



Mining in Brazil

Big, bountiful but bewilderingly bureaucratic.

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This report was researched and prepared by Global Business Reports (www.gbreports.com) for Engineering & Mining Journal.

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A REPORT BY GBR FOR E&MJ

AUGUST 2012

Brazil: an Overview

One of the world's great mining nations needs more investment to capitalize upon its sub-surface potential.

All eyes have been on Brazil since the winning bids for the 2014 FIFA World Cup and 2016 Olympics were announced. Already on the rise as one of the increasingly influential BRIC nations, winning the hosting rights to the two most important global sporting events has provided a welcome boost to Brazil's presence on the world stage.

With a plethora of new stadiums being thrown up in the country's glamorous cities, it is easy to forget that there is more to Brazil than football and beautiful beaches. Mining is at the heart of the nation's economy and has been since 1693.

The importance of this industry is hard to overstate. The Brazilian Mining Institute, IBRAM, estimates that in 2011 Brazil exported \$43.59 billion worth of mineral products, and imported only \$10.02 billion. Without the mining industry, Brazil's \$20 billion trade surplus of 2011 would have been a \$13 billion deficit.

Brazil's economy has grown in recent years, with GDP per capita tripling in the past decade and the economy overtaking the UK to become the world's sixth largest in 2011. The Brazilian market has matured during this period but mining has become a more, not less, important component: the value of mining output grew more than fivefold in this time, from \$7.7 billion in 2001 to \$50 billion in 2011.

Iron ore is by far the most important mineral product mined in Brazil and in 2010 it accounted for 81.8% of all mining exports. Brazil is the world's second largest iron ore producer and, in the shape of Vale, is home to the world's largest iron miner and second largest mining company behind BHP based on market capitalization.

Beyond iron ore, Brazil is the largest niobium producer in the world and in 2010 the alloying agent represented 4.7% of mineral exports by value. Brazil is the world's 12th largest producer of gold in the world and this accounted for 4.6% of minerals exports in 2010. Copper, of which the country produced 213,000 mt in 2010, was the fourth most significant mineral in the country's list of exports that year, accounting for 4.1% of the total. In 2010 Brazil was the third largest producer of bauxite in the world, but with

a substantial domestic aluminum industry consuming the majority of output, it only represented 0.7% of exports.

Despite the importance of mining to Brazil, miners and explorers alike feel that they do not receive the support they deserve from the government. Brazil is an extraordinarily bureaucratic country and red tape clogs the exploration, development and operations processes. Reams of legislation and multiple inefficient supervisory bodies combine with extremely high taxes (a recent Ernst & Young study found the country to be amongst the highest three tax regimes for the majority of minerals), to hold back the development of the industry.

Brazil was ranked 126th out of 183 jurisdictions for ease of doing business by the World Bank in 2012 and 26th out of 32 Latin American and Caribbean jurisdictions. Sitting at the top of the regional rankings is Latin American mining pioneer Chile, followed by exploration stars Peru and Colombia. Chile's GDP grew by 6.5% in 2011, Peru's by 6.9%, and Colombia's by 5.7%. Brazil's GDP grew by just 2.7% that year.

Brazil's poor performance at the macro level is reflected in The Fraser Institute's 2011/2012 Policy Potential Index, a survey of miner's sentiments, though the disparity is less acute between the country and its regional competitors. Brazil is ranked 57th out of 93 jurisdictions, against Chile in the 18th spot, Peru at 56th, and Colombia at 64th.

The effect of this difficult business environment on the mining industry is obvious. In exploration, Brazil underperforms. Per square kilometer Peru attracts 11 times as much exploration capital as Brazil, and Chile 18 times as much. In total, the country attracted 3% of global exploration expenditure in 2010. With high taxes and sluggish permitting processes, Brazil struggles to attract risk capital.

Through Brazil's national geological service, the CPRM, the government is slowly investing to support exploration. "The CPRM is commissioning a series of surveys to evaluate the hydrology and geology of the country. Of chief interest to the mining sector are the 1:100,000 and

1:160,000 scale airborne geophysical surveys. The geophysical survey is progressing well and 30% of the country has been covered but there is still a long way to go. In addition, exploration would be aided if the government were to invest in a geochemical survey.

"The government has also invested in a new form of electromagnetic survey in Bahia and Rio Verde region of Minas Gerais where there are many gold mines. However, the general feeling in the government is that this sort of work should be funded by the private sector. In southern Australia the government has offered to fund 50% of the cost of such surveys and this might be the right compromise that helps to help encourage exploration here in Brazil" said Onildo João Marini, executive secretary of ADIMB, a private-public sector association for the development of the mining industry in Brazil.

Despite this underperformance, the industry holds out hope: "there is a new, modern agency being proposed to regulate the mining sector, which we are in favor of. The question is whether they just change the name of the National Department of Mineral Production (DNPM), the existing regulator, or will they actually create a new, well-resourced agency? We believe that if you have strong public institutions and a strong legal framework the business environment will be more attractive to investors. A new, high-level mining council is also being proposed, linked to the president and dedicated to higher level policies," said Professor Rinaldo César Mancin, director of environmental issues, IBRAM.

This report evaluates the mining sector by mineral type. It provides an update to the 2011 report on the Brazilian mining industry by Engineering & Mining Journal and Global Business Reports and aims to shine a spotlight on some of the country's emergent mineral sectors, such as diamonds and potash. As outlined above, Brazil is a mining behemoth that is failing to attract the risk capital it deserves. In this report we identify the opportunities, the challenges and the solutions, as described to us by some of the country's leading mining executives.

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Mining and Environmental Regulation

Slow administration of outdated codes act as a deterrent to investment despite the stable, democratic political environment.

The Brazilian legal process for mining regulation, from staking to mine closure, is similar to the systems seen in high-performing jurisdictions in North America and Australia. However, the volume of legislation and the snail-like pace of many government agencies sets it apart from these jurisdictions that dominate the top of the Fraser Institute's rankings.

Explorers can either "claim what is called 'open ground,' an area where there are no titles, or make an acquisition. These days, companies usually prefer to look at areas that have been explored before rather than start at pure grassroots. In some cases where land has had past exploration by a major the claims have been dropped, but otherwise the new company must acquire the rights from them. Staking is today done on a first come, first served basis; if the land is considered vacant a claim can be registered on the DNPN's website and, following that, proper paperwork is presented.

"Licenses are granted from one to three years (it is usually three) and there is no limitation on how many times the government can extend them, although more than once is unlikely unless there are special circumstances. The DNPN is very open to granting extensions when there are positive results," said head of mining practice and partner at law firm Pinheiro Neto Advogados, Carlos Vilhena.

Once the exploration process is completed the leaseholder must apply for a mining license: "at the end of the exploration period, a report demonstrating that a resource exists has to be presented to the department if the concession holder wishes to develop. The DNPM will review it and give approval if they agree with the results. Within 12 months, the claimant must lodge a request for a mining concession, providing a plan of how the mine is going to be built and exploited over the years. After this they can start building the mine, and in fact they have to do so within six months," said Vilhena.

The DNPM accepts resource profiles calculated in accordance with foreign regulations such as the NI 41-101 or JORC. "The DNPN understands that many companies use high-tech tools and are happy to accept resource calculations derived from products such as ours; it is not a prescriptive approach," said Beck Nader, executive director, BNA Micromine Brazil and regional director, Micromine South America.

Under the current laws, mining licenses do not come with an expiry date and it is assumed that the license will run until the deposit is exhausted. This may change under the proposed new mining code (see side box), along with a host of other key aspects of Brazilian mining regulation.

As a separate process, environmental licenses must be obtained prior to development. Environmental laws are "enforced at a state level, although they were created by the federal government," said Carlos Orsini, executive director of environmental and social consultants YKS.

The process, and speed of progress, varies greatly between states. In general, it appears to be that if you get your paperwork correct, your application will be processed.

"It is quite exceptional in Brazil to have problems with the local government if you do everything correctly. The system is the same for large and small mines, except for the required size of the environmental study," said Alexandre Sayeg Freire, CEO of consultancy Minaplan.

The problem lies not so much in the wording of the law, but in the extraordinarily slow pace at which under-funded and under-resourced governmental agencies review applications and grant permits. It can take years to gain environmental and mining permits and the level of uncertainty created by this, coming after significant time and money has been spent on exploration, represents the most significant risk when investing in Brazil.

A New Mining Code: What Happens if It Happens?

By Roberta Leonhardt, partner, environmental department and Liliam F. Yoshikawa, senior associate, infrastructure department at Machado Meyer Sendacz Opice Advogados.

The proposal ideas for a New Regulatory Framework, in replacement to the current Mining Code of 1967, have been discussed in and by the specialists of the mining and environmental sectors over the last years. At the beginning of 2011, indeed, the 2030 National Mining Plan of the Ministry of Mines and Energy - PNM 2030 - was issued aiming to be used as guidance to the policies and rules for the development of the mining sector in Brazil for the next 20 years.

PNM 2030 officially introduced the proposal to create the National Mining Agency (replacing the current National Department of Mineral Production – DNPM) and the National Council for Mineral Policy. The new entities would promote the rational use of the mineral resources in Brazil and the supply of mineral resources to remote and difficult access areas. The PNM 2030 indicates the idea for consolidation of the regulatory framework for the sector and the creation of a differentiated policy for the royalties.

Pursuant to the official statements, the New Mining Regulatory Framework would mainly involve three bills of law. Two would encompass the New Mining Code - the modernization of the normative parameters of the current Mining Law and the controversial royalties' policy of the sector – the so-called Financial Contribution for Mineral Exploitation (CFEM). The third bill comprises the creation of the National Mining Agency. It is possible to see that an effort will be made to adapt to the socio-environmental and technological context and to current economic needs, including matters such as sustainability. Changes with a view to incorporating practices into the Brazilian legal framework which are already adopted by the international mining market, which foster investment in the sector and minimize the legal uncertainty, are also under evaluation.

An example of one of the potential changes comprises the permit for mining exploration and prospecting activities – Autorização de Pesquisa (it currently complies with the chronological order principle and the priority right in the granting of the min-



Roberta Leonhardt.



Liliam Yoshikawa.

ing concession) and pursuant to one of the proposals, it would be replaced by a regimen for the granting of authorization or concession depending on the nature of the mineral and its strategic and economic relevance to the country, preceded, each one, by its own public bidding.

