores:** Brazil already has mature laterite and sulphide mining operations, but much of the ore extracted is exported for processing into Class I nickel abroad.

- **Class I Nickel Production:** The production of Class I nickel, which is needed for lithium-ion batteries, is an area in which Brazil needs to expand its infrastructure. This would require advanced hydrometallurgy and pyrometallurgy technologies to treat laterite ores and sulphides locally.

- **Final Product Manufacturing:** Developing the capacity to produce high value-added products, such as lithium-ion batteries, is crucial for Brazil to capture most of the value chain. This involves a coordinated effort to invest in technology and industrial infrastructure.

6.4 Cobalt

6.4.1 Data, Resources and Reserves

Cobalt is a critical element associated with other ores such as lead, copper, nickel and platinum, used in superalloys, lithium-ion batteries and high-strength tools. In 2023, global cobalt reserves were estimated at **11 million tons**, with the **Democratic Republic of Congo (DRC) holding 55% of the world's reserves**, followed by Australia (15%). **Brazil was ranked 9th** in the world in 2017, with 70,000 tons of reserves, but there has been no updated information on its position since then.

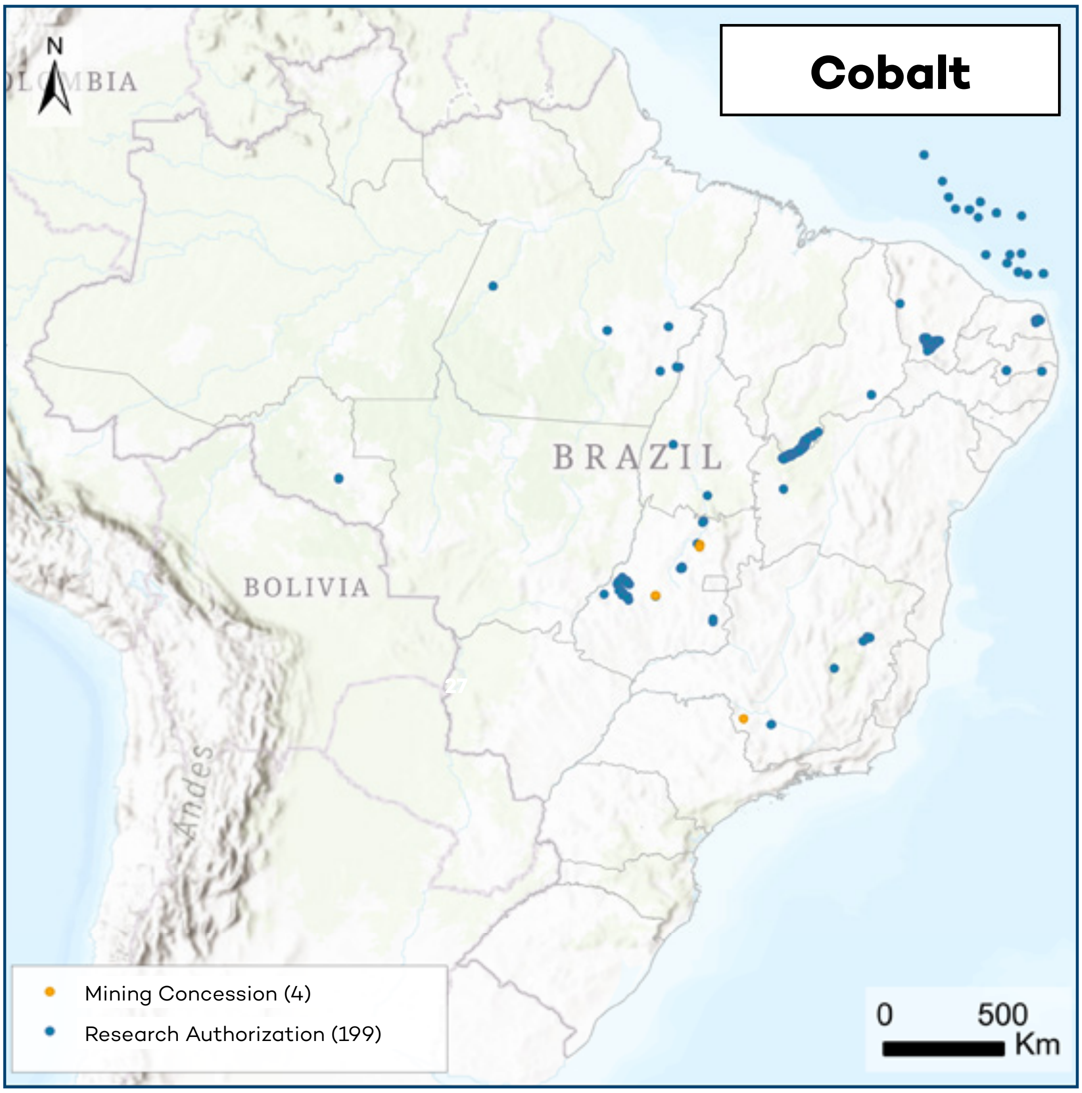
Cobalt reserves and production in 2023 (USGS)

Reserves*	27 Co Cobalt	Production
11 Mt (Co)		**230 Kt (Co)**
(1) DR Congo = 55%		(1) DR Congo = 74%
(2) Australia = 515%		(2) Indonesia = 7.4%
(3) Cuba = 4.5%		(3) Russia = 3.8%
(4) Indonesia = 4.5%		(4) Australia = 2.0%
(5) Philippines = 2.4%		(5) Madagascar = 1.7%
Others = 19%		Others = 11%

*Resources = 25 Mt.

In terms of production, the DRC also leads, with **74% of the world's cobalt production**, followed by Indonesia (7.4%) and Russia (3.8%). Brazil does not have a significant share in global production, mainly due to the shutdown of important mines.

Figure: Map for Cobalt Exploration Authorization and Mining Concession in Brazil (2024)



Elaboration: Jazida.com, ANM database May 2024

6.4.2 Value Chain

The cobalt value chain is dominated by large producers such as the DRC, which exports most of its cobalt for processing in China. China is the main global center for cobalt refining and transformation, responsible for **70% of global processing** and supplying refined cobalt for rechargeable batteries and electronics. Brazil, for its part, has cobalt deposits associated with nickel mining, but **three large Brazilian mines** (Fortaleza de Minas-MG, Americano do Brasil-GO and Niquelândia-GO) were halted in 2017 due to lack of economic viability.

Currently, Brazil depends on the reactivation of these operations and progress in new cobalt deposits associated with nickel, such as **Jacaré**, in Parauapebas-PA, and exploration projects in **São Félix do Xingu-PA**.

