Potential and challenges for the Brazilian mining industry

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This paper presents an overview of the main potentials of the mining industry in Brazil and its challenges. Although the country is well endowed with mineral resources, some of these are unexploited due to several factors, e.g. an economic unstability that prevailed in the last decades, adverse international market, and counteracting legislation changes occurred in 1988. The authors review some of the main challenges for the mineral industry to overcome.
This paper was presented to the First International Symposium on Mining & Development, July 1995, Campinas, Brazil.

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The performance of the Brazilian economy from the mid-1960s until the mid-1970s was impressive with GDP growing at an average annual rate of about 8 per cent . Those years are frequently referred to as the period of "The Brazilian Miracle", when the manufacturing industry grew at a rate of 13.9 per cent per year. Another important factor in the Brazilian boom during this period was the favourable international scenario, which included significant expansion of international trade by the developed countries and a high level of capital flows.

A noticeable change in the macroeconomic setting occurred in the second half of the 1970s. Although individual industries were affected differently, overall the rise in world petroleum prices had strong repercussions on the metal consuming sectors in Brazil. The completion of large public investment programs conducted to modify the balance of payments contributed to internal economic disruptions. Brazil's external debt increased from 62.8 billion USD in 1980 to 121.2 billion USD in 1991, which in addition to the austerity program, economic slowdown, and reduced foreign private investment triggered by the 1988 Constitution have been major constraints on mineral and other industrial development.

During the period of 1980 – 84 the economy experienced a brief period recession, with low GDP growth rates (Table 1). Following this period, the economy again showed growth at historical rates. However, as inflation worsened, a new recessive crisis developed in 1987 and continued until recently. The GDP, according to Central Bank estimates, reached 500 billion USD in 1993 is now in the 10th position in the world ranking, representing about one third of the Latin American economy.

High inflation rates have been one of Brazil's major economic problems in the last twenty years. Four successive economic stabilisation plans (1986, 1987, 1989, and 1990) failed in an effort to reverse the situation. A chronic imbalance of the public sector budgets combined with an overall indexation of prices and wages, prevented any measure of inflation control. On July 1st., 1994, the government established the "Real Plan" based upon exchange rates reserves (anchor) and by reducing the global stock of local currency held by the Central Bank. This program, also based on a rigid control of public deficit, registered a significant drop in the inflation rates at the end of 1994 (average of 2.5 per cent a month).

Table 1. Growth rates by sector

	Annual average variation – per cent		
Sector	1980 – 1994	1985 – 89	1990 – 94
GDP 1.4	4.5	0.8	
Agricultural	4.0	4.1	2.2
Mineral industry	12.6	3.8	1.9
Manufacturing	–0.2	4.0	–0.1
Construction	–2.4	5.2	–0.4
Trade0.5	3.6	0.9	
Transportation	2.0	6.1	2.4
Communications	14.7	15.3	1.8
Financial	6.0	1.1	–4.1
Service and public utilities	8.0	5.8	1.5

Source: Anuário Estatístico do Brasil-(IBGE, several years), Boletim do Banco Central do Brasil (several issues).

However, a significant achievement of the results obtained will depend on the new measures such as reforming the taxation system, downsizing the presence of the government in the economy, and removing the restrictions on mining activities by foreign firms.

Political events in 1994 indicated that in the present presidential term (1995/1998) it will be possible to adopt delicate actions and necessary reforms that will generate a positive impact in the economy as well as in the mineral sector.

The events of the impeachment of the former President Collor de Mello, the Congressional Inquiry Committee (CPI) that investigated the Congress budget, together with the political climate of normality that prevailed during the presidential elections indicated that the democratic institutions are mature and consolidated enough to guarantee the necessary changes.

THE MINING INDUSTRY

The mining industry in Brazil is large and diversified and its share of GDP has been historically around 2.5 per cent (Table 2). The official data does not include an underground economy estimated at 30 – 40 per cent generated not only by tax avoidance, but by the lack of tax mechanisms to reach certain productive activities. For example, considering the mineral sector, the consumption of underground water for irrigation or domestic consumption is not taxed or even included in the statistics. The same situation happens to those minerals used in housing construction. It is possible that with a better-structured system of national accounting the mineral production would reach a value of 18 – 20 billion USD. The gold production from 'garimpeiros' follows the same trend; they are responsible for almost 50 per cent of overall production, being not included in the official statistics (in 1993 the total gold production reached 75.7 t, and the 'garimpo' production was estimated at 30 t).

