BRAZIL mineral
MINING - METALLURGY
40 years
Special Issue - 2023
ISSN 0102-4728

MINING IN BRAZIL
BEYOND IRON ORE

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BRAZIL IS MORE THAN JUST IRON ORE

Despite the decline in output, in value terms, in 2022, reflecting mainly the falling prices of certain mineral commodities on the world market, with iron ore as the prime example, the prospects for the Brazilian mining industry remain promising for 2023 and for future years.

First of all, investments planned for the five-year period to 2027 have jumped to around US$ 50 billion, compared with US$ 40.5 billion in the earlier period. This means new projects have been added to the existing portfolio, in a clear demonsration that companies are wagering on growth, even in the midst of an uncertain international situation, particularly in connection with China — which still today remains the world's top importer of mineral commodities — with the ongoing Russia-Ukraine war, and with surging inflation rates in Europe and the United States. Even in this swirling fog, however, the prices of several metals — such as copper, nickel, and gold — are expected to improve in 2023 and probably in subsequent years as well. Even iron ore, after suffering a few setbacks in 2022, is now thought likely to fetch prices that producers will still find rewarding, particularly those who offer higher-grade ore with fewer impurities that can help to decarbonise steelmaking.

Turning to the domestic political and economic situation, the change of government seems not to have frightened investors away, at least not yet, as emerged from the discussions with corporate and business leaders that took place at the **Brasil Mineral Forum** (*reported in this issue*). The actions taken so far by the new government do not point to any sudden change in mining policy.

The incoming government says it sees decarbonisation as both a priority and an opportunity for Brazil, signalling that the mining industry can play a leading role, both by supplying the mineral products that the world needs in order to decarbonise, and also by helping to reduce deforestation, at least in proximity to mines, and even undertaking to reforest areas that were previously cleared, above all in the Amazon region and other Brazilian biomes.

A majority of mining executives adopt the approach that all governments are transitory, while mining is a long-term activity. In a typical mining project, the timeline far exceeds a government's term of office. Obviously, any sudden change in government policy can easily have a considerable impact on a company's projects. In Brazil, however, there is no reason at this time to expect such a turn of events.

At the same time it clearly emerges from the production statistics that the Brazilian mining industry is undergoing a transformation in the direction of diversification. Although iron ore remains dominant, accounting for more than 60 percent of overall mining output in value terms, some minerals that in the past were produced only on a small scale are now of growing importance. Copper is a case in point. It has now risen to third place in the minerals ranking by value, behind gold. The outlook for the next few years is that copper output will continue to grow, in view of companies' projects now programmed, whether in the form of expanding existing operations or wholly new mines. Growth is also forecast in the production of nickel, niobium, lithium, and other minerals that now play, and will continue to play, a role of growing importance in the energy transition. The conclusion is that in the future, while iron ore will no doubt retain its statistical preponderance, a range of more valuable minerals will tend to encroach on its preeminence. ☐

Francisco Alves, Editor

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Cover photo: Ero Brasil Caraiba

MASTHEAD

BRASIL mineral
ISSN 0102-4728

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Brasil Mineral is published by Signus Editora Ltda. for mining and metallurgical industry personnel in Brazil and abroad. Qualified recipients are management, technical and engineering staff engaged in mining, milling, and smelting; consulting and construction engineers; government staff concerned with mining and metallurgical affairs; and those in associated professional and commercial fields.

Brasil Mineral is normally published in Portuguese. Only special issues are published in English.

CONSULTING COUNCIL

NEW PROJECTS HERALD RETURN TO GROWTH FOR BRAZIL'S MINING INDUSTRY

Francisco Alves

Unlike 2021, when Brazil's mining output, in value terms, achieved a record R$ 339.1 billion (close to US$ 63 billion), the 2022 figure is provisionally estimated at approximately R$ 250 billion (about US$ 48 billion), based on revenues from the Financial Compensation for Mining Exploitation (CFEM). In other words, there was a sharp decline of around 26 percent in the year, mainly the effect of lower prices for mineral commodities on world markets. Particularly hard hit was iron ore,

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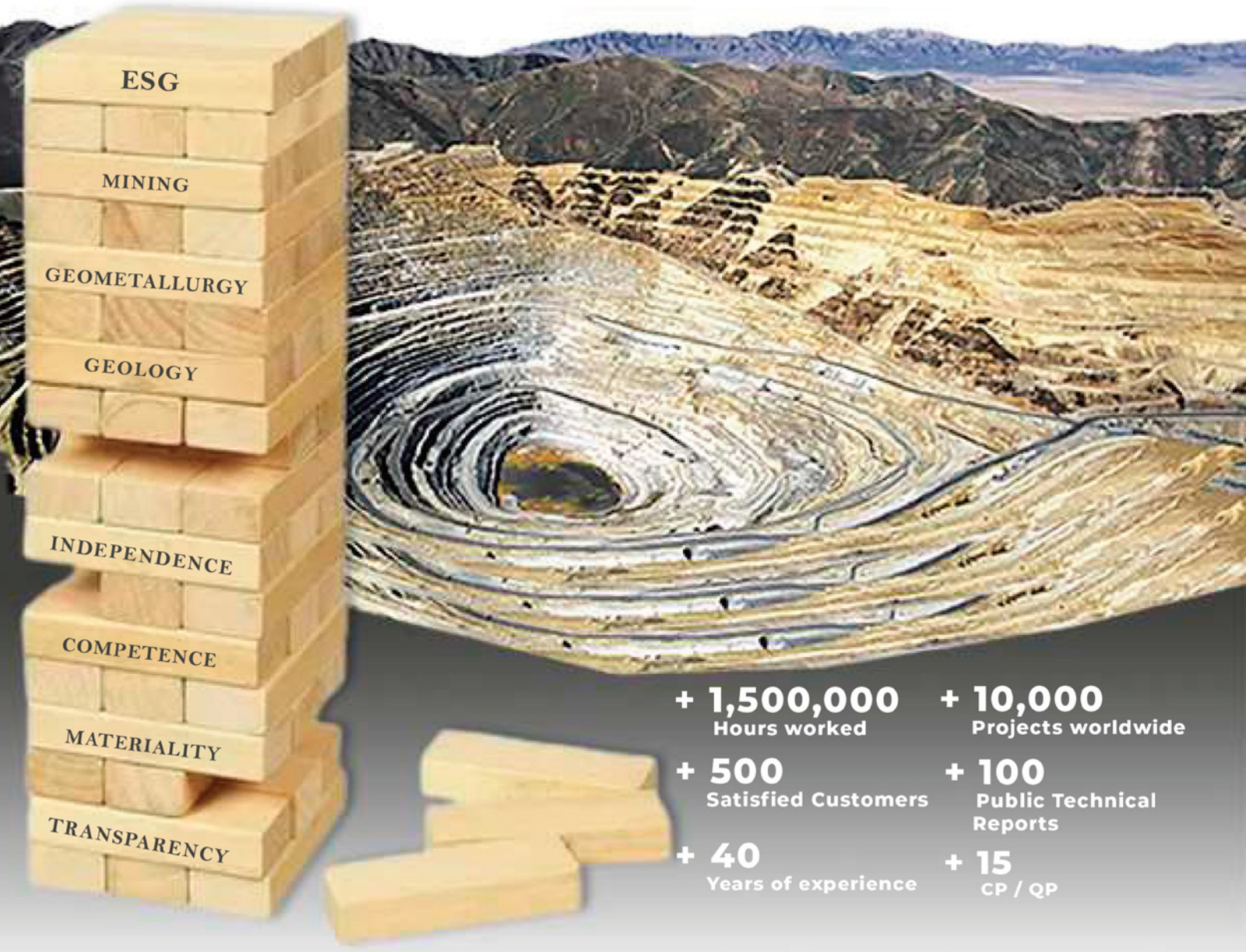

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MAIN MINERALS PRODUCED IN BRAZIL - 2022			
	MINERAL	Number of Operations	OUTPUT (In Reais)
1	Iron ore	148	153.519.524.902,44
2	Gold	754	23.902.306.729,68
3	Copper	12	15.205.422.597,66
4	Dolomitic Limestone	668	8.551.495.191,49
5	Bauxite	59	5.662.387.825,97
6	Granite	925	5.140.357.322,79
7	Phosphate	26	3.246.080.882,76
8	Nickel	8	3.081.202.719,60
9	Sand	4338	3.057.488.509,60
10	Basalt	800	2.586.161.024,28
11	Gneiss	279	2.330.993.782,57
12	Tin	91	2.107.133.043,17
13	Lithium	2	1.456.198.719,52
14	Coal	37	1.298.038.274,80
15	China Clay	61	1.260.668.207,12

Brazil's leading mineral product, accounting for R$ 153.5 billion in 2022 or above 61 percent of all mineral output in value terms. This shows that, despite the diversification of mining output in recent years, the country remains heavily dependent on iron ore to drive its mining industry. Other leading mineral products in 2022 were gold (R$ 23.9 billion), copper (R$ 15.2 billion), dolomitic limestone (R$ 8.55 billion), and bauxite (R$ 5.66 billion).

In terms of geography, in 2022, unlike the previous year, Minas Gerais was the top-ranking state in mining output by value with a figure of R$ 100.5 billion, ahead of Pará, which had been in first place the

previous year, with R$ 92.3 billion. Other leading mining states in 2022 were Bahia (R$ 10.1 billion), Goiás (R$ 9.04 billion), and São Paulo (R$ 7.8 billion).

The decline in mineral output, in value terms, also meant a 30 percent drop in CFEM revenue to R$ 7.02 billion in 2022, down from the previous year's R$ 10.3 billion. Two adjoining municipalities in the northern state of Pará appear at the top of the list of CFEM revenues: Parauapebas with R$ 1.38 billion and Canaã dos Carajás with R$ 1.06 billion, followed by three places in Minas Gerais, Conceição do Mato Dentro (R$ 391.8 million), Itabirito (R$ 317.6 million), and Mariana (R$ 299.0 million).

Exports down

The mining industry reported an overall 4.7 percent decline in exports in 2022, with a year-end total of U$ 76.29 billion. Even so, mining finished ahead of the farm sector, whose 2022 exports amounted to US$ 74.98 billion, for a 36 percent growth rate in the year.

The steep fall in mining companies' exports was led by iron ore, including concentrates, down 35.3 percent in the year, and copper ores, again including concentrates, down 18.6 percent. In both cases the cause was lower prices on world markets.

On the import side, the 2022 figure of US$ 22.05 billion was up 68.9 percent in the year, lending weight to the overall increase in the country's imports in the period.

The main mining products exported in 2022 were iron ore, at US$ 28.88 billion; gold, US$ 4.93 billion; and copper ore, US$ 2.7 billion. On the import side, chemical fertilisers were at the top with US$ 24.7 billion, ahead of coal (US$ 5.54 billion) and raw fertilisers (US$ 287.8 million).

Overall Brazilian exports amounted to US$ 334.46 billion in 1922, and imports to US$ 272.7 billion, yielding a surplus of US$ 61.76 billion, virtually unchanged from the previous year's US$ 61.4 billion.

Mineral exploration

Judging by the number of exploration permits (*alvarás de pesquisa*) published, mineral exploration activity slowed down in 2022. Statistics released by the National Mining Agency (ANM) show 9,732 permits issued in 2022, down from 10,098 the previous year. The ranking by states shows Minas Gerais in first place with 2,245 permits, followed by Bahia (1,823), Goiás and the Federal District (650), Ceará (593), and Mato Grosso (562).

Survey reports, detailing the findings of exploration work, numbered 1,510 last year, down from 1,654 in 2021. Minas Gerais was once again the state with the highest number of reports with 542, followed by São Paulo (248), Paraná (141), Santa Catarina (110), and Rio Grande do Sul (93).

Mining permits (*portarias de lavra*), which are the starting point for production to begin, numbered a total 661 in 2022, a big drop from the previous year's 760. Minas Gerais, with 217 new permits issued, was once again in first place, ahead of Paraná (105), São Paulo (85), Goiás and the Federal District (41), and Bahia (also 41).

Sharp decline for iron ore

Even though it retains its leadership position in the Brazilian mining industry, iron ore declined sharply in 2022, explained by the falling world price rather than by shrinking output. Compared with 2021, when it accounted for 74 percent of the country's overall mining output, with a figure of R$ 249.8 billion, last year its percentage share narrowed to 61 percent or, in currency terms, R$ 153.5 billion. In consequence, iron ore's share in CFEM revenue also fell to 76.0 percent, compared with 84.5 percent in the earlier period.

Vale is still the leading iron ore producer with its 2022 figure (including its subsidiary Minerações Brasileiras Reunidas) declared for CFEM purposes as R$ 115.2 billion, equivalent to about 46 percent of Brazil's total output of all mining products in the year. Other major producers in 2022 included, among others, Anglo American, CSN Mineração, Mineração Usiminas, ArcelorMittal Brasil, Mineração Corumbaense Reunida, Vallourec Tubos, Mineração Conemp, Gerdau Açominas, Itaminas, Mineração Baratinha (part of the Bemisa group), and BAMIN.

In a reversal from 2021, iron ore producers did not benefit last year from high world prices. The average price in 2022 was US$ 100.40 per dry metric ton (dmt). At the same time, they were facing increased costs, partly the result of inflation but in many cases arising from the need to invest in new methods for the processing and storage of tailings. The exuberant results that companies had achieved in 2021 were not to be repeated in 2022. Even so, nobody lost money. They just earned smaller profits. Iron ore producers were well aware that their 2021 bonanza was a one-off event, off the beaten track of the long-term trend, and that today's prices were more closely aligned with the market reality. Within the bounds of this reality, the greater part of companies' iron ore projects now in execution or programmed remain economically feasible, given that none of them has a breakeven point higher than US$ 50 per dmt. What has changed is that companies are now prioritising quality rather than quantity, which means, among other factors, aiming to produce materials that will contribute to the decarbonisation of steelmaking and which will, in consequence, command higher prices.

Vale is a case in point. It has set its sights on becoming a world leader in sustainable solutions to support the decarbonisation of the steel industry, rather than just a high-volume supplier of iron ore. With this new strategy the company has pushed into the background its target of increasing output

Ore piler at a Vale mine

to 400,000 tons a year. In a materiality disclosure to investors, the 2023 target is the range from 310 million to 320 million tons, rising to 340-360 million tons in 2026 and 360 million in 2030. The earlier target of 400 million tons has been set aside. On the other hand, the company is going to triple its output of pellets and briquettes, from the current 33 million tons to a planned 100 million tons in 2030. Vale takes the view that, while the world will continue to demand steel, that steel will have to be increasingly "greener" and the company is readying to be in the forefront of meeting that demand, supplying agglomerated products (green briquettes) and pellets to eliminate sintering and optimise blast furnaces. The new strategy also calls for reducing the all-in sustaining cost (AISC) of production, In the case of iron ore, the cost is set to come down from US$ 49 per ton in 2022 to US$ 42 per ton in 2026. This growth strategy will require Vale to maintain its capex at a high level in coming years, rising from US$ 5.5 billion in 2022 to US$ 6.0 billion in 2023 and averaging between US$ 6.0 billion and US$ 6.5 billion from 2024 to 2027.