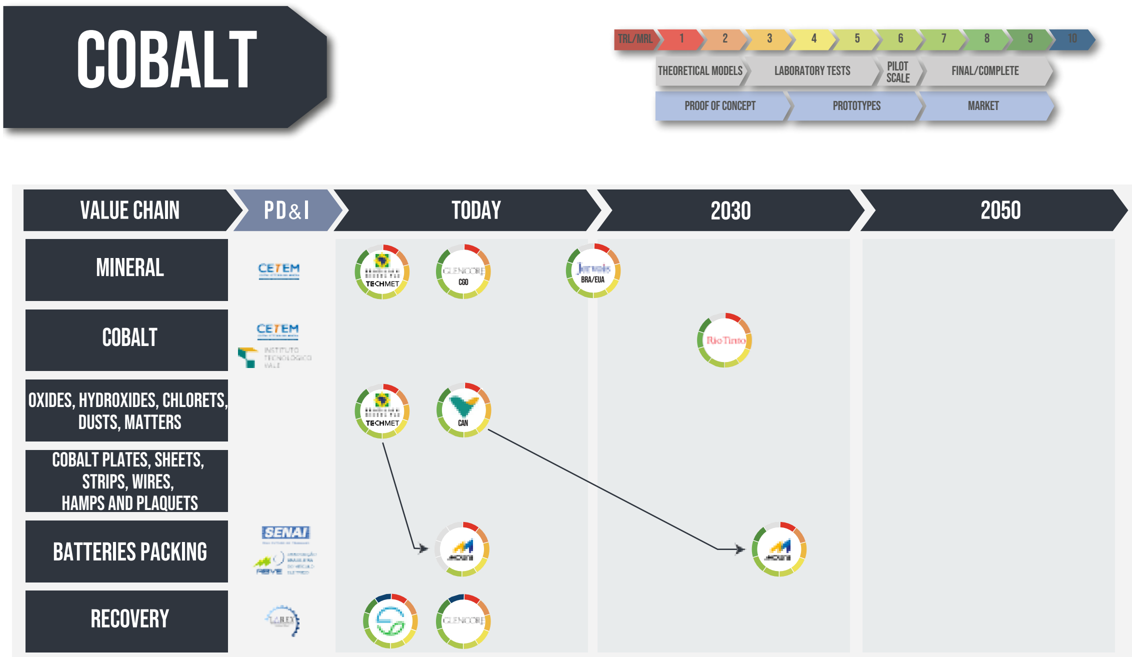
6.4.3 Technology Routes

For Brazil to consolidate its position as a relevant producer of cobalt, it is necessary to invest in the following technological routes:

- **Extraction and Processing of Cobalt Associated with Nickel:** The main source of cobalt in Brazil is associated with nickel mining. Reopening paralyzed mines and investing in new associated cobalt deposits are key to increasing national production.

- **Refining and Purification Technologies:** Currently, Brazil does not have significant cobalt refining capacity. Investments in **hydrometallurgy** and **pyrometallurgy** are needed to purify the extracted cobalt into high-quality cobalt used in lithium-ion batteries.

- **Production of Battery Materials:** Cobalt is essential in the manufacture of **cathodes** for rechargeable batteries, especially lithium-ion batteries, which are widely used in electric vehicles. To capture more value in the cobalt chain, Brazil must invest in infrastructure to directly produce these high-tech components.



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6.5 Graphite

6.5.1 Data, Resources and Reserves

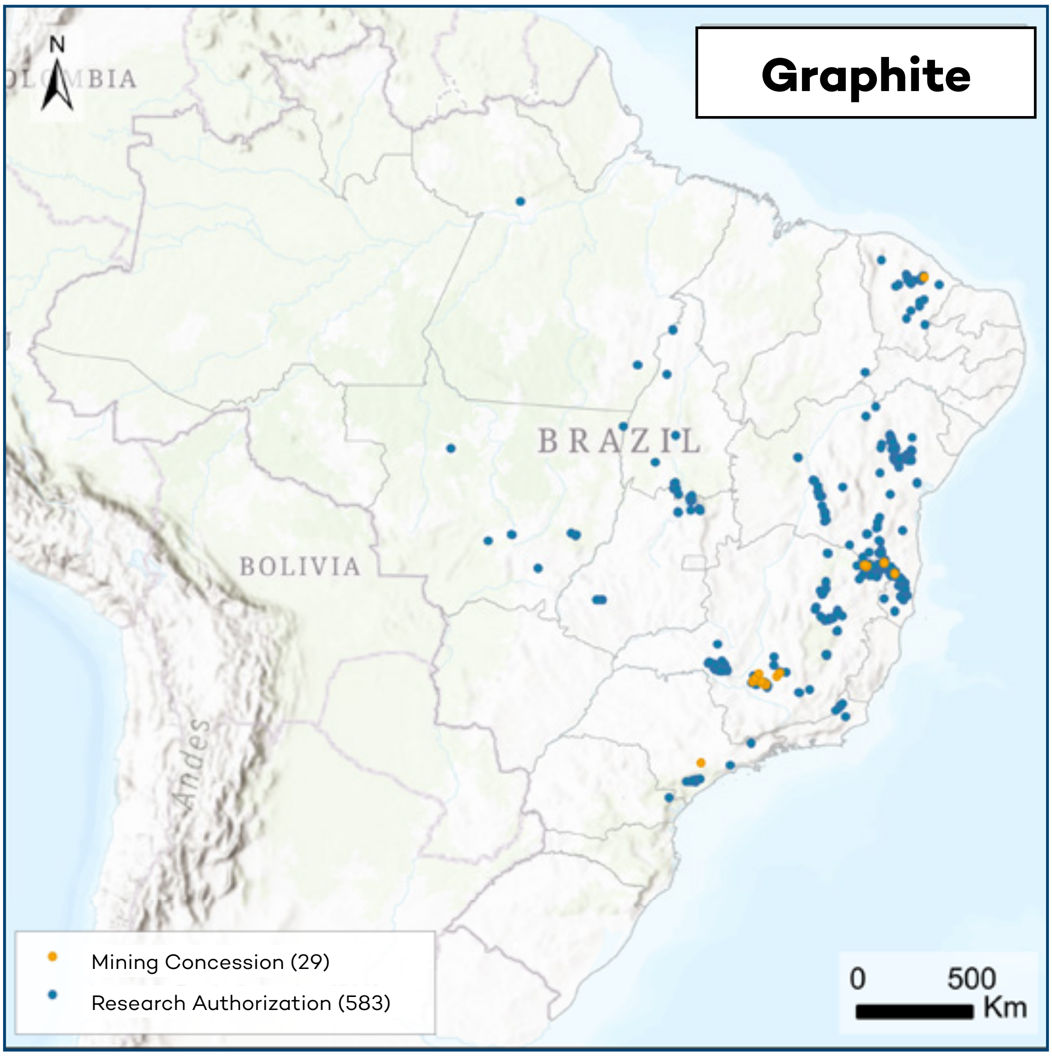
In 2023, Brazil's graphite reserves were in the order of **74 million tons**, which places the country as the **2nd largest holder of global reserves**, behind only China (28%) and representing **26% of the world's reserves**. Despite having a prominent position in terms of reserves, Brazil still has a modest share in global production, with **4.6% of world production**, while China dominates with 77% of production. Brazil's graphite reserves are mainly distributed in the Southeast and Northeast regions, according to the **map of research authorizations and mining concessions** (Image 2), which shows **29 mining concessions and 583 research authorizations**.

Graphite reserves and production in 2023 (USGS)

Reserves*	6 C Carbon	Production
280 Mt (X)		**1,600 Kt (X)**
(1) China = 28%		(1) China = 77%
(2) Brazil = 26%		(2) Madagascar = 6.3%
(3) Mozambique = 8.9%		(3) Mozambique = 6.0%
(4) Madagascar = 8.5%		**(4) Brazil = 4.6%**
(5) Tanzania = 6.4%		(5) Korea R. = 1.7%
Others = 55%		Others = %

*Resources = 800 Mt.

Figure: Map for Graphite Exploration Authorization and Mining Concession in Brazil (2024)



Elaboration: Jazida.com, ANM database May 2024

6.5.2 Value Chain

The graphite value chain in Brazil is still developing, with a large part of production destined for export as raw material. Graphite is an essential material for manufacturing high-tech products such as lithium-ion batteries, components for electric vehicles and other electronic devices. However, Brazil faces challenges in adding value to its production, with most of the processing and manufacturing of end products taking place in other countries. To maximize the economic value of graphite, the country needs to invest in local processing technologies, focusing on the production of advanced materials such as graphene and graphite-based products for batteries and electronics.