There is also a reevaluation of which mineral deposits would be considered strategic or with increased economic potential, being those subject to the mining concession regimen, pursuant to competitive public bidding procedures.

As regards the CFEM, among the discussed propositions, there is the payment of a so-called “special participation” of a minimum percentage by the mineral producer, in the event of large production volumes or ample profitability in the exploitation of mineral resources. Another proposed change, comprises that the special participation would be calculated over the gross mineral production revenue, minus the investments in exploration, operational costs, depreciation and the CFEM itself.

In the same purpose of a legislation modernization, the Brazilian federal government has enacted the New Forest Code, Federal Law No. 12.651/2012, which establishes protection measures to natural resources, amongst other goals. Such law has recognized that mining activities are especially important for the economic growth, in a way that they have been recognized of public utility. Moreover, since the same law allows intervention in permanent preservation areas in case of public utility, the mining activities are now permitted in such areas. In this regard, if we consider that permanent preservation areas are highly relevant for protection of water resources, geological stability, biodiversity and control of erosive processes, we may conclude that the current environmental legislation – considered one of the most stringent of the world – also takes into consideration the importance of the Brazilian economic development.



Vale's Carajás mine in the region of Pará, the biggest open-pit iron ore mine in the world. Photo Courtesy of IBRAM.

Iron Ore

Vale dominates the market, but it is not the only player.



South American Ferro Metals has commenced production from its Ponto Verde iron ore project in the heart of the iron ore quadrangle, in Minas Gerais. Photo courtesy of South American Ferro Metals.

IBRAM estimates that in 2011 Brazilian iron ore output reached 395 million mt/y and production has increased every year for a decade. Iron ore mines traditionally are very large operations, requiring considerable capital and political clout to put into operation. It is no surprise that national champion Vale (publicly listed but still controlled through “golden shares” by the government) dominates the nation’s iron ore landscape. However, as we explore below, foreign majors and juniors alike are increasingly becoming a factor in the nation’s iron ore scene.

Vale enjoys an enviable position in Brazil; it owns exploration rights in perpetuity, sits on much of the most prospective land and historically held a national monopoly. In 2010 Vale produced 81.7% of Brazil’s iron ore, but while its rivals only produce a fraction of what the national champion mines, they are still significant producers in global terms. Usiminas, Brazil’s largest steel maker, was estimated to have mined 7 million mt in 2011 of iron ore. The nation’s second largest steel maker, CSN, has pursued a more vertically integrated strategy and produced 26 million mt of iron ore in 2011.

MMX, the iron ore group established and controlled by Brazil’s richest man, Eike Batista, mined 13 million mt in 2011 and international players Arcelor Mittal and Anglo American added another 5 million mt/y each to national output.

Anglo American is currently Brazil’s fifth largest producer of iron ore but its Minas Rio project will allow it to increase production fivefold and catapult it into second or third place in the nation’s production stakes.

Minas Rio is the largest mining construction project in Brazil and the cornerstone of Anglo’s strategy to become a major player in the iron ore business. “Anglo American is already a leading presence in platinum, diamonds, coal and copper, and a growing presence in nickel. The company wanted to increase its exposure to major iron ore in a big way. There are interesting growth prospects in South Africa through Kumba, but the biggest opportunity for growth is Minas Rio where we can produce 26.5 million mt/y of ore. When Anglo American saw the oppor-

tunity they jumped at it,” said Paulo Castellari, CEO, Anglo American Iron Ore Brazil.

The scale of the project is vast. As well as the mine and associated processing facilities, Anglo is “building a 525km slurry pipeline to deliver the ore to a new port at Acu which we are building in conjunction with LLX,” said Castellari.

“We have 15,000 people from multiple contractors working on 100 work fronts at any one time, to manage this is of course a challenge but it is this sort of development project that Anglo is hugely experienced in and we have strong programs to manage safety at the site,” said Pedro Borrego, head of HR, corporate affairs, safety and sustainable development, Anglo American Iron Ore Brazil.



Paulo Castellari, CEO, Anglo American’s iron ore business unit in Brazil.



Darren Gordon, managing director, Centaurus Metals.

Development of the mine has not been without its problems and, reflecting the general trend toward cost inflation, the budget has crept up since Minas Rio was first acquired outright in 2008. All of the extra investment is, however, contributing to keeping projected operating costs low. "The operating costs for the pipeline will be in the region of \$2/mt. If you compare that to the most efficient railroad in the region, you see that we are very well positioned. We are investing \$5.8 billion in this whole project including the pipeline. Overall, we estimate our operating costs will be \$25/mt to \$30/mt at the port. We will reach China in the region of \$50/mt and not many players will be able to deliver material at that kind of cost," said Castellari.

While the majors may be attracting most of the headlines, a handful of juniors are active in the Brazilian iron ore space and their ranks are swelling.

Iron ore exploration work used to be focused on finding the next "elephant," with smaller deposits passed over. Rising iron ore prices, improvements in beneficiation technologies and innovative business models, including truck to port, have encouraged juniors to start taking a fresh look at smaller deposits.

ASX-listed Centaurus Metals is developing a low-grade project in northern Minas Gerais. Despite the grades and the relatively small size of the resource, the project can turn a good profit, explains managing director Darren Gordon. "We completed the pre-feasibility study last year so we have relatively current costs at present. We arrived at a capital cost of about \$132 million with an NPV of just under \$300 million. Jambreiro will produce 2 million mt/y of 66% iron ore with an operating cost of just under \$20/mt."

"Our target is an ore type called itabirite. At Jambreiro we have a resource of 116.5 million mt low-grade mineralization at 26.8% iron, and a reserve mineralization of 49 million mt at 28.2% iron. The ore is very easy to beneficiate via magnetic separation and will deliver a consistent high quality product," said Roger Fitzhardinge, general manager, exploration and evaluation, Centaurus Metals.

As export capacity is constrained in Brazil and building new railway capacity is not an option for most smaller mines, Jambreiro is being built to service the domestic market, which means lower sales prices but also lower transport costs, capital expenditure, and a simpler project from a development and permitting perspective (railways are subject to long and complex environmental permitting processes just like mines).

For foreign investors used to international price regimes, understanding the local market can be a challenge. "The key for us is to reduce risk by entering into off-take agreements with the steel mills to demonstrate we can sell the ore at the price we want in the domestic market... We still need to prove our product to the local market but I am confident we will achieve the \$73/mt price we used in our feasibility study. From an investment point of view it is a very simple project: good costs, good price, healthy margin and technology that has been used before. However it is complex in that the investor typically looks at projects selling into the international market and are used to higher sales prices, even if this means a higher operating cost and capital expenditure," said Gordon.

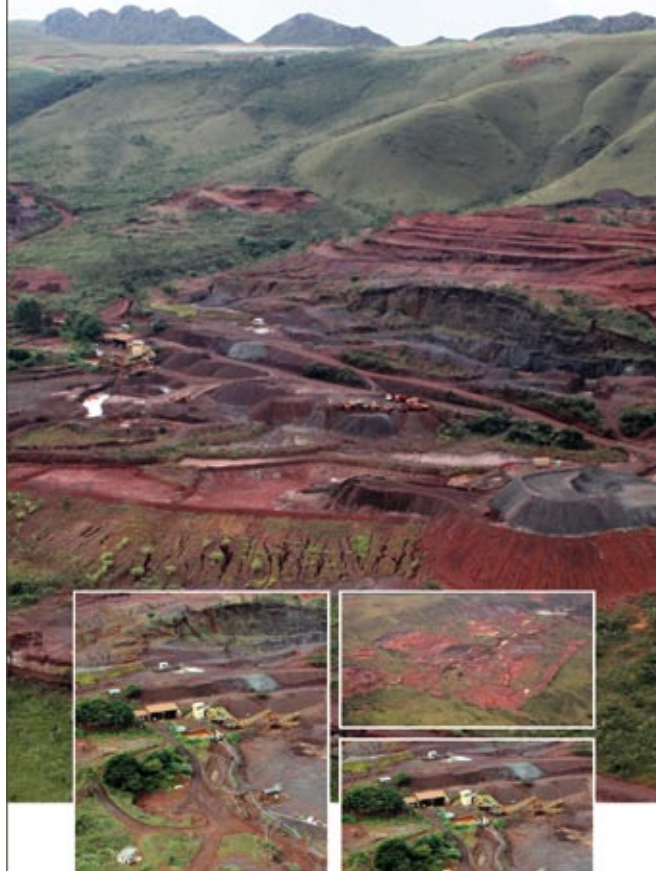
Bemisa Group is unusual in being a Brazilian-managed company backed by local private equity. The company has an extensive portfolio of properties in eight states covering a range of mineral types. Their most advanced project is Planalto Piauí, located in the northern state of Piauí.

"The Planalto Piauí Project has potential resources of over 1 billion tons of iron ore with magnetite as the predominant iron mineral. Our total claim area covers around 250,000 hectares and we have already executed more than 50,000 m of diamond drilling... Our

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MINING IN BRAZIL



Augusto Lopes, CEO, Bemisa.

goal last year was to bring our total certified resources to 700 million tons of iron ore, and we actually ended up with 880 million tons (measured, indicated and inferred). Exploration began in 2008 and this year we entered the engineering phase. We are working hard to start production in the second half of 2015. The final product will be a premium pellet feed fine with more than 70% Fe content, low level of contaminants and direct reduction quality," said Augusto Lopes, CEO.

In a project of this scale, logistics and infrastructure are key and Lopes argues that they are very favorable. "We have already secured allocation on the new Transnordes-

tina railway, which will pass around 6 km from the main ore body and will connect the project with the two major Brazilian ports of Suape (PE) and Pecém (CE). A 500 kv power transmission line passes just 10 km from the future processing plant. In relation to water supply, the National Water Agency (ANA) has granted Bemisa a license to pump 15 million cubic meters of water per year, enough to satisfy our needs," said Lopes.

Typically iron ore operations are the most logistically intensive of mines and, when compared to Australia, Brazil lags far behind. "One of the biggest problems in Brazil is its logistics and infrastructure. A company that has done a lot to change this is Vale, which has been investing in these areas for more than 20 years. However, most Brazilian companies realized only recently the existence of this problem, since they are now facing complex challenges in executing potential projects due to this logistical bottleneck. The Brazilian railway system does not reach all the strategic resources. We are also starting to face bottlenecks at our ports both in terms of the gross tonnage that they can handle and in terms of the size of vessels that they can accommodate," said Ricardo Francesconi, director of consultancy firm Geoservice.