CSN Mineração, with a reported 2022 output valued at R$ 7.9 billion, has made changes to the timetable for its expansion plan, which covers several projects. Stage One of the plan, covering the years from 2022 to 2027, calls for total investments of R$ 13.8 billion, doubling annual capacity from 34 million tons to 68 million, including ore bought from outside suppliers. This stage comprises six projects: recovery of ultrafines, at an annual volume of 1 million tons of ore having a 66 percent iron content, with startup scheduled for the fourth quarter of 2024; Itabirito plant P15, with annual capacity 15 million tons of ore with a 67 percent iron content, to be brought on stream at the end of 2025; recovery of tailings from the Pires dam, to produce 1.5 million tons a year of ore with a 65 percent iron content, also starting at the end of 2025; recovery of tailings from the B4 dam, with a planned capacity of 2.5 million tons a year of ore with a 66 percent iron content, to become operational in the second quarter of 2025; Itabirito plant P4+, to produce 4.4 million tons a year of ore with a 65 percent iron content, beginning in the second quarter of 2026; and finally recovery of fines at CdP (Casa de Pedra), to produce 2.5 million tons a year of ore containing 66 percent iron and startup in the first quarter of 2028. Cumulatively these projects will add 26.9 million tons to CSN's current output capacity. To help finance the execution of the six projects, the company recently concluded an agreement to supply 13 million tons of ore over a four-year period, in exchange for an advance payment of up to US$ 500 million. Like other players

CSN's Casa de Pedra mine

Grinding units at an Anglo American mine

in the iron ore field, CSN is also focused on upgrading the quality of its products. The price differential on world markets favours ores having a high iron content and low levels of impurities such as silica and alumina.

Anglo American, which ranked second among Brazil's iron ore producers in 2022 with a figure of R$ 11.2 billion, reports that its new magnetic concentration plant is now at the ramp-up stage. This plant is part of the Minas-Rio project, where investments are budgeted at approximately R$ 300 million. The new process will enable the company to recover iron from the mud removal stage of the processing plant at Conceição do Mato Dentro, in Minas Gerais, potentially adding 1 million tons a year to output and reducing the volume of tailings stored in the dam.

Itaminas is undertaking significant investments in expanding capacity and improving its production processes. Its first project is Stage One of expanding crushing capacity, to be concluded in mid-2023 at a cost of R$ 64 million. A further R$ 78 million is being invested in a new processing plant at a location close to the magnetic concentration complex, to be brought on stream in June 2024. Another R$ 121 million is earmarked for expansion of the ITM8 magnetic concentration unit, designed to boost the output tonnage of pellet feed with a 63 percent iron content and due to become operational in December 2023. The company's portfolio of planned investments also lists R$ 75 million for a new concentrates plant, with a target date of June 2024. Another project is the third stage of expansion at the filtration plant, budgeted at R$ 129 million, to be concluded in December 2024. Crushing capacity is also to be expanded, with R$ 276 earmarked for the second stage of the project, comprising a new crushing and screening mill, scheduled to become operational in December 2025. A new processing plant using flotation technology, budgeted at R$ 140 million, has a planned startup date of December 2026. Two new ball mills will be added to the processing plant adjoining the magnetic concentration complex. Together they will produce 480,000 tons of fines per month, to be used for pellet feed. For a budgeted R$ 82 million, startup is planned for December 2027. At another new processing plant, similarly situated close to the concentrates unit, a fully automated circuit of flotation cells will produce premium pellet feed with a 64 to 65 percent iron content. Processing capacity is defined as 480,000 tons per month and the investment budget is R$ 190 million.

BAMIN is speeding up the execution of its integrated project located in the north-eastern state of Bahia, comprising an iron ore mine to produce 26 million tons of ore

BAMIN's Pedra de Ferro mine

having a high iron content and an exceptionally low level of impurities, a railway (known as FIOL) to transport the ore, and a shipping terminal at the port of Ilhéus, in the same state. Altogether the venture will require investments amounting to R$ 20 billion. The mine is already producing ore at a rate of 1 million tons per year. The railway will have the capacity to carry 60 million tons a year, though BAMIN itself expects to use only a little over one-third of that. The remaining capacity will serve other mining companies, and will also carry farm products and other merchandise for the export market. The port facility will similarly be shared with other companies. A deep-water terminal will be able to accommodate vessels of up to 220,000 tons.

ArcelorMittal is investing US$ 350 million in capacity expansion at its Serra Azul iron ore mine, located in the municipality of Itatiaiuçu, in Minas Gerais. Capacity will grow to the range from 4.5 million to 5.0 million tons per year. At the same time, the company is investing in capacity expansion at its Andrade mine, which supplies ore for the group's steel mill at João Monlevade, in Minas Gerais. The Andrade expansion is part of a US$ 500 million investment program aimed at expanding capacity at Monlevade. The Serra Azul expansion will enable the low-grade compact itabirite ore to be used for steelmaking. The priority in this case is to supply inputs for a pelletisation plant that the ArcelorMittal group operates in Mexico. The Serra Azul expansion project is expected to become operational in the second half of 2023, and the Monlevade expansion a year later, in the second half of 2024.

SAM – Sulamericana de Metais, part of the Honbridge group of China, has been given the green light by the National Mining Agency (ANM) to go ahead with its Integrated Economic Use Plan (PIAE) for its Block 8 project, calling for investments of US$ 2.1 billion. The PIAE is an essential document for any mining venture, being the basic requirement for a Mining Application (*requerimento de lavra*). The company is now awaiting a preliminary licence (*licença prévia*) which will enable it to start work on putting the project into execution. The Block 8 project is one of the four given priority status under the Strategic Minerals Policy instituted and detailed in the Investment Partnerships Program (PPI) under Decree 10.657/2021. The venture will make it economically feasible to mine low-grade ore (having an average 20 percent iron content) and upgrading it to a 66.5 percent content. The project calls for the construction of a complex at Grão Mogol, in the north of Minas Gerais, with the capacity to produce 27.5 million tons a year, beginning with mining a 20 percent ore and processing it to result in a high-grade product.

Samarco, now operating at 26 percent of capacity, expects to produce 8 million to 9 million tons in 2023, up about 10 percent from current levels. To achieve that aim the company plans to invest R$ 1.6 billion. This includes the R$ 721 million cost of dismantling tailings dams, on which work is now at an advanced stage. The outlook for coming years is that production will have fully recovered, with the mine once again operating at full capacity, by 2028.

The **Bemisa** group, which currently produces 2 million tons of iron ore per year at a mine in Minas Gerais, has announced a R$ 1.5 billion investment project at its Planalto Piauí subsidiary, to set up a specialised shipping terminal for solid bulk mining products at the port of Suape in the northeastern state of Pernambuco, with the capacity to handle up to 13.5 million tons of iron ore per year. In addition, the group will invest a further R$ 10 billion in a group of projects, including R$ 5.7 billion for laying a new railway and R$ 2.8 billion to install an iron ore mine in Piauí, also a state in the Northeastern region.

Ligga is committed to developing its Ferro Sul project by a 2033 deadline. The project is located in the states of Pará and Maranhão, which share a border. In mid-2022 the company laid the foundation stone for an experimental iron ore processing plant in the municipality of Paraupebas, in Pará, in which it has invested R$ 26 million. Potential ore resources amount to more than 5.5 billion tons, Ligga reports, while the planned production scale is 75 million tons per year, to be reached by 2033. During the experimental period, planned annual output is 600,000 tons a year.

Tombador Iron, listed on the Australian Stock Exchange, has released the findings of a pre-feasibility study (PFS) for its Tombador iron ore project in the municipality of Sento Sé, in Bahia, belonging to its subsidiary Tombador Iron Mineração. The study shows reserves totalling 5.59 million tons of ore with a 65.5 percent iron content, enabling the company to produce 1.2 million tons a year over a five-year lifetime. The project calls for an open-cut mine with crushing and screening circuits. Total capex is estimated at US$ 13.1 million, comprising US$ 5.7 million in the pre-production stage followed by US$ 7.4 million in the course of the mine's productive lifetime.

Santa Fé Mineração has made progress in readying startup of production at its high-grade pellet feed plant in the southwest of Bahia. The first unit will have an output capacity of 1 million tons per year of ore with a 65 percent iron content. In the medium term, capacity will increase year by year, possibly rising to as much as 10 million tons, in view of the proven reserves adding up to 1 billion tons in several separate areas at Santa Fé.

Mineração Corumbaense Reunida, acquired from Vale by J&F Mineração, part of the JBS group, has restarted operations at its Urucum mine in the state of Mato Grosso, which has the capacity to produce 2 million tons a year of iron ore plus 450,000 tons of manganese. The company has mentioned the possibility of an expansion, but without giving details.

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Gold attracts further investments

Gold ranked second in Brazil's mining output in 2022 with a value of R$ 23.9 billion or 9.5 percent of the total. It needs to be pointed out that this figure takes account of gold mined by companies plus that part of artisanal producers' output which is traded legally and on which CFEM is duly paid. The 2022 result was quite substantially lower than the previous year's R$ 27.05 billion.

The country's leading corporate gold producers last year were, in order, Kinross Brasil, AngloGold Ashanti, Mina Tucano (currently under a court-appointed administration), NX Gold, Mineração Serra Grande (controlled by AngloGold Ashanti), and Salinas Gold. The recognised brokerage houses and securities dealers that act as intermediaries for the gold mined by artisanal producers and that are prominently listed in the mining output statistics, include, in descending order, Fênix DTVM (R$ 2.8 billion), F.D. Gold (R$ 1.17 billion), OM (R$ 1.14 billion), Parmetal DTVM (R$ 999.3 million), Carol DTVM (R$ 324.9 million), Patacão DTVM (R$ 264 million), and Coluna DTVM (R$ 261.8 million).

The outlook for the next few years is that gold output will continue to grow, as projects now under way begin to come on stream in five states, Pará, Goiás, Bahia, Mato Grosso, and Tocantins.

G Mining Ventures' Tocantinzinho Project

G Mining Ventures in 2022 began execution of its Tocantinzinho project, located in the municipality of Itaituba in Pará. The planned investment total is US$ 605 million, comprising US$ 442 million in setting up the venture, US$ 151 million in sustaining, and US$ 12 million in closing costs. The project calls for an open-cut mine working a deposit that holds 1.87 million ounces of gold, of which 1.625 million ounces will be recovered over a ten-year period, at the rate of 187,000 ounces a year in the first eight years. Production on a commercial scale is due to begin in the third quarter of 2024.

Hochschild's Posse Project

Hochschild is implementing its Posse project at Mara Rosa, in Goiás, where it is investing approximately R$ 900 million. This is an open-cut mine with a processing plant for a planned output of 900,000 ounces of gold over a ten-year period. Startup is scheduled for the first half of 2024, with production on a commercial scale beginning at the end of that half-year.

Aura Minerals has been pursuing a policy of rapid growth since 2018, having already more than doubled its output since then, reaching a volume of more than 255,000 ounces of gold equivalent.

Aura Minerals' Almas Project

The company hopes to grow a further 80 percent in the next three to four years, possibly reaching an output of 450,000 ounces by 2025, bringing into operation three new ventures: Almas, in Tocantins (under construction); Matupá, in Mato Grosso (with a feasibility study now concluded); and Borborema, in Rio Grande do Norte (this project, already duly licensed, was recently acquired from Big River). Aura Minerals is now concentrating on implementing the Almas project, where 80 percent of the construction work has been done and the aim is to begin production in April 2023. Investment in the project is US$ 73 million, and output is estimated at 51,000 ounces of gold per year in the first four years, with an expected productive lifetime of seventeen years. The Matupá project, for which the feasibility study has recently received board approval, calls for a total investment of around US$ 107 million, for a production capacity of 54,700 ounces of gold per year in the first four years of operation. The productive lifetime is initially stated as seven years, but the company hopes to be able to extend it by mining nearby deposits that are now being drilled. The Borborema project, where measured and indicated resources add up to 1.8 million ounces, may yield an annual output in the range from 80,000 to 100,000 ounces of gold for twenty years. The project is already fully licensed and construction work may begin before the end of 2023.

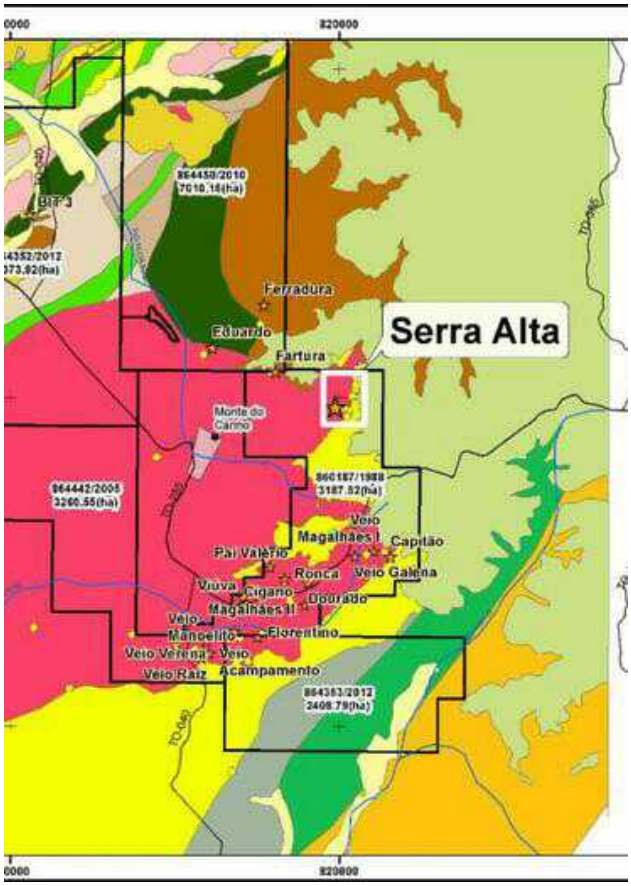
Equinox Gold, having restarted operations in 2022 at its Santa Luz mine in Bahia, now plans to invest US$ 154 million in opening a new underground mine at its Aurizona complex in the state of Maranhão, where satellite deposits will be brought into production alongside the main operation, an open-cut mine which now has the capacity to process 8,000 tons of ore per day. The new project is expected to result in an output of 137,000 ounces of gold per year over an eleven-year period. With the expansion project, the company hopes to boost its total output in Brazil to an average 400,000 ounces of gold per year.

JMC Yamana Gold plans to reach, within a few years, a worldwide production level of 1.5 million ounces of gold. In Brazil, this calls for expanding the Stage Three plant at Jacobina, in Bahia, adding an expected 40,000 ounces to annual output; setting up the Stage Four plant at Jacobina with a planned annual output in the range from 75,000 to 125,000 ounces of gold; and a project for leaching the stockpile at Lavra Velha, expected to yield between 60,000 and 70,000 ounces of gold. The aim is to expand production at Jacobina to around 270,000 ounces of gold per year, by a target date of 2025. A further expansion of Stage Four, providing additional capacity of up to 15,000 tons of ore per day, could raise annual output to more than 350,000 ounces of gold.

TriStar Gold expects to complete, by the end of 2023, the environmental licensing pro-

cedure for its US$ 261 million gold mining project at Castelo de Sonhos, in Pará. The most recent pre-feasibility study, dated 2021, shows that initial capex has risen from an earlier US$ 184 million due to an expansion of planned capacity, the addition of an owner-operated fleet of mining equipment, and higher costs. Annual output is expected to average 121,000 ounces over an eleven-year period.

Serabi Gold plans to achieve a production level of 60,000 ounces in 2025. It is investing US$ 25 million in developing its Coringa project, involving an underground gold mine and a processing plant in Pará. Planned annual output at Coringa is 38,000 ounces, at an AISC cost of US$ 852 per ounce. The estimated productive lifetime of the mine is nine years.