6.5.3 Technology Routes

To exploit the full potential of its graphite reserves, Brazil needs to advance on several technological fronts, including:

- **Graphite Mining and Beneficiation:** Brazil already has significant graphite extraction operations, but needs to expand its beneficiation capacities to produce the high-purity materials needed for batteries and other electronic products. This involves investments in processing technologies to improve the quality of the graphite extracted.

- **Production of Purified Graphite for Batteries:** Demand for purified graphite for the production of lithium-ion battery anodes is growing rapidly, driven by the energy transition and the popularization of electric vehicles. Brazil has an opportunity to increase its share of this market if it invests in technologies for purifying and refining the extracted graphite.

- **Development of Graphene Technologies:** Graphene, derived from graphite, is a material with exceptional properties that can be used in a variety of high-tech applications, from electronics to medicine. Brazil could take advantage of its vast graphite reserves to become one of the world's leading graphene producers by investing in research and development to exploit this niche market.

6.6 Manganese

6.6.1 Data, Resources and Reserves

Manganese is an essential metal for global industry, especially in the steel industry and batteries. In 2023, global manganese reserves were estimated at **1,900 million tons**, with **Brazil ranking 4th in the world,** holding **14% of global reserves**. The largest reserves are concentrated in South Africa (32%), Australia (26%) and China (15%).

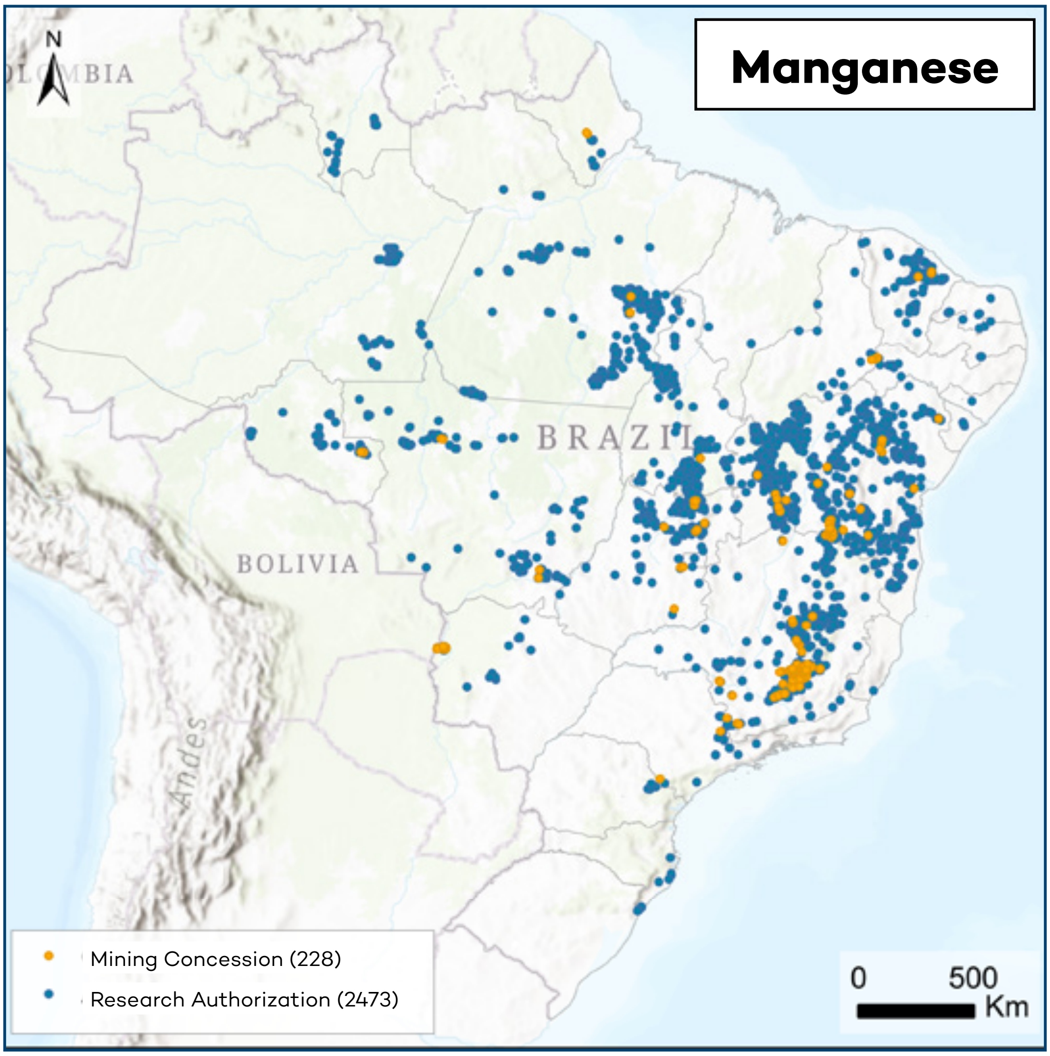
Manganese reserves and production in 2023 (USGS)

Reserves*	25 Mn Manganese	Production
1,900 Mt (Mn)		**20 Mt (Mn)**
(1) South Africa = 32%		(1) South Africa = 36%
(2) Australia = 26%		(2) Gabon = 23%
(3) China = 15%		**(3) Brazil = 15%**
(4) Brazil = 14%		(4) Ghana = 4.2%
(5) Ukraine = 7.4%		(5) China = 3.7%
(2) Gabon = 3.2%		(6) India = 3.6%
Others = 2.4%		Others = 19%

*Resources = N.A.

In terms of production, **Brazil** is in **third place** with **15% of world production**, behind South Africa (36%) and Gabon (23%). The main manganese deposits in Brazil are located in **Minas Gerais and Pará,** where high quality ores are extracted and used on both the domestic and international markets.

Figure: Map for Manganese Exploration Authorization and Mining Concession in Brazil (2024)



Elaboration: Jazida.com, ANM database May 2024

6.6.2 Value Chain

The manganese value chain in Brazil is largely focused on the production of manganese ferroalloys, which are mainly used in the steel industry to improve the quality of steel. The country is also one of the main global producers of ferromanganese, ranking 8th in the world. In addition to the steel industry, manganese is used in batteries, especially electric vehicle batteries, and is also used as a micronutrient in agriculture.

Brazilian production is concentrated in Minas Gerais and Pará, states that have adequate infrastructure and logistics for transporting and processing the ore. Several companies are involved in the extraction and processing of manganese, contributing to Brazil's presence on the global market.

6.6.3 Technology Routes

To maintain its competitiveness and increase its share of the manganese market, Brazil needs to invest in some essential technological routes:

- **•Extraction and Processing of High Quality Manganese:** Brazil already has efficient extraction operations, but it must continue to invest in technologies to improve ore processing, ensuring that Brazilian manganese remains competitive in terms of quality.

- **•Expansion of Manganese Production for Batteries:** The use of manganese in electric vehicle batteries is growing, and Brazil has the potential to expand its presence in this emerging market. This will require the development of new manganese processing technologies aimed specifically at battery applications.

- **Technologies for Advanced Ferroalloys:** Brazil is already one of the main producers of manganese ferroalloys, but it can increase its added value by investing in technologies that enable the production of advanced, high-strength ferroalloys used in cutting-edge industries such as the automotive and aerospace industries.

07 Base Metals for the Energy Transition

7.1 Aluminum

7.1.1 Data, Resources and Reserves

Aluminum, a metal widely used in modern industry, is extracted from bauxite. **Brazil** has the **world's 4th largest bauxite reserves**, with **30 gigatonnes (Gt)**, which represents **9% of global reserves**. Most of these reserves are concentrated in the North, especially in Oriximiná-PA, where **MRN (Mineração Rio do Norte)** is responsible for around **40% of national production**. Globally, Brazil **ranks 6th** in the production of metallic aluminum, contributing **1.6% of world production**.