As Brazil's high-grade ore is exhausted,



Ricardo Francesconi, director, Geoservice.

miners are facing new challenges as they seek to increase output. "Brazil's iron industry is experiencing the same challenges that Minnesota's Mesabi Range did in the late 1940s, with all the high-grade material being mined out and silica and phosphate levels increasing. Miners in Brazil are now seeking American expertise; for almost all of our iron work, we are bringing in process engineers with backgrounds in places like the Mesabi Range," said Barton G. Stone, country manager and chief geologist at engineering and geological consultancy and software provider Pincock Allen & Holt, part of the Australian firm Runge.

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PHASE 1 PRODUCTION

Domestic supply to Brazilian steel mills:

- Jambreiro Project (Minas Gerais) = 2Mtpa by end 2013
- Meet growing domestic demand for iron ore

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- Serra da Lontra (Bahia) = 1-2Mtpa by end 2014
- Existing road, port facilities at Ilhéus

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Gold

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The Tapajos gold province covers some 125,000 sq km in the Amazon basin, including cleared farm land, primary and secondary rainforest, and wetlands, and is the region attracting the most exploration capital in Brazil. In the 1970s and 1980s the region witnessed one of the most extraordinary gold rushes of modern times and by far the largest in Brazilian history. It is estimated that 30 million oz were extracted by artisanal miners or "garimpeiros" miners during the period before strong government intervention and falling local and international gold prices abated the rush. Garimpeiros still mine in the region, with some owning land and minerals rights, but it is geologists from TSX- and ASX-listed juniors that are attempting to re-invent the Tapajos gold story.

The largest and most advanced project in the Tapajos is Eldorado Gold's Tocantinzinho. Rapidly expanding mid-cap Eldorado took full control of the property in 2010 and has now delineated a 2.4 million oz resource at Tocantinzinho.

"Of the three projects we control in the Tapajos, Tocantinzinho is the most important. We drilled 56 holes here, achieving 17,000 meters of diamond drilling," said Lincoln Silva, director president of Eldorado's Brazilian holding Unamgen Mineracao e Metalurgia.

So far, Eldorado has only focused on the hard rock but they are now looking at re-processing tailings: "there are a lot of tailings and because garimpeiros only take the free gold we know that they will contain gold, we are drilling a further 1,000 m."

Numbers from the May 2011 Technical Report on Tocantinzinho are attractive: with an 11-year mine life it is envisaged that the project would produce 159,000 oz/y on average at a cash operating cost of \$559/oz.

Silva acknowledges however that building Tocantinzinho will not be simple: Tocantinzinho "is the first and biggest mining project in the Tapajos region. Tapajos is a very remote area of the Amazonas region, and developing in the region is not without its challenges."

"There are two main challenges associated with working in the Amazon. First of all, the project requires 100 km of new road to access it. As much as 70 of those kilometers are in the jungle, which obviously presents several issues. The Amazon rain is a

problem for construction, and the months of the year in which we can work are very limited. Another challenge is power. Despite the government having a lot of hydroelectric development projects in the region, we do not have power available at Tocantinzinho. The solution for now would be to build a 200 km high-tension power line, and connect it to a substation in the city of Novo Progresso," said Silva.

Despite these challenges, Silva remains confident that Tocantinzinho will be built and Eldorado's other properties in the Tapajos will continue progressing toward development: "we are a very aggressive company in terms of exploration and expansion, and we have a plan to achieve 1.5 million oz of production in the next five years. In five years, we will be operating Vila Nova [their iron ore mine in Amapá] and Tocantinzinho, and possibly developing one or two more projects."

The Tapajos continues to yield significant discoveries. The team who first discovered

Tocantinzinho, Dr Alan Carter and Dennis Moore, have since found two further major deposits in the region for their new vehicle Magellan Minerals. "We set up Magellan in 2006 and acquired and staked 150,000 hectares in Tapajos. Since taking the company public in 2008, we have discovered two gold deposits: Cuiu Cuiu, and Coringa. Cuiu Cuiu has a published resource of 1.3 million oz at 1.2 g/mt based on 26,000 m of drilling, we have drilled an additional 21,000 m but have still to update the resource. The gold anomaly is 12 km long so we could continue drilling for a long time."

"200 km south of Cuiu is the Coringa deposit, a high-grade vein system; the initial resource estimate in 2008 was 370,000 oz gold at 9 g/mt, this was tripled in March 2012 to 1.1 million oz. Our plans for Coringa are to complete a new scoping study by early fourth quarter 2012 followed by a feasibility study," said Alan Carter, president and CEO, Magellan Minerals.

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The LARGEST developing GOLD PROJECT in BRAZIL



Belo Sun Mining Corp. is a Canadian based mineral exploration company with a portfolio of properties including gold in Brazil. Belo Sun's primary focus is on expanding and completing a feasibility study on its 100% owned Volta Grande Project in Para State, which hosts a 2.85 million ounce (Measured & Indicated) and 2 million ounce (Inferred) NI 43-101 compliant gold resource.

Volta Grande Highlights:

- 11 drill rigs presently active on site
- 70,000 metre drill program for 2012
- Definitive Feasibility Study underway
- Increased property position from 195 sq. km to 1,305 sq. km in June 2011



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The Tapajos has been described as a "graveyard of juniors" and companies may go through many iterations prior to establishing a workable model in the region. Serabi Gold was the first foreign company on the ground and the first company to bring a legal mine (Palito) into operation in the Tapajos. "The company overcame a huge amount of hurdles to put a hard-rock mine into production in the middle of absolutely nowhere," said Mike Hodgson, CEO, Serabi Gold.

However, Serabi over-reached: "the growth of the company far outstripped its revenue stream as, being the only game in town, it acquired more and more land, and before long it had 600,000 hectares of Tapajos tied up and a workforce of 400 to 500 people."

Palito was shut down and a new management team, headed by Hodgson, worked through 2008 to 2010 to turn the company around. "The asset was still very good, but with all kinds of hideous overheads it was a painful period. For the company to survive, we put the mine on care and maintenance, reduced the workforce, paid off a lot of debts and spent the next 18 months under administrator-type management.

"We streamlined the company and somehow saved the main asset, Palito, a 600,000-oz high-grade underground gold deposit, a third of which is in measured and indicated resources," said Hodgson.

"Our position is very good now, with 35 employees and no debt, and a very modest mine plan to see what cash Palito, running conservatively, can generate," Hodgson said. "Our initial findings suggest \$10 million from 20,000 oz per year, nothing very exciting but enough to give us security. We are putting out a preliminary economic assessment before the end of May, and will be hoping to raise \$25 million in June to be back in production by June 2013."

Today Serabi has something that is arguably harder to secure than gold rich land: a mining license. "Within our 55,000 actively explored hectares, we have a 1,150-hectare permanent mining license area," said Hodgson. "Despite Brazil's ownership challenges, it is extremely generous with what you can do inside this area: if you change your plans within reason, mining the same types of ore with the same methodology, then you do not need to apply for a new license."

Hodgson has eyes on a larger mine at Palito. "In the last 18 months we have drilled around 1,200 m, making two discoveries similar to Palito," Hodgson said. "Where we are, you do not need many more people to mine 70,000 oz than 20,000 oz, so the new finds will bring economies of scale."

The Tapajos gold rush of the 1970s and 1980s started at Serra Pelada and the site came to personify the era. In January 1979 a local child found a 0.21 oz nugget in a stream running below the Serra Pelada ("Bald Mountain"), and within five weeks approximately 22,000 people were working the surrounding area and the Bald Mountain started to disappear. At the height of the Pelada gold rush it is estimated that 100,000 people worked the pit, building a Hades realm in modern Latin America. As the death toll mounted in a mine that was actually a collection of independently-owned 2- x 3-m concessions, the Brazilian Army was sent in to try and regulate the mine and its surrounding camps, eventually the pit was flooded and mining all but came to a halt.

Yet Serra Pelada is far from mined out and TSX-listed Colossus Minerals has taken a novel approach to resurrecting the mine. "In 2007 Colossus Minerals and the cooperative Coomigasp (garimpeiros) formed a partnership to resurrect and develop the Serra Pelada project... For the main deposit, Area A, the 75%-25% agreement with Coomigasp was the first joint venture with a cooperative in the country and is being used as a model for other companies.

Colossus will be mining the down-plunge extension that was previously mined by the garimpeiros in the 1980s," said Graham Long, vice president of exploration.

Colossus inherited large amounts of drilling data from Vale (who are a joint venture partner on the second land package B at Serra Pelada) and the highlights are extraordinary: drill hole FD-0032 assayed 4,709 g/mt gold, 204 g/mt platinum and 1,174 g/mt palladium at 43 m.

Already possessing full mining and environmental permitting, the company has chosen to pursue a two-pronged strategy, building a decline to mine the core target and continuing exploration. "We have constructed the mine and will be bulk-sampling during summer 2012, with full production in the second half of 2013. Colossus has been focusing on delineating and extending the main ore body.

"We have four drills on surface carrying out exploration; at the same time our technicians are soil sampling and mapping the other units located on the land package where they have identified fault structures in sediments similar to that of Serra Pelada," said Long.

The Serra Pelada story exemplifies a trend that goes beyond gold in Brazil: the push to mine underground. This is of course part of a wider global story but, relative to open-pit operations, Brazil has very few underground mines and the industry is having to re-tool and re-train rapidly.

"Today, Brazil has more than 4,000 mines and quarries but fewer than 110 of those are underground. The trend of underground mining will become increasingly prevalent in Brazil as deposits viable for open-pit mining become harder to find. However, this alone is not enough to justify going underground. The issues that lead to underground mining are diverse, but we should underline the economic and environmental ones. Another reason is that



Belo Sun launched a large diamond drill program to upgrade and expand their Volta Grande project, preparing it for a definite feasibility study in Q1 of 2013. Photo Courtesy of Belo Sun.



the Brazilian underground geology is still very poorly understood, but with further exploration many mineral deposits will be found and considering what we have seen in the past, we believe these mines will have a great potential. In comparison with the open-pit mines, these underground mines are at the same time a challenge and a great opportunity. For example, there are still no underground iron ore mines in Brazil, however, observing the mineral characteristics of the country shows strong indicators that many economic underground resources may be found" said Fabio Netto, technical director of engineering and geological consultants PEC.