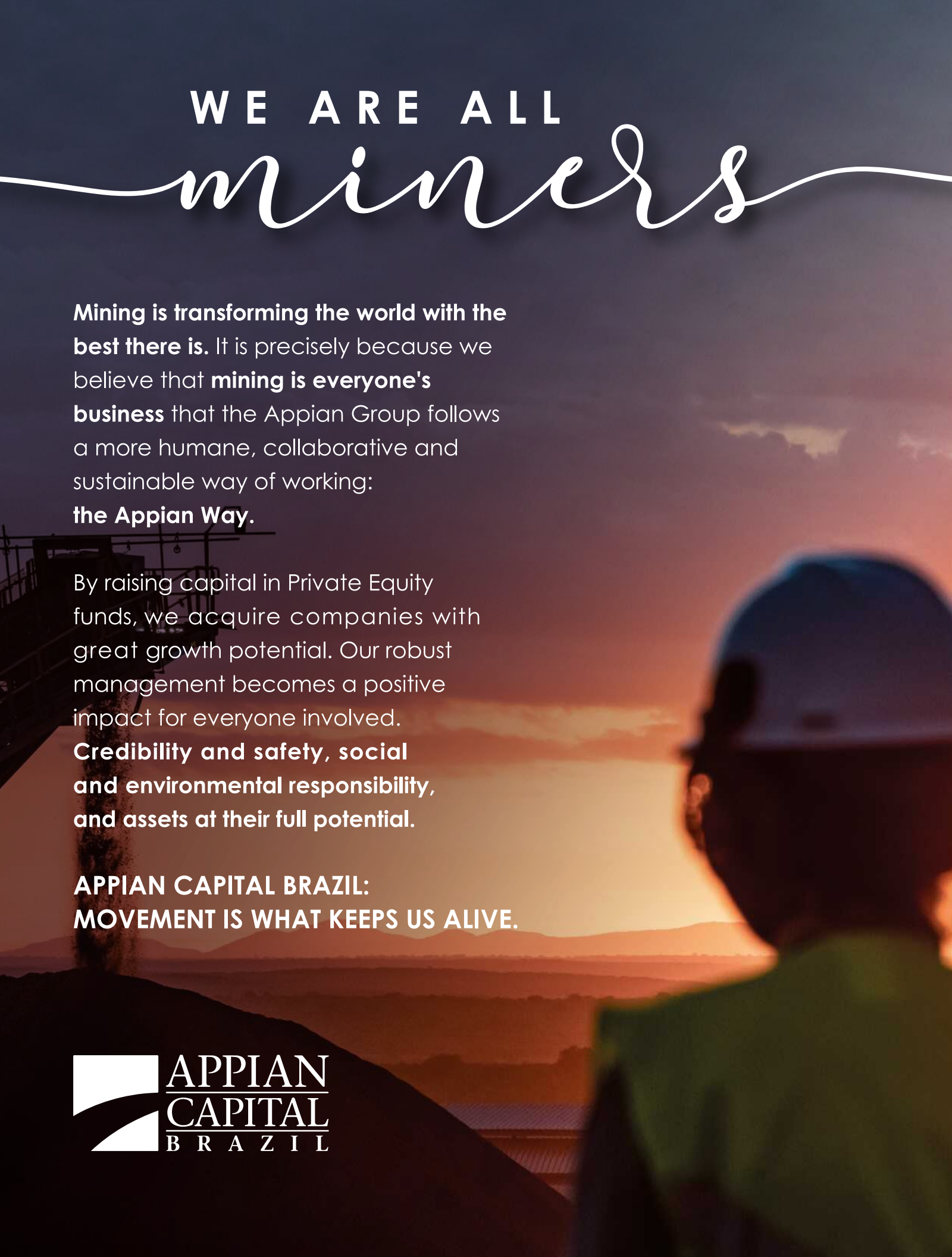


Cerrado Gold's operating area in Tocantins

Cerrado Gold, through its subsidiary Serra Alta Mineração, plans to invest US$ 126 million in an open-pit gold mining operation and processing plant in the state of Tocantins, with the capacity to produce 131,000 ounces of gold a year for eight years, at an AISC cost of US$ 431 per ounce in the first five years, subsequently rising to US$ 612 per ounce.

PA Gold is starting to implement its Mina Paraíba project, comprising an underground mine and an ore processing plant with a crushing capacity of 200,000 tons a year, located seven miles from Peixoto Azevedo, in Mato Grosso. The investment amounts to US$ 51 million. Formerly a *garimpo* worked by artisanal producers, over the last ten years PA Gold has progressively transformed the area into an industrial-scale venture. The mine holds reserves of 617,000 ounces of gold and resources of around 1 million ounces, indicating a fifteen-year productive lifetime. The AISC is stated as US$ 791 per ounce of gold produced.

Bemisa is concluding the first stage of its Água Azul project, a gold mining and processing complex located to the south of the Carajás polymetallic district, four miles from Água Azul do Norte, in Pará. In the first stage, which is now being brought on stream, the plant will have the capacity to process 100,000 tons per year of run of mine ore. In the second stage, with production on an industrial scale, the plant will be able to process 1.5 million tons of ore, beginning in 2025.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Gradual advance in critical minerals

Slowly but surely, Brazil is advancing in the production of what have come to be known in the market as "critical minerals", in particular the ones that are going to play a prominent role in the energy transition because they are needed for the production of electric vehicles and for generating and storing renewable energy sources such as photovoltaics and wind power. Copper is now Brazil's third most important mining product, with a 2022 value of R$ 15.2 billion, and is set to go on growing; new nickel projects are under development; one of the world's largest lithium projects is now coming on stream, with future expansions already planned, and others are on the horizon; niobium output is increasing; and the only vanadium mine anywhere in the Americas is located in Brazil.

Copper

Ero Brasil, an Ero Copper subsidiary, plans to double its capacity in four years, from the 46,300 tons produced in 2022 to the range from 92,000 to 102,000 tons, to be achieved by 2025. This is the expected outcome of two new projects: expansion of the Pilar mine, in Bahia, and implementation of the Boa Esperança project, in Pará. For 2023 the company has programmed a capex (including exploration work) ranging from US$ 342 million to US$ 389 million. The three main items covered in this budget are the construction of the Tucumã project (between US$ 150 million and US$ 165 million); the group of projects known as Pilar 3.0, including expansion at the Caraíba plant and drilling a new shaft at the Pilar mine (between US$ 80 million and US$ 90 million); and exploration work (between US$ 31 million and US$ 40 million, of which a significant proportion is earmarked for drilling for nickel at Caraíba, now under way.)

Ero Brasil's Caraíba mine

Vale, Brazil's leading copper producer with operations at Salobo and Sossego, both in Pará, is investing heavily in an expansion of production capacity. From the 2022 output volume of 260,000 tons, the company has set a target date of 2030 to reach a figure of no less than 900,000 tons, including operations outside Brazil. New expansions ae scheduled at Salobo, among other projects in the Carajás region. In order to strengthen its position in the basic metals sector (including nickel), Vale has decided to seek a minority partner, who might hold as much as 10 percent of equity. The idea is that this side of the business will be managed under a differentiated corporate structure. After bringing on stream its Salobo III project, adding 30,000 to 40,000 tons a year to its copper production capacity, in which it invested US$ 1.1 billion, Vale is now weigh-

Vale's Salobo mine

ing the option of implementing its Salobo IV project, which would expand capacity by a further 30,000 tons of copper content in concentrate. Another project in Vale's portfolio is Alemão, also in the Carajás area, where the feasibility study points to an underground copper mine at the site of the earlier Igarapé Bahia gold mine, and to a high gold content in the copper ore, suggesting the possibility of advance sales of gold from the site under streaming contracts. Vale's third copper project in Brazil is Cristalino, close to the Sossego mine in the area that the company designates its Southern Hub. The project, for which a feasibility study is now being done, could potentially add a further 80,000 tons of copper per year and would also mean an extension of the Sossego processing plant's productive lifetime. Also as part of the Southern Hub programme, Vale is considering the possible mining of outlying deposits such as the three known as Bacaba, Visconde, and 118, which would call for a additional processing plant in the area. Close to Salobo, Vale is looking at the feasibility of a new Northern Hub, involving five deposits labeled Paulo Afonso Sul, Pojuca, Gameleira, Furnas, and Grota Funda, which would jointly contribute an additional copper output thought to range from 70,000 to 100,000 tons a year.

Nickel

Several new nickel projects are in view. Horizonte Minerais is rapidly implementing its Araguaia project, which will produce ferronickel in Pará, requiring an investment of US$ 537 million. In the first stage, with startup expected in 2024, the plant will produce 14,500 tons a year, to be doubled in the second stage. The company is also working to obtain environmental licensing for its Vermelho project, also in Pará, where it will produce nickel-cobalt. The feasibility study is scheduled for publication in the first half of 2024.

Vale has given the go-ahead for building a second furnace at Onça-Puma, in Pará, budgeted at US$ 555 million. It will add 12,000 to 15,000 tons a year to nickel production capacity. The expectation is that the facility will come on stream in the first half of 2025. In addition, the company is proposing to reorganise its basic metals operations in Brazil, centralising its copper and nickel assets in two companies, which will afford greater efficiency in both management and technical procedures. The copper and nickel assets will remain consolidated and wholly owned by Vale.

Atlantic Nickel, controlled by Appian Capital Brazil, has completed a preliminary economic assessment (PEA) extend-

ing from eight to 34 years the duration of operations at its Santa Rita mine, located at Itagibá, in Bahia. The potential for underground mining is stated in the PEA as 26 years, to be added to eight years for the open-pit mine, giving the new total. The Santa Rita operation is to be divided into two stages. Initially Atlantic Nickel will operate the open-cut mine alone until 2028, during which time production capacity is estimated at 20,000 to 25,000 tons a year of nickel content in concentrate. The second stage will see implementation of the underground mine. According to the PEA, the project will call for an investment of approximately US$ 355 million, spread over a five-year period.

Jervois Mining is investing US$ 65 million in rebuilding and enlarging its nickel and cobalt refinery at São Miguel Paulista, in São Paulo state, which it acquired from Companhia Brasileira de Alumínio (CBA), part of the Votorantim group. Jervois expects the facility will restart production in the first quarter of 2024, with the capacity to produce 10,000 tons per year of nickel and 2,000 tons of cobalt cathodes.

Niobium

CBMM, in partnership with Echion Technologies, specialising in innovation in battery manufacture, plans to build a new niobium oxide plant at its existing facility at Araxá, in Minas Gerais. Output capacity will be 2,000 tons per year and the product will be used in Echion's exclusive XNO technology, utilizing niobium oxide in the anode in battery cells, yielding benefits that include safety, quick charging, and a longer lifetime. Due for startup in 2024, the facility will have the capacity to supply a volume equivalent to 1GWh of battery cell production, positioning Echion as the first company in the market to guarantee the supply on a commercial scale of battery cells with niobium-based anodes, meeting the growing demand for electrification. In accordance with its aim of achieving a proportion of 25 percent of sales income from non-steel products by 2030, CBMM will invest US$ 80 million in expanding its entire production capacity for niobium oxides, including this new unit. In addition, the company announced a further investment plan, begun in 2022 and amounting to R$ 7 billion, expanding niobium capacity at its plant in Araxá, Minas Gerais, to 210,000 tons a year, up from the present level of 140,000 tons.

Lithium

Beginning in April 2023 Brazil, which already produces chemical grade lithium, will also become a battery-grade greentech lithium producer. That is the date set by **Sigma Lítio** for bringing on stream Stage One of its Grota do Cirilo project in Minas Gerais. It will then have a planned output 270,000 tons a year of lithium, yielding 36,700 tons of lithium carbonate equiva-

Sigma Lítio's Grota do Cirilo Project

lent (LCE). A recently concluded technical report indicated the feasibility of nearly tripling capacity at Grota do Cirilo to 768,000 tons of lithium, or 104,200 tons of LCE. Capex for the expansion project would be US$ 155 million.

AMG Mineração is readying a chemical lithium plant in Minas Gerais, in which it is investing R$ 1.2 billion. The processing plant will convert concentrate into lithium carbonate, starting in 2026. At this moment the company is engaged in expanding output at its Volta Grande mine, located in the municipalities of Nazareno and São Tiago, in central Minas Gerais, for a R$ 200 million investment. The project is expected to be concluded at the end of the first quarter of 2023, when output is set to grow 45 percent from the current 90,000 tons to 130,000 tons per year. The processing plant for lithium carbonate is scheduled for completion about a year later, in mid-2024.

Vanadium

Brazil's sole vanadium producer is **Largo Inc.**, now wagering on the development of vanadium-based batteries and on more extensive use of vanadium in steelmaking and in titanium production. Largo expects to invest a total of around R$ 2 billion. After acquiring the patent rights at the end of 2020, the company is currently developing its vanadium battery in the United States and simultaneously assembling a prototype battery in Spain. It is also partnering an Italian company in a joint venture to install

batteries in Europe. In 2021 Largo made the decision to add titanium to its products. Titanium is present in ilmenite, the ore which occurs together with vanadium in the Maracás deposits in the state of Bahia. In 2022 Largo began construction of an ilmenite processing plant, scheduled to become operational in mid-2023. The company will then start producing titanium pigment at the Camaçari petrochemicals complex, also in Bahia. The aim is to produce 120,000 tons a year of titanium pigment, supplying two-thirds of Brazilian demand.

Fertilisers: domestic output still lags

Brazil still remains heavily dependent on imports of fertilisers. Although it is the world's fourth largest consumer of fertilisers, it is only the tenth largest producer, indicating the need to increase production in coming years in order to meet demand from a growing farm sector.

Fertiliser imports sharply erode the trade surplus obtained from exports of iron ore, gold, copper, and even soybeans, the country's second most important export product. In a bid to reduce this dependence, in 2022 the government launched a national fertiliser plan, which has made little progress so far. Phosphate provides Brazil's best chance of reducing this dependence, though there are also important projects in the potash area.

The main phosphate project is **Galvani's** Santa Quitéria, where the investment is budgeted at around R$ 2.5 billion. This will be an integrated mining, production, and granulation venture that also includes port facilities and distribution centres for the Northern and Northeastern regions of Brazil. Apart from fertilisers, the Santa Quitéria complex will also produce dicalcium phosphate and yellowcake (uranium concentrate), the latter to be sold exclusively to Indústrias Nucleares do Brasil (INB). With this project, Galvani will quadruple its phosphate production capacity from 540,000 tons to 2.2 million tons a year, while multiplying its sales income fivefold in the space of five years. The Santa Quitéria project is now in the final stages of licensing. The company hopes to begin implementation of the project before the end of 2023.

Águia Fertilizantes has obtained an installation licence to build a phosphate plant at Lavras do Sul, in the state of Rio Grande do Sul. Construction work is expected to take a year. Under an investment budget of about R$ 35 million, Águia will produce 300,000 tons a year of natural phosphate fertilizer, meeting 15 percent of demand in the state.