Brazil has been a leading producer of iron ore, ferroalloys, aluminium, bauxite, tin, manganese, niobium, asbestos, fluorspar, magnesite, kaolin, talc, and dimension stones in the last decades. Brazilian exports of non-fuel minerals and related semi-finished products are in the range of 7 billion USD annually (Table 2); the destination is Western Europe, North America, Japan and the Pacific Rim, and also Latin America. For the domestic market, Brazil has an impressive output of crushed stone, sand and gravel, clays, and limestone. Yet, the Amazon region continues to be one of the least known tracts of the world, mainly because of the tropical rain forest cover, concealing a number of world-class deposits.

The comparison of the Brazilian mineral production with the selected world mineral production (Table 3) allows one to evaluate the size and importance of our mining industry.

Beyond the productive base indicated previously (Tables 2 and 3) it is worth mentioning some relevant aspects that provide a sustainable support and increase the potential of our mineral industry:

- the Brazilian trade balance of minerals and related manufactured products reaches such a volume and diversification of products and supplier/consuming countries that represents a thorough experience in all stages and routines related to international trading. The exports in 1992 reached a volume of 6 billion USD including 38 items, led by iron ore (2.3 billion USD) and aluminium (1.2 billion USD). The imports reached 4.6 billion USD with 37 items (oil – 2.6 billion USD, coal – 685 MUSD, copper – 422 MUSD, potash – 264 MUSD, and aluminium – 232 MUSD);
- the control of technological skills in mining and ore treatment reached a good level of maturity and a wide range of applications, so that the country can easily

Table 2. Major figures of the Brazilian mining industry (1992 constant billion USD)

Year	Mining production	Exports (CIF)	Mineral sector	GDP	1/3	2/3
1980	4.9	5.6	56.4	275.2	1.8	20.5
1981	7.1	5.5	67.3	346.6	2.0	19.4
1982	7.4	5.3	74.9	357.7	2.1	20.9
1983	8.3	4.7	56.5	263.1	3.2	21.5
1984	10.6	4.6	57.3	251.1	4.2	22.8
1985	9.3	4.8	56.9	242.4	3.8	23.5
1986	6.5	5.0	58.3	269.3	2.4	21.7
1987	7.9	5.5	73.8	322.5	2.4	22.9
1988	7.6	6.6	90.8	376.2	2.0	24.1
1989	7.9	9.9	114.7	462.8	1.7	24.8
1990	9.1	8.2	134.2	479.2	1.9	28.0
1991	11.1	5.9	106.3	408.4	2.7	26.0
1992	12.2	6.0	124.0	425.0	2.9	29.2

Note: Mineral sector production including metallurgy plants, ironworks, fertilizers, cement and petrochemical industry in the statistics.

deal with the adjustments for exploitation of any size or class of mine. New processing technologies can be easily absorbed. The industry has the technical capabilities and material conditions to produce internally all kinds of equipment required by the mining industry as well as great managerial skills and entrepreneurship. The same framework can be extended to labour training and education to meet all the demands of the mineral sector

• on the consumption side, there is an enormous political will to better reach the most vulnerable groups in society. A large number of people even with a small rise in their income has prompt psychological and cultural conditions to incorporate industrial and more elaborated products and services thus enlarging the domestic market. There is a significant deficit of housing and infrastructure which means a great potential demand for products of mineral origin.

THE BRAZILIAN POTENTIALITIES

Based upon this framework it is possible that the commodities described below show the following general trends (see Figure 1).

Oil

The adoption of flexible forms of State monopoly will permit Petrobrás to intensify the joint ventures and contracts with the private sector multiplying its huge investment capacity. We estimate that approximately 10 billion USD in projects are now being examined for global investments in refining, transportation (oil tankers, pipelines), and storage of oil and gas.

Coal

Although Brazilian reserves are large, the quality of coal cannot compete with foreign sources for metallurgical use. The coal for electricity generation could be improved with the privatization of the utilities sector and integration with Mercosur.

Uranium

Brazil possesses a good level of uranium resources (total reserves of U_3O_8 are estimated at 301 490 t, of which 163 000 t are in the category of reasonably assured reserves). The use of these resources under government monopoly will not show great perspectives for a change in the near future, even bearing in mind the presence of good deposits as yet underdeveloped. The possibilities of completion of Angra 2 nuclear plant by the year 2000 are very small, considering the need for investments of 1 billion USD and the unfavourable historical events of the existing nuclear plant (Angra 1) and also the public mistrust in safe nuclear power generation in the international context.

