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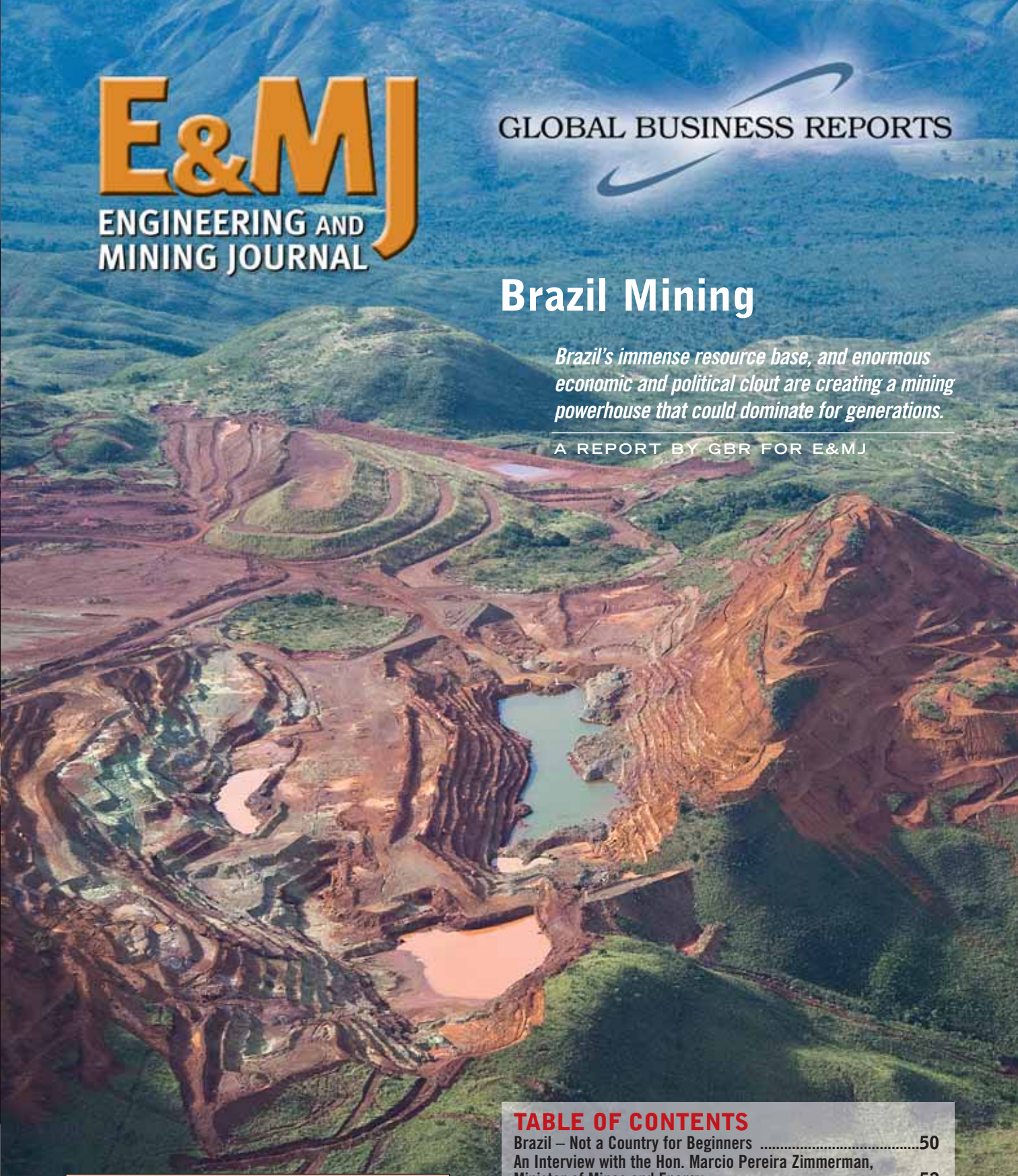
GLOBAL BUSINESS REPORTS

Brazil Mining

Brazil's immense resource base, and enormous economic and political clout are creating a mining powerhouse that could dominate for generations.

A REPORT BY GBR FOR E&MJ



This report was researched and prepared by Global Business Reports (www.gbreports.com) for *Engineering & Mining Journal*. Editorial researched and written by Marina Borrell Falco, Matilde Mereguetti, Caroline Stern and Ozgur Erguney. On the cover, at Fortaleza de Minas, Votorantim Metals produces nickel for the company's Niquelândia plant. (Photo courtesy of Votorantim)

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Brazil—Not a Country for Beginners

Mining powerhouse sets its sights on becoming a better destination for investment

Brazil's continental scale, its resource base, and its economic and political clout are fast rendering the nation a regional and international powerhouse. With 8.5 million km^2 of land mass and 7,500 km of coastline, Brazil dwarfs all of its South American neighbors.

Differences in size and scale aside, Brazil shares a long history of economic and political instability with its Latin America neighbors. However, since the comprehensive economic reform program of 1994—known widely as the Real Plan—Brazil has demonstrated more consistency, both in the functioning of its democracy, and in its many years of continuous economic growth. Today, Brazil stands alongside China, Russia and India under the BRIC acronym as one of the world's leading destinations for foreign direct investment (FDI). With an annual gross domestic product (GDP) growth rate of 7.4% in 2010, coupled with vast geological potential, Brazil's attractions are obvious. Nevertheless, it is important to note that Brazil sits sandwiched between Mozambique and Tanzania as the world's 127th economy out of 183 for ease of doing business according to the World Bank's 2011 survey.

Brazil still has huge strides to make in terms of translating nearly two decades of economic and political stability into a solid and stable business environment that works efficiently and coherently for the international investor. Brazil must be analyzed cautiously and patiently by those new to investing in emerging markets. "Brazil is not a country for beginners," said Franklin Feder, president, Alcoa, which has a 50-year history in Brazil. "The Brazilian people are very gracious, kind and hospitable; however, they are often too kind and hospitable. You really have to know what you are doing in Brazil in order to get things done here."

Brazil's Economic and Political Transformations

Brazil's reliance on coffee production led to a sustained period of import substitution industrialization (ISI) following World War II, continuing until the mid-1960s. In an effort to transform the Brazilian economy from one of inflation and debt to that of a diversified capitalist market economy, the military leadership introduced widespread economic reforms in 1964.

The economic reforms simplified the foreign exchange regime, introduced incentives for investment and promoted exports—the result was a sustained period of growth, averaging around 11%, for Brazil's economy between 1968 and 1973. Despite the oil shock of 1973, the Brazilian government continued to back its high growth policies, putting major strain on the country's macro-economic position. Brazil's current account deficit grew from $1.7 billion in 1973, to $12.8 billion in 1980; foreign debt increased from $6.4 billion to $54 billion over the course of the same time period. Debt led growth throughout the 1980s and early 1990s caused inflation, which remained at around 100% throughout the early 1980s, and grew to 1,000% in the mid-1980s before reaching 5,000% in 1993.

Brazil's politics, meanwhile, have been equally erratic. In common with much of Latin America, Brazil bounced between military dictatorships and populist democracies. The election of Fernando Henrique Cardoso in 1995 marked a clear turning point in Brazil's political and economic history. Cardoso's "Plano Real," enacted the year prior to his election, was the first successful political action plan to sustainably combat Brazil's persistent economic challenges of managing external debt and inflation. The core tenets of the Plano Real were to introduce a new currency (the Real) at a relatively high peg to the U.S. dollar, raise interest rates to curb spending, to encourage investment as well as saving, and to curb government spending.

The Plano Real worked wonders. Brazil soon became the darling of the international investment community, stabilized inflation, and entered a sustained period of economic growth. Brazil's economy has averaged GDP growth of 5% per year since the turn of the 21st century. It would appear the country's economic and political instabilities are finally finished.

Following Fernando Henrique Cardoso's successful two terms as president between 1995 and 2003, long-term leftist presidential candidate Luiz Inacio Lula Da Silva was elected as Brazil's president in 2003. He sustained economic growth and political stability throughout his tenure. By electing Lula's chosen successor, Dilma Roussef, in 2010, the Brazilian electorate demonstrated its approval of Lula's ideological direction and stewardship of the national economy. Roussef also received the thumbs up from the mining community. Professor Joao Marini of the Agency for Technological Development of the Brazilian Mineral Industry (ADIMB) spoke for many when he said, "When Dilma wins the election, expect conditions for the mining sector to improve."

The world's largest iron ore complex—Carajas mine, operated by Vale.

The Country of the Future?

Brazil's relatively well-developed and diversified economy was one of the first to enter and then recover from the recent global financial crisis. After a short period of negative economic growth at minus 0.2% in 2009, the Brazilian economy was already forecast a sustained period of strong growth by early 2010. Brazil's vast resource wealth, leadership as a global agricultural producer, industrial strength, emerging services industries and international status—boosted by Brazil's hosting of the 2014 World Cup and 2016 Olympic Games—are all indicative of the increasingly strong position the country will occupy in the global economy.

The Brazilian economy represents more value, in dollar terms, than all of the other South American economies combined. The Brazilian central bank expected GDP growth of 7.3% for 2010, followed by an average 5.5% per year growth from 2011 until 2013. Goldman Sachs predicts the Brazilian economy will become one of the five largest in the world by 2050.

Concerns remain, however, with regard to Brazil's government policies and the ease (or difficulty) of doing business in the country. A bloated public sector and social policies widely regarded as being over generous have put Brazil's macro-economic sustainability at risk and heralded criticism from the international investment community. Brazil's transportation and energy infrastructure, as well as the country's labor force, would all benefit from significant increases in investment from both the private and public sectors in order to raise overall competitiveness. Nevertheless, from a mining perspective, Brazil's vast resource base combined with today's commodity prices render the country a very interesting proposition for any potential investor.

Brazilian Mining Today

Mining in 2008 made up almost 2% of Brazil's GDP, accounting for $23.95 billion. Growth in the sector is phenomenal, and mining is expected to reach an estimated $46.44 billion by 2014. "Between 2000 and 2008, the size of the industry has grown five times," said Marcelo Tunes, director of mining affairs, Brazilian Mining Institute (IBRAM).

Demand for minerals has pushed up the value of Brazil's mineral production, increasing in U.S. dollar terms by 250% between 2000 and 2008. There was a drop of production in 2009, caused by the global economic crisis, but estimates for 2010 reckon that Brazilian mineral production will surpass $35 billion and continue rising 10% to 15% per year.

In 2012, the country is expected to reach the same levels of production and sales as registered before the financial crisis. IBRAM forecasts a total of $54 billion investment for the period 2010-2014. Iron ore is the principal mineral in which the investments will be made, and will account for around 67% of the total.

Mining directly employed 161,000 Brazilians in 2008. Studies carried out by the Geological Survey of Brazil (CPRM) show the mining industry indirectly created about 2 million jobs in 2008, a number which is increasing. New players are coming into the market, including junior mining and exploration companies, and service providers.

Geological Potential

Brazil is the fifth largest country in the world by landmass and hosts the world's sixth largest mining production. "The Brazilian mining sector has enormous geological potential. Most of the country has not been explored," said Miguel Antonio Cedraz Nery, general director, National Department of Mineral Production (DNPM).

In 2009, Brazil received only 3% of the world's total exploration budget in mining. So far only 30% of its territory has been systematically explored using geological mapping. Although its total area is close to seven times that of Peru, Brazil has invested only half of the amount that Peru has in geological surveys.

The Geological Survey of Brazil has indicated that there is a high probability of finding first class poly-metallic deposits—similar to those found in Carajas in the north of the country—especially in the Amazon region. "Brazil is a huge country, similar from a geological point of view to Canada or Australia. The likelihood of finding major tier one assets remains very high," said Professor Marini.

The Amazon region has the potential for major undiscovered mineral resources in addition to the large reserves of (by volume): iron ore, manganese, bauxite, gold and tin. There are, however, concerns about damaging the Amazon rainforest. Much of Brazil's future mineral production will depend on finding new approaches and technologies that permit responsible and sustainable mining that will not harm the environment. If this can be achieved, then according to Marcelo Tunes: "Brazil has the potential to double or triple its current mining production."

Mineral Production

Brazil produces 70 mineral commodities: 21 metals, 45 industrial minerals and four fuels. The South American giant is the second largest producer of iron ore worldwide, with 19% of total global output. After oil, iron ore is the second largest Brazilian export commodity, with China, Japan, Germany, France and Korea the leading importers.

Franklin Feder, president of Alcoa in Latin America and the Caribbean.

Marcelo Tunes, director of mining affairs, Brazilian Mining Institute (IBRAM).

Miguel Cedraz Nery, director of the Department of Mineral Production (DNPM).

João Bosco Silva, chief executive officer of Votorantim.

Brazil is the world's principal producer of niobium, the seventh largest producer of tin and the thirteenth largest gold producer in the world, producing approximately 55 metric tons (mt) of gold in 2008 according to IBRAM. Recent high gold prices have led to new investments in expansion and exploration so that Brazil's gold production will increase significantly.

In 2008, China became Brazil's largest trading partner, surpassing the United States. China's demand for raw materials should continue to be one of the main drivers for the mining sector in 2011 and beyond. Iron ore accounts for 82.6% of all of Brazil's metal exports, followed by gold. The country's main imports are spread fairly evenly among coal (29.6%), potassium (29.09%) and copper (20.9%). Investment projects delayed by the financial crisis have since been restarted, particularly by the industry's leading companies, including Vale, BHP Billiton, Rio Tinto and Barrick. Brazil is keen to attract foreign investment yet complicated regulations, lack of infrastructure, and a limited pool of qualified professionals have slowed the arrival of foreign capital. Investors are further discouraged by the lack of precise geological data for most areas. The Heritage Foundation's Index of Economic Freedom 2009, which measures the overall environment for setting up a business in 183 countries, downgraded Brazil from "moderately free" to "mostly unfree."

The state remains present in many areas of the economy. Businesses are subject to archaic legislation, high credit costs and frequent regulatory changes. Brazil requires large investments in energy and logistical infrastructure. This presents opportunities for investment in the construction and improvement of roads, railroads, pipelines, port and terminals, and waterways as well as in the power infrastructure.

Brazil spends only about 2% of its GDP on infrastructure—a third of what China and Chile spend, and half of what India spends in relation to its GDP. A study by the Brazilian Association of Infrastructure shows that Brazil needs annual investments of $90 billion in logistics and infrastructure to end bottlenecks in the economy. Should this investment not be forthcoming, the country will be unable to maintain its rate of economic growth. Hopes are high that the new president will address these issues. "The recent election of Dilma Rousseff, who was responsible for the mining sector in the previous government, will bring efficient initiatives for the mining industry's development," Tunes said.