Potássio do Brasil has started the licensing process for a potash complex to be built at Autazes, in the state of Amazonas, where the company has already invested US$ 230 million. The venture is designed to produce 2.2 million tons per year of potassium chloride, also known as muriate of potash. This volume represents around 20 percent of current Brazilian consumption. By the time the plant is fully operational, the company says it will have invested a further US$ 2.5 billion in an underground mine, a processing plant, and the logistics side, comprising a road and a shipping terminal. ☐

THE 100 LARGEST MINING COMPANIES IN BRAZIL - 2022

Ranking	Company	Product	Number of Operations	Output Value (in R$)	% of Output Value
1	Vale S.A.	Iron Ore, Nickel	34	103,450,686,479.22	41.380
2	Minerações Brasileiras Reunidas S.A	Iron ore	4	11,848,300,293.48	4.739
3	Anglo American Minerio de Ferro Brasil S/A	Iron ore	2	11,195,638,200.99	4.478
4	CSN Mineração S.A.	Iron ore	2	7,903,973,736.68	3.161
5	Salobo Metais S.A.	Copper	1	7,085,283,494.80	2.834
6	Kinross Brasil Mineração S/A	Gold	1	4,925,273,009.04	1.970
7	Anglogold Ashanti Córrego do Sítio Mineração S.A.	Gold	6	3,053,811,875.69	1.221
8	Mineração Usiminas S.A.	Iron ore	3	2,901,997,064.31	1.160
9	Mineração Maracá Indústria e Comércio S.A.	Copper and Gold	3	2,462,508,329.83	0.985
10	Mineração Rio do Norte S.A	Bauxite	1	2,275,772,784.63	0.910
11	Mineração Paragominas S.A.	Bauxite	1	2,170,994,390.13	0.868
12	Mineração Caraíba S/A	Copper	3	2,169,359,278.06	0.867
13	Arcelormittal Brasil S.A.	Iron ore	3	2,074,574,625.83	0.829
14	Atlantic Nickel	Nickel	8	1,993,725,190.66	0.797
15	Mosaic Fertilizantes P&K Ltda.	Phosphate and Potassium	6	1,953,572,506.86	0.781
16	Jacobina Mineração e Comércio Ltda	Gold	1	1,764,624,748.19	0.705
17	Samarco Mineração S.A	Iron ore	2	1,571,916,281.00	0.628
18	Mineração Corumbaense Reunida S.A.	Iron ore	2	1,517,893,310.90	0.607
19	AMG Brasil S.A.	Tantalum, Lithium, Feldspar	3	1,345,665,734.23	0.583
20	Vallourec Tubos do Brasil Ltda.	Iron ore	1	1,302,597,150.36	0.521
21	Votorantim Cimentos S.A.	Limestone, Gypsum	57	1,130,377,220.27	0.452
22	Itaminas Comércio de Minérios S.A	Iron Ore	1	1,104,976,409.97	0.442

RANKING

Ranking	Company	Product	Number of Operations	Output Value (in R$)	% of Output Value
23	Cia de Mineração Serra da Farofa	Iron ore	2	1,071,204,265.58	0.428
24	Anglo American Niquel Brasil Ltda	Nickel	2	1,058,140,266.20	0.423
25	CMOC Brasil Mineração, Indústria e Participações Ltda.	Phosphate, Niobium	5	1,055,130,681.69	0.422
26	Extrativa Mineral S/A	Iron ore	1	1,046,009,230.68	0.418
27	Mineração Conemp Ltda	Iron ore	2	1,000,899,103.98	0.400
28	Gerdau Açominas S/A	Iron ore	2	961,305,590.53	0.384
29	Alcoa World Alumina Brasil Ltda.	Bauxite	1	937,975,263.97	0.375
30	Mineração Aurizona S/A	Gold	1	931,642,036.23	0.372
31	Nexa Recursos Minerais S.A.	Zinc	7	878,400,434.98	0.351
32	Mineração Serra Grande S.A	Gold	4	839,246,023.97	0.335
33	Mineração Vale Verde do Brasil Ltda.	Copper	1	832,414,766.46	0.333
34	Imerys Rio Capim Caulim S.A.	China Clay	2	822,762,001.42	0.329
35	White Solder Metalurgia e Mineração Ltda	Tin	20	806,812,472.40	0.322
36	Mineração Serras do Oeste Eireli	Gold	3	727,061,525.86	0.290
37	BAMC Laboratório de Análises de Solos e Minérios Ltda	Chemical analysis	13	709,136,037.57	0.283
38	JMN Mineração S.A.	Iron ore	1	643,864,513.89	0.257
39	Sama S.A. Minerações Associadas *Under administration*	Asbestos	1	641,420,027.93	0.256
40	Mineração Taboca S.A	Tin, Tantalum, Niobium	1	620,317,136.22	0.248
41	Mineração Apoena S.A.	Gold	2	601,220,723.62	0.240
42	Fazenda Brasileiro Desenvolvimento Mineral Ltda	Gold	2	584,794,350.48	0.233
43	Minerita Minérios Itaúna Ltda.	Iron ore	2	563,543,013.60	0.225
44	AVB Mineração LTDA.	Copper	2	514,834,576.10	0.205
45	Mina Tucano Ltda.	Gold	2	510,377,812.41	0.204
46	Companhia Brasileira de Metalurgia e Mineração	Niobium	1	470,853,722.83	0.188
47	Nacional de Grafite Ltda	Graphite	4	437,224,445.73	0.174

Ranking	Company	Product	Number of Operations	Output Value (in R$)	% of Output Value
48	Vetria Mineração S.A.	Iron ore	3	400,321,205,62	0.160
49	NX Gold S.A.	Gold	1	381,882,462,67	0.153
50	CSN Cimentos Brasil S.A.	Limestone, dolomite	30	380,766,005,37	0.152
51	Copelmi Mineração Ltda.	Coal	8	376,209,439,56	0.151
52	Mineração Vale do Jacurici S.A	Chromite	1	375,287,620,63	0.150
53	Polimix Concreto Ltda	Aggregates	25	373,886,102,13	0.149
54	Mineração Belocal Ltda	Limestone	7	354,189,900,55	0.141
55	Morgan Mineração Indústria e Comércio Ltda	Fertilisers	1	333,817,785,29	0.133
56	Companhia Brasileira de Litio	Lithium	1	331,757,279,19	0.132
57	SAFM Mineração LTDA	Iron ore	1	331,707,171,84	0.132
58	Mineração Jundu Ltda.	Quartz Sand	11	317,034,541,75	0.127
59	Mineração Riacho dos Machados Ltda.	Gold	1	315,127,193,07	0.126
60	Embu S.A. Engenharia e Comércio	Aggregates	4	309,545,377,15	0.123
61	Cadam S.A.	China Clay	1	301,880,643,69	0.120
62	Bahia Mineração S/A	Iron ore	1	295,061,537,44	0.118
63	Serabi Mineração S.A.	Gold	5	290,273,636,20	0.116
64	Bemisa Holding S.A.	Gold	1	250,939,434,17	0.100
65	Mineral do Brasil Ltda	Iron ore	10	249,276,229,77	0.099
66	Mineração Comisa Ltda	Iron ore	1	241,235,947,54	0.096
67	Mineração Baratinha S.A.	Iron ore	1	240,869,121,85	0.096
68	Baovale Mineração Sa.	Iron ore	2	237,349,200,26	0.095
69	Minérios Nacional S.A.	Iron ore	1	236,009,139,31	0.094
70	Indústria Carbonífera Rio Deserto Ltda	Coal	4	221,995,050,10	0.088
71	Largo Vanádio de Maracás S.A	Vanadium	1	221,888,724,02	0.088
72	Vermont Mineração Exportação e Importação Ltda.	Dimension Stones	7	219,125,083,47	0.087
73	Carbonifera Metropolitana S/A	Coal	1	211,279,979,92	0.084
74	Mineração Santa Elina Indústria e Comércio S.A.	Zinc	1	207,989,458,27	0.083

OUTLOOK

Ranking	Company	Product	Number of Operations	Output Value (in R$)	% of Output Value
75	Tombador Iron Mineração Ltda	Iron ore	1	207,720,577.13	0.083
76	Mineração Floresta do Araguaia Ltda	Iron ore	1	204,605,996.25	0.081
77	Emal Empresa de Mineração Aripuana Ltda	Limestone	2	195,155,527.52	0.078
78	Intercement Brasil S.A.	Limelstone, gipsite	18	188,935,954.84	0.075
79	Pedreira Irmãos Machado Ltda	Aggregates	3	181,594,003.81	0.072
80	Mmx Corumbá Mineração S.A. *Under administration*	Iron ore	1	179,670,557.38	0.071
81	Ciplan Cimento Planalto S/A	Limestone, Gipsite	6	178,883,558.92	0.071
82	Magnesita Mineração S.A.	Magnesite	6	177,222,504.46	0.070
83	Caltins Calcário Tocantins Ltda	Limestone	4	174,601,011.85	0.069
84	Paupedra Pedreiras Pavimentações e Construções Ltda	Aggregates	1	161,783,699.99	0.064
85	Mineração de Calcário Montividiu Ltda.	Limestone	6	147,303,047.27	0.058
86	Salinas Gold Mineração Ltda	Gold	3	147,294,941.03	0.058
87	Calcário Vale do Araguaia Ltda.	Limestone	4	146,167,791.10	0.058
88	Britacal Ind e Com de Brita e Calcário Brasília	Limestone	14	144,715,854.42	0.057
89	Xilolite S/A	Talc	1	142,933,582.41	0.057
90	Companhia Brasileira de Alumínio	Bauxite	13	141,988,152.97	0.056
91	Pirecal Pirenopolis Calcário Ltda	Limestone	4	140,823,832.94	0.056
92	Geocal Mineração Ltda	Limestone	1	139,632,018.09	0.055
93	Euromaquinas Mineração Ltda	Gold	1	139,539,527.68	0.055
94	Mineração Serra Dourada Ltda	Limestone	7	139,368,980.18	0.055
95	Mineração Itaipu Indústria e Comércio Ltda	Limestone	1	134,122,050.01	0.053
96	Construtora Martins Lanna Ltda.	Aggregates	4	127,422,883.13	0.051
97	MSM Mineração Serra da Moeda Ltda.	Clau, bauxite, iron ore, maganese	1	124,699,886.73	0.049
98	Ferrous Resources do Brasil S.A.	Iron ore	1	121,052,688.89	0.048
99	Companhia Riograndense de Mineração CRM	Coal	2	116,794,839.80	0.046
100	Mineração Morro Verde Ltda	Phosphate	1	114,729,031.34	0.045
	TOTAL			208,495,579,910.43	83.397

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MINING IN BRAZIL UNDER THE IMPACT OF A NEW GOVERNMENT

Francisco Alves and Rodrigo Gabai

Because it is a long-term activity, mining needs, above all, predictability and juridical security, so that projects will not be abandoned unfinished. This viewpoint was clearly expressed by company executives and representatives of business associations assembled at the Brasil Mineral Forum, at the end of 2022, when the general theme was defined as "What the mining industry expects from the new government and companies' plans in the face of a challenging scenario."

Members of the discussion panel were André Maciel Machado (Superintendent of Production, Itaminas), Ivan Simões (Director of Corporate Relations and Sustainability at Anglo American), Ediney Maia Drummond (President of Lundin Mining Brasil), Paulo Misk (former CEO of Largo Inc.), Marcos André Gonçalves (Chairman of the Council at ADIMB), Lauro Dias Amorim, Vice President for Sustainability and Corporate Affairs at AngloGold Ashanti, Fábio Guimarães, Director of Exploration at Be-


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Recognizing the importance of the mining sector for the economic and social development of the country, and aiming to contribute with a sustainable future, the Federal Government of Brazil, through the Ministry of Mines and Energy and the Secretary of Geology, Mining, and Mineral Transformation are acting to vitalize the mining industry in Brazil and to create an investment-friendly environment, ensuring regulatory stability, legal certainty, and the increase of the geological knowledge of the Brazilian territory.
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UNION AND RECONSTRUCTION

misa, Alexandre Aigner, Financial Director of BAMIN, Julio Nery, Director of Ibram, and João Luiz de Carvalho, Vice President of ABPM and a member of the Consulting Council at ***Brasil Mineral***. Moderators were Maria José Gazzi Salum, also a member of the Consulting Council at ***Brasil Mineral***, and Francisco Alves, editor-in-chief of the publication.

Opening the debate, **Maria José Salum** said Brazil's new president-elect, Luiz Inácio Lula da Silva, raises a series of questions of general concern in relation to the Amazon region. "At the recent COP 27, discussions were heavily concentrated on the question of deforestation of the Amazon, the so-called illegal deforestation," she said, stressing her wish to approach the issue focusing on the region's importance as a mineral frontier. "We know we have a mineral frontier across the whole of the Northern region of our country, in the Amazon region as a whole, with the possibility of discovering deposits of the so-called critical minerals. The question is, how will the policy of containing illegal deforestation be put into practice? What we need to know is what is coming in the new policy that will have an impact on mining activity on the new Amazon frontier, whether there are going to be new restrictions of some kind, dictated by social and environmental policy." Turning to the question of decarbonisation, she said she would like the subject to be discussed with particular reference to the critical minerals that may be present in the Amazon, that frontier region that the whole world is watching so closely.

Maria José Salum

Marcos André Gonçalves

The mining industry needs to create its own sustainability standards that all companies will be able to meet, Salum said. "For a mining company, it won't be enough for to say that the material it is producing is essential for the energy transition. It is also necessary that the material should be produced with sustainability. Otherwise the equation won't match up."

Marcos André Gonçalves of ADIMB, the Agency for Development and Innovation in the Brazilian Mining Industry, said a broad national policy on access to the territories is needed, enabling them to be fully known. "There are serious restrictions on the territories and we need to gain better

access to them, in a way that can be seen and accepted by society at large. This is the great challenge," he said. "I believe this is a point that is going to seriously affect everything we know about mining in the Amazon region." It is essential, he added, that we should be fully aware of the gaps that exist in our knowledge of the territories, "because that is where expansion of the mining industry is going to occur."

Ediney Drummond, the president of Lundin Mining Brasil, called attention to the importance of transforming the image of mining activity in the eyes of the Brazilian public at large. "We need to clearly demonstrate to the general public what the positive impacts of mining are, because the negative impacts are constantly present in the media," he said. "We need to use our intelligence to point out the positive impacts of mining. Without mining, there can be no advance in the energy transition, which is highly dependent on essential minerals such as lithium, niobium, and copper. Today we are in the midst of a transformation that is easily observed. Electric vehicles are already in our garages. Just to give you an idea, in the manufacture of a conventional vehicle, the quantity of copper required

Ediney Drummond

Ivan Simões

is, on the average, between 20 and 21 kilograms. In the case of a hybrid vehicle, the quantity doubles to between 42 and 43 kilograms. And for a totally electric vehicle it doubles again, to more than 80 kilograms of copper. How, then, are we going to effect the energy transition without mining? It is not possible."

On the subject of the new government, Drummond said the mining industry hopes to be seen as essential to the process of carbon reduction and the energy transition. The industry wishes to be recognised as having an essential job to do and as being environment-friendly. "We have fantastic examples of mining in the Amazon," he said, "where our footprint is on balance much more positive than negative. The industry has an excellent opportunity now, with this change of government, to put our relationship on more favourable terms."

Ivan Simões, of Anglo American, noted that mining is a long-term industry and that a company must expect to have to deal with five or even ten governments. "And from all of them," he continued, "we expect the same thing: predictability. That is what enables us to make our slow-maturing investments that take a long time to start providing a

André Maciel

return. And also dialogue and juridical security, to ensure the feasibility of those investments."

On the Amazon question, Simões said responsible mining can be done anywhere. "The examples are all there, around the world and in Brazil too, to prove that mining can have a positive impact on the environment and on society as a whole." He recalled that although it is not currently engaged in any mining venture in the Amazon, Anglo American is the only private-sector company making donations to the ARPA project (Protected Areas in the Amazon), the world's largest conservation programme for tropical forests. "It covers more than 70 million hectares (170 million acres), an area twice the size of Germany, which is being preserved with the support of a number of institutions, and we are honoured to be part of his project."