Steel

This is now a fully privatized sector that has been used as a strong argument to encourage other state-owned companies to follow suit. The steel production in 1994 was 25.8 Mt representing a growth of 2.3 per cent over the previous year. The new privatized companies showed a good performance and good profit margins. The majority of firms adopted expansion plans indicating that by the year 2000, Brazil will be ranked as a world leading producer (8th position).

Iron ore

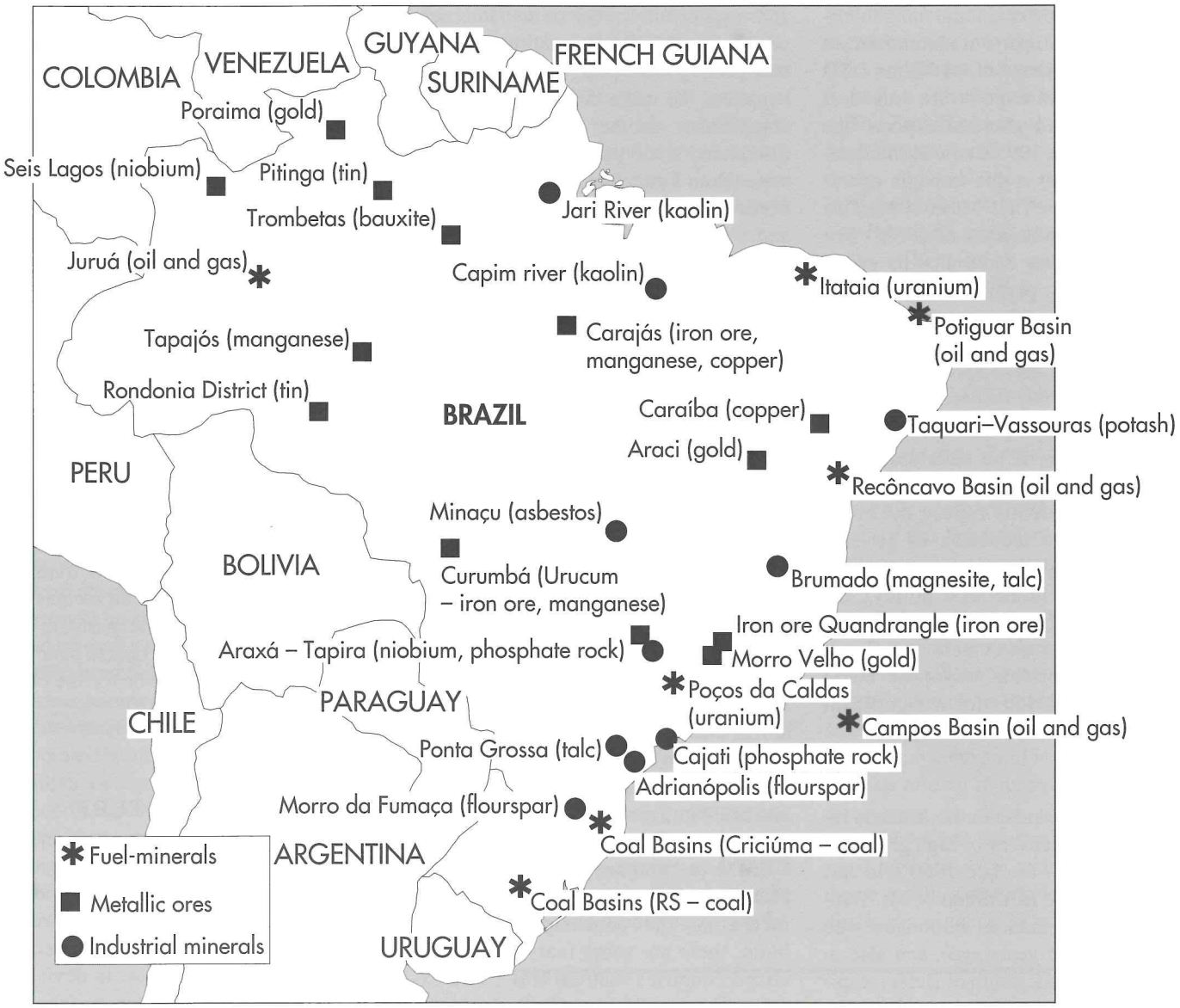
The Iron Ore Quadrangle, located in Minas Gerais State, is still increasing its output, possibly reaching 200 Mt of iron ore by the end of this century. However,