Beyond the Tapajos, pioneers are developing new Brazilian gold provinces. In a country with such a long history of formal and artisanal mining, it is no surprise that most major new discoveries are built off the back of previously-worked claims.



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Since 2007, BEMISA Group has been prospecting and developing a diversity of mineral deposits. BEMISA Group covers thirteen mineral projects encompassing a wide range of minerals: iron ore, phosphate, nickel, copper, gold, limestone and rare earth elements. With two projects on a implementation phase and four in an advanced exploration stage, BEMISA Group is present in 8 Brazilian states. Served by a high qualified technical team, with several levels of specializations in Brazil and abroad, exploratory works are still in progress with 45,000 meters of drilling programmed to be done in 2012, totaling more than 100,000 meters in BEMISA's lifetime.

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Perhaps the best example of this approach is ASX-listed Crusader Resources' Borborema asset. "We found the Borborema gold mine, a heap leaching operation from the 1980s through the early 1990s, was listed for sale as a tailings re-treatment opportunity. Some of the tailings had been re-treated, but there was a substantial amount still there. The owners only considered the value of the remaining tailings, but we thought there were still resources from the primary mineralization in the ground. At the time the estimated resource was 320,000 oz, and the site was in excellent condition; there were buildings, roads, infrastructure, and a town nearby. We purchased three tenements covering 2,000 hectares for \$1.6 million, and then continued land acquisitions along a 150 km strike."

"Our first resource estimate was 500,000 oz, then 1.7 million oz, and now it is 2.3 million oz, indicated and inferred. We have commenced a full bankable feasibility study because we are updating our resource estimate, and there is the assumption that we will get all of those ounces into indicated. We are working through the permitting and environmental study processes, and if all goes well we will have our implementation agreement by the end of September, which will allow us to start construction," said Mike Schmulian, COO, Crusader Resources.

Belo Sun Mining Corp, a TSX-listed Brazil focused junior supported by the Forbes and Manhattan group, is working on what it describes as the "largest developing gold project in Brazil." Belo Sun have invested in one of the most aggressive drilling campaigns witnessed in recent years in Brazil to substantially enlarge their Volta Grande project. At a cut off of 0.5 g/mt, the company now has a measured resource 1.85 million oz of gold at a grade of 1.71 g/mt plus 970,000 oz of indicated and 2.08 million oz of inferred.

Belo Sun recently struck a deal to acquire all surface rights across their entire mineral rights package at Volta Grande. "This is another outstanding achievement by the Belo Sun team. It represents a remarkable milestone in the de-risking of the Volta Grande project and a key step in its development. Moreover, Belo Sun is pleased to have completed this transaction at very fair market price" said CEO and president, Mark Eaton.

The company struck a cash and shares deal with the local land holder, helping to ensure that the local community interests are aligned with those of the mine. As a part of the deal, garimpeiro mining must cease on the property before the second tranche of payment is made and the deal concluded.

Diamonds

The Braúna project could change how prospectors perceive the country's opportunities.



Samples of kimberlite being mined from Lipari's 100 m deep bulk sample shaft excavated into the BR3 kimberlite pipe. Photo courtesy of Lipari.

While Brazil is undoubtedly a glamorous country, it has nonetheless never held a strong reputation as a producer of that most alluring of minerals, diamonds.

Brazil has been producing diamonds for almost 300 years; records place the first diamond discoveries as far back as 1725. Even today, it ranks alongside Guyana as Latin America's top diamond producers. Yet despite this long history and current position, production has always been exclusively alluvial; deposits are typically small and often of low grade. When faced with the rich prospects of South Africa, Botswana, Russia, and other jurisdictions, prospectors can perhaps not be blamed for focusing their attention elsewhere.

Despite this, not everybody has written off Brazil as a potential diamond producer. In the 1990s De Beers searched for the feeder kimberlites in the northern state of Bahia. After disposing of their exploration assets (following disappointing results), one property, Braúna, was acquired by Vaaldiam Resources. According to Kenneth W. Johnson, ex-Vaaldiam managing director and current Lipari Mineração managing director, the new owners "excavated deeper trenches to collect some bulk samples and found that the grade was 10 times more than what De Beers had calculated."

The results give cause for optimism for any prospective diamond hunters in the country. "Our exploration yielded 22 kimberlite occurrences, in the form of a series

of kimberlite pipes and dikes. In 2011 Vaaldiam transferred its interest in the project to Lipari," said Johnson.

Braúna does not buck the historical trend; it remains a relatively small deposit despite the discoveries made by Vaaldiam Resources and Lipari Mineração. Yet while Johnson acknowledges this, he also maintains that the project represents a captivating proposition.

"Braúna has some really spectacular large diamonds; there are colored diamonds, including highly-valuable pink diamonds and yellow diamonds. Almost all the diamonds from Braúna are of gem-grade. We are hoping to start production by the first quarter of 2014 at a total capital cost of \$25 million, projecting an open-pit mine with a five-year life, producing 125,000 carats per year, accumulating to 500,000 carats over the life of the open-pit operation, following which we expect the mine to continue as an underground mining operation."

If Lipari does succeed in building what should in theory be a simple mine with a minimal environmental footprint, it will represent an important milestone not just for Brazil, but also for the entire continent. For all Latin America's mining strength, it has never managed to gain a reputation as a source of the glittering carbon. Braúna could be a first step in proving this potential. "By world standards this is a small mine, but it will be the largest diamond producer in South America," said Johnson.



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Nickel

Already in the world's top 10, Brazil offers significant upside potential.



The Poços de Caldas unit (mining and processing) of Votorantim, in Minas Gerais. Photo Courtesy of IBRAM.

Brazil is the world's 10th largest producer of nickel, mining 66,200 mt in 2010. There is significant potential for increasing production: the USGS estimates that the country holds 12% of the world's reserves.

Anglo American is investing heavily in the Brazilian nickel sector. Its Codemin subsidiary has been in operation for 30 years and produces about 10,000 mt/y, but it is the Barro Alto project that is a game changer for both the company and the country.

Barro Alto started production this year and will reach 100% capacity by the beginning of 2013. It will average 41,000 mt/y in the first five years, increasing Brazil's output of nickel by 62%.

"Barro Alto is a Ferro Nickel project from laterite ore, where we have very good reserves: around 120 million mt of ore. Implementation began in 2007, but, like many

major projects, it was delayed for one year by the 2008 global financial crisis. Barro Alto was a four-year construction project, with 37 million man-hours of work," said Walter De Simoni, CEO, Anglo American's Nickel Business Unit.

At Barro Alto, Anglo has had to demonstrate their commitment to sustainable practices. "There was some hostility towards Anglo American in our first Barro Alto community forum in 1998, so it was very pleasing to see that the same people who challenged us then were thanking us for our presence during the last forum in 2011," said De Simoni.

Barro Alto "had an excellent safety record, with no fatalities, which we are very proud of; and we finished on time and within budget. The project was also excellently executed from environmental and social responsibility perspectives, in line with Anglo American targets. Compared to our other projects, energy consumption at Barro Alto will be 8% lower; for water consumption, we will save 11% on top of the 25% reduction that has been made at Codemin in the last three years," said De Simoni.

Barro Alto is a laterite deposit and Anglo wa processing test batches of ore from 2005 at Codemin to fine tune the new processing plant. "I feel that the market will be, more or less, in balance until 2016, at which point some analysts are forecasting better prices for nickel. Based on the current stream of projects, a big production gap is being predicted for 2020 to 2025, so the long-term

news is good. Interestingly, nickel production used to come from sulphides, but by 2014 more than 50% will be from laterites. The companies that develop the best hydro-metallurgical processes to deal with laterites will lead the industry," said De Simoni.

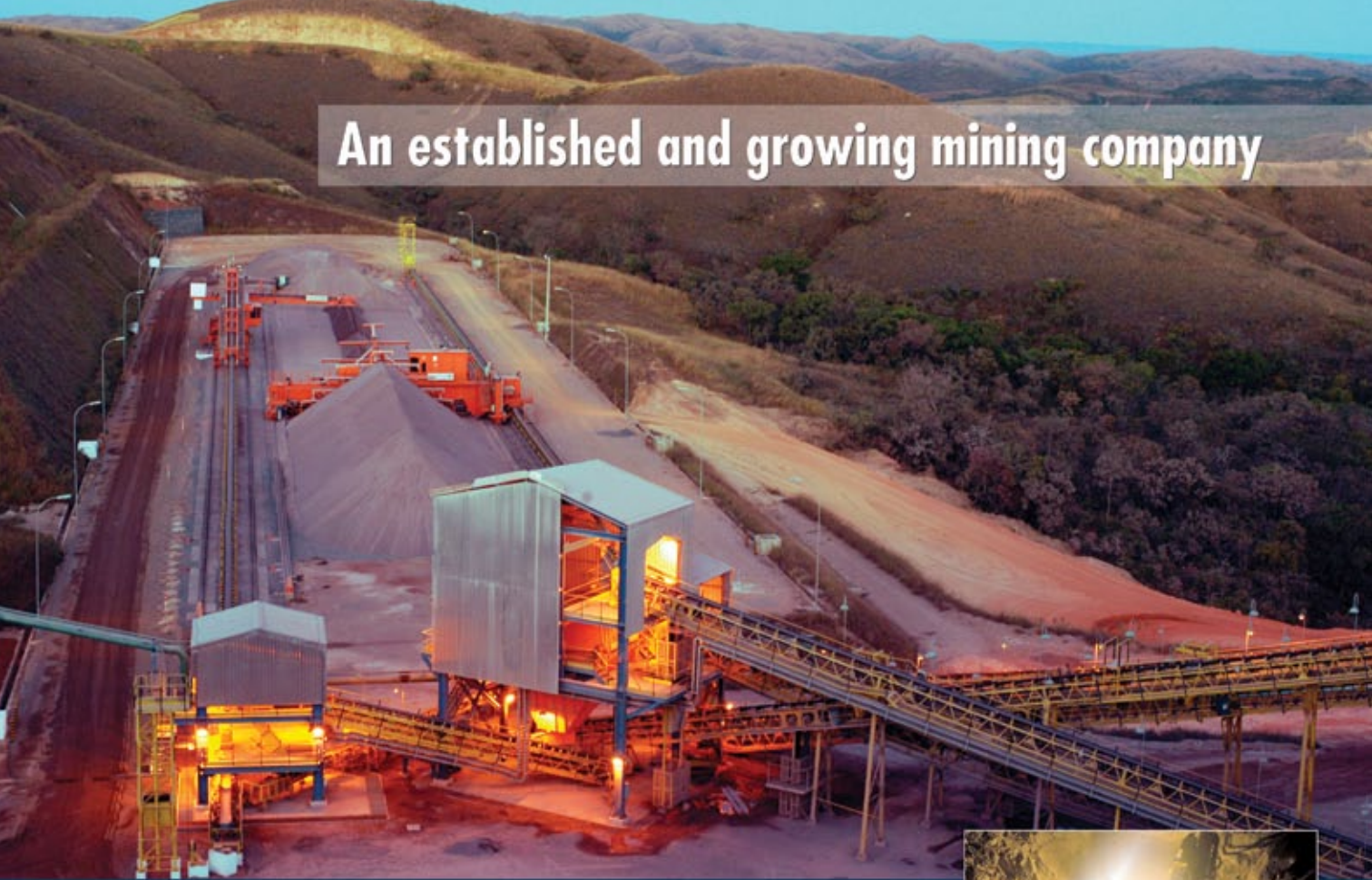
Anglo has the potential to add a further 66,000 mt/y to its output in Brazil through projects in a range of stages of development, the most advanced of which is Jacare. "The Jacare project in Para State has over 500 million mt of ore. There, we can choose between using hydro-metallurgical and pyrometallurgical processes. At the moment, we are at the pre-feasibility stage, and I hope there will be at least a first evaluation by the end of the year. We know that there are logistical challenges in the region, but Jacare is a world-class deposit."