André Maciel, of Itaminas, reminded his audience that a war is on, making it even more important that all mineral resources should be well known and well mapped. The mining industry, he said, faces a further challenge in the form of disunity, unlike other industries that act effectively in their common interest. Noting that Australia and the United States, among others, are today worried about commodity prices, Latin American countries are worried, instead, about juridical security, the environment, and social concerns, demonstrating, he said, "that we still have a lot of maturing to do."

On the question of how Brazilian public opinion views mining activity, Maciel said that now, more than ever before, communication is essential, "since it is now in the power of the media to disseminate either knowledge or ignorance of the reality of mining. Once again, this shows how necessary it is for us to stand together."

Paulo Misk asked about his expectations for the incoming government, said his hopes are the same as those of all Brazilians and all sectors of the economy, "that we will have a government that seeks to improve the quality of life, focusing strongly on education, because there is no other way; that will let us work for a better Brazil; that acts responsibly; that takes good care of the people and the environment, and that follows a path leading to development."

For the mining industry, he added, it is important to restore the role of mining, an activity that occupies only a very small land area in comparison with the wealth and the number of jobs it creates. On the Amazon

Paulo Misk

João Luiz de Carvalho

question, Misk said mining is one of the two most appropriate activities for the region, as it acts locally, bringing great social benefits. "If we look at the example set by Vale, with the Carajás National Forest," he said, "we see that a mining enterprise has the potential to protect, to create conditions of preservation, covering a very wide area, which is more than a government can do on its own."

Summing up, Misk said that everything a company does has people as its main focus. "Mining only exists to improve people's lives," he said. "It only exists because a technology is coming that requires raw materials. People in mining need to reassert the importance of their contribution to the world of today."

Diversification of mining products

In the second session of the Forum, moderated by Francisco Alves, editor-in-chief of ***Brasil Mineral*, João Luiz de Carvalho**, of the ABPM, said, "We are going through a change of focus in mining. In Brazil we have one mineral that dominates our trade balance, and that is iron ore. We need to open our eyes a little instead of seeing ourselves as a one-mineral country. We have a great opportunity ahead of us. We need to take into consideration everything we can pos-

Fábio Guimarães

sibly discover in Brazil. Not just one ore. But to do that, we also depend on the National Mining Agency (ANM) to speed up its processing of applications, for big-budget mining projects to be feasible."

A recent development, Carvalho said, is the Invest Mining initiative, in which the Brazilian Association of Mineral Exploration and Mining Companies (ABPM) is working alongside the National Economic and Social Development Bank (BNDES), Ibram, and several other institutions and associations. Invest Mining will publicise investment opportunities in the mineral production chain in Brazil, with the principal aim of developing projects for mining the so-called "critical minerals" now in increasing demand to meet the needs of the energy transition. Pointing out that mining activity generates a high GDP in a small area, Carvalho argued that, in the Amazon region, mining is in fact a better investment than farming, which requires extensive deforestation before crops can be planted.

Fábio Guimarães, of Bemisa, recalled that when his company was first set up, in 2007, it saw its field of activity as preparing investment projects for other companies to operate, not as operating a mining business itself. Each project, when it was ready, could be sold to a mining company or, alternatively, Bemisa could go into partnership with a company that was duly equipped to operate the venture.

On the question of what his company expects from the new government, Guimarães stressed the long-term nature of mining, in comparison with other industries. "To get a project from the initial stage all the way through to becoming operational is a process that can often take decades," he said. "Whether we like it or not, we're going to experience several changes of government in that time: left-wing or right-wing or governments of the centre. What we truly need from each one of them is that it should improve procedures and efficiency, introduce new ideas, and further the development of the mining industry. Bemisa, being a mineral exploration company, together with the ABPM, hopes that everything that has been developed in the last few years will carry on following the same path; that the Geological Survey of Brazil will be further strengthened, enabling it to become an

Alexandre Aigner

instrument that will help companies locate new deposits, particularly of those minerals needed for the new energy model; that it will hold auctions to reduce the number of sites where exploration was abandoned and left unfinished, making more areas available for exploration and leading to an ever increasing number of discoveries in Brazil."

Alexandre Aigner, of BAMIN, describes his company as "quite large and quite significant." It is a young company, he said, having begun its activities seventeen years ago, and having advanced strongly during the period of the pandemic. "It is an iron ore mine in Bahia that will produce 26 million tons of high-grade ore with extremely low levels of impurities," he said. "This contributes to the energy transition by releasing fewer pollutants."

Since the mine is a long way from its markets, logistics were needed, Aigner said, leading to a delay in implementing the project. While it was working on a solution to its logistics problem, the company made use of the time to gain a more thorough knowledge of the geology of the deposit. "We drilled more than 60,000 metres (about 200,000 feet), he said. "This gave us pretty exact knowledge of the reserve. The rail link, known as the West-East Integration Railway (FIOL), which was already under construction, emerged as a possibility and we soon realised it was the right choice. It was competitive, it was on the right scale for us, and it would meet the mine's needs over the long term. We immediately took the next step, a shipping terminal. The Bahia state government had

Júlio Nery

a project for a new southern port facility at Ilhéus. It was to be a large-scale complex, and we went for the option of our own private terminal. At that point the only thing that was still missing was the backbone of the project, the railway itself. We were going to have to wait a few more years for it. Then the state government decided to privatise the railway, putting it up for auction. We took the opportunity to submit a bid, we won, and we signed the contract in 2021. Today we are the concession holders for the railway, and we have a fully integrated project."

In 2023, Aigner said, BAMIN is going to speed up implementation of the project. "We are going to move ahead quickly with the port project, which is a critical element. With the railway, we have finished all the preliminary due diligence. We have settled all the legal questions, all the environmental questions, and our construction planning. The mine itself is already producing on a scale of 1 million tons, under a provisional structure that will end the moment construction is completed."

Júlio Nery, of the Brazilian Mining Association (Ibram), said the mining industry still needs to demand juridical security. Very often, he said, environmental licensing procedures end up in court; in Minas Gerais there are some projects whose licensing is still mired in legal delays after eleven years. Everyone needs to understand, he said, that a company's time is different from the public sector's time. "Apart from anything else," he said, "capital exerts pressure. A company works on borrowed money and one day it is going to have to repay its loans, while a government department has all the time in the world."

Lauro Amorim, of AngloGold Ashanti, warned that rising costs are putting companies under pressure, posing a challenge to their operations. Companies need to think about ways in which they can induce modernisation, not only within the mining industry itself but in other activities as well. Decarbonisation is already a reality, he noted. "When we look at today's ESG policies, we see that anyone who fails to focus on decarbonisation is out of the running," he said. "When we look at the COP, at the position taken by governments around the world, or at the ICMM (the International Council on Mining and Metals), we see that the world's leading mining companies have already announced their reduction targets. This is not just a social commitment but an attraction in mining itself as an inducer to create this opportunity". □

Lauro Amorim

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In the Brasil PDAC 2023 agenda, the Brazilian Mining Day (BMD) is the benchmark event. Set for March 6, 2023, the BMD will showcase success examples of mineral projects carried out by major and junior companies in diversified geological environments in Brazil, within an economic, regulatory and infrastructure framework presented by the Federal Government.

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Representatives of the business entities taking part in the Invest Mining Network

INVEST MINING, A NETWORK TO CHANNEL INVESTMENTS INTO NEW PROJECTS

Francisco Alves

With the aim of generating a greater volume of funding for mining activities in Brazil, a number of institutions and business associations have jointly set up Invest Mining, a cooperative network whose purpose is "to incentivize actions that result in the improvement of the business environment, in attracting investments, and in the diversification and strengthening of mine production, by increasing the number of mining companies active in the country," in the words of Miguel Cedraz Nery, the mining engineer appointed as the coordinator of the new institution. A former director of both the National Department of Mineral Production (DNPM) and the Brazilian Agency for Industrial Development (ABDI), Nery is now the executive manager of the Brazilian Association of Mineral Exploration and Mining Companies (ABPM).

The ABPM is one of five entities that are jointly in charge of coordinating Invest Mining, the others being the Brazilian Min-

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ing Association (Ibram), the Agency for Development and Innovation in the Brazilian Mining Industry (Adimb), the Secretariat for Geology, Mining, and Mineral Transformation, part of the Mining and Energy Ministry (SGM-MME), and the National Economic and Social Development Bank (BNDES). The Management Committee includes representatives of other entities, such as the Brazil-Canada Chamber of Commerce (BCCC), the National Mining Agency (ANM), and the Geological Survey of Brazil (CPRM).

Invest Mining has started work on drawing up, under the title Project Hub, a catalogue of exploration and mining projects. "We published a notice inviting submissions," Nery says, "as a result of which we received thirty-three proposals, some from companies seeking funding for new ventures, others from business groupings. All the proposals were examined by a panel of specialists who picked twelve of them to proceed to a business round in a matchmaking format. This procedure took place at a workshop session in the course of the Brazilian Mineral Exploration Symposium (Simexmin), held last November in Ouro Preto, in Minas Gerais. The purpose was to bring companies together with investors and financial intermediaries." Immediately after the workshop, Nery recalls, the panel learnt that three of the twelve projects had already found prospective investors.

The thirty-three projects would require investments adding up to R$ 1.89 billion, while the twelve projects selected by the panel called for a total of only R$ 180 million. These twelve were:

- Itabira (Minas Gerais), bauxite;
- Barra Mansa (Rio de Janeiro), potash;
- Macabu (Rio de Janeiro), mineral water;
- Mineradora Tabuleiro Ltda., Novo Horizonte (Bahia), rutile for pharmaceuticals;
- New Stone, Itaoca (São Paulo), limestone;
- New Stone, Guadalupe (Piauí), attapulgite;
- New Stone, Apiaí (São Paulo), absolute black;
- Santa Cruz, Itabela (Bahia), graphite;
- Itaoeste, Barreiras (Bahia), thalium, manganese, cobalt;
- Belo Horizonte (Minas Gerais), fertilisers obtained from materials recovered from diamond mining;
- Rezende, Vitória da Conquista (Bahia), rare earths;
- Fides Gold Mineradora S.A., Peixoto de Azevedo (Mato Grosso), União project.

The Invest Mining network also seeks to contribute to the improvement of the regulation of mining activity in Brazil by holding discussions with government agencies. "One of our priorities," Nery says, "is that mining rights should be an acceptable form of collateral in financing contracts, and also that they should be duly noted in the proceedings of the ANM."

In 2022, he points out, Congress approved the government's Provisional Measure 1133, which included a clause recognizing the use of mining rights as collateral. "This is a modernization," he says, "that affords security to an investor considering a mining project at the initial stage of the exploration permit."

The network is also engaged in talks with the ANM, Nery reports, proposing to restart the publication of notices offering available areas for exploration. In his own

words, "the regular offer of newly available areas means more opportunities for investments in mineral exploration in Brazil."

Also under discussion is the question of mining in border areas, currently subject to restrictions. "The previous government," Nery recalls, "signed Decree 11,076, simplifying some procedures and cutting back the bureaucratic red tape. However, we still need to discuss the requirement that any company operating in a border area needs to have at least 51 percent of its equity owned by Brazilian nationals."

Worldwide, the capital market has clearly been the prime mover driving investments in junior companies, Nery says, and Brazil needs to follow suit, if it wants to remain as attractive to investors as its competitor countries. "That is why we are now beginning talks with B3, the Brazilian stock exchange, aimed at creating, here in Brazil, an open market in venture capital, so that a company that has not yet become operational can gain access to the stock market," he says. "We have prepared a draft project suggesting a suitable structure for this market, readying it to generate risk capital for Brazil's mining industry."

In the same way, the Invest Mining network will later submit a proposal to the federal government proposing to adopt tax concessions along the lines of Canada's flow-through shares, which give the initial purchaser the right to claim a tax deduction equal to the amount invested. In practice, flow-through shares allow companies to pass on certain exploration costs to shareholders.

Nery further notes that certain financial mechanisms that help to channel investment funding into Brazil's agribusiness sector could serve as the model for similar arrangements benefiting the mining industry. As an example, he singles out the Investment Funds in Agroindustrial Production Chains, known by the acronym Fiagro, where the return on investments is exempt from income tax.

Miguel Cedraz Nery

Summing up the results achieved so far, Nery mentions the use of mining rights as a guarantee for every stage of the mining process; the maximum validity of the exploration permit extended to four years; and the cancellation of the earlier requirement that the award of mining rights was conditional on presentation of an attestation of financial capacity.

"These are examples of changes that members of the Invest Mining network were able to bring about, acting in their capacity as leaders in their respective institutions," Nery says. "They are contributions they made in the form of proposals that were adopted in due course by Congress." ☐

Blocks exhibited at Vitoria Stone Fair 2023.
Photo by Cid Chiodi Filho

BRAZILIAN PERFORMANCE IN THE INTERNATIONAL DIMENSION STONES MARKET IN 2021 AND 2022

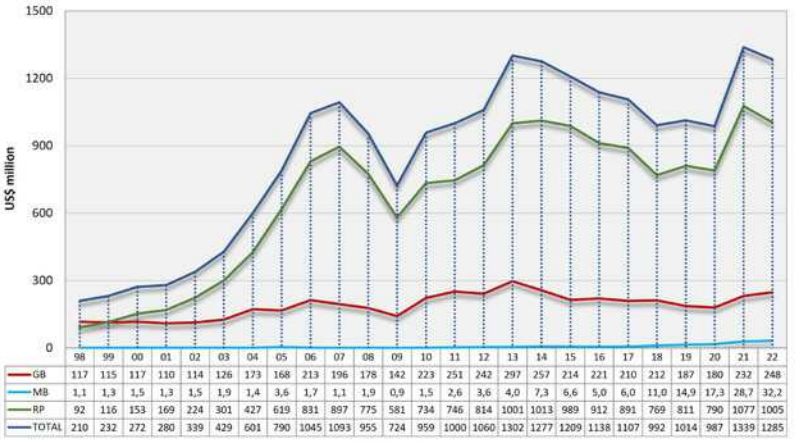
Geologist Cid Chiodi Filho, technical consultant for ABIROCHAS

After an extraordinary increase of 35.5% in 2021, reaching US$ 1.34 billion, Brazilian dimension stones exports registered a slight decrease in 2022, with almost US$ 1.3 billion (Figure 1). This revenue was sustained by higher added-value stones, including marble, quartzite, pegmatite and other exotic materials, with average prices for slabs even exceeding US$ 2,000/t.

In this regard, 2021 and 2022, witnessed a record number of launches of new varieties of Brazilian stones in the international market. Thus, the general average export price increased by 21.6% in 2021 and 10.1% in 2022, offsetting costs increases in production and ocean freight, occurred in the period. Despite a 12.75% decline in physical volume exported in 2022, compared to 2021, there was a drop of only 4% in revenue.