Aluminum reserves and production in 2023 (USGS)

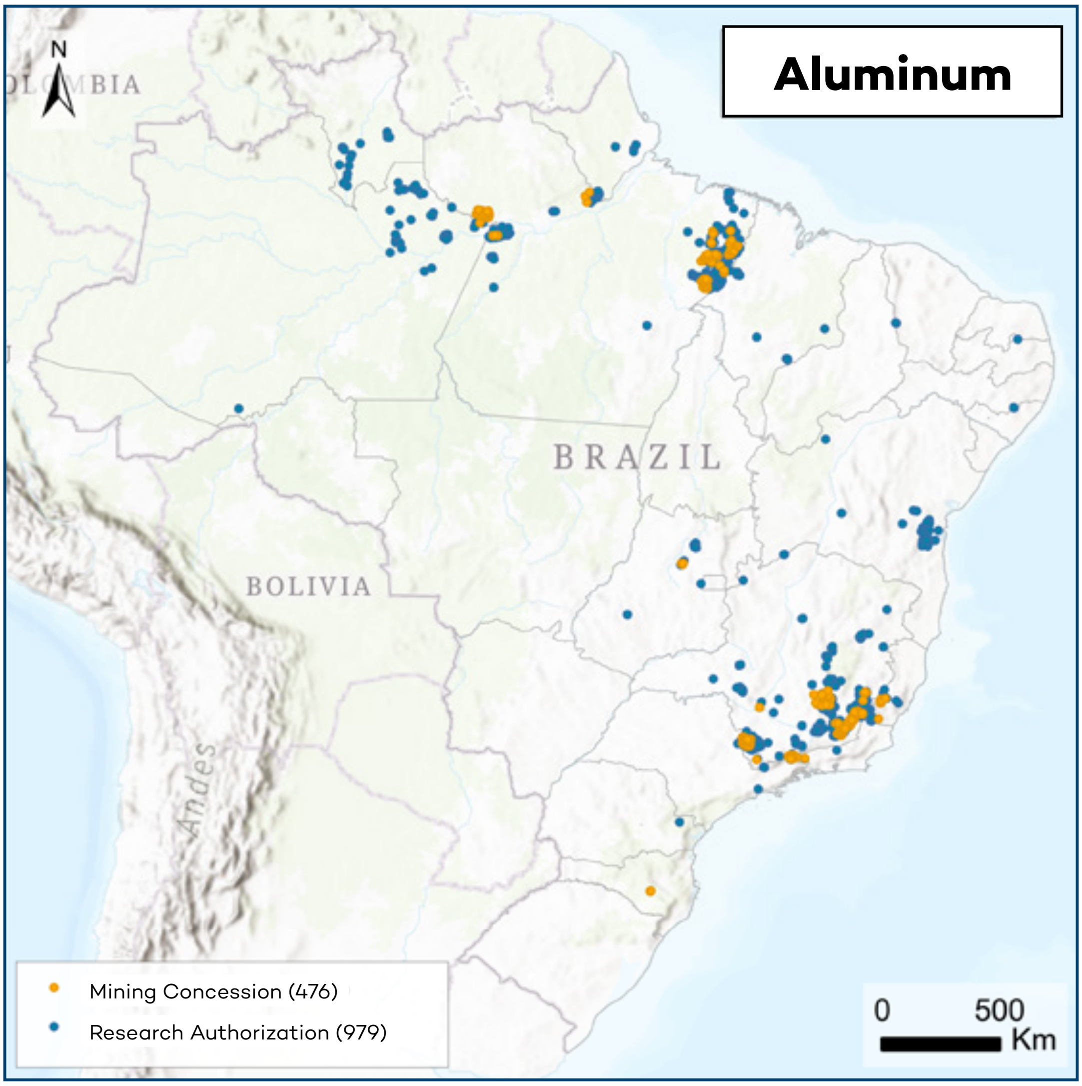
Reserves*	Production	13 Al Aluminum	Alumina	Aluminum
30 Gt (bauxite)	**400 Mt (bauxite)**		**140 Mt (Al2O3)**	**70 Mt (Al)**
(1) Guinea = 25%	(1) Australia = 25%		(1) China = 59%	(1) China = 59%
(2) Vietnam = 19%	(2) Guinea = 24%		(2) Chile = 14%	(2) India = 5,9%
(3) Australia = 12%	(3) China = 23%		**(3) Brazil = 7,1%**	(3) Russia = 5,4%
(4) Brazil = 9.0%	**(4) Brazil = 7.8%**		(4) India = 5,2%	(4) Canada = 4,3%
(5) Jamaica = 6,7%	(5) Indonesia = 5.0%		(5) Russia = 1,7%	(5) United Arab Emirates = 3,9%
(6) Indonesia = 3,3%	(6) Jamaica = 1,5%		(6) United Arab Emirates = 1,6%	**(6) Brazil = 1,6%**
Others = 25%	Others = 14%		Others = 211%	Others = 20%

*Resources = 55 to 75 Gt

The **map of bauxite exploration permits and mining concessions** in Brazil (Image 3) shows the vast distribution of exploration areas, with **476 mining concessions** and **979 research permits**. This shows that Brazil still has great potential to expand its production of bauxite and aluminum, especially in the North and Southeast, where the main deposits are concentrated.

With a solid base of resources and reserves, a structured production chain and opportunities for sustainable growth, Brazil is well positioned to increase its share of the global aluminum market, especially in a context of growing demand for green aluminum and more sustainable technologies.

Figure: Map for Bauxite (Aluminum) Exploration Authorization and Mining Concession in Brazil (2024)



Elaboration: Jazida.com, ANM database May 2024.

7.1.2 Value Chain

The aluminum value chain begins with the mining of bauxite, which is transformed into **aluminum oxide (alumina - Al2O3)** and then into metallic aluminum through reduction processes. Brazil ranks 3rd in the world in alumina production, with **Hydro Alunorte**, located in Pará, producing 5.5 million tons of alumina, accounting for **54% of national production**.

Aluminum metal production in Brazil has already been higher, reaching 1.5 million tons in 2014/2015. However, due to economic issues and the fall in aluminum prices on the international market, production fell, and Brazil dropped to **15th place** in 2023. However, there has been a recent recovery, with the country producing **1.1 million tons of aluminum** and rising to **8th place** in the world ranking.

Currently, Brazilian aluminum production is concentrated in two major producers: **Companhia Brasileira de Alumínio (CBA)** and **Albras**, the latter of which has Norwegian and Japanese capital. There is also **Alumar**, located in the state of Maranhão, also an important producer of primary aluminum, formed by a consortium of the companies **Alcoa, Rio Tinto and South32**.

It is important to note that aluminum recycling already accounts for more than 50% of Brazilian consumption, resulting in a major reduction in energy consumption and CO2 emissions. This highlights the importance of recycling in reducing the environmental impact of the aluminum industry. With the move towards cleaner and more renewable energy sources, and with recycling playing an increasingly important role, the aluminum industry in Brazil is moving towards a more sustainable future, with the production of greener aluminum, which puts Brazil at a competitive advantage, but which has not yet been transformed into greater value.