Table 3. Ranking of the Brazilian mining production in 1993 in selected minerals (values expressed in Mt)

	World	Brazil	Rank	Per cent	Trend
Oil[1]	3 169.7	33.0	18	1.0	stable
Coal	4 500	4.5	–	0.1	downward
Natural gas[2]	1 838.7	–	–	–	–
Steel	725.3	25.2	9	3.4	upward
Iron ore	938.0	155.0	3	16.5	upward
Aluminium	19.6	1.1	6	5.6	upward
Bauxite	113.0	11	4	9.7	upward
Cement	1 396.0	31	9	2.2	upward
Lime	141.0	5.8	6	4.1	upward
Kaolin[1]	26.5	0.91	4	3.4	upward
Phosphate	117.0	3.5	8	3.0	stable
Manganese	19.5	1.5	5	7.7	upward
Gold[3]	2 281	75.7	7	3.3	upward
Magnesite	14.7	0.9	6	6.1	upward
Chromite	9.9	0.3	7	3.0	stable
Talc	8.8	0.48	6	5.4	upward
Tin	0.116	0.027	2	23.2	stable
Niobium	0.014	0.011	1	80.1	stable

Notes: 1. 1992. 2. t of oil equivalent (toe). 3. t including "garimpo" output estimate.
Sources: Mineral Commodity Summary (several), Sumário Mineral-DNPM (several), Metals & Minerals Annual Review (1994).

Major mineral deposits in Brazil.



the successful newcomer indeed is Carajás, jumping to an output of 55 Mt of iron ore from zero in 1985. Its reserves of high grade ore are about 18 billion t. In addition, Carajás metallogenetic province is proving to be rich in other metals, such as manganese, copper, gold, nickel, tin, and tungsten. The state-owned CVRD is responsible for an expressive share of production which includes not only iron ore deposits, but also railroads, dedicated ports, steel plants, and cargo ships (1994 sales of iron ore reached 100 Mt). CVRD is slated to be privatized in 1996, and is attracting the attention of investors from Japan, Germany and other countries. Privatization and increased access by the private sector can restore efficiency by increasing competition. Freed from mineral production and the administrative drain caused by public-enterprise problems, the government can concentrate on those actions that are best suited to the public sector in mining: the provision of infrastructure for mineral investments and to help develop human-capital resources.

Aluminium

Bauxite is being produced mainly in Trombetas district, also in the Amazon region, by Mineração Rio do Norte-MRN, and will reach 12 Mt in year 2000. The reserves are abundant, estimated at 1.5 billion t, and located in sparsely populated lands, well endowed with cheap

hydroelectric power in the neighbourhood. Brazilian exports of aluminium are presently in the range of 1.1 billion USD per year; bauxite exports are valued at 120 MUSD, and alumina exports one fourth of that. In 1995 a new alumina refinery (Alunorte) is due to begin operation and will reach 1.1 Mt in 1997. This new plant is a subsidiary of CVRD like MRN. This sector could also be privatized and the new partners can give a new dimension to the programmed expansions or plans.

Cement

The cement industry as well as the aggregate sector will be solicited in the new government to provide low cost-products to gradually reduce the housing deficit. The reduction of government intervention in the real state business (mainly in home lease policy), the deregulation of market and reduction of import duties on cement to balance the Brazilian private oligopoly could create the conditions for a significant growth in the cement industry.

Kaolin

Another good surprise in the Amazon region was the discovery of high grade kaolin deposits, in the late 1960's in Jari district (once the El Dorado of Mr. Daniel Ludwig, the famous billionaire who died a couple of years ago), and also in Capim river banks, south of Belém, capital of Pará State. Anchored in quite abundant reserves, Brazil is rapidly boosting its exports of processed kaolin, mainly for the consumption of the paper industry all over the world, and may reach 2.5 Mt in year 2000. This is really an accomplishment, especially in view of the fact that some decades ago only England and the US had a place in the sun in this exclusive market (Machado et al., 1994).

Tin

The best tin district is Pitinga, in Amazonas State, discovered less than 20 years and responsible for the tremendous success of Brazil in the international market, thus putting some pressure on traditional suppliers. To make things worse for the competitors, another rich deposit was discovered some years ago in Rondonia state (Bom Futuro) close to the Bolivian border, and mostly exploited by diggers and subject to smuggling. As Brazil is not a member of ITC, there has been a lot of pressure aimed at reducing Brazilian output of low cost concentrates and consequent flooding in the international market, depressed since the tin crisis occurred in 1985.