Brazil's Mining Market Structure

The Brazilian mining market is dominated by approximately 15 mining companies of both international and domestic origin. Iron ore is by far the most prevalent mineral exported to the international market from Brazil. Vale's pre-eminence in the Brazilian mining sector is expressed by the company's dominance over the iron ore market; representing 80% of total Brazilian production, with CSN, Anglo American, MMX and Samarco making up the shortfall.

Brazil's other leading mineral commodities are also dominated by a relatively small group of mining firms. Mineracao Rio Do Norte, Alcoa and Vale dominate the production of bauxite and alumina. Niobium production is overwhelmingly dominated by CBMM, while manganese production is almost entirely controlled by Vale. Votorantim is Brazil's only producer of zinc, while the company is also responsible for around half of Brazilian nickel production alongside Anglo American Brazil. Brazil's relatively under-developed copper production is dominated by just two companies: Vale

An Interview with the Hon. Marcio Pereira Zimmerman, Minister of Mines and Energy

The mining sector in Brazil was reformed in the 1990s, when the Brazilian market was opened. The ministry has recently decided to reform this sector once again. These reforms will involve three main projects: creating a regulatory agency, reviewing the royalties system, and renewing the regulatory framework.

What needs to be updated in the Brazilian regulatory regime?
We intend to create a national policy council to define mineral policies and a regulatory agency which can contribute to attracting investment in Brazil.

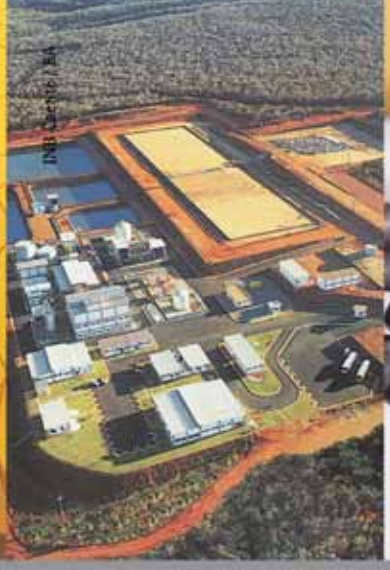
What is the situation of geological mapping in Brazil and how do you hope to improve mapping in the country?
The Brazilian Geological Survey (CPRM) does important work on geological mapping. We already have achieved mapping for the whole country at a scale of 1:1,000,000 and we would like to arrive at a scale of 1:250,000 mapping in the Amazon region and 1:100,000 mapping in the rest of the country.

How do you attract investment across the medium-term?
With geological and aero-geophysical surveys and the new regulatory framework, there will be further private investment in Brazil's mining sector.

What are the challenges for the mining sector regarding the respect of environmental sustainability and relations with local communities?
The emerging global economies such as China, India, South Africa and Brazil have to face the challenge of development with environmental sustainability. The Amazon region has the potential for major undiscovered mineral resources in addition to the large reserves of iron ore, manganese, bauxite, gold and tin. There are, however, concerns over biodiversity in the Amazon rainforest, which comprises 20% of the world's remaining tropical forests and provides shelter to 10% of the earth's plant and animal species as well as removing excess carbon dioxide from the atmosphere.

What are the main projects forecast for the following years?
The state of Para, where the Carajas projects (iron, nickel and copper) are located and the exploration of bauxite and gold in other regions of the Para, has great potential. Many companies are investing in the Amazon region.

What is your message to Engineering & Mining Journal's international readership?
Brazil has a long tradition in the mining industry. We know that modernization of the regulatory framework is an effective way to attract further investment and support the development of the mining industry. International investment is a good sign of development. Brazil has concluded its National Plan of Mining 2030, for the next 20 years to provide this growth.



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and Yamana. Gold production is perhaps the most evenly divided of Brazil's mineral resources, with Anglo Gold Ashanti, Yamana Gold and Kinross representing the major part of supply alongside smaller producers such as Eldorado Gold and Jaguar, as well as *garimpos* settlements in Brazil's more remote regions.

Brazil's *garimpos* are artisan miners, producing outside of the auspices of Brazilian regulations and often regarded as illegal operators. There are major concerns about the environmental impact of practices employed by the *garimpos*, such as the use and subsequent dispersal of mercury into soils and waterways.

Brazil has a long tradition of fostering domestic engineering and services firms, such as Camargo Correa and GeoSol, in engineering and drilling services respectively. International players such as Master Drilling, SRK Consulting, AMEC, Coffey Mining and Ausenco are also present. An interesting recent phenomenon has been the formation of joint ventures and takeovers between established international firms and domestic players, such as the recent merger of Minerconsult and SNC Lavalin, and the agreement between CNEC and Worley Parsons. The combination of international experience and technical expertise, and the local knowledge of Brazilian firms, is widely acknowledged as being extremely effective. The growth forecasts for Brazil's mining industry outlined above are set to further increase international interest from services and engineering companies.

The equipment supply market is more mature than the services sector, with major international players such as Metso established in the country for more than 50 years. From Volvo, Komatsu and Cat, to FLSmidth and Cummins, the vast majority of suppliers can be found in Brazil, many with significant manufacturing capacity on the ground. Agents such as Tracbel and Sotreq for Volvo and Caterpillar respectively have world class service offerings to complement their leading technologies, while suppliers of domestic origin such as Technometal and Rossetti are continuing to grow their market share in Brazil's rapidly expanding equipment supply market place. Although still widely regarded as an emerging market, Brazil boasts an extremely high level of technical standards with regards to the manufacturing and supply of equipment, with numerous international companies such as Siemens and Scania locating parts of their international research and development hubs in the country, alongside groundbreaking local firms such as GEOID, CEMI and Brasfond.

Brazil's Regulatory Framework

Brazil's regulatory regime is particularly complex, with jurisdiction for particular tenets of the approvals process divided between municipal, state and federal levels of government. At a federal level, the three key government agencies responsible for Brazil's mining industry are the Ministry of Mines and Energy, DNPM and CPRM.

Mining in Brazil is governed by the Mining Code (1967). Law number 9314 of the mining code signed in January 1997 states that all mineral exploration licenses are granted by the DNPM, with development concessions issued by the Ministry of Mines and Energy. Under Brazil's 1988 federal constitution, it is stated that all mineral resources are assets of the federal government and that rights to mine such resources are issued in alignment with the Mining Code. All companies formed according to Brazilian law, with headquarters and senior management in Brazil, are eligible to apply for licenses for the exploration and production of Brazilian commodities.

As set out in the 1988 constitution, environmental sustainability is of great importance to the way industrial activity is conducted in Brazil. Environmental regulations in Brazil vary between state authorities, thus having the potential to create confusion and duplication throughout the applications procedure. Essentially, the environmental applications process involves adherence to three separate levels of control. Initially, an environmental impact assessment (EIA) must be completed. Following completion of an EIA, an environmental license (LA) is required to ensure environmental impacts of a particular project are in accordance with the respective environmental regulations of the state in question.

The final regulatory process is the Plan of Recovery of Degraded Materials (PRAD). The PRAD ensures appropriate steps will be taken to ensure an environmentally sustainable approach toward mine decommissioning and the removal of tailings. Brazil's two key environmental regulatory authorities are IBAMA and the Ministry of the Environment.

Throughout 2009 and 2010 there has been ongoing debate regarding a wholesale modernization of Brazil's mining regulatory

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framework, with a view to making Brazil's mining sector more attractive and easier to manage for international investors. Proosals for a complete overhaul have been submitted to congress.

"The Brazilian Government has some priorities in terms of regulatory change," said Claudio Scliar, secretary for Geology, Mining and Mineral Processing. "First, we are undertaking a 20-year national plan of geology and mining and mineral processing. This national plan already exists in other economic sectors, however it is lacking in the field of mining. Second, the government wants to transform the DNPM into an agency that oversees the regulation of the mining sector. The government will also create a National Council of Mineral Policy that will update the outdated Mining Code. Finally, the government is discussing mineral royalties, which need some changes by the ministry. Brazil overall needs a new policy for the mining sector."

The overall consensus is Brazil's new regulatory regime will simplify applications and licensing processes, thus helping to render Brazil a more interesting investment proposition for international firms.

Some key proposals are as follows: A new National Mining Policy Council will be established, headed by the minister of Mines and Energy, reporting directly to the president on matters of policy and strategic direction for the mining industry overall. The government aims to replace the DNPM with a new National Mining Agency. The new agency will incorporate DNPM's present structure, although there will be a clear focus upon recruiting more technical staff. Areas of major mineral interest will be designated and promoted for investment as opposed to the current more arbitrary approach. On top of this, current mining licenses will be replaced by mining contracts with more specific terms, valid for variable periods of up to 35 years. With a view to incentivizing a more concerted move downstream for the mining industry, the royalties' regime will be charged at differential rates, progressively lower for firms that adopt more comprehensive ore processing within their overall production strategy.

Under the new regulatory regime, a number of proposed measures also aim to mitigate the negative impacts and bottlenecks created by speculation in the mining market. Prospective concessions will be awarded under a public bidding process in contrast to the closed shop/first come first served process currently in place. Furthermore, exploration permits will be limited to a maximum, non-renewable period of five years. Permit holders that have not conducted surveys within this period will forfeit their rights to the respective prospects. As opposed to the relatively low, flat rate presently charged for concessions, the annual rate will run on a progressive scale increasing each year the concession is on license.

In a move to further improve Brazil's record on social and environmental performance, a series of adjustments will be made to the regulatory regime, such as holding public hearings for major projects to engage communities, as well as placing discretionary limits on the sizes of particular areas that are allocated to one single company. Finally, a mandatory transitional period will be incorporated within the proposed changes in order to ensure that all companies are provided with a suitable amount of time to adjust to the new regime.

Brazil's Geological Survey

The CPRM has overall responsibility for the geological mapping of Brazil's entire land surface, as well as for compiling a database of prospective regions for potential mineral development. "Essentially, CPRM generates the basic geological information on the 13 million m^2 of Brazilian territory for those interested in investing and developing prospects in Brazil, not limited only to the mining sector," said CPRM President Agamenon Dantas.

Despite being allocated its largest budget ever for 2010, the CPRM's work is generally perceived as being inadequate. There is debate as to who has the precise responsibility for detailed mapping of Brazil's entire land mass and offshore resources. The private sector regards this duty as incumbent upon CPRM, whereas CPRM regards more detailed mapping and exploration activities as the reserve of the private sector. The present status of this debate is viewed by the mining industry as something of an obstacle to increasing international interest and subsequent investment in Brazil's largely unknown geological profile.

The crux of the debate is whether CPRM should prioritize mapping the entire Brazilian land mass, excluding the Amazon at a scale of 100,000:1, or, whether CPRM should focus on narrower, more exciting areas for the mining industry with a view to attracting private investment into the industry. "It is of course the dream for all entrepreneurs for CPRM to carry out detailed mapping of all areas of potential geological interest, but the reality is CPRM's job is to detect areas potentially interesting for min-

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ing and other industries," said Dantas. "It is then up to the private mining sector to undertake more detailed mapping themselves. After all, CPRM does not work only for mining; we have social goals such as locating water sources beyond pure economic development in mind."

Professor Marini disagrees with that approach. "Brazil doesn't have good mapping and geological information for potential investors. Many Brazilian companies are going to work abroad. For example, Vale is investing in Africa, Mongolia and in Peru."

"There is an obvious lack of mapping in Brazil and I believe this is a lack the government should be required to fulfill, in much the same way as happens in Australia, in Canada or in France," said Ricardo Francesconi, director of geological exploration services firm Geoservice.

The ongoing debate surrounding Brazil's geological mapping is far from being resolved. What is clear, however, is Brazil's geology is very much unknown relative to other mining nations. This presents an excellent opportunity for firms with a focus upon exploration to find huge assets in frontier regions such as the Amazon and Northern Minas Gerais State.

The Tax and Royalties Regime

Taxation policy between Brazil's myriad of federal, state and municipal authorities is a matter of complexity. In its most simple terms, taxation varies for mining companies depending upon the region of Brazil they mine in, and the mineral they are mining. Ultimately, all mining companies in Brazil are subject to corporate tax of between 10% and 15%, as well as to the royalties regime—otherwise known as the Compensation for Exploiting Mineral Resources (CFEM). Under the terms of the CFEM, mining companies are liable to pay a maximum of 3% on net sales of mineral assets. Precise percentage ranges vary depending upon which mineral is being extracted and sold. For example, the rate for bauxite and manganese is 3%, iron ore is 2%, and gold is 1%. Royalties are shared between federal, state and municipal authorities, with each receiving 12%, 23% and 65% respectively.

There is speculation that plans are afoot to increase VAT or taxes on exported mineral commodities so as to encourage mining companies to develop downstream capacity as opposed to exporting raw materials to markets such as China and Japan. Given the importance placed upon such industrial policy by Lula, there is tangible concern throughout the industry that newly elected Dilma Roussef will begin pursuing such policies more vigorously following her inauguration in January 2011.