The second major new project in Brazil is ASX- and TSX-listed Mirabela Nickel's Santa Rita project: the largest nickel sulphide discovery in a decade. Mirabela brought the project from discovery to production in a little over five years, demonstrating that things do not always happen slowly in Brazil. The deposit has proven and probable reserves of 159 million mt with a nickel grade of 0.52% and 0.13% copper and phase two was put into operation in 2011 bringing Santa Rita's name plate capacity up to 7.2 million mt/y. Mirabela were targeting 20,000 mt of production for this year, but lower than expected grades have recently forced them to lower this estimate by 1,000 mt.



Walter De Simoni, CEO, Anglo American's nickel business unit in Brazil

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Phosphates and Potash

Securing strategic supplies for fertilizers.

Few topics are as emotive, political and topical as food production. The uproar caused by BHP Billiton's aborted takeover bid for Potash Corporation of Saskatchewan in 2010 helped re-focus attention on the fertilizer mining sectors. The link between food production and long-term potash and phosphate supply has become an increasingly political issue in Brazil and the government has set itself the ambitious task of becoming fertilizer independent by 2020.

Brazil is a farming powerhouse. "This country has more arable land than any other, and plenty of rivers and rain," said Mauro Meinberg, chief financial director, Anglo American Niobium and Phosphates.

The country has undergone a "green revolution" in the last half a century and, as Meinberg noted, ongoing soil improvement has been a key component of this for the simple reason that "to certain extent the soil is nutrient poor." Brazil is therefore a major consumer of potash and phosphate and, with "40% of consumption imported and de-

mand... only growing," it is a "good place to grow in phosphate or fertilizer production."

Vale is Brazil's sole potash producer but production from its Taquari-Vassouras mine falls well below what the country consumes. Brazil is typically the third largest global consumer of potash, consuming 6.8 million mt in 2009, but it imports 90% of its potash requirements.

Exploration at this stage has been limited by the high cost of drilling and the constrained availability of land (state-owned oil major Petrobras has tied up mineral rights across vast swathes of Brazil's sedimentary basins where potash is most likely to occur and has been slow to release it to the mining sector). However, some companies are making headway. "Potassio Brasil (Brazil Potash) owns a large section of what appears to be one of the three largest potash basins in the world. Brazil is one of the world's largest consumers of potash and the government wants to become potash independent. The Amazonas project will play a key role in this," said David Argyle,

CEO of Brazil Potash Corp and its parent company Forbes & Manhattan South America.

A key constraint to exploration is the cost of drilling. "Drilling potash is not like drilling iron ore. You need to invest in big machines, lots of tools and you need to import those tools, which is very expensive. There are several clients asking us to drill, say, four holes, 1,400 m deep for potash but we cannot bring the rigs here for such a small order, we need a minimum number of meters to bring the equipment to Brazil," said Carlos Ferreira, director of drilling contractor Layne.

Given the cost of potash exploration and development, juniors are focusing on bringing their (cheaper) phosphate projects into production first and then spending the free cash flow on "company-making" potash assets.

TSX-listed Rio Verde Minerals Development Corp. own the Sergipe potash project and a range of phosphate assets, the most advanced of which is Fosfatar. "Fosfatar will be going into production in the third quarter of this year... We have about 95% of the



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An Emerging Phosphate and Potash Company in Brazil

Agua Resources Limited, ("Agua") is an ASX listed company whose primary focus is on the exploration and development of large scale phosphate and potash projects in Brazil. Through its 100 per cent owned subsidiaries Agua Metais Ltda and Potassio do Atlantico Ltda it has an established and highly experienced in-country management team based in Belo Horizonte, Brazil with corporate offices in Sydney, Australia.

equipment on site, a strong technical team in place, and marketing in full force... We are just waiting for the final signature from the director of the DNPM, which will allow us to produce 100,000 mt bi-annually. This is double the capacity we had planned for. With an overall deposit of two million mt, we can generate a cash flow of R\$30 million a year to support our potash explorations at Sergipe. A potash plant would cost around \$2 billion, whereas the phosphate plant that we are planning to build will probably cost around \$10 million. So it makes sense for us to get Fosfatar into production now," said Luis Azevedo, COO, Rio Verde.

Agua Resources Ltd., an ASX-listed junior also affiliated to Forbes & Manhattan, is pursuing potash and phosphate plays in Brazil. The company owns the Atlantic Potash Project, located close to the port of Aracaju in the northern state of Sergipe. The company has reviewed 300 well logs gathered during oil and gas exploration work in the area and assembled a 178,000-hectare land package. Projects located in the Sergipe-Alagoas basin are far easier to develop than Amazon basin projects, with existing infrastructure and fewer environmental hurdles as salt tailings can likely be disposed of directly into the sea. Crucially, the mine is close to a large port which allows cheap

shipment to southern Brazilian and international markets.

Phosphates and potash are bulk commodities and, beyond the iron-ore provinces, railroad infrastructure is limited. Transport costs, therefore, have a considerable impact.

Anglo American dominates supply in the southern states of Goiás and São Paulo and their model is one that emergent producers are looking to emulate. "Anglo's phosphate assets are held in our subsidiary Copebras, which is the second largest producer in Brazil after Vale. Copebras consists of a phosphate mine and processing plant at Ouvidor in the state of Goiás and a processing plant in Cubatão near the port of Santos in the state of São Paulo... Our capacity is 1.35 million mt/y of phosphate concentrate," said Meinberg.

Anglo American nearly sold off the Copebras subsidiary in 2010 but the management team achieved such improved results while preparing the operation for takeover that Anglo pulled back from the sale. Key to this has been a more considered approach to sales; reducing supply when demand is low and releasing stocks when local prices are high. "We have substantial storage capacity and this helps us get the best price... Operating profit last year was around \$136 million, lower than the record level in 2008 but 68% higher than in 2010," said Meinberg.

Like Anglo, Agua have pursued a "close to market" strategy for their phosphate projects, picking sites in Brazil's agricultural heartland. "Rio Grande and its neighbors are the biggest consumers of phosphate in Brazil, but there is no production in the area. The nearest is in Minas, but the fertilizer vendors in the area are bringing in phosphate from Florida, Morocco, Jordan and other countries. Fertilizer comes to farms in this region of Brazil by sea, by rail and by road. We want to change the dynamic of this and market by producing and distributing in the area directly," said Fernando Tallarico, technical director, Agua.

An additional revenue stream for phosphates projects in Brazil may be the extraction of associated rare earth elements. "There is a series of intrusive carbonatite deposits (in Brazil) that have actually been quite well known here for about 100 years. This type of deposit almost always contains rare earths, and in Brazil they are also a primary source of phosphate fertilizers," said Runge's Stone.

Making money out of Brazil's REE's is more a question of investment and processing technology than it is of geology: "the geology is quite well understood, its more about adding processes into the existing infrastructure to recover them," said Stone.



Brazil Potash Corp. is a private company with its base of technical operations located in Belo Horizonte Brazil and a corporate office in Toronto, Canada. Its primary focus is on exploration and development of its significant potash properties in the state of Amazonas, Brazil. The Company is positioned to capitalize on the growing demand for potassium-based fertilizers needed to grow healthy and sustainable crops in the agricultural sector in Brazil and globally.



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Environmental and Social Issues

Brazil's mining industry leads in a number of key environmental indicators as it seeks to overcome legacy challenges.



Transportation of iron ore pellets, UBU, ES. Photo by Samarco, courtesy of Geoklock.

Brazil contains multiple climatic and ecological zones, many of them delicate. The mining heartland of Minas Gerais is well populated and mines are rarely far from an existing settlement. In the emergent

northern states, the population is typically sparser, but miners are nevertheless often close to indigenous populations. Gaining a social license to operate is key to the development of any mine. Despite the heavy red

tape, it is actually the private sector that has led the drive to improve performance, notably in terms of tailings and carbon management.

Communities typically first become a factor in the mining process when drilling commences. In Brazil mineral rights are owned by the state but, normally, explorers seek to acquire land rights outright rather than negotiating access agreements.

Buying land can be a complex process. "More than 50% of land owned in Brazil does not have real documentation, and it can be difficult to buy land from a guy that does not have the titles; sometimes it happens that companies have to pay twice. I can think of one case where over 1,000 people made claims to the land: this is a case where buying the land is not possible, and a legal process is necessary," said director of social consultancy Integraçao, Rolf Fuchs.