Niobium

Niobium has a very peculiar position in the Brazilian mineral sector. This country is endowed with 85.8 per cent of the world niobium reserves and 80 per cent of world production; the other countries with significant reserves are Canada, Nigeria, and Zaire. The huge reserves found in Araxá-Tapira district (Minas Gerais state) support an yearly export of Fe-Nb alloys that surpass 100 MUSD in value; there are also exports of high purity Fe-Nb alloys, Ni-Nb alloys, niobium oxide and niobium (metal). In spite of the efforts spent by the major producer – CBMM (a company jointly owned by Moreira Salles group and Molycorp) in increasing the consumption of niobium, there are some fears in industrialized countries that CBMM could exert a monopolistic control over this market. It seems possible that the future development of new Russian projects could bring some benefit to Brazilian producers, a rather unique case of positive competition in favour of a former solitary supplier.

Gold

Monetary stability and economic growth in Brazil will likely induce the production of "garimpos" only in very high grade deposits. For the first time in the last years, the industrial production in 1994 was higher than the "garimpo" output. The actual exchange rate (1 USD = 0.86 R$), the international levels of gold price, and new jobs creation in urban areas altogether help to reduce the "garimpo" production share. It must be emphasized that the potential of gold is far from being fully known, and well planned prospecting campaigns can generate good results in the future.

THE BRAZILIAN CHALLENGES

If Brazil is to consolidate its key role in the mining sector of the Americas, it has necessarily to overcome a number of challenges of varying nature and difficulty levels, in order to cope with the prevailing patterns in the international scene. The world scenario in the end of this century is likely to demand new kinds of behaviour that must translate into new ways of action. Old recipes designed for success in the past are not guaranteeing any more a course of action adequate for the present or for the coming future, as well.

CHALLENGES OF POLITICAL NATURE

One of the most sensitive matters in this context is related to Brazil's foreign affairs policy. The globalisation process, intensified by the communications revolution and the vigorous trend to the formation of economic blocs, is deviating the focus about the importance of the national states in this new framework, and also the adaptations that they must undergo in order to accomplish old and new functions.

As the concept of sovereignty is continuously evolving, this implies a political organization quite different from what existed so far. This means that the political parties' structure and their attention should be directed both to domestic and foreign policy issues. A sharp distinction between these two different approaches is not valid any more. Many problems are so globalised that the inter-

vening organizations act in a world scale, demanding decisions that balance the impact of actions on the domestic and on the international level. As a consequence of this perception, the process leading to political representation should take into account the awareness about the presence of external forces.

The establishment of a permanent technical structure in the political parties and in Congress itself is required to overcome the present and future political challenges. In addition, those issues related to science and technology become of higher priority ever and ever. In the particular case of the mineral sector, it is essential the existence of competent and knowledgeable cadres to give assistance to government decisions and actions. When dealing with complex issues and when communicating with the public in general about difficult decisions, a lot of effort will be required from policy makers to be successful. Old assumptions that used to establish a relationship between national security and the self sufficiency in raw materials were replaced by more elaborated matters, such as the formation of alliances to guarantee a mutual supply of goods, access to markets, certification of product quality, fair competition, countervailing duties, and so on. The creation of a new organizational structure able to materialize such actions is one of the great challenges facing Brazil.

CHALLENGES OF ECONOMIC NATURE

Social improvements and income distribution

These challenges do not refer exclusively to the mineral sector, but they rather imply the political and social stability of the country. In other words, this means to implement social reforms aimed at reducing income inequalities and also eliminate some privileges that groups or corporative bodies accumulated for decades. These challenges will present enormous difficulties and will require more than one political legislature. Its resolution will certainly pave the way to other positive accomplishments. The setting of new rules able to provide stability and justice in the social relations will create a fruitful business environment to the whole economy, and to some projects in the mining industry that are very sensitive to these issues.

Special economic relations

The high intensity of capital cost and the long lead time of mining projects require specific treatment procedures, e.g. capital repatriation, compensation, and taxation. On the other hand, the inherent risk involved in this kind of activity and its cyclical character are other features that many times deserve a specific treatment for each industry or even for each individual project. However, this discretionary treatment should contemplate fair competitive conditions for the domestic and the external market, compensating unique characteristics of the mineral deposit, aspects of health and safety, and also of environmental protection.

Taking into account the above reasons, the national state has a key role to play, either in the domestic or in the international level. When a competent decision is made with the participation of all stake holders, chances to attract necessary investments will be greater. In the international business environment, it will provide conditions of competitiveness accepted on a worldwide basis.