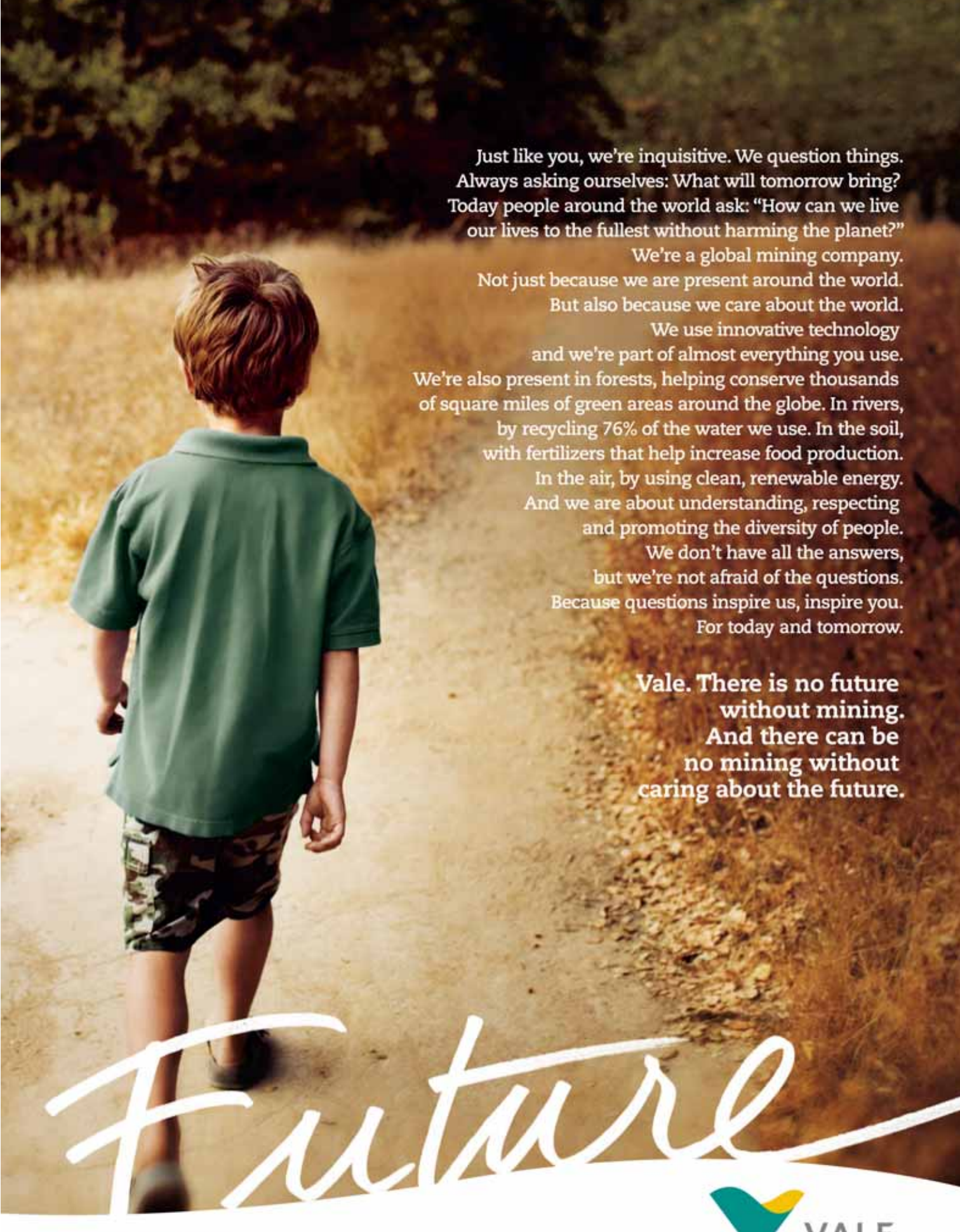
Brazil's 2030 Plan for the Mining Industry

Alongside the Brazilian government's new proposals for regulating the mining industry, a 20-year strategic plan, covering the period 2010 until 2030, has also been tabled to provide a strategic planning tool for the mining industry, putting forward proposals for programs and structuring measures for developing them, according to Fernando Lins, director, Department of Mineral Processing within the Secretariat for Geology, Mining and Mineral Processing.

There is clear impetus in the 2030 plan to provide the Brazilian mining industry with the necessary demand side data to ensure that mineral commodity production in the country is targeted toward meeting domestic demand in a sustainable way. The plan is also directed toward maintaining Brazil's position as one of the leading global suppliers of key resources such as iron ore, manganese and bauxite. In line with recent international trends, the Brazilian mining market is shaping itself toward becoming a global leader in the supply of other bulk commodities, such as potash and phosphate, particularly in view of the country's status as a leading international player in the agricultural industry. Vale's rapid move into phosphate and potash production best underlines this trend.

The 2030 plan has a clear focus on aligning mineral production with Brazil's domestic market potential, sustainably supplying key input materials such as processed aluminum, steel, phosphates and copper to its dynamic domestic market.

On top of the key agenda of targeting Brazilian mineral production far more specifically toward domestic demand, the 2030 plans second fundamental tenet is to move industrial capacity further downstream. As mentioned earlier, the government's downstream agenda has created differences in opinion with major players such as Vale. On the one hand, Brazil's growing labor force and resource base sets the ideal foundation for added value industrial development; however, much industrial development may be nonviable considering the wage differential and infrastructure advantages steel mills and aluminium smelters can leverage in competing economies such as China and South Korea.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and Palladium in the Brazilian Amazon

focus on sustainability and good prospects for investors

mineralization patterns of the various ore types within the Serra Pelada deposit display similar enrichment patterns. The deposit is oxidized to depths of more than 300m. Consequently, sulfides are lacking and gold and PGE's occur mainly as metals and alloys.

The highest grades of gold, platinum and palladium occur in the moderately to steeply dipping parts of the central zone which are up to 150m in vertical extent and in places more than 50m wide.

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Environmental Sustainability and Social Responsibility within Brazil's Mining Industry

Brazil's top mining companies are driving the effort to achieve world-class standards

Brazil's borders encapsulate the vast majority of the Amazon Rainforest: a unique symbol of nature's strength and the focus of attention from Copenhagen to Kyoto. Brazil has adopted some of the most stringent environmental regulations known to the international mining industry and demands the highest possible standards from the dozen or so mining firms that dominate mineral production in the country. Brazil's work in protecting its rainforest sets a good example for the world. "Brazil has an A class mining industry that still has a great deal of development to look forward to. Everyone in Brazil wants to do the right thing," said Helcio Guerra, vice president of AngloGold Ashanti.

Economic growth and integration of the Amazon Region are capable of promoting continuous improvement of the quality of life of its population and are unthinkable without the development of its mineral resources, according to the ADIMB. During the past decades, the mining industry has effectively contributed to the improvement of the living standards of [Amazon] populations, generating new jobs and building infrastructures for the region. The contribution of the mining sector to the sustainable development of that region is relevant and effective. The preservation of the environment is not jeopardized by organized mining activity.

Mining is often perceived as a major threat to eco-systems, however the main threat to today's Amazon rainforest is the agricultural production of commodities such as soybeans and cattle.

Corporate social responsibility and environmental sustainability are the life-blood of Brazil's contemporary mining industry. This is demonstrated by Alcoa's Juruti project in terms of its depth and scale of community engagement and its environmental ambitions. "We will know exactly how unique and successful the Juruti project is in 75 to 100 years from now when the bauxite reserves have been exhausted and we have the opportunity to find out whether the original area has been returned to its original biodiversity and environmental state, and the Juruti municipality has found a path of economic development independent of the Juruti bauxite mine," Feder said. "These two issues are the key metrics this project should be judged by. The municipality of Juruti has approximately 45,000 inhabitants distributed between 180 towns, villages and cities. Thousands of these people were involved in the public consultation process that occurred in the early stages of the project. More than 6,000 were involved in the public consultations that occurred in Juruti city. Alcoa understood from the very beginning that this project would only work if we brought the community together with us into the mine. By concept, the Juruti mine is fully integrated with the local community; there are no fences around the project aside from those areas where individual personal safety would come into question. The schools and infrastructure we are developing are all open to the community. This is by no means an act of philanthropy from Alcoa; the only way this was going to work was if we brought the community along with us.

"Not all of our discussions with the community have been easy," Feder said. "What is most important is we have engaged throughout the entire population and the two major opinion polls we have conducted have demonstrated an overwhelming majority of the local community are in favor of the project. Some older sections of the community are more averse to change and we understand that perspective, however many of the younger people see this as an opportunity to get a job and grow the local economy.

"It has been important for Alcoa to take all of these perspectives into account and build them into our plans," Feder said. "From the outset, Alcoa has engaged with numerous NGOs, resulting in an excellent network of help, assistance and engagement for Alcoa in Juruti. The model Alcoa is operating involves three principles. First, Alcoa is not the municipal government in Juruti; we

don't want to be confused as this. Alcoa's view is that fundamentally it is the local people that are responsible for the development of the region; Alcoa has acted as a catalyst in achieving this. We established a local council with 16 seats for a variety of institutions; Alcoa occupies one of these seats.

"The second key principle involves metrics; how do we measure our success? A series of metrics ranging from how many trees have been felled to adolescent pregnancy rates have been developed for us to better understand Alcoa's impact upon the local communities in Juruti," Feder said. "The Getulio Vargas Foundation has been the key player in developing these metrics, engaging community members to decide what is important for them.

"The third element of Alcoa's approach involves the implementation of a development fund," Feder said. "We are undertaking a process whereby we can train people in determining key requirements, and developing business cases in order to achieve their objectives in realizing such requirements. The bottom line is that this is an experiment and Alcoa is committed to achieving success in the Juruti project."

The focus on environmental sustainability and community engagement in the Brazilian mining industry is led from the top, with major players such as Vale, Votorantim, Ferrous, Alcoa and Yamana at the forefront of the industry's investments in this vital area. Despite a widespread population of *garimperos* throughout Brazil, whose practices are often far from environmentally sustainable, Brazilian mining standards are increasingly regarded as matching those of Australia and Canada. Equipment suppliers and services suppliers such as Metso, Tracbel, Enfil, Coffey, SRK and AMEC also invest significant time and energy in working with local communities, training and development, as well as innovating with the development of more environmentally sustainable technologies such as low impact emissions filters and energy efficient engines.

"Safety and sustainable development issues are recognized as key value drivers within Anglo American," said Stephan Weber, president, Brazilian iron ore, Anglo American. "Anglo American has been included among the top 20 companies for the third year consecutive as an example in sustainability by the Guia Exame de Sustentabilidade. We have also been named to have the safest mine in Brazil by the Brazilian magazine, *Brazil Mineral*.

"Anglo American has one of the best tools for social environmental impact assessment," Weber said. "The Social Economic Assessment Toolbox [SEAT] was developed by Anglo American in 2004 and aims to improve the company's understanding of our socio-economic impacts, whether positive or negative. In 2006, SEAT was considered by the One World Trust as the best tool for social environmental impact assessment globally. It is possible to build a more structured dialogue with stakeholders to create better internal capacity to manage social and environmental issues and advances in terms of transparency and local accountability. SEAT enables us to better understand the concerns, needs and priorities of communities associated with Anglo American's operations. Our commitment to safety and sustainable development includes ensuring that we act consistently across the group in relation to safety, health and the environment. Anglo American works in partnership with NGOs to create development opportunities in the local communities, as well as to invest in education, health and sustainable activities like music school, e-learning projects and social prevention against HIV. Mining can be a source of development for communities living in remote areas."

Brazil's Super Miner: Vale

Established in 1942 by the Brazilian Federal Government as Companhia Vale Do Rio Doce (CVRD), Vale—as the company is now known—influences all levels of Brazil's mining industry. Privatized in 1997, Vale is now positioned as the world's second largest mining company with 2009 revenues of $28.5 billion and a permanent staff of 115,000. While Vale is a diversified mining company with operations ranging from nickel extraction in Canada to potash in Argentina, the company's core revenue driver is the export of iron ore from Brazil, which represents 65% of the company revenues.

Vale is by far and away the world's largest producer of iron ore with an output of 230 million mt/y. Similarly to BHP Billiton and Rio Tinto in the Pilbara, Vale's key to success is the immense infrastructure the company owns with more than 10,000 km of railway lines, 216 locomotives, nine ports and a vast fleet of ships. Almost every single equipment supplier and services company with operations in Brazil has Vale as a major customer. Vale is an omnipresent force throughout Brazil's mining industry.

Vale's lead in Brazilian production is matched by the company's leadership in technological innovation and investment in sustainable practices and technologies. Having recently announced the establishment of the Vale Technology Institute (VTI), the company is in the process of establishing three international research centers throughout Brazil, with a focus on developing new and innovative technologies in the areas of mining, sustainable mining development and renewable energies that will better equip both Vale and the industry in general to overcome the challenges of the future. The VTI represents the largest public-private research partnership ever seen in Brazil.

"The idea is that interaction between the company, universities and government entities will stimulate high-quality domestic scientific output, and therefore make the institutions better able to attract government funds," said Luiz Mello, director, VTI. "This will generate a virtuous cycle that will benefit the whole community."

A recent innovation of particular note is the development of bio-fuel facilities based upon palm oil, planned to transform Vale's entire rail fleet by 2014.

Unsurprisingly for a major Brazilian mining company, corporate social responsibility activities are of huge importance to Vale's overall business model, having invested $900 million in this area in 2009. Underpinning the benefit of mining to regions such as the Amazon, Vale has more than 2 million hectares of forest, equivalent to 3 billion trees under the company's protection. Over the course of the past three years Vale has planted more than 26 million trees.

Described by *The Economist* as "the biggest company you have never heard of," Vale is now starting to emerge from its backyard in Brazil and is making a huge impact upon a diverse range of national mining industries all over the world. Following a $19-billion takeover of Canadian nickel giant Inco, Vale has encountered controversy and strike actions from employees with regard to pay conditions, pensions and the breakdown in negotiations between the company's Brazilian managers and Canada's unions.

Moreover, there is widespread speculation regarding latent tensions between the left leaning leadership of the Brazilian government and Vale's management, whose focus is to maximize overall shareholder value for the New York Stock Exchange listed company. Lula has used both the Brazilian government's 5.6% shareholding and the Brazilian media to pressure Vale to expand its investment program and subsequent job creation within Brazil's borders. Prioritizing national development often runs in direct contradiction to Vale's international agenda.

Vale has consistently rebuffed speculation that the government exerts a major influence on company strategy. Logic would also dictate that the 5.6% government holding is far from enough to consolidate any substantial influence over the direction of the Vale board.

Vale has recently made several successful investments internationally, most notably in Guinea-Conakry's iron ore reserves and Mozambique's coal and logistics industry. Despite rumors to the contrary, the general consensus is that Vale's transition from the biggest company no one has ever heard of to the pinnacle of the world's diversified super major mining company is well under way.