7.1.3 Technology Routes

To consolidate its position in the global aluminum market and increase its added value, Brazil needs to invest in different technological routes:

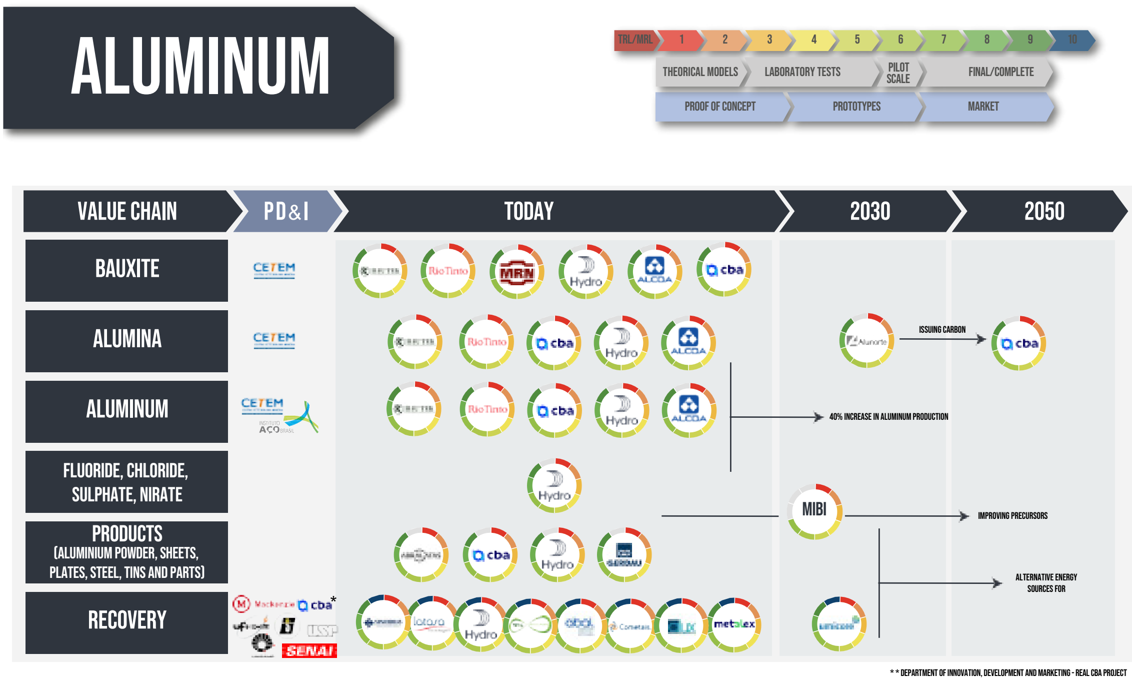
- **Improving Bauxite Mining and Processing:** Bauxite mining in Brazil is already efficient, but optimizing extraction and processing technologies could increase the competitiveness of Brazilian production. This includes more sustainable extraction methods and reducing environmental impacts.

- **Expansion of Alumina Production:** Brazil is already one of the largest alumina producers in the world. The implementation of advanced refining technologies can further increase production efficiency and reduce costs, positioning the country as a key supplier of high-quality alumina to global markets.

- **Development of Green Aluminum:** The demand for low-carbon aluminum is growing, especially in markets seeking to minimizetheir carbon footprint. Brazil already has competitive advantages in "green" aluminum, with more than 50%

of national production coming from renewable energy sources such as hydro-electricity. Investing in recycling technologies and the use of clean energy can further strengthen this position. It is important to note that the cost of energy is a restrictive factor for new primary aluminum production facilities in Brazil.

- **Aluminum Recycling:** Brazil is one of the world leaders in aluminum recycling, with more than 50% of its production coming from recycled material. This practice not only reduces CO_2 emissions, but also offers a significant economic advantage. The country can further expand this route with investments in infrastructure and recycling technology.



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7.2 Copper

7.2.1 Data, Resources and Reserves

Copper is a metal with remarkable properties, including excellent electrical and thermal conductivity, corrosion resistance and the ability to alloy with other metals. It plays a crucial role in the energy **transition**, especially in **renewable energy generation** technologies and the **production of batteries for electric vehicles**.

Copper reserves and production in 2023 (USGS)

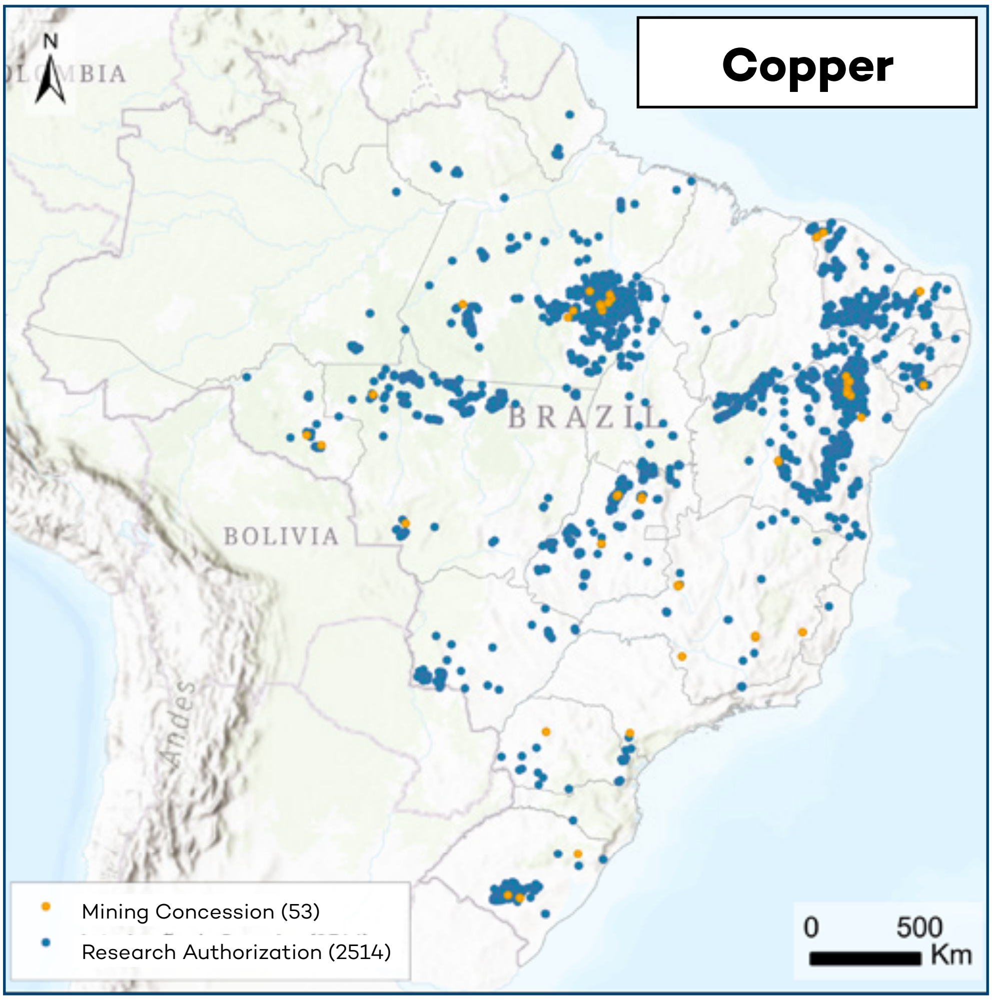
Reserves*	29 Cu Copper	Production	Refined
1.0 Mt (Cu)		**22 Mt (Cu)**	**27 Mt (Cu)**
(1) Chile = 19%		(1) Chile = 23%	(1) China = 44%
(2) Peru = 12%		(2) Peru = 12%	(2) Chile = 7.4%
(3) Australia = 10%		(3) DR Congo = 11%	(3) DR Congo = 7.0%
(4) DR Congo = 8%		(4) China = 7.7%	(4) Japan = 6.8%
(5) Mexico = 5.3%		(5) USA = 5.0%	(5) Russia = 3.7%
(17) Brazil = 1.1%		**(13) Brazil = 1.6%**	**(17) Brazil = 1.0%**
Others = 55%		Others = 51%	Others = 30%

*Resources = 2,1 Gt

Brazil's copper ore reserves are in the order of **11 million tons** of contained copper, with **90% concentrated in the state of Pará**, which has the country's main mines. This represents around 1% of global reserves, placing Brazil **17th in the world** in terms of copper reserves. Globally, Chile leads the way with **19% of the world's reserves**, followed by Peru and Australia.