The Brazilian mining industry expects from international investors some concerns beyond the direct outcomes brought about to the local economy, as many projects might generate significant in direct benefits as well. This is really important in our case, where the geographical deconcentration of industrial activity and the coupling of new spaces are quite relevant items for national economic development policies. The existence of several world class deposits bear advantages that should be shared by all stake holders. The need of a different economic approach and the social acceptation of this fact are two challenges to be addressed in the coming future.

Capital markets

Another kind of challenge associated to economic affairs is the improvement of the capital markets operating in Brazil. A strong effort must be directed for the attraction of saving and investment money into the mining industry, which is rather uncommon in these days. Regulation procedures and transparent mechanisms must be adopted in order to give confidence to all investors. It is important to eliminate as much as possible some er-

Table 4 . Primary Energy Production and Consumption in Brazil

	1980		1990		1993	
Fuel/source	**Prod.**	**Cons.**	**Prod.**	**Cons.**	**Prod.**	**Cons.**
Oil	9.08	54.32	31.90	59.38	32.46	59.90
Natural gas	2.13	1.08	6.07	4.14	7.12	4.80
Steam-coal	1.46	1.19	1.56	1.91	1.75	1.77
Metallurgical coal	0.97	4.01	0.31	7.46	0.04	8.20
Hydroelectricity	37.38	37.38	59.95	59.95	68.08	68.08
Biomass[1]	38.87	40.77	48.21	48.30	47.21	44.42

Note: 1. Timber, charcoal, sugar-cane products.
Source: Balanço Energético Nacional-MME (1994), Mt of oil equivalent (toe)

rors or traps that lead to undesirable risks usually generated by unethical behaviour from insiders. The funds collected by capital markets should in principle boost production, although speculation always exists and one has to live with.

INSTITUTIONAL CHALLENGES

One of the great challenges that Brazil is facing is to set up a modern, fast and technically competent organizational structure to manage the nation's reserve base and to improve every effort to discover and explore unidentified mineral resources. The international experience points in the direction of three agencies: a mining concession department, a department or bureau of mines, and a geological survey. It is mandatory to loose the bureaucratic ties of the agency in charge of exploration permits and mining leases, so that any mining company would be encouraged to start or continue production of mineral commodities. In addition, information about land tenures and free access should be provided on-line to the public. Each agency must be independent, autonomous, and have a multi-year budget according to its own responsibilities and tasks.

GEOLOGICAL KNOWLEDGE CHALLENGE

The geological knowledge of any nation is always a technical and scientific activity financed by the public sector, and should be a permanent concern. This standpoint takes into account the evolution of sovereignty concepts in modern societies. There is no sovereignty whatsoever upon what you do not know. The knowledge of the mineral potential implies to gather all the information already produced and to be able to infer or forecast information or clues not yet available. Having a large land mass (8 511 965 square km) – the fifth largest country in the world – Brazil has always been short of accurate information. On the other hand, the amount of information seized by the government is lagging behind the information already available from different sources. In addition, for unpopulated areas (Amazon region is one striking example) the government did not yet obtain the minimum information that is commonly considered as necessary for rational planning objectives. Everyone should realize that it is essential to establish a long range planning to improve the geological knowledge of the Brazilian territory, besides the operation of a system designed for integration and better use of the presently available data.

This concern will be addressed in a megaproject that the Brazilian government is just starting nowadays – Sistema de Vigilância da Amazônia-SIVAM (Amazon Surveillance System) – with a budget of 1.4 billion USD, designed to obtain a multipurpose monitoring of the whole Amazon region, encompassing several activities from detection of mineral deposits, action of "garimpeiros" and illegal mining companies, deforestation spots, until the war against cocaine merchants operating illegal airstrips and distributing drugs to Brazilian cities and foreign countries. The most modern technology available abroad will be used in this project, more sophisticated than the former Project RADAM (radar imagery in the Amazon region) that was set up in the early 1970's

Recent studies identified 160 mineral provinces in the whole Brazilian territory (Santos et al., 1994). Some of them are already producing mining districts, such as the Iron Ore Quadrangle (Minas Gerais) and Carajás (southern Pará), but the majority still deserves further exploration work for assessing mineral reserves replacing resources. Private enterprises will be welcome to accomplish the follow-up investigations that are needed.