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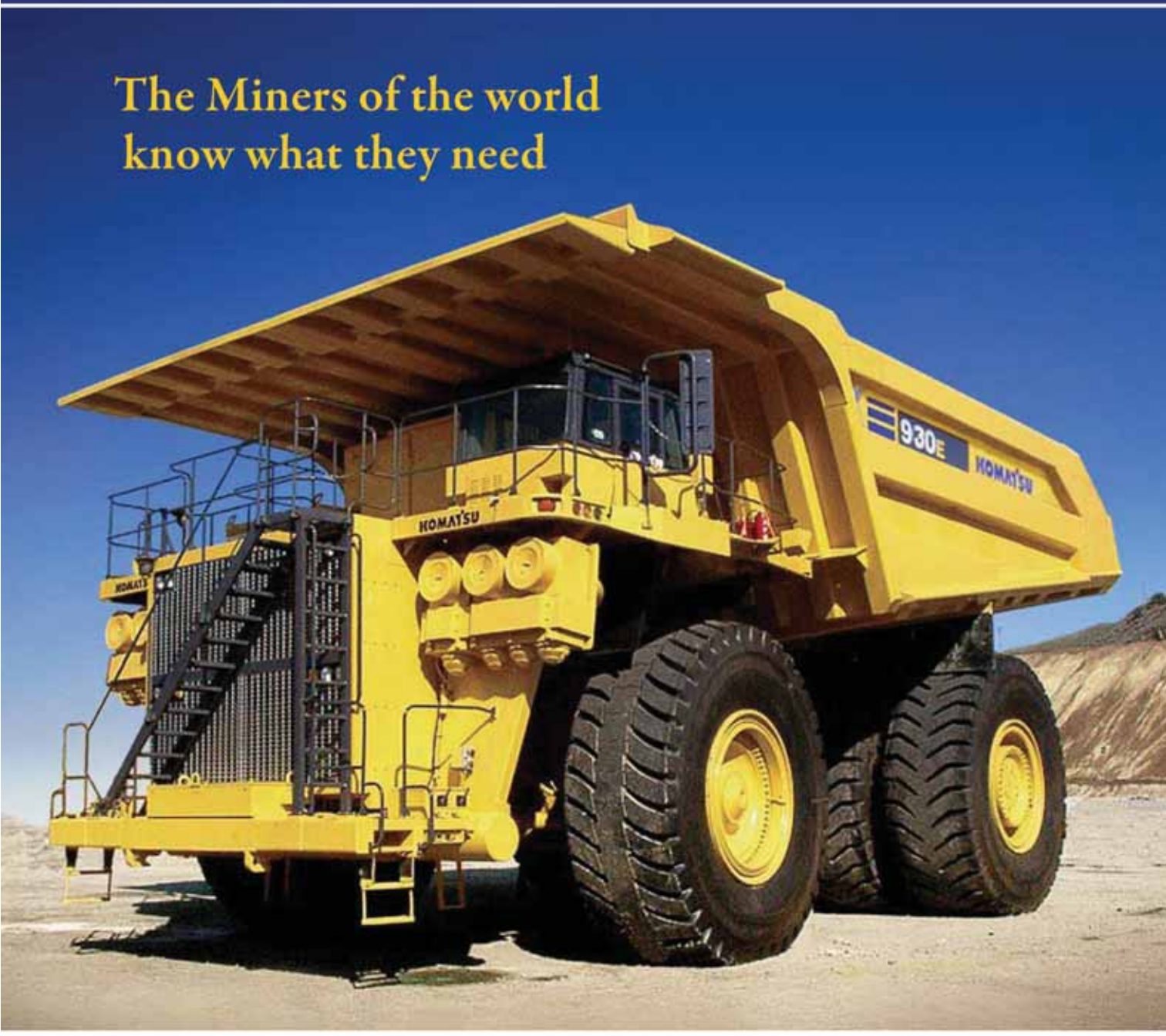

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Key Minerals, Companies and Projects

Brazil produces 70 mineral commodities: 21 metals, 45 industrial minerals and four fuels

Iron Ore

Despite recent turbulence in global financial and commodities markets, iron ore has experienced a significant boom in pricing over recent years as the three iron ore super powers of the world (Vale, Rio Tinto and BHP Billiton) have re-negotiated pricing contracts with their key markets. Having experienced price increases in the region of 100%, from $70 up to more than $160/dry metric ton in today's market, the prospects of iron ore profitability have changed significantly.

Iron ore is the mineral of greatest value to Brazil's mining industry, representing 78% of total mining exports; $16.5 billion of a $22.5 billion industry in 2008. Over-reliance upon the production and export of iron ore to China, the overwhelming driver of demand for Brazil's iron ore, presents an acute risk to the industry. A potential housing bubble in China or a currency revaluation has the potential to suddenly reduce the country's demand for Brazilian iron ore. Despite this risk, Brazilian iron ore producers remain buoyant.

"The Brazilian mining economy is very dependent upon Chinese demand," said Antonio Rigotto, director of operations, Ferrous Resources. "Since the urbanization process in that country has been rapid, internal consumption and industrial production of a vast range of consumer goods will inevitably increase Chinese demand for steel. Consequently, the demand for iron ore is going to be the defining trend in Brazil's mining market for at least the next five years. I expect prices of iron ore to grow by at least 20% over the next 10 years because iron ore demand will outstrip growth in supply. I expect Chinese demand to be a key driver in the Brazilian mining economy for at least the next five years."

As Chinese iron production goes into decline, opportunities for Brazil's iron ore exporters will increase over the medium term.

With combined, measured and indicated reserves of iron ore standing at 26 billion mt, Brazil has the fifth largest iron ore resource globally. Brazil's iron ore is of the highest quality, on a par with that found in Australia's Pilbara region. Hematite—found in the state of Para—averages a 60% grade, while itamirite—found in Minas Gerais state—averages 50% grade. With production standing at 380 million mt in 2008, Brazil ranks as the second largest global producer of iron ore behind China.

Vale is responsible for 79% of Brazil's iron ore output, CSN produces 7%, MMX 3% and others such as Ferrous and Samarco account for the remaining 10%. Brazil's key iron ore producing states are Minas Gerais, which accounts for 71% of output, Para makes up 26%, and others such as Bahia account for the remaining 3%.

In terms of major iron ore projects, Vale's Carajas complex in Para State is the crown jewel of Brazil's iron ore industry and the world's largest iron ore complex. Discovered on July 31, 1967, the Carajas complex of four open cast mines first came into production in 1985 with output of 1 million mt of iron ore. Today, Carajas produces 300,000 mt of iron ore each day. All of the iron ore produced at Carajas is transported along Vale's 892-km railway track to the ports of Itaqui and Ponta Da Madeira for export to international markets.

Inaugurated at the end of 2007, the Carajas Operational Control Center provides total control over operations at the Carajás Mining Complex from one location. The mine operation areas, remote monitoring (telemetry) of equipment's essential systems, the treatment plant and dispatch facilities are all controlled in real time by means of satellites. Images of mine operations can be visualized at any production stage, for example, with available data ranging from macro figures on a given operational area to the amount of material in a crusher. Based on this advanced control system, it is possible to determine the optimal routes from the location the ore is extracted from, to the place where the first stage of beneficiation will take place; or the most efficient combination of equipment required to raise productivity in a given operation. The control system also makes it possible to maximize synergies between mine, plant, dispatch and maintenance operations from a single location. The Operational Control Center is an example of Vale's continued investment in advanced technology, with continuous process improvements involving automation used to achieve operational excellence. New technology also enables a reduction in energy consumption, while raising production capacity and boosting competitiveness in relation to external markets.

In accordance with recent steep increases in the price of iron ore, new investments in this sub-sector of the Brazilian mining industry will represent

Esperança mine is an example of the commitment Ferrous has to the environmental recovery of its mineral assets. (Photo courtesy of Ferrous)

$37 billion over the course of the next five years. MMX is in the process of investing $2.35 billion in its System Minas-Rio which is expected to produce 26.5 million mt by 2011. Rio Tinto will invest $1 billion in its Mina De Corumba, expected to produce 15 million mt/y by 2014. Vale has ambitious plans to double output from the Carajas complex combined with further investments in organic expansion in the Minas Gerais iron ore Quadrangle. Two relatively new entrants into Brazil's iron ore market are Anglo American, with its 2008 purchase of MMX-Minas Rio for $5.5 billion, and domestic firm Ferrous Resources, established in 2007.

The establishment of Ferrous Resources is a reflection of the buoyancy currently surrounds the iron ore sector in Brazil. The company recently invested $2 billion in its flagship Viga project. "Ferrous acquired the Viga mine, located in Congonhas, Minas Gerais, in 2007. The company is in the process of building a pipeline to link the Viga mine with the Espirito Santo coast where Ferrous is going to build a port," said Rigotto. "The pipeline will be 420-km long, with one pumping station, unlike the majority of pipelines in Brazil, which have two pumping stations. In the first phase, from 2013, the pipeline will have the capacity to transport 25 million mt/y of iron ore, while in the second phase, from 2017, the capacity has the potential to expand to 50 million mt/y of ore. The port is situated in a submarine hole, which will be linked onshore by a 5.5-km bridge. The port will be at least 21 m in depth. Ferrous expects to start mine production by the middle of 2013. We plan it to be the largest plant in Brazil, with the country's largest processing plant, even larger than any of those in Carajas mining complex. Ferrous has four other active mine prospects in the state of Minas Gerais and one active prospect in the state of Bahia. For this project, Ferrous is working in partnership with a variety of local companies.

"Ferrous' processing capability enables us to develop a very successful business with relatively low grades of iron ore," Rigotto said. "We are the leading company in Brazil in terms of the development of low grade processing technologies."

Ferrous' plans and ambitions are a positive indicator for the investment potential inherent in Brazil's vast, high quality iron ore resource. The diversification of established international gold miners, such as Eldorado Gold, into iron ore production serves to underline how recent price rises have galvanized a surge of investment in Brazil's leading mining sub-sector.

"Eldorado has bought the Vila Nova mine, located in Amapa State, in the Amazon region," said Lincoln Silva, director, Eldorado Gold. "In May 2010, Eldorado decided to do a trial operation and in June, our first shipment of iron ore begun. Current production is 45,000 mt of final product per month, about 500,000 mt/y."

Manganese

Manganese prices have experienced considerable volatility in recent years, owing to demand fluctuations in major consumer nations such as India and China, as well as price influences associated with the global financial crisis. Prices peaked in 2008 at $302/mt, but currently stand at around $156/mt. Globally, Brazil is the second largest producer of manganese ore, behind South Africa, producing 1.7 million mt in 2010. Brazil currently produces 18% of the 10 million mt of global manganese output. Brazil's combined measured and indicated resources of manganese stand at 566 million mt, 10% of the global total, second only to South Africa's total reserves of 4 billion mt. Brazilian manganese reserves are concentrated in Minas Gerais state with 87% of the total, and Mato Grosso and Para with 6.5% and 4.3% respectively. Exports of Brazilian manganese stood at 2.5 million mt in 2010, key export markets are China and India.

In terms of production, Vale is unrivalled in its dominance over manganese production in Brazil, accounting for some 95% of overall output. The fact that manganese production represents just 2.2% of Vale's business overall offers some insight into the size and scale of the company. Vale's Brazilian manganese output is concentrated in four production complexes distributed throughout the country: the Minas Gerais complex produces approximately 200,000 mt/y alonside the Bahia, Corumba and Mina do Azul complexes.

Brazil's other player in manganese production is Mineracao Buritirama. "Mineração Buritirama S.A. was setup in 1982 with the purpose of mining and commercializing the significant manganese ore reserves of the mine located at Serra de Buritirama, municipality of Marabá in the State of Para," said Director Ricardo

Mining operations have a clear capacity to mitigate deforestation. (Photo courtesy of Mineração Buritirama)

Dequech. "The Buritirama ore body was discovered in 1966. The implementation of the project began in 1992 and finished in January 1994. Total reserves are estimated at 18.4 million mt of high-grade manganese ore. We have a productive capacity of 1 million mt/y of first-class manganese. Buritirama manganese ore may be ranked as metallurgic, with 45% Mn grade, low phosphorous grade and high Mn/Fe ratio. Mineracao Buritirama's manganese is exported mainly to China, but also to Europe and Latin America. About 20% of the production is directed at the Brazilian internal market. Today we have a solid position in the manganese market, supplying five different products."

As steel production in Europe has declined, Brazil's manganese producers have turned their attentions toward emerging Asia. Brazil's vast manganese resource and established status as a key global supplier provides plenty of opportunities for new entrants to come into the market. The key challenges for potential investors to overcome are Brazil's traditional challenges, surrounding logistics and energy infrastructure. Vale's vast logistical network is a key support mechanism for the company's dominance over Brazilian manganese production.

Gold

As uncertainty in the global economy lingers on and gold prices continue to increase beyond records set months and weeks previously, the world's relatively untapped gold mining regions, such as Brazil, have become of increasing interest to a host of domestic and international interests. NYMEX gold prices have increased by almost 500% since 2000, from $250/oz to more than $1,400/oz. Brazilian gold exports have grown alongside price increases to $2 billion in 2010. Gold is now Brazil's second most important mining export after iron ore. "When you look at the fundamentals, internationally things do look positive for gold producers. There is ongoing currency instability, particularly in the U.S. dollar and emerging markets, which is having an increasing impact upon the global market. These trends have seen the global investment community look to gold as a safer asset," said Helcio Guerra, vice president of AngloGold Ashanti.

With gold reserves of 2,000 mt, 4.5% of global ore reserves, Brazil ranks as the sixth most endowed country. Brazil is currently the 13th largest global gold producer with 61 mt of total gold output and accounts for just 2.5% of global production. This output gap represents a significant investment opportunity for new entrants to help bring production into proportion with Brazil's reserves.

Brazil's main gold producing states are Minas Gerais, Goias, Bahia and Para accounting for 64%, 11%, 11% and 3% of overall production respectively. Current production levels are shared between three major firms: AngloGold Ashanti, Yamana Gold and Kinross, each accounting for approximately 25% of output, with smaller firms such as Jaguar Mining and Eldorado Gold making up the remaining share of production. As highlighted previously, Brazilian *garimperos* have significant involvement in national gold production, with 9% of total output.

AngloGold Ashanti is Brazil's leading gold producer with a 2010 output of 500,000 oz between the company's Serra Grande and Brazil Mineracao operations. "Brazil is of significant importance for AngloGold Ashanti's operations moving forward," said Guerra. "The geological poten-

Roger Agnelli, CEO of Vale. (Photo courtesy of Vale)

Helcio Guerra, vice president of AngloGold Ashanti. (Photo courtesy of AngloGold Ashanti)

Ludovico Costa, president and CEO of Yamana Gold. (Photo courtesy of Yamana Gold)

Jones Belther, mineral exploration director of Votorantim. (Photo courtesy of Antonio Larghi)

tial is huge and the business environment for miners is very conducive, particularly in Minas Gerais. Brazil has an excellent culture for mining and the understanding of the mining industry is very strong. Currently, one of the key challenges is the strength of the Real, which makes market conditions for us exporting a dollar denominated commodity quite tough in terms of operational profitability."