In 2023, copper production in Brazil reached **350,000 tons**, with the **Salobo (145 kt)** and **Sossego (82 kt)** mines, both in Pará, accounting for **65% of national production.** Brazil ranks **13th in terms** of copper production, contributing **1.6% of global production**.

Figure: Map for Copper Exploration Authorization and Mining Concession in Brazil (2024)



Elaboration: Jazida.com, ANM database May 2024

7.2.2 Value Chain

The copper value chain in Brazil is mainly focused on the **production of copper concentrate**, which is exported to be refined in other countries. **Copper concentrate** is the initial form of the ore after the extraction and beneficiation process, and requires further refining stages to be transformed into refined copper, used in end products such as electrical wires and cables.

Currently, Brazil has limited **copper refining** capacity, accounting for only **1% of the copper refined** globally, which places the country in **17th place in the world**. Most of the copper refined comes from China (44%) and Chile (15%), which own the main refining plants.

Mining in Pará dominates Brazilian production, but there are also important operations in Goiás and Bahia. The main part of the copper (concentrate) produced in Brazil is destined for the foreign market, limiting value addition in the country.

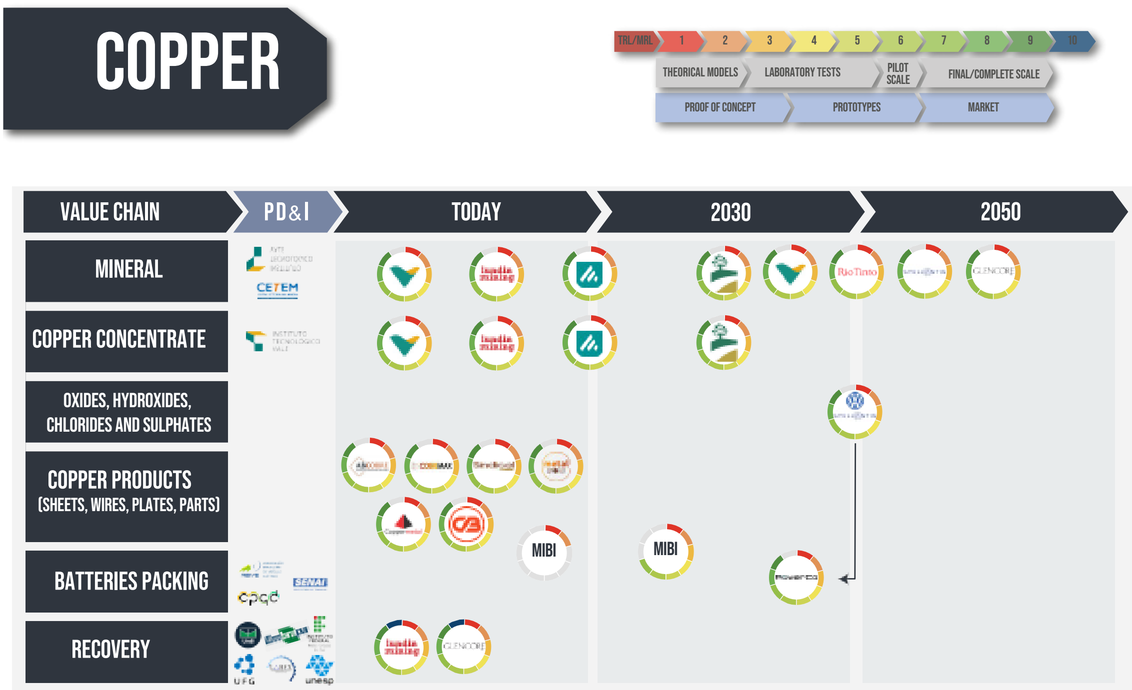
7.2.3 Technology Routes

In order to strengthen its position in the global market and increase the added value of its production, Brazil needs to invest in various technological routes:

- **Expansion of National Refining:** Currently, Brazil exports most of its copper concentrate without adding value in the country. The development of domestic refining capacities is crucial to increasing the production of refined copper, meeting the growing global demand for high-purity copper, especially in the technology and energy sectors. Supply and cost of energy limit the expansion of copper metal production in the country.

- **Optimization of the Production Chain:** Improving the efficiency of copper mining and processing operations could increase Brazil's competitiveness. Investing in automation and digital control technologies in mines and processing plants will help reduce costs and increase productivity.

- **Sustainable Use of Energy:** Brazil has a renewable energy matrix, which can be used as a competitive advantage, reducing the carbon emissions associated with copper production. Investing in projects that use renewable energy sources such as solar and wind power in mining and refining operations will help the country meet global demands for sustainable materials.



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08 Food security and CSMs

8.1 Potassium

8.1.1 Data, Resources and Reserves

Potassium is a fundamental element for agriculture worldwide, used mainly in the production of potash fertilizers (KCl) which are essential for plant nutrition. In 2023, global potash reserves were estimated at **3.6 gigatonnes (Gt) of K_2O** equivalent, with Brazil **ranking 12th with 0.1% of global reserves**. The countries with the largest reserves are Canada (31%), Belarus (21%) and Russia (18%).

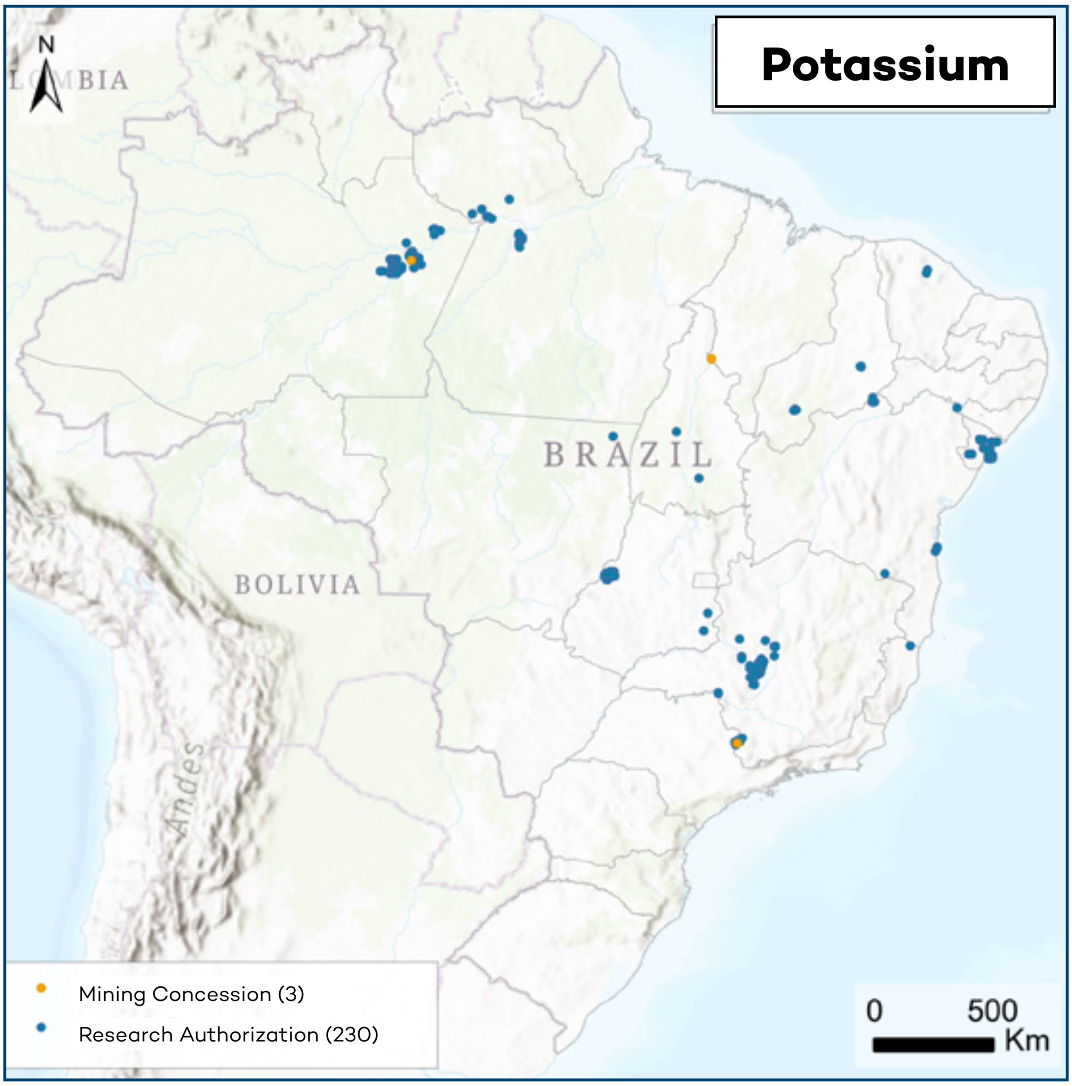
Potassium reserves and production in 2023 (USGS)