While most of the country is open to mineral exploitation, Fuchs noted that "some areas are designated for indigenous communities, and there is also land claimed by the descendants of slaves that can be an issue when setting up a mine."

With steel falling under the EU's Emission Trading Scheme and similar carbon taxes on the way in the USA, South Korea and Australia, the carbon footprint of iron ore is becoming a purchasing consideration. "Steel makers are looking to reduce the carbon footprint of their product and sourcing from the lowest carbon

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iron ore miners is an effective way to do this... Lots of companies who are hiring our services are becoming interested in acquiring a complete carbon inventory of their product. They want to know how carbon intensive their production is. Brazilian miners have a real advantage when it comes to carbon; 50% of the country's energy is sourced from renewables and the country's iron ore is about as low carbon as you can get," said Ernesto Moeri, CEO of engineering and environmental consultants Geoklock.

Mindful of the competitive advantage that a low-carbon product offers, emissions minimization is starting to factor into mine design and operations optimization. "Our approach to environmental management considers ways to reduce the combined impact of mining, processing and the logistical side of projects; it is a total approach. For example, we advised an iron ore mine how to alter its logistics to reduce carbon emissions," said Carlos Orsini, executive director of environmental and social consultants YKS.

Righting past wrongs and improving the environmental performance of existing mines has been the route that one junior took to achieve production. "In 2007, we bought the mineral rights for a mine called Ponto Verde. There had been several environmental violations under the previous owners, so we had to negotiate with the government to try to restart operations there. After two years, we were granted a license of operation for a 1.5-million mt/y mine. We started mining in October 2010 and started our plant operating in March 2011," said the COO of ASX-listed South American Ferrous Metals (SAFM), Eduardo Freitas.

"Recovering Ponto Verde involved recuperating some of the degraded areas and guaranteeing a mine closure plan. We had to create a fence between the mine and an environmental park next door, and create a recovery plan for this as well... We really had to improve the mine's image with the public," said José Márcio Paixão, CDO, SAFM.

Now that SAFM has demonstrated to the authorities and the public that Ponto Verde can be mined responsibly, they are looking to increase production at the site in a significant manner. "We need to get a new license to increase operations to 8 million mt/y. But the authorities are happier now and I believe we have shown great progress since acquiring the mine," said Paixão.

Tailings management in Brazil, a country prone to flooding and host to some of

the world's most environmentally sensitive ecosystems, is vital. "For every unit of concentrated iron that is produced we create 2.5 units of tailings plus waste on average. If we consider the total amount of iron that is been planned by one of the biggest mining company in Brazil for the year 2015 and put together the total amount of residues that they need to manage, it is the equivalent of a dump 100 km long, 50 m height and 300 m wide," said Paulo Cella, chief geologist at engineering consultants BVP.

While Brazil is famed for its heavy legislation, its often private sector that leads when it comes to environmental sustainability. "It is interesting to observe that in Brazil it was mining companies who first started worrying about handling tailings. What we are seeing is a constant push by the companies to develop new technologies and to better manage the environmental impact of their tailings," said Cella.

The government is now becoming involved in regulating tailings management and in 2010 imposed new laws regulating the maintenance of tailings dams. Miners are now required to demonstrate the continued safe management of dams and many are choosing to employ an independent third party to audit their earth structures.

One of the early pioneers in the field of tailings dam safety auditing was geotechnical consultancy Pimenta de Ávila. "We have developed our own procedures for auditing, as the law does not specify exact requirements. The level of detail of the audit work is defined in agreement with the client's objectives. We have been commissioned to develop a large risk management system and program for all of Vale's geotechnical structures. It is now being provided to other major companies in addition to Vale, including ALCOA and Votorantim Metais," said geotechnical engineering consultant Rafael Jabur Bittar.

"Like auditing, there is significant growth in demand for closure services. We are sending our staff to countries like Canada and South Africa, which began considering mine closure more than 10 years ago, to gain expertise," Bittar said. States are starting to bring in supplemental regulations on mine closure: "Minas Gerais is developing a new law to regulate mine closure, and is probably the most advanced state of Brazil on the issue," Bittar said.

João Paulo Vieira de Ávila, adds that "today closure is a topic that must be considered right from a mine's initial design. Laws in Brazil are becoming more strict, and the big companies care about respecting our environment."

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Vale's Brucutu iron ore mine, located in São Gonçalo do Rio, Minas Gerais. Inaugurated in 2006, it is considered the country's second largest mine, with reserves estimated at more than 650 million tons. Photo Courtesy of IBRAM.

There exists a degree of tension in Brazil between the private and public sectors and this is most clearly manifest in the equipment industry. Brazil has battled long and hard to add value to its raw materials and build its manufacturing industry through protectionist trade policies. The country has built a substantial industrial sector, though the private sector generally holds that this is despite, not because of, government policy. Domestic manufacturers are saddled with extremely high employee taxes (which can reach 125% of salaries), sales taxes and extraordinary levels of red tape.

The government has not, however, chosen to specify that a certain proportion of goods and equipment used in the development of mines should be locally sourced, as it did with the recent round of offshore oil and gas licenses.

Brazilian buyers in the mining sector tend not to distinguish between internationally and domestically manufactured goods and the market is increasingly quality aware, argued country manager of Swedish steel company SSAB Paulo Seabra. "Historically, Brazil has been more cost-conscious than quality-conscious, but we have seen an increased focus on quality in the last 10 years. Companies understand that to be more competitive globally, they must be more efficient locally. People are willing to pay more for our steel, as long as they can see how it adds value to their business."

"The Brazilian market is not very mature, but there is a great deal of potential. If you

look at major countries like Germany or the US, high-strength steel accounts for 7% to 10% of all steel consumption. In Brazil, high-strength steel use is half of what it is in those countries, we are very optimistic because of the amount of investment in the country and the vast amount of upgrading that needs to be done," said Seabra.

Despite the high tariff barriers, a few global manufacturers are looking to set up shop in Brazil. German processing equipment manufacturer Steinert is one of the handful of producers looking to establish a manufacturing capability in Brazil. "Steinert has been present in Brazil since 2006... The decision to transition to manufacturing comes now that we are well established here."

"Manufacturing is easy, but not at high-quality German or Australian standards. Brazil is getting more expensive to manufacture in everyday, so we need to distribute our spending effectively, train people and be very creative. Where we decide to set up will depend on what kind of tax arrangement we can make with the government of Minas Gerais" said Paulo Da Pieve, general manager, Steinert Latioamericana.

Locating a factory in Brazil is about more than just proximity to market, labor and input costs observes Da Pieve. "The states of Brazil are in a sort of fiscal war with each other, with tax systems that vary in very complex ways; to compete with manufacturers based in São Paulo, I have to either set up there or be very efficient in Minas

Gerais. The engineering and mining companies are all in Belo, but I have to consider our competitiveness, especially with my main supplier in São Paulo. Our Brazilian manufacturing operation will grow step by step; in the beginning, we will focus specifically on mining products, with technical support coming from Australia. It will not be a labor-intensive operation. We will continue to produce the same high-technology equipment as in Germany and Australia.”

Brazil is the fifth largest country by area in the world, and, outside of the populous south, transport infrastructure is often sparse. Given the geographical and transport constraints, it can be a major challenge for equipment suppliers to ensure the parts and services availability that mining clients require across this vast and challenging territory.

“Brazil is as big as the US and there is a lot of variation in the development of each region. To meet these challenges we have at every site a branch fully dedicated to providing service and maintenance to our customers. Every branch has spare parts in stock. This involves major investment in logistics and IT. Every mine has an IT hub, so if a part is not available in the on-site facility we can deliver it within twenty four hours by truck. In the rare circumstance where



Caterpillar's equipment at work, Sotreq is the multinational's biggest dealer and supplier in Latin America. Photo Courtesy of Sotreq.

something is not covered by our system, we will ship by airplane” said Marcelo Ribeiro, mining unit director at the nation's largest Caterpillar dealer, Sotreq.

Caterpillar's 2011 acquisition of Bucyrus has reshaped the mining equipment landscape globally. In Brazil, the acquisition was particularly well timed for Caterpillar's agents. Underground mining is growing in Brazil and “the acquisition will enable us to offer an entire underground portfolio; big loaders, rope shovels, draglines, and hydraulic excavators. Essentially, we can provide higher capacities and go underground” said Ribeiro.



Marcelo Ribeiro, mining unit director, Sotreq.

Caterpillar dominates the heavy equipment market in Brazil. The company recently opened a new diesel-electric locomotive factory in Brazil but, at the time of writing, had no public plans to open mining equipment plants in the country.

With its extensive domestic market and access to Mercosur customs union markets, including Argentina, Brazil is a location that few global mining equipment manufacturers can pass over. However, until the real weakens, and taxes and electricity rates fall, the country is unlikely to see major investment in its manufacturing sector.

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Minas Gerais

A center of excellence



Marzagão Dam, Ouro Preto, Minas Gerais, Photo Courtesy Pimenta de Ávila Consultoria Ltda.

The state of Minas Gerais, located north of São Paulo and Rio de Janeiro, has become a center of excellence for mining services and technology and its largest city, Belo Horizonte, has become the Brazilian mining sector's unofficial capital. The state's name is derived from the Portuguese for "general mines" and it was gold discoveries in the state during the late 1600s that promoted the population of south-central Brazil and led to the development of São Paulo and Rio as trading hubs for the new frontier.

Today Minas Gerais, the fourth largest state in Brazil, produces 48% of the nation's minerals output by value. However, it is the expertise that has been built over three centuries of mining that really distinguishes the state. It contains some of the best mining research and education facilities in the country and is host to a multitude of service and equipment providers. Aside from Santiago de Chile, it's probably the only city in South America where it is possible to find all the expertise required to discover, design, build and run a mine.

In a typically virtuous circle, the companies found in Minas Gerais are both attracted by this expertise and serve to perpetuate it; the presence of both international giants and local talent serve to reinforce the notion that Belo Horizonte is the home of Brazil's mining industry.

U&M is a large, privately-held Minas Gerais construction company that has specialized in mining projects since its inception 37 years ago. Today, the company does more work outside the state than it

does within and has chosen to focus on safety, environmental performance and customer service to distinguish itself from the low-cost competition. "I think that attitudes are changing, and the mining industry is paying ever more attention to safety and the environment, but in big contracts price is still very important. Customers that only consider costs do not tend to work with us, but it is our view that we can only afford to charge a little bit more for a premium service. It is very important for us to add value for clients, and we like to focus on establishing very good long-term relationships," said Marcelo Ribeiro Machado, CEO, U&M.