In accordance with the company's increasing focus on Brazil, AngloGold Ashanti has expansion plans in place with output set to increase to 700,000 oz/y on the back of a $350 million mine development program in Minas Gerais State. Sustainable practices are integral to AngloGold's strategic approach according to Guerra. "We have a specific environmental sustainability department. AngloGold Ashanti also focuses very heavily upon the development of education in terms of economic development and the maintenance of local cultures in the communities within which we operate. Anglo Gold Ashanti employs a participative approach whereby our local stakeholders decide upon which specific projects are of interest and should be invested in. Engaging at these levels with communities builds your reputation in Brazil, which serves greatly in the long run in terms of having efficient approvals and quality relationships with the regulatory bodies in the country."

Latin America-focused Yamana Gold's global production is increasingly based on the company's Brazilian operations as highlighted by President and COO Ludovico Costa. "Currently, Yamana Gold has six operating sites; three in Brazil, two in Chile and one in Argentina. Brazil currently accounts for around 30% to 35% of Yamana Gold's production. We plan to add three new operations (in Mato Groso, Goiás and Bahia state) in Brazil and one in Mexico in the following years, increasing Brazil's GEO participation to more than 40%. Moreover, Yamana has its exploration department in Brazil, which conducts extensive exploration activity in the country. Yamana has been active in Brazil since 2003 and has built a world class operating and construction team. Since 2003, we have developed significant expertise here that we have actually used for expansion into other parts of Latin America. Our experience has given us significant knowledge regarding the potential mining opportunities in Brazil, and we have built up signifi-

Colossus Minerals' first of many planned projects is unique in Brazil in that the company has negotiated a cooperative working alongside the garimperos' union COOMIGASP in order to complete underground exploration of the Mina Nova Serra Pelada site. (Photo courtesy of Colossus Mining)

cant exploration capacity in four greenstone belts in Brazil. We have made construction decisions at C1 Santa Luz, Ernesto/Pau-a-Pique and Pilar. This will create significant organic production growth after two years in construction. We have made a new exploration discovery at Suruca, which will add only gold production to our existing Chapada mine. According to IBRAM (Brazil's Mining Institute), Brazilian gold production will increase 50% by 2014."

Canadian-based Kinross accounts for the third element of Brazil's tripartite of leading gold producers. The company's flagship Paracatu mine is of particular interest as the world's lowest grade gold mine with just 0.4 g/mt of ore. "From the beginning we thought the Paracatu mine's potential was very high," said Regional Vice President Jose Freire. "However, after conducting a drilling campaign and an exploration campaign to re-evaluate the potential of the operation, we realized the potential was three or four times higher than previously anticipated. Kinross invested $500 million in 2006 and expanded Paracatu's production by three times from 18 million to 61 million tons of ore. The Paracatu operation is relatively cheap, because the amount of hard rock in relation to the amount of ore is low. The deeper we go however, the more costs increase as our efficiency drops. Kinross' goal is to continuously strive to find the best extraction methods, with the aim of maximizing our profitability. Our total recovery is determined by a combination of our floatation and magnetic recovery technologies. Flotation is currently around 82% and iron metal recovery is around 96%. Total overall recovery stands at about 79%. This year Kinross' current production of gold from Paracatu will be around 490,000 oz. Kinross' Brazilian operations account for around 22% of Kinross International's production. Right now the current cost of production is about $500oz; on the whole this is competitive, even if the ore grade is as low as it is. At full capacity, Paracatu will be the largest gold producing mine in Brazil. Kinross is currently building a new processing mill and we have just approved the construction of a fourth mill. Next year we will finish construction of a new tailings dam, which is a huge investment, but will suffice for the entire duration of the life of the mine. Next year we will also increase production to between 492,000 to 550,000 oz; while in 2012 production will reach about 575,000 oz. Kinross expects the life of Paracatu mine to endure for approximately 30 years."

Three emerging gold miners of particular interest in Brazil are Jaguar, Colossus and Eldorado Gold, whose relatively recent entries into Brazil underline the country's immense potential for gold production. "Jaguar Mining started its operations in Brazil in 2006 and is currently producing gold at its Turmalina, Paciência and Caeté operations, which combined produce about 220,000 oz of gold," said COO Lucio Cardoso. "Jaguar's gold operations are located in the Iron Ore Quadrangle region, near the city of Belo Horizonte in the state of Minas Gerais, Brazil. Belo Horizonte serves as the commercial center for Brazil's mining industry, and has excellent infrastructure to support world-class mining operations. The Iron Quadrangle, where Jaguar controls 93,000 acres, is a prolific greenstone belt that has produced significant quantities of gold at competitive costs per ounce from open-pit and large-scale underground mining operations for more than 300 years. However, it remains relatively under-explored compared to the other great greenstone belts around the world, with a relative absence of active junior mining and exploration companies. An encouraging fact about the Iron Ore Quadrangle is the existence of multiple examples of gold resources running to depths exceeding 2,000 m, with similar widths and grades to those seen at shallower depths. This is important to Jaguar because the average depth of its resources is less than 400 m from the surface. The bulk of these resources are open at depth and laterally, giving the potential for substantial discoveries.

"In addition to its activities in the Iron Quadrangle, Jaguar also has plans to develop the Gurupi Project in the state of

Walter De Simoni, CEO Nickel Business of Anglo American Brazil. (Photo courtesy of Anglo American)

Stephan Weber, CEO Iron ore Business of Anglo American Brazil. (Photo courtesy of Anglo American)

Alfredo Tranjan Filho, President of INB - Industrias Nucleares do Brasil. (Photo courtesy of INB)

Maranhão, where it controls 293,000 acres that Jaguar Mining acquired in 2009 from Kinross. Through a joint venture with Xstrata, Jaguar is also engaged in gold exploration at a greenfield site in the state of Ceará covering 182,000 acres; the Pedra Branca Project. Last year we achieved an average cost of $468/oz, while this year we have an estimated cost of production of $750/oz. Over the course of the next few years we expect production of 220,000 oz/y. We intend to consolidate our operations in Minas Gerais and start implementing the Gurupi project. The project is located in the state of Maranhão, Brazil. In May 2010, Jaguar filed a National Instrument (NI) 43-101 compliant pre-feasibility technical report on the Gurupi Project, which was prepared by AMEC. The AMEC pre-feasibility report, which assumes an average gold price of $950/oz and a cut-off grade of 0.3 g/mt of gold, registers an estimate of 65.4 million mt of indicated mineral resources at an average grade of 1.14 g/mt totalling 2.4 million oz. We expect to start production in Gurupi between 2013 and 2014," said Cardoso.

Specialist exploration firm Colossus Minerals is unique in Brazil in that the company has negotiated a cooperative working alongside the Garimperos' union COOMIGASP in order to complete underground exploration of the Mina Nova Serra Pelada site. "The Nova Serra Pelada is located on 100 hectares very close to the pit where the largest *garimpo* in the world is operated," said Colossus Director Luis Celaro. "During the 1990s, the Brazilian government decided to shut down the garimperos due to security reasons. Since then, panners organized in a cooperative known as Coomigasp which developed the dream of once again mining ore in that region. With the support of the Brazilian government, Coomigasp carried out a process to select a mining company that would perform underground exploration, in order to confirm the existence of a commercially exploitable deposit. The cooperative holds the mining rights to operate at the site, in accordance with a document issued by the federal government. Colossus, using its Brazilian technical staff, studied the situation and recommended to the management of the company in Canada that it study the possibility of submitting a proposal for a commercial partnership with Coomigasp, which took place in 2007.

"Having been the only one to make a formal proposal, Colossus was selected by Coomigasp. Beginning at that time, Colossus conducted a series of geological studies in the area of 100 hectares and concluded the deposit could yield an economically viable amount of precious metals, including gold, platinum and palladium. Given these findings, we both formed a joint venture, Serra Pelada Companhia de Desenvolvimento Mineral (SPCDM), who became the holder of the mining rights and is responsible for administration of the Nova Serra Pelada project," said Celaro.

"This was an important step in the history of Colossus. Up until this time, we had only been dedicated to the mineral exploration phase. The implementation of a mining project is a very promising challenge. The geological exploration indicates an ore body in the area of 100 hectares which could produce 3.5 mt of precious metals per year. The first extraction of ores is expected for the middle of 2010. At the moment, SPCDM is progressing with the excavation of the decline and the implantation of the industrial facilities for the beneficiation of ore in that area. Gold, platinum and palladium will be transformed into bars by industrial process in Serra Pelada, something totally unprecedented in that region," said Celaro.

Despite being a very new entrant into Brazil's precious metals industry, Colossus has been quick to embrace Brazil's tradition of investing in the communities. "The Vila de Serra Pelada is a collection of houses made of wood, where sanitation and paved sidewalks exist. The community displays high indices of HIV and child prostitution. Trash collection does not exist, public equipment is damaged and there are no hospitals. When we arrived at the place with a proposal to once again extract ores that could become wealth, Colossus could not ignore the local neediness, so we decided to take an attitude together with regional governments," said Celaro. "The arrival of Colossus in Serra Pelada was considered a milestone in the history of that region and not just because of the future extraction of gold, platinum and palladium, but for the contribution to the restoration of citizenship for these thousands of people."

Vancouver-based Eldorado Gold invested in its most significant gold prospect in July 2010 with the acquisition of Brazauro Resources Corp. "This transaction affirms our commitment to explore and develop the Tocantinzinho project in Para state and provides us with option agreements on two nearby early-stage exploration projects; Agua Branca and Piranhas," said Eldorado Director Lincoln Silva. "The Tocantinzinho project is a granite-hosted disseminated deposit containing 2.1 million oz of gold. At Agua Branca, located approximately 25 km south of Tocantinzinho, 2,000 m of diamond drilling will be completed to test gold anomalies outlined by soil geochemistry surveys. The Piranhas project area contains a very strong gold-in-soil anomaly and extensive areas of garimpo workings, located approximately 15 km west of Tocantinzinho. If Eldorado gets positive results from the Tocantinzinho project, we can begin the pre-feasibility study. We expect to finish the pre-feasibility study by January 2011 and complete the feasibility study in July 2011. The environmental studies should also be finished in September 2011. By the end of next year or early 2012 we can decide whether to undertake construction and start production."

Given the upward macro-economic pressures on the gold price, it is no surprise Brazil is seeing an upsurge in international interest in the country's gold reserves. The relative output gap between output and reserves makes Brazil an extremely attractive location for gold prospecting and mine development.

Bauxite/Alumina

Given the long-term nature of contracts for the supply of bauxite and alumina, Brazilian fluctuations in production have been relatively mild over the course of the past decade, with output steadily increasing from 135 million mt in 2000, to 205 million mt in 2010. Prices have experienced fluctuations with peaks of $35/mt in 2008 and lows of $25/mt in 2010. Exports of Brazilian bauxite in 2010 are forecast to reach 5.9 million mt.

With reserves of bauxite of 3.8 billion mt of a global total of 34 billion mt, Brazil ranks fifth overall globally behind Australia, Guinea-Conakry, Vietnam and Jamaica, with just over 11% of the global total. Brazil is currently the world's third largest producer of bauxite, representing 14% of the global total. Para state dominates bauxite production in Brazil accounting for 85% of overall output, while Minas Gerais produces the country's remainder. Mineracao Rio Do Norte accounts for 68% of Brazil's bauxite, followed by Norsk Hydro and Votorantim with 12% and 8% respectively. In May 2010, Norwegian based aluminium producer Norsk Hydro acquired all of Vale's bauxite and aluminium activities in a $4.9 billion deal representing the largest single foreign direct investment into Brazil's alumina and bauxite industry for the year 2010.

Mineracao Rio Do Norte (MRN), a consortium of major bauxite producers operating out of the Oriximina municipality in Para state, overwhelmingly dominates Brazilian bauxite production. With key shareholders such as Norsk Hydro, Alcoa, Rio Tinto, Votorantim and BHP Billiton, the firm boasts world-class expertise in possibly the most geographically challenging location for a mining operation in the world. Deep in the Amazon Rainforest, MRN's operational site is serviced by its own airport, rail infrastructure and ports.

Established in 1974, MRN has worked hard to integrate the company's operations with the sustainable development of local communities, investing in widespread reforestation initiatives and the Quality of

Mining operations in the world's most remote regions are common in Brazil. (Photo courtesy of Alcoa)

Life Program (PQV) which aims to raise health and educational standards for the communities of North West Para state.

Alcoa's Juruti project is the most recent major investment in Brazilian bauxite production. "Juruti first started production in 2009. After one year, we are at an approximate annual rate of 3 million mt. We will remain at this level of output for the foreseeable future. All of our bauxite output is shipped to our smelter at the Port of San Luiz in the state of Maranhão. The infrastructure that we have in place is capable of ramping up significantly; however at this stage we are stabilizing production at between 3 and 3.5 million mt/y of bauxite," said Alcoa Brazil's President, Franklin Feder.

Tin

Tin prices have increased significantly over the course of the past decade, from $5,429/mt in 2001, to $26,700/mt in 2010. Despite such steep increases, Brazilian production has remained relatively flat over the same period, averaging approximately 300,000 mt/y. Brazil's tin reserves account for 11% of the global total, placing the country fifth in terms of its share of global tin reserves. Brazil's key tin producing states are Amazonas and Rondonia, accounting for 60% and 40% of total national output respectively.

Mineracao Taboca is Brazil's leading producer of tin, working the company's flagship Pitinga mine in the Amazon. Pitinga has suffered from a scale-down in production recently as Mineracao Taboca aims to modernize the operation and bring the company's depreciated capital stock back up to optimal standards. "The Pitinga mine started its development in the 1960s. The production of tin started several years later," said Mineracao Taboca President Joao Luiz Serafim da Silva. "In the 1980s, the company was sold by the founders to a group of investors led by investment funds. In 2008, a Peruvian family group bought the Pitinga mine from Paranapanema. The company has suffered from some decisions taken in the past and has got multiple asset and maintenance issues, including the poor status of equipment. In 2009, we decided to reduce output, step back and produce only out of tailings and take some time to refurbish our equipment. Currently we are processing tailings and rebuilding the whole plant in order to modernize the operation. We hope to restart the mine's production from hard

rock in 2012. We expect to increase production by five times in the next couple of years. Pitinga is the key project for Mineracao Taboca in Brazil for the next few years. We produce multiple minerals in the mine but mainly tin and an alloy of niobium and tantalum."

Zinc

Following a significant dip in 2008 resultant from the global financial crisis, zinc prices have recovered from their 2008 low of $1,090/mt, stabilizing at $2,350/mt in 2010. Brazil's 6 million mt of total global zinc reserves account for roughly 3% of global total reserves. China and Australia account for the largest global zinc reserves, accounting for 16.5% and 10.5% of total respectively. Brazil is currently ranked as the 12th largest global producer of zinc with output of 175,000 mt of concentrate in 2010, accounting for 1.5% of total global output. Minas Gerais state is the sole zinc producing region in Brazil occupying 88% of the country's total reserves.