CHALLENGES RELATED TO INFRASTRUCTURE

Any private enterprise in Brazil is dealing routinely with higher costs than the usual ones due to structural inefficiencies, commonly referred to as "Brazil cost". This burden in the mining industry is due either to the inexistence of adequate infrastructure or when the existing infrastructure does not meet the international standards, translated into high tariffs and duties, or slow bureaucratic procedures.

The set up of energy and transportation infrastructure in Brazil was historically overloaded by inflated costs as compared with other competing nations for several reasons (domestic inflation rates, official delays to pay contractors and suppliers, corruption practices, to name a few). This resulted mainly from a bad relationship between contracting and contractor parties, plagued by old-fashioned practices. As a consequence, there is an array of dormant or abandoned public works in the whole country.

It is expected that under new rules there will be plenty of room for reducing these high costs. After completion, many public works will benefit large regions including mining projects.

Notwithstanding all these arguments, it is important to realize that the Amazon region will continue for many areas as a virgin portion of our territory. In developing countries, it will be a continent-sized regions. So to say, the adequate infrastructure in the Amazon region for mining projects is something pinpointed; it is advisable to examine case by case. New public works will be submitted for approval to more stringent legislation than in the past. Sometimes the legislation originates in multilateral agencies, such as the World Bank.

Energy

There is an enormous potential in the area of electric power generation, that even built with the actual level of marginal costs can be generated with competitive tariffs. The installed capacity, estimated at 59.5 GW, is 54.1 of hydroelectric and 5.4 of thermal sources. Nevertheless, the generating potential from hydrosources is estimated at 251 GW in 1993

(Balanço Energético Nacional, 1994). This type of energy is particularly important for new metallurgical plants willing to operate in Brazil. The perspectives open by privatization of the entire energy sector will create new possibilities of investments, and will replace the government action, almost absent in the last years due to the lack of financial resources. As pointed out previously the adoption of new forms of management of oil resources will increase the efforts in exploration and production, considering the expected inflow of new venture-capital. Even if considerable progress is made in efficiency and energy conservation programs in Brazil, new energy sources will ultimately be required to meet continuing demands for industrial development and population growth. Table 4 indicates commercial energy production and consumption by fuel in Brazil.

The availability of uranium resources and the improvements in nuclear technology can materialize a future energy option for the country, if followed by the increase of safeguards for its use. The possibilities of participation of private (domestic and international) firms in such a programme will be a challenge to overcome in the long term. A long period required is necessary to create an efficient government structure linked with international organizations to regulate its use, considering the potential impact of environmental risks and also the defence interests of Brazil.

Transportation

Transportation is a key factor in the competitiveness of the mineral industry in Brazil. There are no challenges to surpass in transportation in half of Brazil for the domestic and the international market. Most problems to solve refer to the Amazon region, as everybody knows. On the other hand, it is out of consideration a heavy traffic network in the Amazon waterways in the foreseeable future, due to environmental concerns.

The roadways are unfortunately an important system of transportation for many raw materials in Brazil. In 1991 the network reached 1.5 Mkm with only 10.5 per cent of paved roads. However, there is a growing interest in the use of railways, navigable rivers, lakes, and pipelines. The waterways system is partially in operation and comprises: Prata Basin, Tiête-Paraná and Paraguay-Paraná System, Southeast Basin, Northeastern Basin, São Francisco Basin, Amazon Basin-Tapajós System and Tocantins-Araguaia System. These systems coupled with railroads will represent the incorporation of new mineral and agricultural frontiers to the country. This should be associated with the modernization and the privatization of ports and the domestic cargo coastlines, with the speeding up of Law 8630 (port modernization) and amendments to article 178 of 1988 Constitution. These policies open new ventures considering the Brazil's extensive coastline of 7 400 km, 57 organized ports of which 16 are dedicated for special purposes (solid and liquid bulk cargos).

ENVIRONMENTAL PROTECTION CHALLENGES

The relationship between the environment and mineral development is another challenge to overcome in order to achieve all the potentialities of the country. The interaction of the both determinants (environment and mineral resources) requires a proactive action of the main three public actors (government, congress, and the court system) to establish objective and rational rules for a sustainable development. The actual relationship between those actors is far away from the interests of the mineral resources use and the environment by introducing barriers that should be eliminated. We have an impression that the main actors (miners and environmentalists) still keep a strong confrontation. The context of effective cooperation is not reached yet. Recent data from DNPM in the Amazon region (surface of 3 591 180 km^2 estimated that mining activities in the region reached only approximately 0.35 per cent (12 591 km^2).