Brazilian stone production was estimated at 10 million tons in 2022, including more than 800 commercial varieties. Exports in 2022, which totaled 2.1 million tons, were shipped to 124 countries, with the main destinations being the USA, China, Italy, Mexico and the United Kingdom. It is worthwhile mentioning that, for more than 15 years, Brazil has

Fig. 1 - Annual evolution of Brazilian dimension stones export revenues – 1998/2022
GB - granite blocks; MB - marble blocks; PS - processed stones

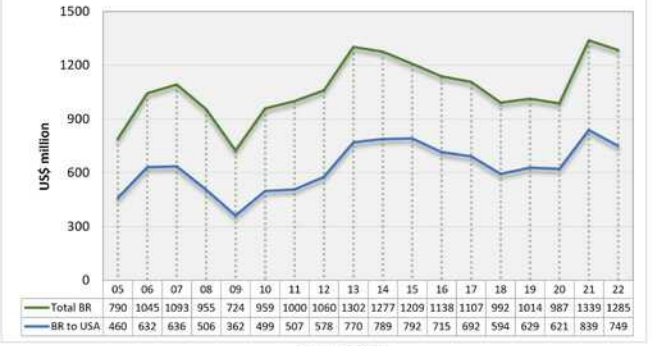


	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22
GB	117	115	117	110	114	126	173	168	213	196	178	142	223	251	242	297	257	214	221	210	212	187	180	232	248
MB	1,1	1,3	1,5	1,3	1,5	1,9	1,4	3,6	1,7	1,1	1,9	0,9	1,5	2,6	3,6	4,0	7,3	6,6	5,0	6,0	11,0	14,9	17,3	28,7	32,2
RP	92	116	153	169	224	301	427	619	831	897	775	581	734	746	814	1001	1013	989	912	891	769	811	790	1077	1005
TOTAL	210	232	272	280	339	429	601	790	1045	1093	955	724	959	1000	1060	1302	1277	1209	1138	1107	992	1014	987	1339	1285

ABIROCHAS, 2022

Figure 1 comments *- Performance of Brazilian export sales have been conditioned by processed stones.*

Fig. 2 - Annual evolution of Brazilian dimension stones export revenues (total Brazil and Brazil to USA) - 2005/2022



	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22
Total BR	790	1045	1093	955	724	959	1000	1060	1302	1277	1209	1138	1107	992	1014	987	1339	1285
BR to USA	460	632	636	506	362	499	507	578	770	789	792	715	692	594	629	621	839	749

ABIROCHAS, 2022

Share (%) of exports to the US in total Brazilian exports of dimension stones

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Share %	58,2	60,5	58,2	53,0	50,0	52,0	50,7	54,5	59,1	61,8	65,5	62,8	62,5	59,9	62,0	62,9	62,7	58,3

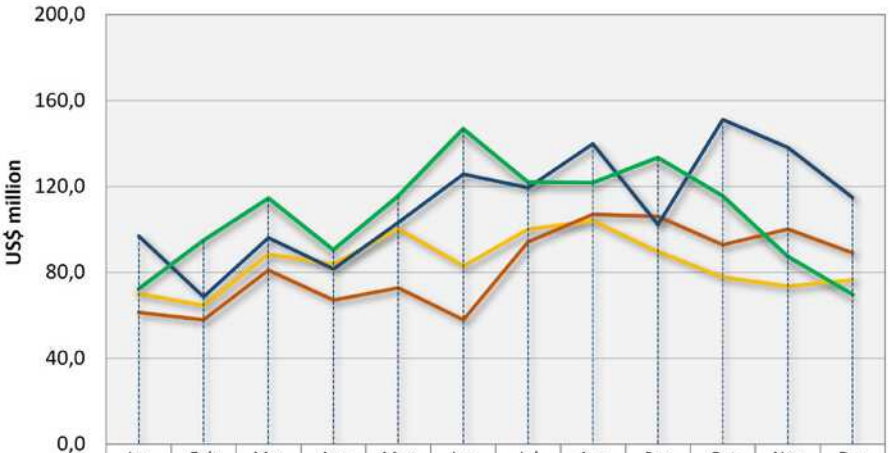
Figure 2 comments *- Strong correlation between stones exports to the USA and total Brazilian exports of dimension stones. Brazil is the world's main supplier of processed rocks (SH4 6802) to the US.*

remained the main supplier to the USA, the world's largest importer of processed stones (Figure 2), as well as the fact that dimension stones represent the 5th most exported mineral-based product by Brazil (excluding petroleum and gas) after iron ore, gold bars, ferro-niobium, and copper ore. Likewise, both production and export levels, as well as the ability of Brazilian companies to respond to positive and negative market fluctuations, reinforce Brazil's ranking among the five main world players in the dimension stone industry.

From a longer-term perspective, Brazilian stones exports grew from US$ 200 million in 1999 to the level of US$ 1.3 billion in 2021 and 2022, at the same time that the share of processed stones increased from 50% to 80% of revenue from these exports. These and other advances resulted from a strategic development project, formulated and conducted by ABIROCHAS, the Brazilian Dimension Stones Industry Association, which is the national representative sectorial entity of the industry in the domestic and international markets. The ABIROCHAS project had broad exporting companies' participation and the support from financial resources of ApexBrasil - Brazilian Agency for Export Promotion and Investments, contributing to the technological modernization of the industry and the requalification of exported products, as well as allowing it to target new commercial frontiers.

The strong increase in Brazilian exports, recorded from 2nd half 2020 to 3rd quarter 2022 (Figure 3), was backed by the gigantic incentives package contributed as a countercyclical policy by the developed economies, especially the USA, to face the negative impacts of the Covid 19 pandemic. Strongly channeled towards real estate

Fig. 3 - Monthly Brazilian exports of dimension stones - 2019/2022

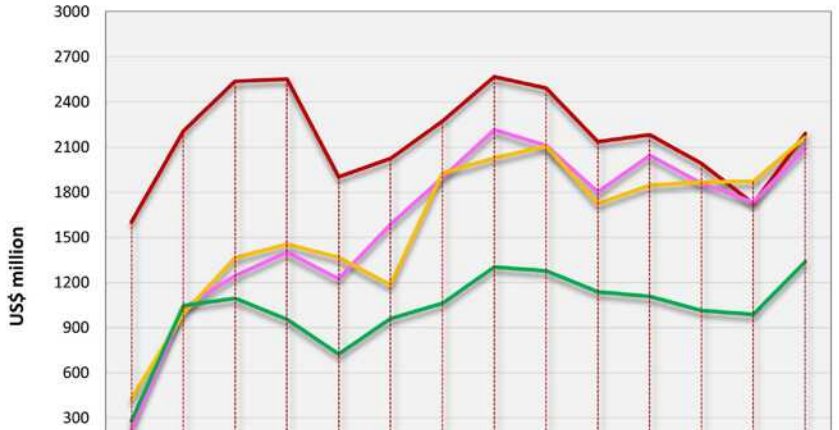


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	70,2	64,6	88,4	83,9	100,4	83,0	100,2	103,9	89,7	77,7	73,6	76,4
2020	61,3	58,0	81,0	67,0	72,8	57,9	94,2	107,0	106,0	92,9	100,2	89,1
2021	96,9	68,7	96,2	81,7	103,2	125,8	119,5	139,9	102,3	151,1	138,1	114,8
2022	72,3	94,9	114,5	90,5	115,7	146,9	122,1	121,8	133,4	115,6	87,5	69,7

ABIROCHAS, 2022

Figure 3 comments *- Observe the increase in exports in the 2nd half 2020 and the drop in these exports in 4th quarter 2022.*

Fig. 4 - Evolution of the world's main dimension stones exporting countries, except China - 2001/2021



	2001	2006	2007	2008	2009	2010	2012	2013	2014	2016	2017	2019	2020	2021
Italy	1603	2207	2538	2551	1903	2024	2274	2567	2490	2135	2181	1992	1723	2189
Turkey	223	1027	1243	1402	1223	1586	1898	2215	2110	1801	2044	1859	1734	2093
India	425	992	1363	1455	1367	1182	1927	2026	2105	1725	1846	1866	1871	2166
Brazil	280	1045	1093	955	724	959	1060	1302	1277	1138	1107	1014	987	1339

Montani, 2022; ABIROCHAS, 2022

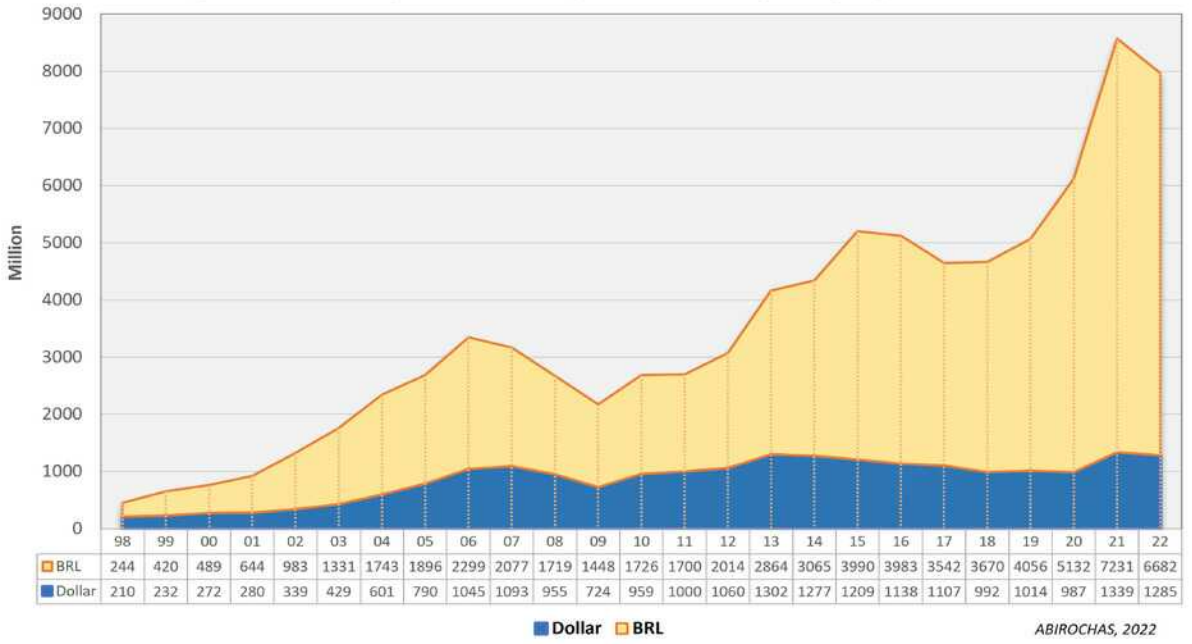
Figure 4 comments *- Observe the quantitative leap registered in 2021 for all major world exporters.*

civil construction, such investments benefited the world's main exporters of dimension stones (Figure 4). The decline in these exports, observed in 4th quarter 2022 (see Figure 3), suggests the imposition of new constraints on the international market, related to the developments of the war in Ukraine and the instability generated in the world economy.

Also important was the appreciation in the US dollar exchange rate – which surpassed the level of R$ 5.00 in 2020, 2021 and 2022 –, significantly improving the profitability of Brazilian exporters. Due to exchange rates, exports made in 2013 and 2021, both around US$ 1.3 billion, represented revenues of R$ 3 billion and R$ 7.23 billion, respectively (Figure 5).

Having already overcome the Brazilian "first export wave", of blocks, and reaching the revenue goal provided by the "second export wave", of slabs, ABIROCHAS continues to endorse the consolidation of the "third export wave", involving the commercialization of finished products for the direct servicing of large works in the international

Fig. 5 - Evolution of export revenues – importance of exchange rate policy – 1998/2022



	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22
BRL	244	420	489	644	983	1331	1743	1896	2299	2077	1719	1448	1726	1700	2014	2864	3065	3990	3983	3542	3670	4056	5132	7231	6682
Dollar	210	232	272	280	339	429	601	790	1045	1093	955	724	959	1000	1060	1302	1277	1209	1138	1107	992	1014	987	1339	1285

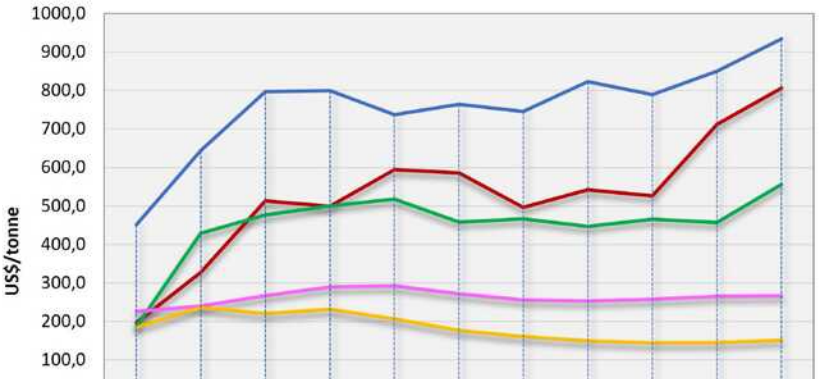
Year	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22
$1 → BRL	1,16	1,81	1,80	2,30	2,90	3,10	2,90	2,40	2,20	1,90	1,80	2,00	1,80	1,70	1,90	2,20	2,40	3,30	3,50	3,20	3,70	4,00	5,20	5,40	5,20

Figure 5 comments *- Note the importance of the appreciation in the US dollar exchange rate, which rose consistently from 2018 and reached R$5.40 in 2021, when exports totaled R$7.23 billion.*

market. This business modality, widely practiced by Italy and China, will not only diversify Brazilian stones exports to the US and other important markets, but will also further differentiate its average price compared to those of India and Turkey (Figure 6).

This is the value-added frontier envisaged for dimension stones in the international market, supported by Brazil's exceptional geodiversity, capable of promoting qualitative and quantitative leaps in exports. ❍

Fig. 6 - Average price of the world's main dimension stones exporters 2001/2021



	2001	2010	2013	2014	2015	2016	2017	2018	2019	2020	2021
Italy	451,5	643,8	796,5	800,1	737,4	763,9	745,6	823,3	789,2	850,2	934,2
China	197,4	327,9	513,7	498,9	594,3	586,1	496,7	542,3	526,1	712,3	806,0
Brazil	186,6	429,0	476,6	499,8	517,9	458,5	466,3	446,7	465,7	457,6	556,4
Turkey	226,4	240,2	266,8	289,7	292,2	271,6	256,0	253,2	257,7	264,7	266,3
India	185,3	236,2	220,6	231,4	205,9	176,6	160,8	149,5	144,1	145,0	151,7

trademap.org, 2022; ABIROCHAS, 2022

Figure 6 comments *- The average price practiced by India and Turkey, formed by a large share of raw products with lower added value, is much lower than those of Brazil and China and, above all, those of Italy. Exports from Italy and China are almost exclusively represented by finished products. The average prices in Brazil, formed by semi-finished processed rocks, are close to those of finished products in China.*

THE ANM REACHES OUT TO INVESTORS

Francisco Alves

A regulatory environment that springs no surprises on investors and ensures juridical security: this is the promise that Mauro Henrique Moreira Souza, who took over as general director of the National Mining Agency (ANM) at the end of 2022, is making to all those wishing to invest in mining in Brazil. Although the Agency is a very young institution — it was created just four years ago, replacing the old National Department of Mineral Production (DNPM) — and is not yet as fully structured as it needs to be, it has made progress in its ability to regulate mining activity by setting standards and issuing regulations, meeting the industry's needs. "It is now our intention," Souza says, "to make a broad advance in our capacity to incorporate best practices from within Brazil and worldwide." He notes that the Agency's recently adopted Resolution 94, governing the reporting of resources and reserves, is fully consonant with the recommendations issued by CRIRSCO, the Committee for Mineral Reserves International Reporting Standards, thus aligning Brazil with international requirements and helping to attract further investments.