Through its wholly-owned subsidiary CIA Mineira de Metais, Brazilian conglomerate Votorantim is the only producer of zinc in Brazil. "Votorantim Metals is the largest producer of zinc in Latin America and is among the three largest worldwide," said Votorantim President Joao Bosco Silva. "In 2010, its productive capacity reached 706,000 mt/y. The zinc business unit began in 1956, with the establishment of the Mineira Minerals Co. in Três Marias, Minas Gerais. In 2002, it acquired the Paraibuna Metals Co., housed in Juiz de Fora, also in the state of Minas Gerais. In 2004, Votorantim Metals took control of its first unit outside of Brazil. The acquisition of the Cajamarquilla Zinc Refinery in Peru is a reflection of a new growth strategy for the group, which intends to increase its activities in Latin America. In Peru, we have a total of $15 billion and participation in a mining company called Milpo Minerals Co., Peru's fourth largest zinc mining corporation, which we currently control entirely. Votorantim's Caquamarquilla project in Peru has just been expanded with an investment of $500 milion."

Nickel

Volatility has been rife for nickel prices over the past five years, peaking at US$ 33,500/mt in 2006 before falling to a recent low of $11,000/mt in 2008. Currently, they appear to be more stable at an average price of $24,105/mt in 2010. Brazilian nickel reserves stand at 9 million mt, representing 6.6% of the global total of 144 million mt. With annual production of 74,000 mt in 2010, Brazil is ranked as the world's 10th largest nickel producer. Brazil's key nickel producing states are Bahia, Goias and Minas Gerais, accounting for 46%, 42% and 12% of total output respectively.

Brazil's nickel production is dominated by Votorantim and Anglo American who account for approximately 60% and 40% respectively of overall Brazilian nickel output. However, as new investments come on stream from companies such as Vale and Mirabella, it is widely expected Brazilian nickel production to reach 200,000 mt/y by the end of 2011.

"Votorantim Metals is currently the largest Brazilian producer of nickel and Latin America's only producer of electrolytic nickel, with a capacity of 44,000 mt/y," said Joao Bosco Silva. "This unit began operations in 1981. The mining area of this business unit is located in Niquelândia (Goiás), where laterite nickel is mined and nickel carbonate is produced. These products supply a metallurgical plant located in the neighbourhood of São Miguel Paulista, São Paulo. This unit manufactures electrolytic nickel and cobalt. In Fortaleza de Minas, Votorantim Metals produces nickel for the international market." Votorantim recently invested in upgrades on the company's Niquelândia plant in order to increase production from 27,000 to 37,000 mt/y.

Anglo American's Codemin project has been in operation since 1982 and currently produces approximately 9,500 mt/y of nickel. Anglo American is investing $1.5 billion in its Barro Alto project with a view to significantly raising the firm's overall Brazilian nickel production. "The Barro Alto project is located in the state of Goias, approximately 170 km from Anglo American's existing Codemin nickel operation," said Walter De Simoni, CEO Nickel Business of Anglo American. "The project was approved in December 2006 and is forecast to come into production in the first quarter of 2011. Average production over the 32-year life of mine will be at 36,000

Anglo American's Barro Alto nickel mine. (Photo courtesy of Anglo American)

mt/y of nickel. Once at full production, the operation is expected to be in the lower half of the cash cost curve, and will more than double Anglo American's nickel production. Anglo American will complete the conceptual study by the middle of 2011 for our Jacaré project in Para state. And after that, the pre-feasibility and the feasibility study. Nickel demand is expected to have a CAGR of 5% up to 2015. By 2011 Anglo American will be producing more than 60,000 mt of nickel. Anglo American is also conducting the feasibility study of the Morro Sem Bone nickel project."

Vale's recent acquisition of major Canadian nickel producer Inco has catapulted the company into second position as the world's largest nickel producing company behind Norilsk of Russia. Vale has begun an investment program of organic growth in its Brazilian nickel producing capacity. The Onca Puma project represents a total investment of $2.3 billion and is expected to deliver annual output of 58,000 mt/y when it comes online in the first quarter of 2011.

Mirabela is a relatively new entrant into Brazil's mining industry, first tendering for the Bahia based Santa Rita project in 2005. "The Santa Rita project was discovered in 2004 by CBPM, following which a tender was issued and subsequently won by Mirabela. Santa Rita is a record breaking project—discovery to first nickel production was achieved in just five years, compared to the normal timeframe of 10 years," said Mirabela Director Luiz Nepomuceno. "It is also important to note Mirabela had to contend with the disruptions caused by the global financial crisis during the development period. I think the main point was how efficiently we were able to work with the state government in getting environmental licenses and studies completed. This was a huge contributing factor to our successful project development.

"Mirabela has the flexibility to get things done quickly. The Santa Rita mine is the largest nickel sulphide mine in Brazil, and the second largest open-pit nickel mine in the Americas behind Inco of Canada, so we are obviously very excited about delivering the full potential of this deposit," said Nepomuceno. "Currently, the Santa Rita mine is aiming to produce around 10,000 mt of nickel concentrate for 2010. We expect the mine to achieve full production by the end of 2011 of between 23,000-25,000 mt of nickel con-

Votorantim's Juiz de Fora mining operation. (Photo courtesy of Votorantim)

centrate on an annualized basis. I think the fact the Santa Rita project was brought into production in five years demonstrates that Brazil has a very good environment for the development of mining activities. Environmental and construction licenses are critical for any mining project in Brazil and you have to work closely with, and have the support of the government when undertaking these plans. We have found the state government of Bahia is a very friendly authority to work with."

Uranium

Uranium prices have increased seven fold over the past decade, jumping from $7/lb in 2000 to $48/lb in 2010. Brazilian reserves of uranium are currently ranked seventh globally with 310,000 mt accounting for 7% of the global total. With production of 390 mt in 2010, Brazil is ranked as the world's twelfth largest uranium producer behind international uranium powerhouses such as Kazakhstan and Canada. Global demand for uranium currently stands at 67,000 mt/y, however this figure is widely expected to double by 2030.

The Brazilian uranium industry is a monopoly under the control of Industrias Nucleares de Brazil (INB). "Brazil has the seventh largest deposit of Uranium in the world, despite the fact that only 30% of Brazilian territory has been explored," said President of INB, Alfredo Tranjan. "There are 310,000 mt of known reserves, beyond that, there are a further 300,000 mt we strongly believe to exist in two deposits in the states of Pará and Amazonas. Even beyond that, given the similarities of Brazilian soil and terrain to, for example, Australia, there are a possible further 500,000 mt of uranium ore that could be explored. We are looking at a total of approximately 1.1 million mt, which would place Brazil securely as having the world's second or third largest uranium reserves.

"We are focusing on the opportunities presented by international trade, since Brazilian production far exceeds the needs of the domestic population. Most significant is, perhaps, the exploration model we have already initiated with Galvani Mineração, a major Phosphate producer in which we buy the Uranium by-product created from the excavation of phosphate that would otherwise go unused," said Tranjan.

"Today Brazil is getting rich through technological innovation, and we own the technology for all of the steps in the production of nuclear energy. The problem is that the use of uranium as fuel has a limited shelf life, and will eventually be substituted as new technology creates other sources of energy that are more feasible. From Brazil's perspective, if this shift happens before all of the country's Uranium is explored, we will have lost a massive opportunity. It is important, then, to increase exploration and production as soon as possible, so that the end of the need for uranium coincides with the end of Brazilian explorable uranium itself," said Tranjan.

"INB's main impediment to growth is due to a political conviction that Brazil does not produce enough Uranium to satisfy national demand. This idea must be overcome; Brazil dominates the production cycle, which few countries internationally do, and we produce more than enough Uranium to meet our growing national demands. We hope INB will be able to export its product. We plan on entering the international export market within the next four years, be it during exploration or at different phases of

production. As far as uranium is concerned, Latin American Reserves are Brazilian reserves and there is a big interest on the part of MERCOSUR to create some continental integration based on a strategy of creating mutually beneficial partnerships."

Niobium

Niobium prices have almost doubled over the course of the past decade, increasing from $13,197/mt in 2001, to $23,091/mt in 2010. Brazil's 5.2 million mt of niobium represent more than 90% of the global known total of 5.7 million mt. Given the above figures, Brazil dominates global niobium production accounting for 80,000 of the 83,000 mt produced in 2010. Brazil's key niobium producing regions are Minas Gerais, Goias and Amazonas, each accounting for 57%, 42% and 1% of national production respectively.

Three companies effectively control the Brazilian niobium productive sub-sector. Companhia Brasileira de Metalurgia e Mineração (CBMM) accounted for 60% of production in 2010, while Anglo American and Mineracao Taboca accounted for 21% and 12% of output respectively. CBMM, a predominantly family-owned business with minor participations owned by U.S. company Unocal and the Minas Gerais state, sells more niobium or niobium-derived products than the rest of its competitors together.

From Chapada mine, Yamana sells copper concentrate to Hindalco (India) and Atlantic Copper (Spain), as well as to Trafigura, Louis Dreyfus (trade companies) and Paranapanema in the domestic market. (Photo courtesy of Yamana Gold)

CBMM owns the world's largest deposit of pyrochlore, the most important mineral for niobium extraction and production. This mine, located at Araxá, in Minas Gerais State (Brazil), is operated as an open-pit, without much need for drilling or explosives and its production supplies between 65% and 70% of the world demand for niobium products. China is the world's largest producer of steel, and therefore the single-largest consumer of niobium. Brazil has the world's largest reserves of niobium.

AngloGold Ashanti's Gold operations are set to grow significantly in Brazil. (Photo courtesy of AngloGold Ashanti)

Potassium and Phosphate

Potassium prices have more than doubled in recent years, increasing from $144/mt in 2004 to $374/mt in 2010. Brazil occupies seventh position in terms of total potassium reserves with 284.7 million mt representing 1.6% of total global reserves. Brazilian potassium production accounted for approximately 500,000 mt in 2010, placing the country in ninth position amongst global producers.

Global prices of phosphate rock have somewhat levelled out from peaks of $192/mt in 2008, coming back down to US$95/mt in 2010. Brazil's 319 million mt of phosphate rock reserves ranks the country in 12th position globally, accounting for 0.6% of total reserves. Brazilian phosphate rock production accounted for 6 million mt in 2010, positioning the country in sixth position with 4.3% of overall global output.

Brazil's status as one of the world's leading agricultural producers of everything from cattle to coffee, has positioned the country as one of the key global swing markets for fertilizers. Despite Brazil's strength in phosphate and potassium reserves, the country still relies upon imports for fertilizer inputs into the agricultural industries. This reality has not been overlooked by Vale. The company has made major strategic inroads into the fertilizer industry during 2010 with acquisitions of major producers Bunge and Fosfertil. The establishment of Vale Fertlizantes has emphatically set out the company's strategic ambitions for diversification into the growing strategic importance of fertilizer producing raw materials such as potassium and phosphates.

"Following the privatization of Vale in 1997, the company has had a specific policy of diversification. Vale has been operat-

ing a potash mine in Brazil since 1992 and with the development of the phosphate mine in Per, we have established a solid platform for growth supported by the excellent fundamentals in the fertilizer industry," said Vale Fertilizante's Operations Director Ruben Fernandes. "This is an area where Vale is now working to achieve critical mass. Brazil has a huge demand for fertilizers with two harvests a year, plenty of arable land and the country's favorable conditions for agriculture. The market for fertilizers also has a very different cycle if you compare it to iron ore or base metals. Fertilizers are related to food, whereas metals are related to heavy industry. As a result our risk is minimized when you consider the fluctuations in economic cycles. This has led Vale into the acquisitions of Bunge and Fosfertil. Vale has no interest in producing fertilizers as such; the company's interest is in providing the raw materials for these industries. We will go as far as producing MAP, TSP or SSP, which are the basic fertilizers for the blenders; we don't want to become a blender.

"Vale also has fertilizer operations in Peru, Argentina and Mozambique. In five years from now Vale Fertlizantes expects to be one of the world's top three fertilizer companies. We aim to produce 12 million mt/y of potash and 16 million mt/y of phosphate rock. Iron ore will always be Vale's main business; however we genuinely believe that fertilizers will be Vale's second business in the near future."

Copper

Despite a dip in the copper price throughout the most serious period of the global financial crisis, the price has increased many times over in the past decade from lows of $1,500/mt in 2001 to highs such as $8,400/mt in 2010. Brazil's 15 million mt of copper account for 2% of the global total and copper output in the country ranks fourteenth overall globally with 230,000 mt in 2010. Brazil's major copper producing states are Para, Bahia and Goias accounting for 60%, 20% and 20% of overall output respectively.

CVRD started producing copper at Sossego, near Carajas in northern Brazil in mid-2004. Currently, the company has four more copper projects and expects the Salobo project to produce 200,000 mt/y of copper metal over 30 years. Vale dominates copper production, accounting for 57% of total output in 2010, followed by Yamana and Mineracao Caraiba with 25% and 14% respectively over the course of the same timeframe.

No major new copper mines are expected to come on stream through 2012 and existing mines are aging, meaning that ore grades continue to fall. Meanwhile, copper consumption continues to grow at an expected increase of 4.6% worldwide in 2011. The growth in world usage is largely due to growing consumption in Japan, the EU, Brazil, India, Korea and Taiwan. According to the non-ferrous metals association Sindicel, copper consumption is expected to rise in Brazil too. Geraldo Haenel, president of the Brazilian Copper Association has forecast copper metal's growth will be stronger than that of copper products. Haenel, CEO of the Paranapanema non-ferrous metals group, added production capacity of refined products—copper wires, cables and brass—increase at a slower rate. Paranapanema owns Caraiba Metais, Brazil's only copper smelter.

However, construction works for the upcoming 2014 Football World Cup and the 2016 Olympics will actively boost the demand for copper products.

Brazil's Services and Equipment Supply Chain

The nation's abundant mineral resources have drawn major international investor interest, but lack of infrastructure is hindering development

Until the turn of the century, Brazil was dismissed as a market of low importance by the majority of mining equipment suppliers. Today, in accordance with Brazil's status as a powerhouse for the production of mineral commodities such as iron ore, the country is considered to be of vital strategic importance. "Brazil's mining industry offers a profound set of opportunities that companies such as Atlas Copco have to be involved in," said Paulo Almeida, general manager of Atlas Copco.