A little more than 10 years ago U&M became the first contract miner in the country and today they continue to lead the market, although Machado acknowledges that competition is tough. "Mining companies



Marcelo Ribeiro Machado, CEO, U&M.

can do the work themselves, so we need to compete with them as well as other contractors. There is not yet another big company like us... We are the only contractor in Brazil who can provide heavy mining equipment, but I believe that other Brazilian companies will enter this market and grow, and that international companies will start building a presence here."

U&M was one of the first Brazilian mining contractors to work overseas and Machado sees growth both domestically and internationally. "We started in Zambia moving 20 million mt/y, and next year will be moving 70 million mt/y. There are lots of opportunities in Africa, but there are also a lot in Brazil. Since our business began, we have seen great turmoil in Brazil but everyday it becomes more stable and is doing well as a democratic country. Last year our turnover grew by 40% so things are good for us in Brazil."

A host of international high-tech companies have chosen to establish their regional headquarters in Belo Horizonte, recognizing it as the best place from which penetrate the South American market.

Brazilian miners are very open to new products and technologies and companies (both locally and foreign owned) are willing to invest in hardware and software that improves performance and drives efficiency. This is a welcome contrast to the prevailing attitude in other BRIC mining markets where domestic firms often do not understand the application of software or are not willing to pay for original licenses.



Davi Freire, general manager, Modular Mining Systems.

"In my opinion, [Brazilian clients] have been very proactive... They have been calling us to know more about our products' technology and functionality; many have visited our office or asked us to go to their mine sites. They want us to help them solve specific problems, and they want better reports that they can trust. Another problem they want to solve is a lack of optimization, so many are interested in high-precision GPS technology. Finally, Brazilian companies have become very interested in safety innovations," said Davi Freire, general manager of Modular Mining Systems do Brasil.

Modular is best known for its fleet optimization products and have found a ready market in Brazil. "Our main fleet management solution, DISPATCH®, is now installed in nine of the 10 largest surface mines in the world and nine of the 10 largest mines in Brazil. Mine sites are very complex, and there are dozens of possible locations for trucks. The primary objective of the technology is to dispatch haul trucks to the right place, at the right time," said Freire.

Recognizing the business opportunity presented by the mining industry's drive to improve health and safety performance, Modular has integrated a fatigue alert system into their offering. FatigueAlert™ "monitors truck drivers, mainly, and can preemptively warn anyone on the mine if an operator is about to fall asleep... it gives Modular a big competitive advantage. FatigueAlert is already being used in mines in Africa, and we are now introducing it in Brazil, where companies like Vale are focused on achieving zero accidents," said Freire.

The entry route taken by Australian software and consulting company Micromine is a classic one. In 2008, they established a distribution agreement with Brazilian distributors BNA, at the beginning of this year they acquired BNA and are now using the Brazilian team to increase market share in



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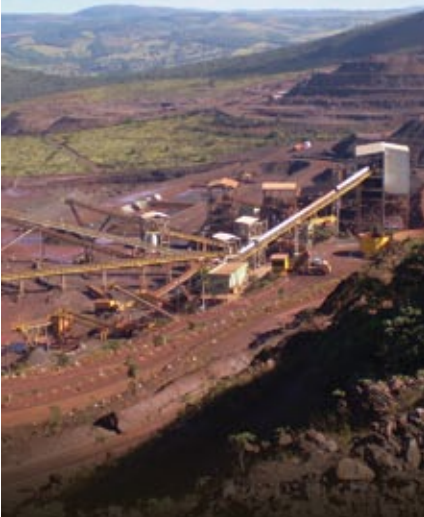


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Beck Nader, executive director, BNA Micromine Brazil and regional manager, BNA Micromine South America.

the country and build the brand in other Latin American markets.

Uptake has been strong amongst consultancies and larger miners, but executive director Beck Nader argues that smaller miners do not yet understand the value of mine management software. "There is an educational issue: small miners are not well versed on this kind of technology. It is still, in a way, expensive for them, but I am very keen on showing that there are overall economies to be made. I cannot do this alone, but must work with the government, universities and communities. I think we are on the verge of seeing a step change."

Companies such as Micromine, whose strength lies in their offer of advanced products, experience another benefit from being located in Minas Gerais; the state contains some of the best geological and engineering faculties in the country. As a result, the most promising graduates in Brazil enter their professional lives well aware of the most recent processes and technologies.

Using the Belo Horizonte office as a hub, Nader intends to build market share in other Latin American markets. "I look to double our business every year. Peru has amazing opportunities; there are already internation-

al companies there who have purchased the software from Australia, but we want to offer more service support and increase sales to new customers. We opened our office in Chile in 2010 and it is clearly a crucial market. Latin America is going to be very important for Micromine; it should be worth at least 25% of global revenue."

As the Brazilian mining industry has matured, clients have become sophisticated when it comes to the acquisition of products and services. "the power within companies, especially major ones, to make the decision to invest in software has moved from individuals to groups. Today, we talk more to IT people than geologists or mining engineers" said Paulo Felipe Martins, country manager, CAE Mining.

Aircraft training and simulation provider CAE entered the mining market via the 2010 acquisition of UK based Datamine, which also gave them access to Datamine's exploration, resource modeling and mine planning and management software.

The mining team has started to adopt service offerings pioneered in the aircraft space to service its clients, offering outsourcing of all training or hybrid solutions: "for large companies we can develop and operate their training centers, using simulators that they have purchased from us. We also invest in our own training centers for small and medium sized clients" said Martins.

"Unfortunately, the mining industry does not have the same safety regulations as the aviation sector, but I think it is only a matter of time before these regulations are tightened. In the future, our intention is to develop remote operational centers for mines – this concept comes from the military and aviation industries. Remote centers have the potential to reduce risk as well as costs. It is something that the mining industry is preparing for and I think we will see it becoming more common in the next two to three years" said Martins.



Paulo Felipe Martins, Latin America regional manager and Eduardo Yamamoto, senior mining consultant, CAE Mining.



Brent Thompson, senior vice president, mining division, Tetra Tech Wardrop.

American EPCM and environmental consulting firm Tetra Tech, traditionally known for their offshore and water and waste water capabilities, entered the world of mining through the 2009 acquisition of Vancouver based Wardrop Engineering. Since acquiring Wardrop, Tetra Tech has continued to build their global capacity through a string of mining-focused buyouts.

In May 2012 the company announced the acquisition of Belo Horizonte-based CRA Engenharia Ltda. Brent Thompson, senior vice president of the mining division, explained Tetra Tech's Brazil strategy: "Tetra Tech has not had a large term presence in Brazil over the years, instead we have come in from time to time to provide high technology oriented services to oil and gas clients and to help large organizations in the mining industry look at process engineering."

"We are going to come in permanently on the back of the mining industry; a number of our key customers globally are here, and they want us to be as well. We hope to be in the country on a full-time basis before the end of the calendar year. From there we hope to grow our renewable energy practice, which is particularly strong," Thompson said.

"The reason you see a lot of partnerships being formed is because that really is the best way to enter the country, for a variety of reasons. Obviously, it is a large country with many regions and different cultural practices; the government regime is also complex in areas such as taxation and HR. Foreign companies often find it a lot easier to take their first step with a partner that already understands the systems and processes," said Thompson.

Belo Horizonte not only hosts high-tech foreign firms looking for a South American base, but also has own crop of homegrown firms as well. Established and owned by a Brazilian team, Devex is the country's largest mining software house.



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MINING IN BRAZIL

Devox's main product is Smartmine. Smartmine "controls, monitors and optimizes open-pit and underground mine operations. Controlling mobile environments requires a very different approach from plants because the configurations are constantly changing. Since 2000, critical aspects of the solution, like wireless networks and high-precision GPS, have become cheaper and the technology's application has grown. We started with one mine in 1997, by 2000 we were operating in two or three mines and today we work in 37 mines," said Guilherme Bastos Alvarenga, founder and CEO, Devox.

"Our system provides optimization by having a statistical database that creates a complete understanding of a mine and can simulate its future. However, as you can simulate an infinite number of possibilities, there is an intelligent algorithm that chooses situations to analyze. It can manage thousands of calculations per second, and within 10 seconds will find the optimum asset arrangement. So, when a truck goes down, for instance, it will find the best solution," said Alvarenga.

Devox recently entered the underground sector. Alvarenga believes that there will be substantial demand for optimization software in the coming years and that this will help catapult the company into the interna-



Marco Aurélio Soares Martins, director of operations, CEMI.

tional market. "At least 75% of mine sites globally do not have an automated, integrated management system in place. They are using programs like Excel in their control rooms and communicating by radio... In Brazil only 40% of mines have a system, but about 30 are planning on bringing one in within two years; around the world, it will be 300 in three years. Demand will be huge. We intend to capture 20 of these Brazilian mines, and expand our international market share substantially."

CEMI, another Brazilian-owned and managed firm based in Belo Horizonte, specializes in mill and process plant optimization.

The company has developed a range of modeling systems to help clients design new processing facilities and improve the performance of existing mills. Most of CEMI's work is focused on providing clients with consultancy services to model, identify bottlenecks and implement solutions as well as retailing their propriety software and hardware.

"Vale is using our dynamic simulation to test scale-up plans on several projects. We can simulate one or two years into the future to identify future bottlenecks, and can improve recovery rates by up to 10% within a few months. Clients' systems are dynamic rather than static, and should be treated as such," said Marco Aurélio Soares Martins, founder and director of operations, CEMI.

Like Devox and Modular, CEMI operate in a niche field where there is a limited awareness of their product's utility: "our challenge is to convince clients that advanced process control can be useful to their operations."

The company used to sell its products internationally through a well-known global processing technology firm, but two years ago started selling direct. "We can sell five times more independently, and are now completely free to expand. Only 10% of the business today is export-oriented, but we aim to grow this to 50% within a maximum of four

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years. We have agreements with Outotec to implement our advanced control system in a sinter plant in India, and with Vale to work on a phosphate project in Peru and on a pelletizing plant in Oman," said Soares Martins.