On the other hand, we should realize that the Amazon region possesses a number of fragile ecosystems that should be the focus of comprehensive and thorough scientific studies before a project is approved by the authorities and set up. Domestic and international NGO's have shown deep concerns over these issues.

CORPORATION MANAGEMENT CHALLENGES

The mining enterprises in Brazil present a great level of heterogeneity ranging from corporations that use the most recent modern management techniques to firms with very rudimentary know-how. The majority of Brazilian firms present attitudes that are not compatible with the international framework in the following aspects: structure (family-owned and/or non-public companies), payroll parameters, marketing information, quality of the end-products (certification), management methods, technology use, yearly investment in R&D, and a good institutional image for the community.

Despite the good results achieved by several companies in some economic sectors, and including few mining firms, in the sense of operating at international levels, this examples had not been extended to the majority of mining enterprises. Recent research conducted by Price Waterhouse in 1994 (Indicadores de Qualidade e Produtividade) on the thousand largest firms operating in Brazil (not including the state-owned companies), indicated that the decision levels fell down in 1991 from an average of 6.8 to 5.2 in 1994. This international trend of reducing the decision levels coupled with total quality programmes must be followed not only by retraining the existing human resources, but also directing professional education towards an intensive use of modern information technology.

The results of the same research indicated that 60 per cent of the sampling universe spends less than 100 USD/year per employee in training. The export companies are claiming to train more than 50 per cent of their working force; the non-exporting firms are in the range of zero to 25 per cent . These results clearly indicated that investment in human resources is not fully activated through adequate funding both inside the firms and externally into the neighbour community.

The challenges relating to industrial capacity and human resources could easily be managed by the country.

Some mineral and industrial projects already in operation indicate that exists some reason for hope. An interesting campaign was launched by MBR-Minerales Brasileiras Reunidas to prevent work accidents, to avoid pollution and cost reduction. It is claimed that savings of 100 000 USD per year have been achieved, only by introducing an intensive training together with measures of cleaning the processing plants. This indicates that a good background and capabilities exist in the country to deal with any type of project or operation foreseen in the near future. The national framework in the field of basic and applied engineering, equipment, and construction reveals positive results by all means.

Another challenge faced by private companies is its relation with diggers or prospectors, its legalized cooperatives or even small companies, who are eager to exploit outcropping mineral reserves. This uses to be a sensitive problem in remote areas, where some aboriginal people may live, thus further complicating the issues, and where the presence of government may be rather weak or discontinuous. Obviously, the richer the deposit of these high-value minerals, the bigger the dispute between the interested parties. New legislation is required to resolve peacefully all these conflicts.

Brazil's has an undergraduate and graduate system of education in geosciences and mining engineering that covers the majority of specialized fields. Despite its heterogeneity, there are important centres highly competitive in most fields demanded by actual mining activities.

CONCLUSIONS

As a consequence of the drop of inflation and the process of economic recovery, Brazil presents now a more favourable framework to overcome most of the forementioned barriers. This indicates a new environment to develop the already known mineral resources and to identify new mineral opportunities, mainly in the Amazon region, our last frontier.

The early signals available are indicating a favourable set of preceding conditions to overcome the challenges of the last decades. On top of that, recent events in the international environment reflected favorably in the domestic level, indicating a close interaction that both scenes have in shaping the Brazilian economic and political decisions. Finally, this situation strengthens the importance of surmounting the challenges, not only to render the potentialities of the mineral sector, but also to allow the mineral sector put in practice a positive influence for the country in the international environment.

References

DNPM. 1994. Plano Plurianual para o Desenvolvimento do Setor Mineral. Brasília(DF), 102 p.

Ferraz, C. P., Machado, I. F. & Suslick, S. B. 1995 The Brazilian mining industry: current issues and prospects. MEMS Fourth Annual Professional Meeting, Boulder (CO), 15 p.

Machado, I. F.; Bordonalli, S. P. and Hegenberg, F. E. N. 1994, Virgin versus mature reserves: a dilemma for new investment, Raw Materials Report, 10 (1):8 – 16.

Mining Journal. 1994. Emerging Markets, special supplement no. 8295, vol. 323, Sept. 30, 1994, London, UK

Price Waterhouse. Indicadores de Qualidade e Produtividade. Folha de São Paulo, 30/03/95, p. 2 – 8.

Santos, B. A. et al. 1994. GT 22: Desenvolvimento das províncias minerais brasileiras (Unpublished report to "Plano Plurianual para o Desenvolvimento do Setor Mineral"). ■