According to the Brazilian Machinery and Equipment Association (ABIMAQ), overall machinery manufacturing and equipment supply throughout Brazilian industry accounts for $80 billion per year in revenues, 245,000 jobs and 4,000 companies.

The healthy outlook of Brazil's mining industry sets an excellent motivation for further expansion in both domestic and international firms supplying specialist equipment. "I believe Brazil's GDP will grow by approximately 10% to 11% in the next year," said Aurelio De Paula, president of medium-scale manufacturer Majestic. "We now have a very stable economy, a growing consumer population as well as strong agricultural and industrial bases, on top of the obvious wealth in raw materials. This progress is the main reason why so many international companies have started to focus on Brazilian growth."

The Brazil Cost

The Brazilian economy is currently ranked as the eleventh largest capital goods producing market globally, but has slipped from its position of fourth place 40 years ago. This decline can in part be attributed to a general trend in Brazil's capital goods market, increasingly apparent since 2005: the expanding choice of Asian imports and the declining domestic industrial base in Brazil. The key reason for domestic decline is known by ABIMAQ as the "Brazil Cost," whereby Brazil is rated as 44% less competitive for the manufacturing of capital goods than leading global suppliers Germany and the United States. The country's relatively under-developed infrastructure, which places inflationary pressures on input costs throughout the supply chain is a key contributor to the 'Brazil Cost,' as are high rates of taxation and the extremely unfavorable exchange rate for domestic producers competing internationally.

Commercial lending rates from state owned banks in Brazil are some of the highest in the world for a major economy, with collateral requirements of up to 130%. In short, Brazil's domestic business environment is prohibitive to industrial manufacturing. International imports from China are rated by ABIMAQ as high as 100% more competitive.

"Companies operating in Brazil are progressively moving production abroad to cut costs," said Marcelus Geraldo de Araujo, president of Tecnometal. "Brazilian companies in particular suffer competition from cheap Chinese products, which have the advantage of an artificially undervalued currency."

Despite Brazil having a very high tax regime for imports into the country, the current competitive disparity domestic manufacturers have to endure is poised to set a trend of deindustrialization, and the mining industry is increasingly looking externally for capital goods input into the industry.

From an investment perspective, this trend leaves the door wide open for capital goods importers who want to move into Brazil's vibrant mining market. Given forecast rates of growth for the Brazilian mining sector, as well as the present pressures on lead times for delivery, the Brazilian mining market presents extraordinary opportunities for international investors and suppliers. The strength of the Brazilian real renders importing into the Brazilian market from international sources an attractive proposition.

Infrastructure capacity remains one of the key challenges for mining operators in Brazil. (Photo courtesy of Alcoa)

Infrastructure and Staffing

The familiar themes of Brazil's deficits in infrastructure, affordable energy and qualified labor continue to be the main inhibiting factors on the market's growth. "The Brazilian market lacks professional human resources. Since demand is very high, there is strong competition to find qualified professionals," said Sandvik's Regional Manager Victor Becattini. "To overcome this, we finance training projects for our employees. A lack of infrastructure in Brazil increases the import prices of machines, and the delivery times to our clients. This problem is common amongst our competitors as well."

It is important both new and established firms focus on sustainable investment in Brazil in order to maintain supply of key inputs such as qualified staff, as well as thinking strategically and innovatively in terms of how to overcome business critical challenges associated with transportation and energy infrastructure. Brazil's mining industry is in the midst of a period of extraordinarily high demand for fixed capital inputs, and it is vital for companies competing in the market to innovate in any possible way that will give them a cutting edge over their counterparts operating in the market.

Dante De Matos, country manager of relatively new entrant into the market, Outotec, underlines the industry view regarding people and infrastructure in Brazil: "The fundamental challenge in Brazil is the lack of well trained and skilled people, due to the boom of the industry and the consequent high demand for trained professionals. There is huge demand for mining, metallurgical and civil engineers. Brazil also lacks infrastructure and pipelines to transport people, material and goods. In order to be competitive you need to have good professionals that can contribute with both engineering and technical capacities."

Despite the range of challenges presented to major capital goods suppliers operating in Brazil's mining market, the industry remains very competitive. This is largely down to the existence of a culture of innovation rarely found in emerging markets. The consensus among Brazil's business leaders is that the challenging environment has helped to galvanize an operational culture of patience and adaptability and stimulated some world leading companies in terms of their design and engineering capacity.

Brazil's increasingly stringent environmental regulations are another driving force for innovation in the national engineering and manufacturing industries. Established in 1994, environmental solutions provider Enfil is becoming an increasingly recognised international player. Enfil Director Franco Castellani Tabani attributes this success to sustained investment in research and development. "The technologies applied to the systems offered by Enfil arise from years dedicated to research and development, applied to hundreds of systems the company has supplied throughout the mining industry. Enfil has a proven track record of efficiency for the development of equipment and systems for the atmospheric control of water and liquid effluents treatment. Enfil develops its own technology as well as collaborating with international consultancies, in order to

develop the most innovative technologies available on the global stage."

Outsiders are often surprised by the confidence Brazilian firms have in their ability to innovate. Negotiating the myriads of sophisticated administrative and other hurdles that Brazil throws in their path gives Brazilian businessmen an entrepreneurial attitude and excellent problem solving skills. Companies such as Enfil demonstrate Brazil is not simply an emerging market with huge potential, but also a focal point for the development of new and interesting technologies designed to help overcome many of the mining industry's 21st century challenges.

Marcelo Ribeiro, managing director of Sotreq S.A. (Photo courtesy of Sotreq)

Luiz Gustavo, vice president of Tracbel. (Photo courtesy of Tracbel)

Alexandre Reis, marketing and sales director, SEW Eurodrive Brazil. (Photo courtesy of SEW)

Innovation in Heavy Industry and Capital Goods

The capital goods market structure in Brazil is mature, and many of the world's largest mining equipment suppliers—Caterpillar, Metso, Liebherr, Volvo, Atlas Copco, ESCO and SEW Eurodrive—are well established, some with large manufacturing bases in the country. On top of this, technologically advanced Brazilian firms also have a strong presence: Technometal, SEMCO, CEMI, GEOID and Enfil lead the industry in areas as diverse as plant automation systems, information technology systems and environmental equipment. Both in its breadth and depth, the Brazilian equipment supply market is vast. Of particular note are Brazil's world class equipment supply agents such as Tracbel and Sotreq, representing Volvo and Caterpillar respectively, whose range of additional services are as comprehensive as any seen throughout the international mining industry.

The presence of the major international mining equipment suppliers in Brazil's mining sector ensures the technological quality of the products on offer is beyond reproach. Competitive advantage is therefore often based on the additional services a given company is able to offer. This conceptual approach has lead to equipment suppliers also providing engineers throughout Brazil's

major mining sites, conducting maintenance and training activities. "Sotreq's mining division is very keen on the TCO concept whereby we minimize the total cost of ownership for our customers," said Marcello Ribeiro, managing director of Caterpillar supplier Sotreq's mining division. "Sotreq's fundamental concept is to maintain the machines we sell with a high level of availability, in the long term we benchmark at between 85% and 90% availability for our customers. We obviously have to have some downtime for maintenance however, the whole business is geared up toward ensuring the minimum downtime and maximum efficiency usage for our customers. This is best demonstrated by the near 1,000 employees we have distributed throughout our customers' operational sites providing maintenance, training and logistics, 24 hours a day, seven days per week, as well as various other services."

The support service focused-nature of the Brazilian mining market's heavy capital goods equipment supply industry has led to numerous technological innovations. Sotreq uses satellite technology in order to monitor its machines' performance on respective mine sites throughout the country; Volvo supply agent Tracbel, has developed its own software platform in order to improve the company's service offering. "Tracbel Volvo uses a software package called Matrix, which manages our machines' operations, allowing us to follow our operators and track efficiency," said Tracbel Vice President Luiz Gustavo Rocha. "For example, with MMX we take care of their machines in terms of maintenance and productivity, ensuring they work 90% to 92% of their capacity per week at the lowest possible fuel consumption. Our engineers are always situated at our customers' mine sites, supporting the operations in terms of technical assistance and maintenance."

The increased emphasis on additional services extends to multinational firms operating in Brazil. Swedish company Scania, which has been present in Brazil for more than 50 years, is gearing its operation toward the provision of more services, according to General Director Marcos Cesar Arantes. "In the next five years, Scania intends to develop its services' segment in order to provide the best possible solutions for our clients. Scania offers to its clients in Brazil the same level of service and training that you would find in Europe. This is the

Ferrous' ambition is to become the world's fifth largest iron ore producer by 2015. (Photo courtesy of Ferrous)

SEW Eurodrive has invested significantly in expanding its Brazilian manufacturing capability. (Photo courtesy of SEW Eurodrive)

key point of competition for equipment suppliers to be successful in the Brazilian mining industry."

The growing physical presence of suppliers on mine sites, directly interacting, and working in partnership with their clients to understand their needs, is testament to the services available. While Brazilian equipment suppliers are under significant price pressures from international competitors competing on price differential, their service offering has grown exponentially in importance in terms of maintaining competitiveness over the entire product life-cycle for major capital goods such as plant infrastructure. "Polysius provides a range of complementary services such as spare parts supply, erection, commissioning and start up supervision for plants. Besides that we also do training on issues such as safety, efficiency as well as many of the technical aspects of our equipment. Being prepared to offer a full range of services to our customers provides our business with a significantly more attractive proposition to the Brazilian mining market. Polysius is prepared to embed staff within operations in order to ensure our products are used to their maximum potential," said Flavio Hanek of Polysius Thyssen Krupp.

As with many of the world's most mature mining markets, the increasing focus of Brazil's suppliers is to provide an all-encompassing end-to-end service to its customer base. Given forecast growth in Brazil's mining industry over the course of the next five years at least, there is huge potential for established players to expand their operations and for new entrants to join the market. Brazil's 2030 industrial plan also provides plenty of opportunity for specialist firms able to deliver advanced processing plants to sustain the strategic move downstream for Brazil's mining industry.

"Mining in the short term can give you an enormous return on investment," said Dante De Matos of Outotec. "I believe in the long run, the Brazilian mining industry should capitalize to sell more manufactured products. For that the engagement of both federal and state governments together with the local industry executives is of paramount importance in order to secure a smooth balance between demand, local development and participation of foreign suppliers in the industrial goods chain of Brazil. We truly believe the market is strong and big enough to accommodate demands and aspirations of all these players."

Brazil as a Manufacturing Base

Both domestic firms and international investors are gearing up their productive capacities for huge growth expectations over the course of the next five years. In this context, there are tremendous opportunities for new players to develop successful franchises or stand alone businesses. The key strategic decision for international equipment suppliers with an interest in the Brazilian mining market is whether or not to locate their manufacturing bases in the country.

Present market conditions with the over-valued local currency, high input

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costs for manufacturers and a lack of competitiveness logically dictate for companies with international capacity to produce in lower cost markets. Numerous international players have nevertheless reinforced their commitment to Brazilian manufacturing by retaining their productive bases in the country. "Tecnometal has ensured control over its entire manufacturing output by keeping it in Brazil and not outsourcing any of it. This strategy ensures quality. We consider this to be a key strength for our company, even though we need to support the production sites when there is no commissioned work," said Tecnomateal President Marcelus Geraldo de Araujo.

Unsurprisingly, many other Brazilian firms have opted to diversify their manufacturing base, such as Enfil. "Enfil has a manufacturing plant in Brazil, but we also produce much of our equipment in China as it is more competitive. It makes sense for us to do this in order to retain market share relative to the competition," said Director Franco Castellani Tabani.

SEW Eurodrive—the national market leader in supplying gear-engineering technologies—is another company for whom a domestic manufacturing base is of paramount importance. SEW Eurodrive has a huge manufacturing plant in the Guarulhos area of Sao Paulo. A further $235 million has been invested in consolidating the company's production capacity in Brazil with a view to meeting expected rapid increases in demand from the mining sector over the course of the next five years. "SEW has a service center in every Brazilian state, this clearly distinguishes us from the competition in a market where 100% reliability and productivity is the key priority," said SEW Eurodrive Commercial Director Alexandre Dos Reis.

For numerous firms, a strong presence in Brazil increases access to the wider Latin American market. "Locating our manufacturing base in Brazil, we are much better able to adapt to the changing requirements of our customers, as well as further increase our market-share in regional markets such as Colombia and Chile," said Daniel Rosetti, director of family-owned transportation manufacturer Rosetti. "Rosetti is currently in the process of expanding our Brazilian manufacturing base in Sao Paulo by 40% in order to capitalize upon the spectacular growth that the Brazilian mining sector is currently experiencing."

Given the size of the Brazilian market and the dominance of the country's economy throughout Latin America, international firms are also increasingly using Brazil as a base to enter the Latin American market and then subsequently expand operations throughout the continent. "Brazil is a huge emerging market with diversified economic interests throughout key industry sectors such as agriculture, oil and gas and minerals," said a spokesperson from international laboratory services firm Intertek. "Intertek is a huge international company, head-quartered in London with great strength throughout Asia and Australasia. Intertek Minerals entered the Latin American market in 2008, with a clear strategy for strong rapid growth. We now occupy approximately 15% of the mineral market in Brazil. The idea now is to use this growth to develop other markets in important South American countries such as Chile and Peru."

ESCO Corp., which has been active in Brazil since the 1960s, acquired domes-

tic firm Soldering in 2007 in order to consolidate its position in the Brazilian market place. "We significantly increased our interest in Brazil with the 60% acquisition of a company called Soldering in 2007," said Jose Rogerio de Paula Silva, ESCO. "The main attraction of the Brazilian mining market was the iron ore boom that has been taking place with huge lines of supply into China. Companies such as Vale and MMX have been significantly increasing production in recent years and this opportunity has been regarded as too good to miss."

As the Brazilian mining market continues to evolve toward procurement strategies increasingly focused upon the requirements of maximum reliability and productivity, a domestic manufacturing base combined with a comprehensive service proposition is ever increasingly the choice for equipment suppliers operating in Brazil.

Consultancy and Engineering

Despite suffering a recent retrenchment in demand caused by the global financial crisis, the Brazilian market for mining and engineering services has followed the trend of strong growth in the broader mining market.

The growth of the Brazilian market, coupled with widespread forecasts of its future expansion, has galvanized a raft of investments, partnerships and smaller start up consultancies throughout the industry. Whilst many of the world's best known international mining engineering and consultancy practices such as SRK and Worley Parsons have an established presence in Brazil, the services market also has a wealth of domestic firms, all of whom are competing to develop the most advanced technologies to overcome the myriad of challenges present for miners in the country.