Reserves*	19 K Potassium	Production
3.6 Gt (K2O eq)		**396 Mt (K2O eq)**
(1) Canadá = 31%		(1) Canada = 33%
(2) Belarus = 21%		(2) Russia = 17%
(3) Russia = 18%		(3) China = 15%
(4) USA = 6.1%		(4) Belarus = 9.7%
(5) China = 5.0%		(5) Germany = 6.7%
(12) Brazil = 0.1%		**(12) Brazil = 0.5%**
Others = 19%		Others = 18%

*Resources = 250 Gt. Mineable reserves (ROM) = 11 Gt

In terms of production, Brazil contributes just **0.5% of global production** and is highly dependent on imports to meet its domestic demand. World potash production is led by Canada (33%), Russia (17%) and Belarus (17%), which together account for around 70% of global production.

Figure: Map for Potassium Exploration Authorization and Mining Concession in Brazil (2024)



Elaboration: Jazida.com, ANM database May 2024

8.1.2 Value Chain

The potassium value chain in Brazil is dominated by dependence on imports. Brazil is the **world's second largest consumer of potassium**, consuming around **10.7 million tons of K_2O equivalent** annually, **96% of which is imported**. This growing dependence puts pressure on the agricultural sector, since potassium is one of the main inputs in fertilizer production, directly impacting the competitiveness of Brazilian agriculture.

Brazil's biggest sources of potassium imports are Canada, Russia and Belarus. In Brazil, there is modest national production, concentrated in the **State of Sergipe**, with the **Taquari-Vassouras** mine, which is currently operated by **Mosaic Fertilizantes**. The annual production of this mine was **193,000 tons of K_2O** in 2023, representing a tiny fraction of national demand.

8.1.3 Technology Routes

In order for Brazil to reduce its dependence on imports and strengthen its domestic potassium production, it is necessary to invest in various technological routes:

- **Development of New Deposits:** Brazil has identified reserves in Sergipe (sylvinite and carnallite) and Amazonas (sylvinite), which could be exploited to increase domestic production. One of the projects in the spotlight is that of *Potássio do Brasil*, which aims to start exploring new areas in Autazes, in the state of Amazonas. It is important to highlight the need to search for new potash deposits in Brazil to meet the country's domestic demand.

- **Remineralization Technologies:** In addition to conventional mining, Brazil can invest in the development of remineralization technologies, using alternative sources of potassium as soil remineralizers. This would include the use of potash rocks, which offer a way to reduce dependence on imported potassium.

- **Expansion and Modernization of National Production:** Modernizing potassium extraction technologies, especially in areas such as Sergipe and Amazonas, could increase the efficiency and economic viability of domestic production. The Autazes mine project in Amazonas represents a significant opportunity to expand national production.

- **RD&I for New Sources of Potassium:** Investments in research and development (RD&I) are crucial to discovering new sources of potassium and creating more efficient and sustainable extraction processes. This will allow Brazil to become one of the main global producers in the future, taking advantage of its agricultural capacity and its need for local inputs.

8.2 Phosphate

8.2.1 Data, Resources and Reserves

Phosphate is a crucial mineral for global agriculture, used mainly in the manufacture of phosphate fertilizers. In 2023, the world's **phosphate rock** reserves were estimated at **746 gigatonnes (Gt)**, with Brazil occupying **7th place globally**, holding **2.2% of the world's reserves**. The largest holders of reserves are Morocco (70%), followed by China (5.1%) and Belarus (3.8%).

Phosphate reserves and production in 2023 (USGS)

Reserves*	15 P Phosphorus	Production
746 Gt (Rock)		**220 Mt (Rock)**
(1) Morocco = 70%		(1) China = 41%
(2) China = 5.1%		(2) Morocco = 16%
(3) Egypt = 3.8%		(3) USA = 9.1%
(4) Tunisia = 3.4%		(4) Russia = 6.4%
(5) Russia = 3.2%		(5) Jordan = 5.5%
(7) Brazil = 2.2%		**(6) Brazil = 2.4%**
Others = 12%		Others = 20%