The ANM also intends to speed up its examination of mining applications received: the backlog currently amounts to some 70,000 applications. This will result in a greater number of areas being offered to the market at auctions. Two such auctions are planned for 2023, one in each half-year, with 4,500 areas on offer on each occasion. Another change is coming, too, Souza promises: the Agency is studying ways to simplify the Exploration Reports that companies are required to submit. The volume of data will be reduced to no more than those essential items that are specified under the terms of the Mining Code, the Brazilian Constitution, or other provisions of the

Mauro Souza

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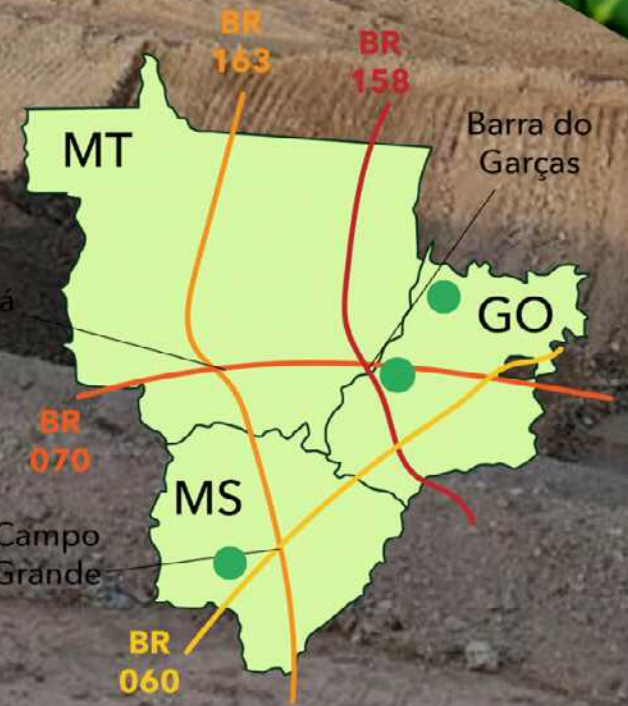

"IN A CASE WHERE A COMPANY HAS TO TAKE ACCOUNT OF A PARTICULARLY COMPLEX PROCEDURE, OR IF IT NEEDS TO CONDUCT MARKET TESTS FOR A LONGER TIME, TO MAKE SURE THAT ITS PRODUCT DOES IN FACT MEET THE MARKET'S EXPECTATIONS, THEN THE AGENCY'S RULES WILL NATURALLY TAKE SUCH VARIABLES INTO CONSIDERATION."

legal framework within which mining takes place. The aim is to reduce bureaucracy, so that "mining activity can develop without any avoidable hindrances," in Souza's words.

Another change to the Exploration Reports that Souza's team is working on has to do with the deadline, currently three years with the possibility of a three-year extension. Souza's plan is to lengthen the period to four years, with the proviso that different deadlines may apply to different minerals. Souza explains: "In a case where a company has to take account of a particularly complex procedure, or if it needs to conduct market tests for a longer time, to make sure that its product does in fact meet the market's expectations, then the Agency's rules will naturally take such variables into consideration."

On the other hand, there are also cases where Souza sees a need for the Agency to tighten up its controls and enforce stricter compliance. In cases where a company is using subterfuges to extend the term of its right to a given area without starting a mining operation, the financial penalty for noncompliance will be increased, Souza warns, and similarly the Agency is considering the possibility of increasing the annual rate per hectare that holders of mining rights are required to pay.

The purpose, however, Souza says, is not so much to inflict punishment as to induce the mining industry to adopt more sustainable practices. "The industry is more strongly committed now to ESG [Environment, Social, and Governance] compliance," he notes. "This is something the ANM will be emphasising even more in the future." In addition, the Agency will be looking around the world in the search for other countries' experiences "that can and should be adopted in Brazil. The same goes for our own attitude when we reach out to prospective investors, acting as a country that believes in fulfilling contracts and adopts appropriate practices to ensure that mining will develop along a path that is environmentally sustainable, socially just, and economically conducive to our country's growth."

Mining policy must necessarily reflect Brazil's commitment to sustainable development goals (SDGs), climate change, and "other criteria in pursuit of strict environmental standards, respect for human rights, and the social questions that afflict our people. We have an important role to play as an agency and we are going to be closely engaged," Souza says, "not least because it is our obligation to follow and apply the policies that are drawn up by the various instances of the organic institutional framework of the Brazilian state." ☐

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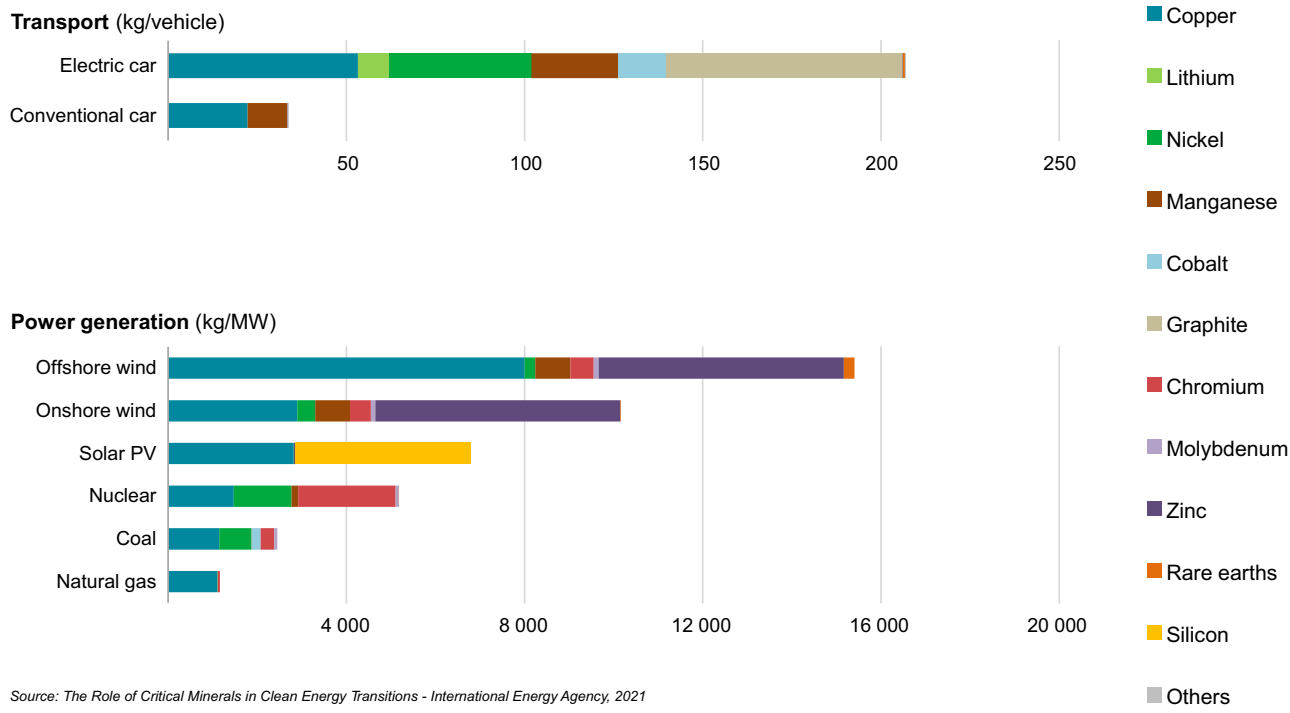


Figure 1: Minerals used in selected clean energy technologies

THE GEOLOGICAL POTENTIAL OF BRAZIL FOR THE ENERGY TRANSITION MINERALS

Marcio José Remédio, Gustavo de Assunção Mello, Iago Sousa Lima Costa, Guilherme Ferreira da Silva, Gilberto Dias Calaes (*)

According to the IPCC (Intergovernmental Panel on Climate Change), the burning of fossil fuels in electricity generation, as well as in transport and industrial activities, causes an increase in greenhouse gas emissions (GHG) and global average temperature, which may compromise the economic and social order of the planet. The rules for reducing emissions, limiting the increase in global average temperature to 2°C relative to pre-industrial revolution levels, were established by the Kyoto Protocol (1997) and the Paris Agreement (2015), which set mandatory emissions reduction targets for 36 industrialized countries and the European Union.

In this context, new opportunities for value generation in mineral enterprises in developing countries will arise from the developments of the agreement established in COP 21, which seeks to reverse the global warming process through the reduction of GHG emissions and the consequent stimulation of non-renewable energy sources; and also of the New York conference (2015), which established the seventeen Sustainable Development Goals (SDGs), with their 169 targets.

An energy matrix powered by clean energy technologies differs significantly from one powered by traditional hydrocarbon resources. The construction of photovoltaic solar plants, wind farms, and electric vehicles generally requires more minerals than their fossil fuel-based counterparts. A typical electric car requires six times more mineral inputs than a conventional car, and an onshore wind farm requires nine times more mineral resources than a gas-fired plant. Since 2010, the average amount of minerals needed for a new energy generation capacity unit has increased by 50%, as the share of renewable energy has increased.

The classes of mineral resources used differ according to the technology. Lithium, nickel, cobalt, manganese, and graphite are crucial to the performance, longevity, and energy density of the battery. Rare earth elements are essential for permanent magnets that are vital for wind turbines and electric vehicle motors. Electrical grids require a large amount of copper and aluminum, with copper being the cornerstone of all electricity-related technologies.

The clean energy transition will generate a significant increase in demand for these minerals, which means that the energy sector is becoming an important force in mineral markets. Until the mid-2010s, the energy sector represented a small portion of total demand for most minerals. However, as energy transitions gain momentum, clean energy technologies

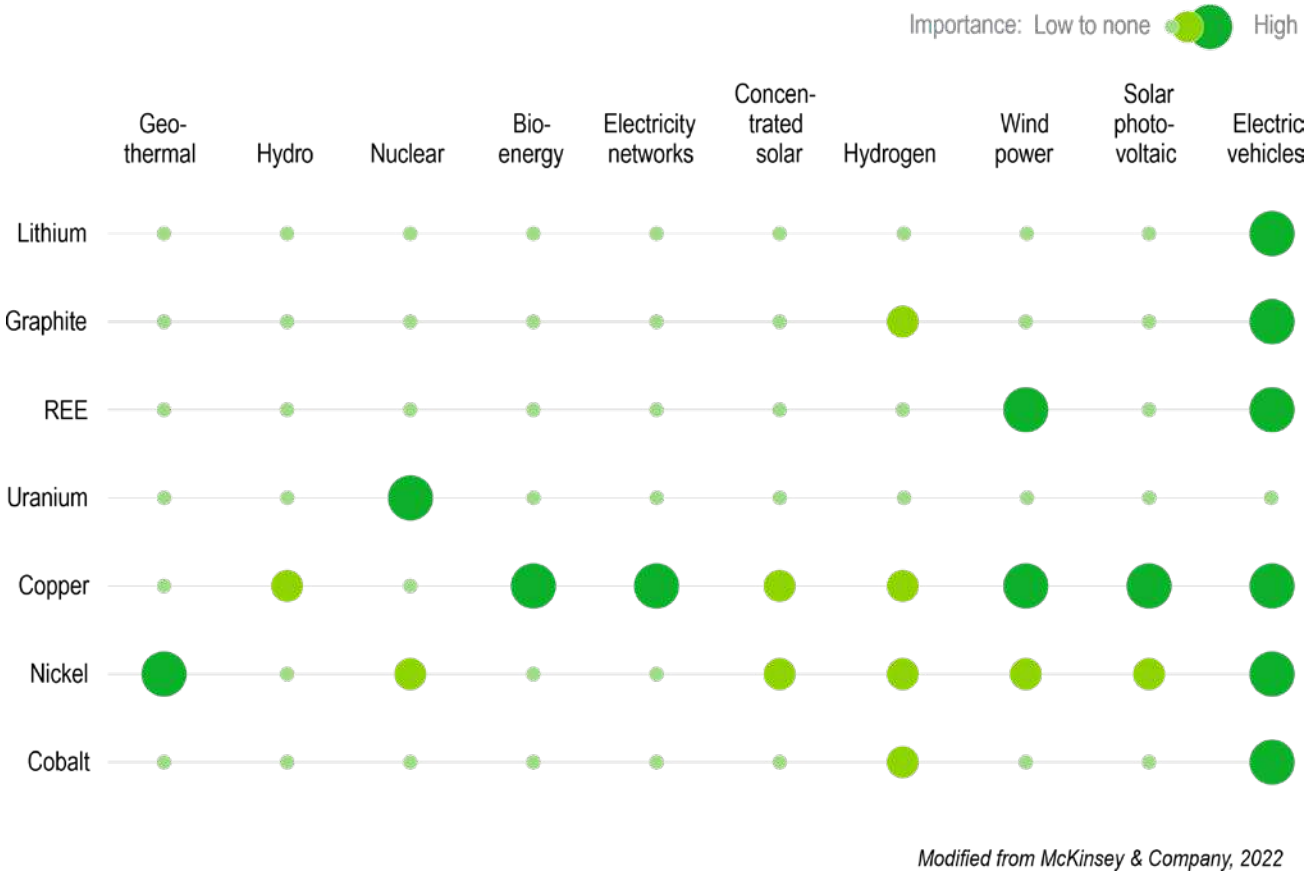
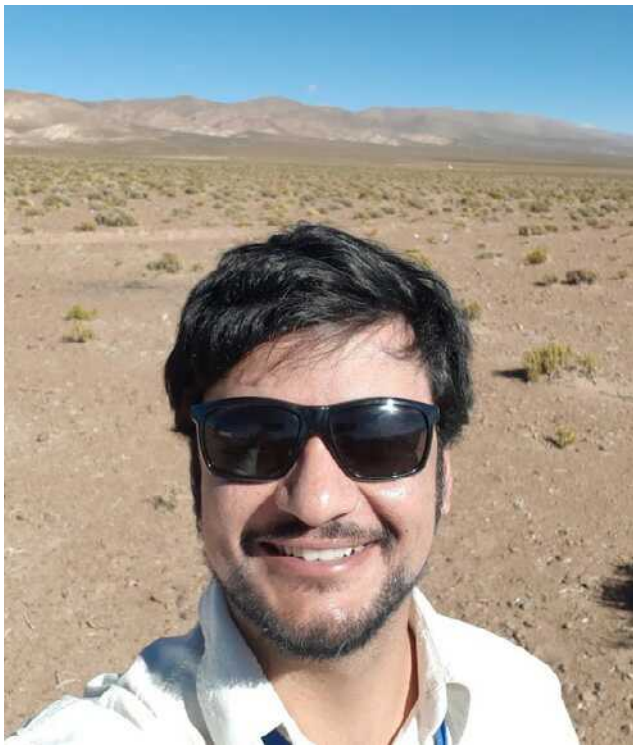


Figure 2: Critical Minerals for transition to a low-carbon economy, by technology type



Guilherme Ferreira da Silva

are becoming the fastest growing demand segment.

In a scenario that meets the Paris Agreement targets, the share of clean energy technologies in total demand will increase significantly over the next two decades to more than 40% for copper and rare earth elements, 60% to 70% for nickel and cobalt, and nearly 90% for lithium.

Future projections of the current supply of critical minerals for the energy transition are very far from what would be needed to support an accelerated and comprehensive deployment of solar panel fields and wind turbines, as well as the expansion of electric vehicle production. Many of these minerals come from a decreasing number of producers, such as lithium, cobalt, and rare earth elements, where the top three world producers control more than three-quarters of global production.