"As the demand for qualified personnel is very intensive at this time in the country, investing heavily in training our team is of vital importance to the long term sustainability of our continuous business expansion. We invest a lot in our team of geologists and engineers, sending them to various parts of the world like England or Australia to further develop their skills and capacity," said SRK Country Manager Gielson Coutinho.

The vast majority of engineers and consultants working the domestic market are Brazilian. This serves to alleviate the labor challenges that exist throughout Brazil's mining industry. Brazil's engineers have delivered some of the mining world's most complex operational project developments such as the Carajas Complex and supporting infrastructure for Mineracao Rio Do Norte's operations in the depths of the Amazon. "As far as international companies looking to come to Brazil, I would say the most important single aspect to guarantee a successful project is to look to the labor of qualified, local people. Above all, do not underestimate the value and quality of Brazilian engineers," said Jose Ricardo Barella, president of domestic engineering firm Progen.

Brazilian engineering firm Brasfond is an excellent example of the country's unique engineering expertise, having developed global leading capacity in underground engineering. A number of other companies are now taking their first steps toward expanding internationally, with a particular focus on the Portuguese speaking regions of Africa,

Latin America's mining centers and Southern Europe. For engineering and construction firms such as Brasfond, Brazil's much talked about infrastructure challenge presents more of a business opportunity than a threat to operational capacity, said Administrative Director Delio Libano. "Despite the huge costs for their operations, we are now seeing mining companies such as MMX and Vale investing huge sums privately to expand their logistical capacity, and bring their operations into production. This pattern of investment can only be viewed as an opportunity for engineers firms such as Brasfond."

A recent trend has seen an increase in international partnerships or takeovers of local firms by international engineering and consultancy companies. Eduardo Dias, director president of SNC-Lavalin Minerconsult—a leading engineering and construction group in infrastructure development—describes the benefits of such partnerships. "The merger of Minerconsult with SNC-Lavalin facilitated the growth of our portfolio of services, as well as the geographical expansion of the company's operations in the international market place. We have been able to achieve this while preserving all of the features and agility of Minerconsult as a domestic Brazilian company that understands the market and industry here."

CNEC WorleyParsons is another recent merger between an international and domestic engineering firm, whereby domestic Brazilian company CNEC was subject to a takeover by Australian engineering firm, WorleyParsons. "Following CNEC's takeover we are now able to offer a full range of services to projects, from conceptual and feasibility studies to basic and detailed engineering as well as full program management," said Jose Ayres, president of CNEC WorleyParsons. "We are combining the capabilities of the WorleyParsons offices outside Brazil, which have an extremely impressive database of projects, with our extensive local knowledge of the Brazilian market."

While carefully managed mergers such as the one between SNC-Lavalin and Minerconsult, and CNEC and WorleyParsons have proved profitable, this is not always the case. "Many international investors have a distorted perception of Brazil. Foreign companies often talk a lot about seeking local partners in Brazil, but in truth they do not respect the views and methods of local businesses," said Marcelus Geraldo de Araujo, president of Tecnometal.

As the mining industry in Brazil continues to strive for greater standards of environmental sustainability and protection in some of the industry's most hostile environments, innovation is key. While Brazil is replete with engineering expertise, international engineering companies are able to leverage their wider ranging resources and experience in order to gain a competitive edge. "Martin Engineering has a research and development center in our corporate office in the United States which develops the latest technologies for Martin Engineering worldwide. Between 12 and 15 products will be launched into the Brazilian market in 2011," said Javier Schmal, general director of Martin Engineering.

According to Marco Aurelio Soares, operations director of software firm CEMI, the Brazilian mining market is

becoming more autonomous and may become less dependent on research and development undertaken overseas to drive the industry forward. "Brazil has changed; it is more mature now and the mining sector here is booming. Brazil no longer has a colonial mentality, we are able to build ourselves and take responsibility for our national development."

The Brazilian mining services segment, although at a level of high technical proficiency, has extraordinary potential for growth in terms of the range of challenges that are present within the Brazilian mining industry. From ensuring environmental sustainability to implementing the correct due diligence on international markets, the Brazilian mining market is of increasing strategic importance to a range of international and domestic engineering and mining consultancies. "BVP has plans to increase our revenues by 10 times over the course of 2011," said President of BVP Engenharia, Sergio de Brito. "As a company our strategy is to position ourselves to work effectively with both international and domestic firms; the Brazilian market is extremely exciting for BVP as a company right now. The Brazilian economy finds itself in a historic position, we fully intend to capitalise upon this."

Jaguar is widely acknowledged as one of Brazil's emerging gold producers. (Photo courtesy of Jaguar Mining)

The Financing Challenge

Access to affordable finance is an obstacle for the entire Brazilian economy and for the mining industry in par-

ticular. Brazil's aforementioned history of economic instability and inflation has rendered the national economy and financial services industry averse to conventional terms of credit and affordable interest rates. Currently, Brazil's commercial lending rate is above 11%; a rate widely regarded as prohibitive throughout the mining industry's value chain from the supply of equipment to basic operational requirements such as cash flow management.

On top of this, Brazilian banks are suspicious of potential debtors and have created a lending regime of extraordinary restriction in access for those without the largest of balance sheets. When asked about the reasons for restrictive credit conditions such as the requirement for 130% collateral on loan applications, Head of Brazilian Development Bank BNDES Mining Division Paulo Moreira De Fonseca said: "Brazil has a history of economic instability and extraordinarily inflation. This legacy has driven the banking sector toward demanding credit conditions such as these. In a broader sense, Brazil does not have as well developed or liquid financial market as those in Europe or North America; over time I am sure this will change. However, as it stands, Brazilian mining companies are at a competitive disadvantage in terms of their access to financing."

The reassessment of risk by both lenders and borrowers in the wake of the global financial crisis has resulted in a less borrower-friendly environment and more restrictive funding terms.

According to DNPM, a consistent number of the licenses it grants to mining companies are returned because businesses no longer have access to the credit needed to finance site's exploration or development. To solve this problem, the Brazilian government has adopted legal measures that allow companies to obtain bank loans using their mineral deposits as credit. However, many banks are cautious about using mines as a guarantee, as cash, when the companies go bankrupt, getting cash from the mines is an expensive and complicated process.

Financing equipment purchases in an efficient and economic manner is of vital importance. In coordination with the Brazilian Federal Government, ABIMAQ has worked to encourage the National Bank for Economic and Social Development (BNDES) to extend the Financing for the Acquisition of Capital Goods' (FINAME) program for up to 10 years. Under the conditions of FINAME, equipment purchases can be financed at significantly lower rates than Brazil's basic interest rate of 11.75%. FINAME has gone a long way toward maintaining growth in Brazil's equipment supply market throughout the global financial crisis and beyond.

In order to overcome the constraints associated with Brazil's extremely prohibitive commercial banking rates and illiquid capital markets, the majority of Brazil's mining industry is funded by international markets. International funding requirements at a domestic level are a key source of opportunity for the services and consultancy market. "ERM can technically support companies to raise money through international stock exchanges and international financial markets by managing them through the due diligence processes required to be approved for such funding. ERM needs to find a way to develop international contacts and to demonstrate our skills and experience to potential international clients," said Walter

Ladeira, technical director of domestic consultancy ERM.

Opportunity exists for companies that can advise as to corporate governance structures and due diligence processes that prospective firms will need in order to present themselves to the world's key exchanges such as the TSX, AIM and ASX. Brazil's underdeveloped and prohibitive finance regime is regarded as an opportunity for international investors and consultancies to make a return on delivering finance for Brazil's nascent, but expanding portfolio of junior companies.

Geophysical Scanning Services

Services that provide information on the 70% of Brazilian territory that is unknown in terms of its geological profile (and give further insight into the 30% that is known) are of particular importance to the Brazilian market. Geographical profiling helps mining and exploration firms narrow down prospective sites for new development.

CPRM is the government agency responsible for the country's geological mapping. "They do a good job in terms of investing in geophysical surveys, which are the basis for the geological mapping," said Jorge Hildenbrand, head of Fugro Lasa's mining division. "The big problem for CPRM is it doesn't have a large enough workforce to face the challenge of mapping a huge country like Brazil. Currently, less than 30% of Brazilian territory has been mapped at the 1:500.000 scale and less than 5% of the country has been mapped at the 1:50.000 scale. We have only 1:50.000 scale geological mapping for the main mineral provinces like Carajas. Most Minas Gerais has been mapped with 1:100.000 scale, while the Amazon region, the west and the central-west region have 1:250.000 scale mapping on the well mapped areas. The rest of the country is mapped at 1:1000.000.

Luis Melges, managing director of Golder Associates in Brazil.

Paulo Libanio, regional director of Ausenco in Brazil.

"The government should speed up the geological mapping of the country since this is particularly relevant for the mining sector's growth. Chile, Peru, Australia, Canada and South Africa have very detailed geological mapping and therefore are leading mining countries. Our company has been involved in the surveys performed for more than 50% of the Amazon region, and I believe if this data was transformed into geological

information, that would open huge opportunities for the mining industry. The Brazilian government has made consistent investments in magnetic-radiometric surveys, but it should also invest in new technologies like the airborne gravity and electromagnetic surveys. This could offer better opportunities for the development of the industry, and also provide for a rapid full geological mapping of Brazil's territory," said Hildenbrand.

Mining in the Amazon

The Amazon region has a potential for major undiscovered mineral resources in addition to the large reserves of, in order of volume, iron ore, manganese, bauxite, gold and tin. There are, however, concerns over biodiversity in the Amazon rainforest, which comprises 20% of world's remaining tropical forests, and which provides shelter to 10% of earth's plant and animal species and removes excess carbon dioxide from the atmosphere. Therefore, according to the DNPM, much of future mineral production will also depend on finding new approaches and technologies to allow mining in a responsible and sustainable way. "The country has the potential to double or triple the current mining production," said Marcelo Tunes, director of mining affairs, Brazilian Mining Institute.

Exports from the region account for almost 30% of Brazil's extractive mining industry according to the Brazilian Mining Institute. The Amazonian state of Pará, for example, is the second largest mining exporting state in Brazil, after Minas Gerais. Iron ore exports from the Amazon totalled around $2.6 billion in 2008, followed by copper ($515 million) and manganese ($402 million). However, exploration was hit by the financial crisis, with a number of smaller prospectors going bust in 2009.

Luis Melges, CEO of Golder Associates—who work in planning mining development in the Amazon region, elaborates on the complexity of mining in the Amazon. "Mining in remote areas in the Amazon forest has a very high social impact, as thousands of people migrate to developing projects searching for work. Golder Associates takes into account all the environmental and social aspects, which are related to the development of a new project. The Carajas mining region, explored by Vale, is a good example, because the mines have been developed in the Carajas National Forest, a conservation area, in a sustainable way. Environmental sustainability is of primary importance for Golder Associates activity."

In some cases, responsible mining can have a positive impact on the surrounding Amazon rainforest. According to Ricardo Dequech, director of Mineracao Buritirama, an aerial photo of the Buritirama mine clearly depicts an island of forest encircled by recently established farmland. "With regard to mining in the Amazon rainforest, the impact of the mine is limited compared to the impact of intensive agriculture," he said. "In addition, the mining companies reinvest in social and environmental sustainability in the area because environmental sustainability has become an essential aspect of the industry." Much of future minerals production will depend on new approaches and new technologies being applied for economic and social developments that

protect the environment in a responsible and sustainable way.

The Amazon forest is the supplier of one-fifth of all free-flowing fresh water on earth and Brazil's government is planning to build several hydro-electrical plants in order to produce energy. According to the Brazilian minister of mining, huge investments need to be made in new generation capacity over the next few years to develop the economy and this will create thousand of job places.

For projects in the Amazon forest it can be very difficult to have access to energy, so many mining companies have built dams next to their operations. For example, the second largest mining company in Brazil, Votorantim produces about 68% of the energy needed from 33 hydroelectric plants and five thermoelectric plants. The company is able to generate 2,380 MW. "We seek the integration in order to keep costs under control," said Joao Bosco Silva, president of the Group.

Votorantim has plans to expand its energy production to reach a production level of 85% of the consumed energy.

Drilling Services

Although Brazil's mining industry is dominated by a handful of major firms with significant capacity for vertically integrating their operations, independent drilling operators dominate the market. In terms of market structure, GEOSOL stands out as the market leader, followed by several family-owned Brazilian firms and an ever increasing number of international players such as Master Drilling, Layne Do Brazil and Boart Longyear. As major players such as Vale expand exploration budgets by the hundreds of millions, and global financial markets become emore interested in the country's junior firms, opportunities for drilling contractors are forecast to grow.

"Continuous investment in technology and human capital always made GEOSOL stand out in the Brazilian and world drilling market," said Joao Carvalho, president of GeoSol. The company currently has approximately 250 drill rigs in operation.

GEOSOL, in a partnership with the Victor Dequech Foundation, is poised to create a new research, development and innovation department. "We have a special focus on new technologies to increase production and to reach the highest safety standards. Our objective for the next few years is to become more international and to increase our revenue by 15% in 2011," said Carvalho.

Poised for Leadership?

The Brazilian mining market is one of vast potential. Despite 70% of the country's geology being unknown, Brazil plays host to colossal mines such as Carajas in Para and at the Iron Ore Quadrangle in Minas Gerais. Brazil faces similar challenges to those of many of the world's leading mining economies: skilled labor shortages, a requirement for improvements in infrastructure, and a lack of reliable and cheap electricity. Brazil also faces more unique challenges—those presented by undertaking mining in the Amazon, and by abiding to the country's very strict environmental regulations. In spite of these challenges, Brazil's mining market is enjoying a boom at present, which we expect to continue for at least another five years and beyond.

Although the China-led East Asian commodities boom is having a huge influence on the demand profile in the Brazilian market, the industry is, in many ways, hedged against a sudden decline in Asian demand as a result of the increasing profile of domestic demand within Brazil.

Brazil's housing stock is in deficit by eight million houses; this, combined with the swath of infrastructure developments resulting from the upcoming Olympics and World Cup, positions Brazil as one of the world's most exciting markets for international investment throughout the mining productive chain.

"Brazil is in the midst of an historical moment," said Da Souza Lima, president of GEOID. "In the past, Brazil has experienced political and economic instability. We believe these issues have now been resolved. There is more and more foreign investment coming into the Brazilian market as investors are increasingly interested in developing their businesses inside Brazil. Brazil is now in a position to fulfil the country's enormous potential as a global leader in the mining industry."

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