South African firm Master Drilling are global leaders in the contract raise boring market. Chilean Jorge Nicolau Paredes, executive director, relocated to Belo Horizonte to open the Brazilian operation in 1999, acknowledges that "in the beginning business was difficult because raise boring was considered too expensive, but slowly people have come to see its benefits in terms of reducing risk, shortening operating times and the additional control that comes from not using explosives."

Brazilians have traditionally excelled at open-pit mining, reflecting the dominance of iron-ore over the sector, but more and more underground mines are coming into operation and this creates opportunities for specialist firms. Brazilians clients are increasingly adopting raised boring, which involves drilling a pilot hole from one mine level downwards to a second level, and then attaching a reamer and pulling back to create a large, smooth sided borehole. "In Chile, Peru, Mexico and Brazil we started with one machine and this year we will have 40 in Chile, 20 in Peru, 13 in Brazil



Caio Libaneo, director, Libaneo & Libaneo.

and 10 in Mexico. We have been careful to grow at a sustainable rate to maintain safety standards: we have to train our people from scratch as there is no one else in the market doing what we do" said Paredes.

Now that raise boring is gaining traction, Master Drilling are looking to introduce other specialist drilling such as through pass boring into the Brazilian market.

As most miners require their geological work to be certified to Canadian or Australian standards, it is often the case that they will seek a foreign consultancy to conduct resource calculations, pre-feasibility and bankable feasibility studies.

Caio Libaneo, director of Belo Horizonte-based consultancy Libaneo & Libaneo, noted: "one of the great challenges that we face is that international clients still question the credibility of companies from Brazil. Many of these international clients have had bad experiences in the Brazilian market and this has left them skeptical of Brazilian companies."

Libaneo & Libaneo has developed the capability to deliver NI 43-101 and JORC-compliant work, and he argues that this, combined with the on-the-ground knowledge that being local brings, is a highly valuable offering. "Our focus is on geological services from exploration through to mine planning. Among others, some of the services we offer include survey planning, mineral mapping, geological modeling, sample preparation and interpretation of the geochemical results."

To win contracts from foreign clients, domestic engineering firms are entering into partnerships with their international competitors said Jackson Oliveira Bragança, director of engineering consultancy Tecnomin Projetos e Consultoria: "international companies are also demanding our services but because of the laws in some countries, we have to partner with a foreign partner in order to win and execute the project."

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Photo courtesy of consulting services firm Libaneo & Libaneo.

Labor: not enough (at the right price)

Despite a 5.8% unemployment rate and massive wage inequality, labor availability is a major issue for companies in Brazil.

The global shortage of experienced geologists, metallurgists and mining engineers is undoubtedly one of the biggest issues facing the international mining community. In Brazil, it is particularly acute.

Even with the valiant educational efforts in Minas Gerais, Brazilian universities do not produce enough mining graduates and have failed to do so for decades. This skills gap is probably the biggest impediment to growth across all sub-sectors of the industry, from junior explorers to consulting groups.

“In the last 10 years, we have always grown at least 25% annually,” said Rafael Jabur Bittar, geotechnical engineer and consultant, audit and risk management project manager at consultants Pimenta De Ávila. “Brazil’s biggest problem today is a shortage of skilled workers... the next two or three years will be very difficult in terms of human resource constraints.”

Industry veteran Jackson Oliveira Bragança, of Tecnomim Projetos e Consultoria, added: “in the last five years we have grown at a far faster rate than we anticipated. Looking forward, our growth rate is more likely to be constrained by labor availability than it is by business opportunities. Here in Minas Gerais we have the greatest concentration of mining expertise in the country, but it’s not enough. The industry needs to overcome the global shortage of labor and we in Brazil need to work together to improve education and training.”

The labor shortage is not confined to the professional sector, Brazil is also struggling to produce sufficient trades people; once found, companies must work hard to retain their staff. “One of Sotreq’s main concerns in Brazil is a shortage of skilled labor; the market is booming, retaining employees is an issue. We are very well positioned in terms of salary, benefits and work environment in Brazil. We always have an aggressive package of benefits for our employees so they are content with their work environment,” said Marcelo Ribeiro, mining unit director at Caterpillar dealer Sotreq.

Like many of their competitors and clients, Sotreq can no longer source enough trained mechanics to facilitate growth and are investing in major new facilities to train recruits from scratch. “One of our largest current capital investment outlays is in the ABC School. The school will train mechanics at every level, providing a career path for them as they progress. It will help to sustain our growth and continue supporting our customers. We forecast training around 2,500 mechanics in the coming years, with a focus on bringing people to the ABC School for training and then sending them back to their home regions” said Ribeiro.

As the mining industry knows all too well, Brazil is not unique in its labor difficulties. Yet as an emerging market, with its population and, indeed, international business expecting it to maintain its high rate of economic growth, finding a solution to this problem becomes all the more pressing.

Conclusion

Significant opportunities exist in one of the world's most stable emergent economies.



The Bemisa Group has 13 mineral projects, distributed in eight Brazilian states. Photo courtesy of Bemisa Group.

Without doubt, Brazil is a country that could do better when it comes to mining. Taxes are high and the industry does not see a lot in return. Those outside the industry rightly contend that the commodities su-

per cycle has gifted vast profits to miners at a time when host countries, including Brazil, are struggling to maintain growth and keep national debt down. But the extraordinarily slow pace at which mining and en-

vironmental permits are granted holds the industry back, acts as a major disincentive to investment and pushes back the point at which mining starts to benefit society. The sluggish rate at which existing laws are ad-

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Vale's Taquari-Vassouras potassium mine in Sergipe. Photo courtesy of IBRAM.

ministered is mirrored at the legislative level where successive governments have failed to pass a new mining code.

Yet in spite of this less than ideal legal environment, politically Brazil scores well. It is a stable, property-respecting democracy with a broadly pro-mining sentiment. The country is almost unique in the developing world: it has produced world-class domestic miners and has successfully opened its doors to foreign players. Today, Brazilian firms such as Vale have started to build considerable overseas mining and mid-stream operations, demonstrating their world-class capabilities. Services providers, notably concentrated in the state of Minas Gerais, have kept pace with their clients and have built a center of mining excellence in the city of Belo Horizonte.

By dint of its sheer size, Brazil hosts some of the most prospective land in the world. Despite its long tradition of mining, it remains extremely under-explored; even today, with mineral prices at a high, only a handful of juniors are active in the country. If a well-designed new mining code brings an end to the uncertainty hanging over the nation and it is matched by well-resourced licensing bodies, Brazil should become one of the biggest recipients of exploration capital in the world.

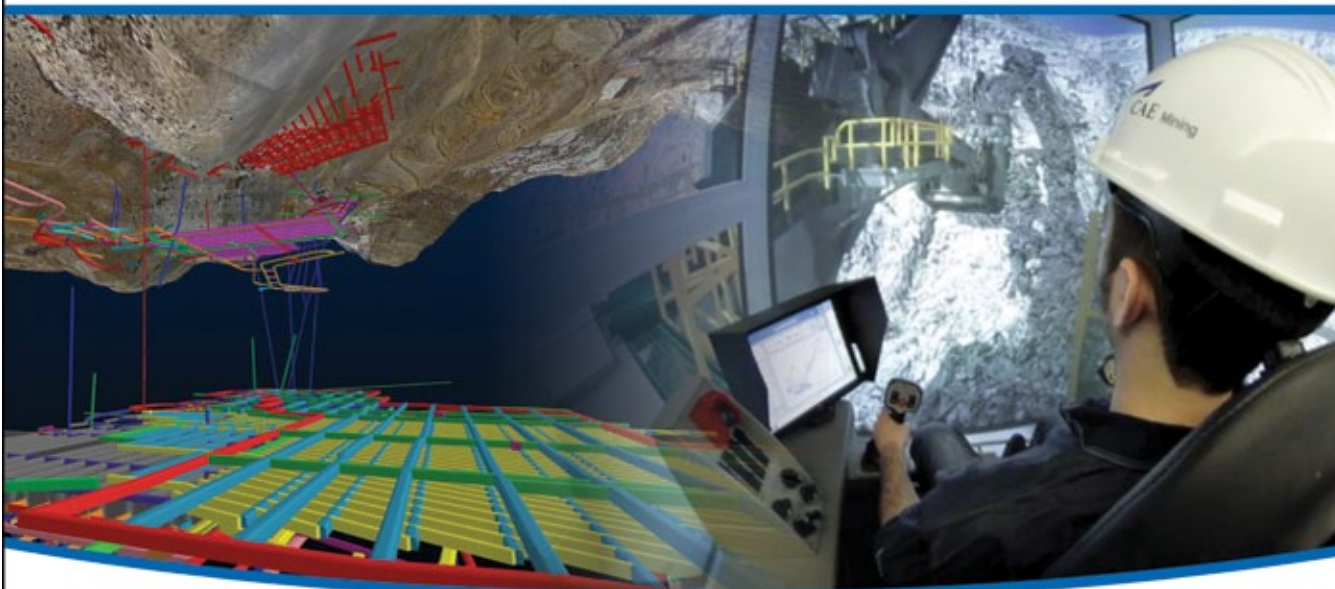
We thank Rinaldo César Mancin, director of environmental affairs, IBRAM

IBRAM, the Brazilian Mining Institute, is the association representing companies and institutions working in the mining industry, which aims to gather, represent, and promote the mineral industry, contributing to its national and international competitiveness. In addition, the Institute also aims to promote sustainable development and use of best practices in occupational health and safety in mining, stimulating studies, research, development and innovation. IBRAM organizes the event EXPOSIBRAM, which will be held this year in Belém, Pará, Brazil from the 5th to the 8th of November 2012, and will focus specifically on mining in the Amazon region: EXPOSIBRAM AMAZONIA 2012.

We thank Onildo João Marini, executive secretary of ADIMB

ADIMB, the association for the development of the Brazilian mining industry, promotes technical and scientific development and the training of human resources for the mineral industry through cooperative action between government, businesses and research institutions. ADIMB organizes SIMEXMIN, a bi-annual symposium. The Forum is a point of reference that brings together the Brazilian and international mining community in the traditional mining town of Ouro Preto, in Minas Gerais, Brazil. This year SIMEXMIN was held from the 20th to the 23rd of May 2012 and gathered the cream of the crop of Brazil's mining industry with top notch speakers and presentations.

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