

THE MINERAL INDUSTRY OF

BRAZIL

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Brazil, the third largest country in the American continent with about 170 million people, had a gross domestic product (GDP) of \$755 billion¹ in 1997; GDP increased slightly to 3.6% compared with 3.2% in 1996 (Ferrer, 1998; Mining Journal, 1998). Foreign exchange reserves were \$51.4 billion. Brazil's total debt burden amounted to \$187.6 billion at yearend. The trade deficit amounted to \$8.4 billion with exports of \$53 billion and imports of \$61.4 billion (Departamento Nacional de Produção Mineral, 1998, p. 2-3). The Brazilian Congress supported the Government's economic plan for stabilization, Plano Real, which was based on strict control of the domestic deficit, issuance of a new currency, stable foreign exchange rates, renegotiation of its foreign debt on favorable terms, and reduction of tariffs.

Brazil responded to the October crisis, provoked by the financial turmoil in Asia, with a massive increase in interest rates to 46% per year from 28% as of September 1997, a package of \$18 billion in emergency budget cuts, congressional reforms to address the twin deficits in the current and fiscal accounts, and a reduction in the role of Government. The response to ensure the country's stability was encouraging, and the risk of an economic meltdown appeared to be ever more distant for Brazil (Moffett, 1998).

In comparison to past plans, Plano Real was based on constitutional reviews, privatization of Government-owned companies, and joint ventures to increase capital flow into the country. There were no price freezes, and the Real Plan relied solely on macroeconomics to achieve its goals. The Real Plan succeeded in restraining Brazil's chronically high inflation, which was held at 7.5%. The Government continued to use a tight monetary policy and high short-term interest rates with the objective of curbing inflation and preventing a price explosion (Bragança, 1998, p. 1; Ferraz, 1998, p. 1). Lower inflation encouraged foreign direct investment (FDI) in Brazil; the U.S. Department of Commerce reported that the FDI amounted \$65.5 billion for 1997. The Brazilian Central Bank also reported that Brazil received \$8.8 billion of FDI in the minerals sector compared with \$9.4 billion in 1996, \$3.9 billion in 1995, and \$2.2 billion in 1994 (Dyer, 1997; U.S. Department of Commerce, 1998a, p. 1-3). Investment opportunities for U.S. and foreign companies have increased because of the stability and liberalization of the Mercosur countries' economies and the privatization of many South America's infrastructure sectors (U.S. Department of Commerce, 1998b).

According to the Brazilian Departamento Nacional de Produção Mineral (DNPM)'s Sumário Mineral of 1997 and 1998, the country produced bauxite, columbium (niobium), gemstones,

gold, iron ore, kaolin, manganese, tantalum, and tin from large deposits and exported them to the global marketplace. In Latin America, particularly within the Southern Cone Common Market (Mercosur), Brazil continued to be the leading producer of aluminum, cement, ferroalloys, gold, iron ore, manganese, steel, and tin. The country continued with its ambitious petroleum exploration program to expand reserves and to reduce dependence on oil imports, which satisfied about 60% of its crude oil requirements. Brazil's reportedly large identified mineral reserves and resources helped make it one of the most dynamic markets in the world, ranking ninth in the global economy and constituting one-third of the Latin American economy (Brito, 1997, p. 1).

Government Policies and Programs

In August 1995, the Brazilian Congress approved constitutional amendments allowing the participation of the private sector via privatization, joint ventures, and deregulated investment in the sectors of mining, petroleum exploration, natural gas distribution, coastal and river shipping, and telecommunications. The lower House approved a bill ending the 40-year Government monopoly of the oil and gas industries and fuel price subsidies after 3 years and allowing *Petróleo Brasileiro S.A.* (Petrobrás) to enter into joint ventures with foreign investors. The Government has established the *Agência Nacional do Petróleo* (ANP) in 1997. ANP will regulate the petroleum industry, which is open to foreign investors (Ferraz, 1998, p. 8). Other significant actions were undertaken by the Brazilian Government—the Brazilian import tariff was lowered to about 14% from 28% in 1990; an Industrial Products Tax, a Federal tax levied on most domestic and imported manufactured products, was set between 0% and 15%; 100% of equity ownership was allowed via privatization or by direct acquisition; and profits were allowed to be expatriated. In the mining sector, restrictions on foreign investments were removed in August 1995. The Concessions Law, also passed in 1995, should create additional opportunities for the private sector in public utilities previously reserved for the Government. These actions were undertaken by the Government to open the Brazilian economy to international competition and have continued to create a favorable and positive environment to attract domestic and foreign investments equally. The establishment of joint ventures, such as in construction and management of railroads, ports, and hydroelectric powerplants, has become a common practice in Brazil. The legal structure of the country via the New Mining Code, law No. 9314 of 11/14/96, was also providing greater flexibility for investment in the Brazilian mining sector. Article 7 of this law stipulates that the exploitation of mineral