*Resources = 300 Gt

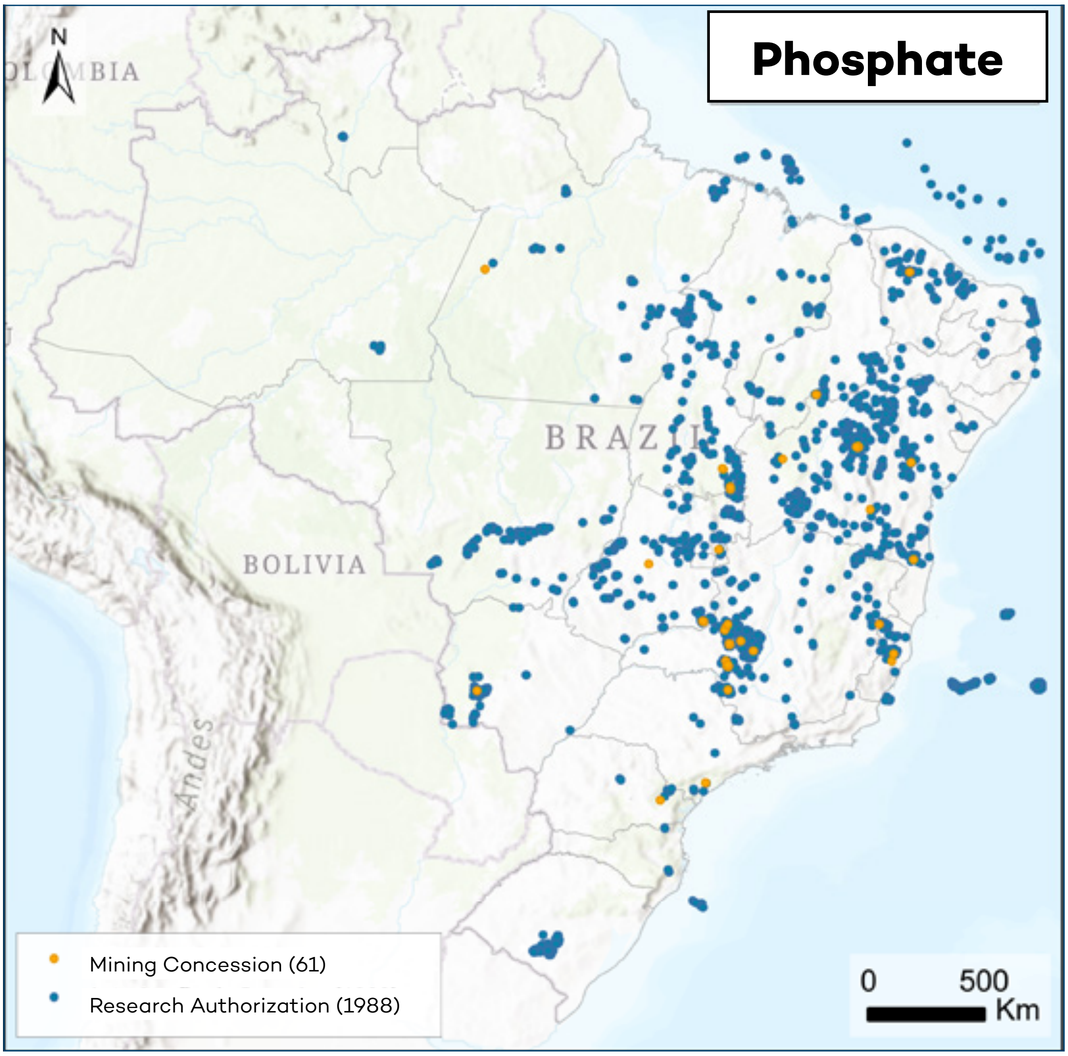
In terms of production, Brazil contributes **2.4% of the world's phosphate rock production**, placing it **6th in the global ranking**, behind giants such as China, Morocco and the United States, which together account for more than 80% of the world's phosphate production. Brazil's phosphate production is essential to meet the needs of its large agricultural industry.

The **map of mining concessions and research authorizations in Brazil** shows great potential for the expansion of phosphate exploration, with **61 mining concessions and 1,988 research authorizations** distributed in various regions of the country. The state of **Minas Gerais** and the **Central-West** region stand out as the main phosphate exploration centers in Brazil.

In addition, the country has ambitious goals for **2050**, which include expanding national phosphate reserves and production, with the aim of reducing foreign dependence and consolidating Brazil as an important global producer of phosphate fertilizers.

Increased production will be essential to meet the growing domestic demand for fertilizers, especially with the expansion of agriculture.

Figure: Map for Phosphate Exploration Authorization and Mining Concession in Brazil (2024)



Elaboration: Jazida.com, ANM database May 2024

8.2.2 Value Chain

The phosphate value chain in Brazil begins with the extraction of **phosphate rock**, which is processed to produce **phosphate fertilizers**. Brazil has an integrated production chain, with national and international companies operating in both the mining and processing of phosphate. The main companies operating in Brazil include **Mosaic Fertilizantes** (responsible for 52% of national production), **CMOC** (20%).

However, Brazil still depends on *imports* to meet the demand for phosphate fertilizers, mainly due to the limitation of high-quality reserves and the growing demand from the agricultural sector. External dependence is aggravated by the need to import inputs such as sulphur and sulphuric acid, which are essential for fertilizer production.

8.2.3 Technology Routes

In order to reduce its dependence on imports and expand domestic production, Brazil needs to invest in various technological routes:

- **Improving Mineral Processing:** The technology for concentrating phosphate ores by flotation can be optimized to improve phosphate recovery, especially in ores with impurities. The country must also invest in technologies to use phosphogypsum, a by-product of phosphoric acid production.

- **Development of Alternative Sources:** Brazil has experience in processing apatite, an alternative source of phosphate. The development of technologies for extracting alternative sources of phosphate, such as the use of lower-grade phosphate minerals, could be a promising route to guaranteeing the domestic supply of fertilizers.

- **Expanding Production and Improving Logistics:** Investing in new mining projects and improving transportation and logistics infrastructure is crucial to increasing production capacity. Projects such as Três Estradas (RS) and Santa Quitéria (CE) aim to increase phosphate production capacity and reduce dependence on imports.

09 Geopolitical and prospective analysis of Brazil in the context of the CSMs

The geopolitical and prospective analysis of Brazil in the context of critical and strategic minerals (CSMs) is essential to understanding the role the country can play on the global stage. Brazil has a vast wealth of natural resources, especially minerals such as niobium, graphite, nickel, copper, manganese and lithium. These minerals are essential for the energy transition and ecological transformation, in line with international demands and new global sustainability policies.

1. Geopolitics of Critical and Strategic Minerals (CSMs)

The geopolitical context of CSMs involves growing global competition for resources essential to the energy transition, such as those used in batteries, renewable technologies and electrification. Brazil, with its vast territory and mineral resources, is one of the main potential players in this scenario. The country has significant reserves of **lithium** (5th largest producer in the world), **niobium** (responsible for 85% of global production) and **graphite**, and is the **3rd largest** in rare earth reserves.

The growing international demand for these minerals, particularly from economic blocs such as the European Union and the United States, which are seeking to reduce their dependence on countries like China, opens up a window of opportunity for Brazil. However, this opportunity comes with challenges related to infrastructure, industrialization and the formulation of public policies that better integrate CSMs into the Brazilian economy, aiming to add value instead of just exporting raw materials.

2. Economic Opportunities and Challenges

The **global energy transition** is driving demand for critical minerals, representing an opportunity for Brazil to diversify its economy and increase its export revenues. Verticalization of the production chain for these minerals can generate added value and increase Brazil's participation in global value chains. The country, however, faces challenges such as the lack of advanced industries that use intermediate products and limited integration between the mining, mineral processing and final goods industries.

In addition, the country must strategically position itself in international partnerships to strengthen its competitiveness on the global stage. Brazil could benefit from an industrial policy that promotes adding value and fosters innovation in CSMs processing and exploitation technologies.

3. Prospects for Industrial Development

Brazil has a matrix of electricity based predominantly on **renewable sources**, which gives it a competitive advantage in the production of low-carbon CSMs. This is essential in the context of the growing demand for sustainably produced minerals. Brazilian **neo-industrialization** should focus on promoting the development of new industries and technologies associated with the exploration and processing of CSMs, with the aim of transforming the country into a leading player in the production of high-tech intermediate and final goods.

However, the development of this new industrial policy requires the **strengthening of public policies**, investments in **research, development and innovation (RD&I)** and the **integration of production chains**. The creation of **mineral transformation processing zones (ZPTM)** in mining regions is one of the proposals to leverage the potential of CSMs in Brazil, attracting investment and stimulating the formation of local productive arrangements.

4. Geopolitical Impacts and Future Scenarios

The forward-looking analysis highlights that the supply and demand dynamics of critical minerals will be one of the main influencing factors in the coming decades. Brazil needs to balance its position as an exporter of raw materials with building an industry capable of adding value. This depends on a clear industrial policy, with strategic objectives that promote adding value and integrating production chains across the country.

The future scenarios vary between a **sovereign insertion** - where Brazil adopts a neo-industrialization model and transforms its mineral resources into higher value-added products - and a **dependent subordination**, where the country maintains its role as a commodity exporter, without adding value to what it produces.

Brazil is well positioned to play a central role in the global chain of critical and strategic minerals, but it needs **proactive public policies** to maximize this opportunity. The energy transition and the growing demand for sustainable minerals open a window of development for the country which, if seized, could turn Brazil into a key player in the global geopolitical scenario of CSMs.

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