These critical minerals offer a different and distinct set of challenges for the energy sector, but their increasing importance in a decarbonizing matrix demands that energy policy makers and investors expand their horizons and consider potential vulnerabilities and new opportunities.

Brazil has 8.5 million km² of continental area and an additional 4.5 million km² (3.6 million km² from the Brazilian Exclusive Economic Zone plus 900,000 km² of extension claimed with the UN) of marine territorial extension, totaling about 13 million km².

Within this vast territory, there is a robust mineral legislation in line with the best global practices and a geological complexity that should attract investors from all over the world for various commodities and mineral resources. However, mineral exploration investments are still modest compared to the potential of the territory.

Brazil comprises a large portion of the South American Platform and, geologically, encompasses several tectonic domains that are propitious for a broad range of mineral commodities. However, the lack of rock exposure due to thick soils and cenozoic coverage, represents a challenge to be overcome in mineral prospecting and may be responsible for some missed opportunities.

The elements necessary for the energy transition are also found within this context, and their respective fertile geological environments exist from north to south of the country.

Acknowledging the importance of the mining sector for the economic and social development of the country, and aiming

to contribute to a sustainable future, the Federal Government of Brazil, through the Ministry of Mines and Energy, and the Secretary of Geology, Mining and Mineral Transformation, is working to enhance the mining industry in Brazil, and the Geological Survey of Brazil is fulfilling its institutional role of providing pre-competitive geoscientific information, improving the geological knowledge and contributing to a favorable environment for the development of the Brazilian mining sector.

Lithium

The world's largest lithium producer is Australia, with 47% of production in 2022, producing 61,000 tonnes of Li2O. Chile and China ranked second and third, with 39,000 and 19,000 tonnes, respectively (USGS, 2023). Argentina also stands out among the main producers. Brazil always remains among the six main countries in the global extraction of lithium and the national production of lithium concentrate reached 2,200t of Li2O in 2022.

Iago Sousa Lima Costa

In Brazil, lithium occurs in lithium-cesium-tantalum (LCT) pegmatite deposits, with spodumene being the most important ore, followed subordinately by amblygonite, petalite, and lepidolite. Although the state of Minas Gerais is the main player for lithium exploration, with emphasis on the Médio Jequitinhonha region, there are also potential areas in northeastern Brazil (such as Ceará, Rio Grande do Norte, and Paraíba States) with over one hundred Li-bearing pegmatite bodies identified. In addition, greenfield areas comprise the southern regions of Tocantins–northern Goiás and Itambé (southern Bahia State).

The Geological Survey of Brazil (CPRM) has developed research projects in the main lithium areas in Brazil to promote the development of the mining industry in the national territory. So far, projects have been completed in the Médio Jequitinhonha (Minas Gerais State) and Borborema Pegmatite Province in northeastern Brazil, resulting in new targets identified for lithium mineralization. In addition, two other projects are currently active in the following areas: Eastern Minas Gerais and Solonópole Province (Ceará State; Silva, et al. 2023).

Graphite

In 2022, Brazil was the fourth largest producer of natural graphite in the world (6%), after China (65%), Mozambique (13%), and Madagascar (8%). Its known reserves are around 74 Mt, which represent 22% of

global reserves (USGS, 2023). The country hosts three graphite suppliers that produced 78,5 kt of graphite in 2021 (ANM, 2023), with activities concentrated in five mines located in the Minas–Bahia Province.

In Brazil, graphite occurrences are confined to metamorphic environments. The degree of metamorphism is the main variable in evaluating the potential for graphite, being decisive for the degree of crystallization and for the ore grade. In general, mineralization is concentrated in three types of metamorphic rocks: schist, amphibolite, and paragneiss.

The Minas–Bahia Province is one of the most active graphite provinces in the world, with over 70 years of continuous production. In addition to the five mines in operation, it has three projects in the exploration and development phase. Other important graphite deposits are located in Ceará, Rio de Janeiro, and Mato Grosso. Moreover, studies from the Geological Survey of Brazil indicate that the Rondonian-San Ignácio Province in the Amazon Craton has a significant potential for expanding Brazilian graphite resources (Silva, et al. 2023).

Considering the potential, graphite production in Brazil still needs to be improved, and there is space for sector growth. The Brazilian government has shown interest in developing graphite production in the country, and investments in the sector are expected to increase in the coming years. In the long run, Brazil offers attractive prospects for the exploration and growth of graphite due to the increasing market demand for the mineral.

Rare Earth Elements

China currently controls 70% of the world's rare earth mineral production, with only Australia and the United States having significant-sized mines (USGS, 2023). There are also small operations in Russia, Vietnam, and Burma; however, many of these operations are not documented.

Brazil holds the world's third-largest reserve of REE (21 Mt OxTR), but is much less relevant in the production of these elements on a global scale. REE production in Brazil comes mainly from monazite concentrated in paleo-beach sands. In 2021, 903 tons of monazite were produced (ANM, 2023).

Most of the REE reserves in Brazil are located in alkaline-carbonatitic rocks, granites, and, to a lesser extent, in sedimentary deposits. The largest REE deposits in Brazil occur in carbonatites, which are responsible for a large part of the world's niobium production, located in the southern part of the state of Minas Gerais. Concentrations of REEs associated with monazite and ilmenite in coastal paleoplacers and cassiterite in continental paleoplacers form smaller deposits with potential for new discoveries (Silva, et al. 2023).

Although the existing REE production in Brazil is small, the country has great potential to expand production. Currently, Brazil has two advanced REE projects under development in the states of Goiás and Minas Gerais. There is also an early stage exploration project in Bahia that has the potential to produce rare earth oxides from monazite contained in coastal placers.

Gilberto Dias Calaes

Uranium

Kazakhstan has been the world's largest uranium producer since 2015, accounting for 41% of global production in 2020, estimated at 47,731 tonnes of U. In that same year, it was followed by Australia with 13% and Canada with 11%, these three countries making up more than half of the total global production. There has been a sharp decline in production in Kazakhstan and Canada, and a slight increase in production in Australia and Uzbekistan between 2015 and 2020 (Fundação Gorceix, 2022).

Brazil currently has the seventh largest uranium reserve in the world, with around 280 kt of contained uranium, occupying the fourteenth position among producer countries. However, it has the potential to be among the top three largest reserves in the world if its territory is systematically investigated.

Several types of uranium deposits have already been identified in Brazilian territory, such as metasomatic deposits, Archean paleoplacers, Paleoproterozoic unconformities, associated with phosphate deposits, and sedimentary deposits.

The only uranium mine in operation in Brazil is located in Caetité–Lagoa Real, in the state of Bahia, where mineral resources are associated with metasomatic deposits and estimated at 99,100 tons of uranium. Over 38 anomalies (areas of high uranium concentration) have been identified in this area, which is referred to as a uranium province (Silva, et al. 2023).

Although no discoveries have been made since the late 1980s, Brazil maintains the seventh largest uranium reserve in the world. Currently, the expansion project of the Caetité–Lagoa Real mine is being developed, which has the capacity to produce about 400 tons per year, with the potential to reach 800 tons per year. Additionally, the project to exploit the Itataia deposit in Santa Quitéria, Ceará, where the ore is associated with phosphate deposits, is also in the initial implementation phase.

Copper

Brazil accounted for 1.6% of global production in 2021. Chile is currently the largest producer, accounting for 23%, followed by Peru (10%), Republic of Congo (DRC) (10%), China (8%), and the United States (6%).

Brazil has eight copper producing mines, although production is dominated by two mines, Salobo and Sossego; these two operations accounted for 67% of Brazil's copper production in 2022. The other six mines are considered medium and small-scale. The

Marcio José Remédio

reported reserves and resources of projects in advanced development and exploration phase total 16.4 Mt with an average grade of 0.49% copper.

The mineral potential of Brazilian copper is almost entirely in pre-Cambrian domains. Most of the Brazilian copper deposits are located in the Carajás Mineral Province, which also corresponds to the mineral province with the largest amount of metallic copper in the country, with a total estimated at 27.34 Mt contained metal. In Carajás, most of the deposits are of the IOCG type, but Brazilian copper deposits are also classified as Volcanogenic Massive Sulfides, Porphyry, SEDEX, and Sediment-Hosted.

The Juruena–Teles Pires Mineral Province has the second largest potential. It comprises 7.23% of contained copper in two VMS-type deposits, the larger of which is named Cabaçal, and is a province with potential for discoveries of this mineral commodity in the copper porphyry and VMS models.

The Goiás Magmatic Arc has an active copper mine and potential for discovering medium to small-sized metamorphosed porphyry copper deposits, as well as VMS deposits.

The Cupriferous District of Vale do Curaçá has cataloged deposits of magmatic segregation. The Curaçá Valley Copper District has cataloged deposits of magmatic segregation. Recent studies have identified alterations and mineralization characteristics of the IOCG type in this province, which tends to increase the potential for discovering medium to large-sized deposits (Silva, et al. 2023 and references therein).

Nickel

Indonesia is the largest global producer of nickel ore, accounting for almost half of global production capacity in 2022. The next largest producer is the Philippines (10%), followed by Russia (6%) and New Caledonia (5%). Brazil accounted for approximately 2.5% of global production in 2022. Indonesia and Australia have the world's largest known nickel reserves, each with 21%. Brazil is the third largest holder of reserves, with 16% (USGS, 2023).

Brazil has several deposits of lateritic and sulfide nickel, mainly featuring the first type. The lateritic nickel deposits are spread throughout the country, and most deposits are products of lateritic weathering of ultramafic rocks. Four states have the largest concentrations of ultramafic rocks: Goiás, Pará, Bahia, and Minas Gerais. The Brazilian nickel industry is well-structured, with five mining operations and several projects in different stages of exploration.

An essential by-product in many Ni

deposits is cobalt, although Brazil has not had any recorded production of this metal since 2016, cobalt is reported as a secondary commodity in at least 8 Ni deposits in Brazil, distributed among lateritic and sulfide operations and projects. The Nickel-Cobalt projects in Brazil, in addition to a reasonable infrastructure available, have access to low-cost and low CO2-emitting hydroelectric power networks, which gives producers advantages over the global market, both in operating costs and carbon footprints.

Conclusion

The strengthening of the energy transition minerals production chain is essential to enable the fulfillment of the commitments made in the Paris Agreement, aiming at reducing GHG emissions and decarbonizing the economy.

This process should aim at identifying alternatives and integrating the production structure, in order to provide the appropriate use and value adding to the corresponding Brazilian mineral resources, as well as improving the competitiveness and sustainability conditions of the respective mineral industry segments.

In this scenario, Brazil is a recognized producer and exporter of several mineral commodities, being a global player in Nb, Fe, Mn, Ta, Al, and graphite, and an important producer of Ni, Mg, Sn, Cr, and Au. However, its mineral potential goes far beyond this group of commodities, and the production is not yet reflected in the Brazilian Gross Domestic Product.

The ongoing energy transformation presents significant opportunities for the implementation of high-capacity, structuring enterprises for technological innovation, infrastructure and logistics improvements, international trade agreements, market development, human resource formation, and sustainable socioeconomic development of the country. ☐

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Associação Brasileira da Indústria de Rochas Ornamentais – Abirochas

(Brazilian Association of the Ornamental Rocks Industry)
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Associação Brasileira da Infraestrutura e Indústrias de Base – Abdib

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Associação Brasileira de Fundição – Abifa

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(Brazilian Association of Mineral Exploration and Mining Companies)
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Secretaria_exec@abpm.net.br
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(Brazilian Association of Equipment and Machinery Industry)
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Associação Brasileira do Carvão Mineral – ABCM
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Associação Nacional das Entidades de Produtores de Agregados para Construção Civil – Anepac
(National Association of Civil Construction Aggregates Producers Entities)
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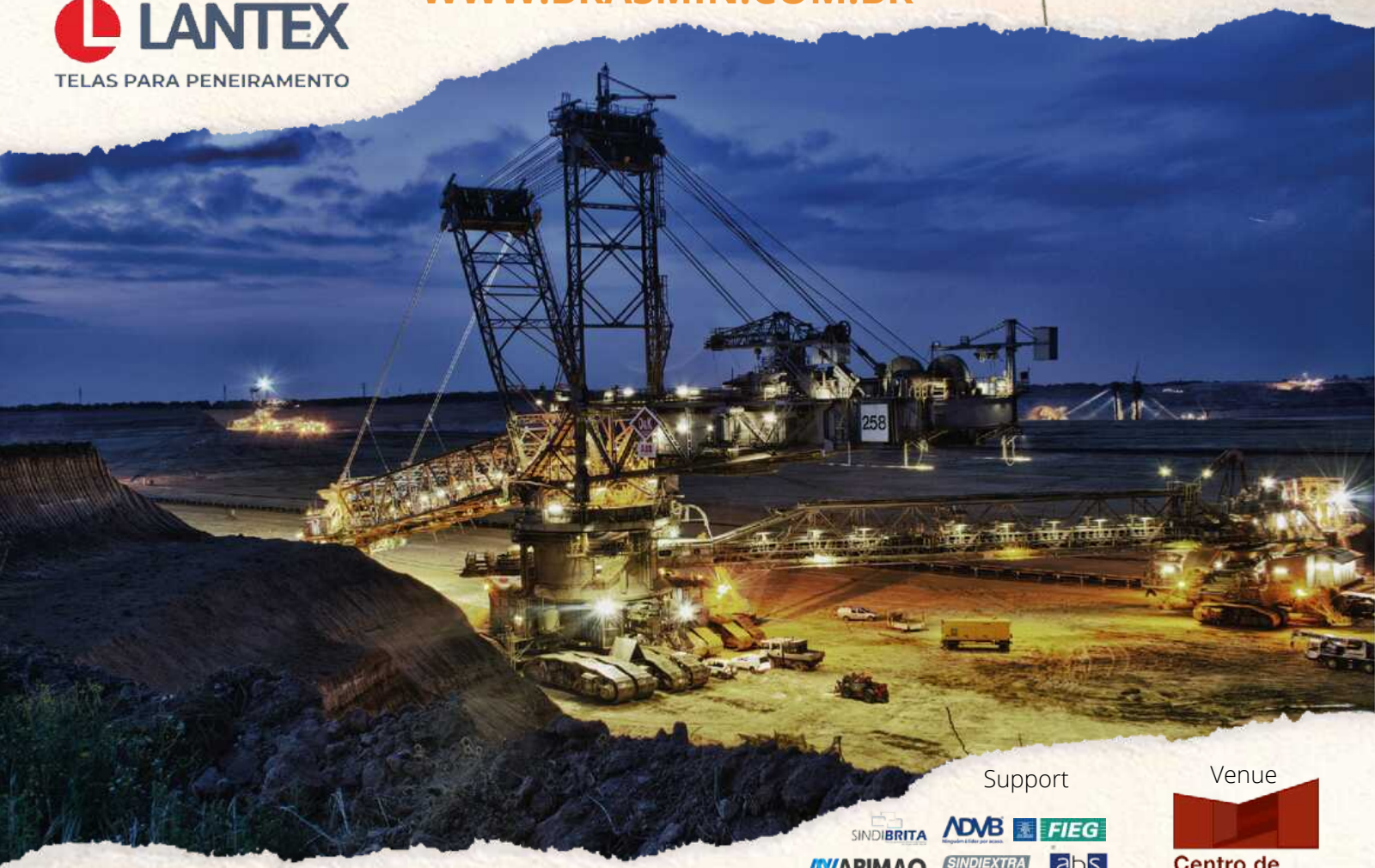

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