¹Where necessary, values have been converted from Brazilian Real R\$ to U.S. dollars at the rate of R\$1.176=US\$1.00.

deposits will depend upon an Exploration Authorization Permit granted by the General Director of the DNPM and a Development Concession issued by the Minister of Mines and Energy. In conformance to this law, the DNPM will enforce this mining code and its complementary legal provisions (Barbosa and Matos, 1997).

The Brazilian Geological Survey, Companhia de Pesquisa de Recursos Minerais was developing programs for basic geological mapping, metallogenetic and hydrogeological mapping and prospecting in areas of potential development, in addition to creating and maintaining geological and economic data bases, particularly for coal, copper, diamond, gold, kaolin, nickel, peat, and zinc, to assist potential investors in the minerals sector (Martins, 1997).

Privatization of Government-owned firms led to lower employment levels and more efficiency. Since yearend 1991, the Government has sold 56 companies, including firms in the utilities and telecommunications sectors, worth \$18 billion to the State plus a transferred debt of about \$8 billion compared with about \$15 billion between 1991 and 1996 (Ferraz, 1998, p. 1; Lapper, 1998, p. I). In April 1997, the privatization of Companhia Vale do Rio Doce (CVRD), the huge mining conglomerate that includes steelmaking and pulp and paper, provided Brazil a revenue of \$3.3 billion and a transferred debt of \$4.3 billion. CVRD's new owner is a consortium led by Companhia Siderúrgica Nacional (CSN), the largest steelmaker and manager of state-pension funds (Ferraz, 1998, p. 1). It appears that privatization will continue—in spite of the steep decline of the stock markets, sales in the utilities and other sectors were expected to generate about \$24 billion in 1999 and \$14 billion in 2000 (Mining Journal, 1997; Welch and Bacha, 1997a; Lapper, 1998, p. I). With CVRD's privatization, the CSN Group will be able to expand investments and production in several mine projects in the near term and to seek expansions in Europe, Latin America, and the United States via joint-venture projects and direct investments.

The country's mining industry continues to attract interest because of the Government's economic policies, Brazil's diversified minerals endowment, and a skilled labor base. Major international mining companies are returning to Brazil. Several of them, which fled Brazil after the promulgation of the 1988 Constitution, began acquiring exploration properties and mining prospects, particularly for gold. Notable active foreign mining corporations in Brazil included Barrick Gold and Newmont of the United States; Placer Dome, INCO Limited, and TVX Gold Inc. of Canada; Anglo American Corp. and General Mining Union Corp. Ltd. of South Africa; Rio Tinto Zinc Mineração Ltd. (RTZ) of the United Kingdom; and BHP Minerals and Western Mining Company of Australia.

Environmental Issues

According to the Conselho Nacional de Meio Ambiente, an environmental license was required for all mining activities in Brazil. In 1986, law No. 88351 established the National System for the Environment, which comprises representatives of the Federal, states, and local governments and private foundations involved in environmental protection and improvement. Article

225 of the 1988 Constitution stipulated that mining operators must reclaim areas they have environmentally degraded. Later, detailed legislation, which was passed with a goal of harmonizing mining activities with the environment, included the Plan for Recovery of Degraded Areas and the Environmental Control Plan (Departamento Nacional de Produção Mineral, 1996).

The Ministério de Minas e Energia enforces the 1989 decree, which prohibits the use of mercury and cyanide in the mining of gold unless approved by Brazilian local environmental agencies, and offers technical assistance to *garimpeiros* (small-scale independent miners), in particular, on producing gold without affecting the environment. It is expected that environmental impacts will be lessened in the future.

Resolution 010 of December 6, 1990, required that all mining operations obtain environmental licenses prior to the granting of mineral rights by the DNPM. As environmental problems increased, antipollution measures were enacted to eliminate the sources of pollutants and to mitigate their effects on the environment.

Production

The total value of minerals produced in 1997 was about \$14.6 billion, or almost 2% of the GDP. Crude oil and natural gas amounted to almost \$6.4 billion. Brazilian minerals production, which increased by 6.7% from that of 1996, was related to the iron ore output, which increased by 7.8%. Increases also were recorded in production, in descending order, of fluorite, 32.7%; columbium (niobium), 30.9%; zinc, 30%; kaolin, 21%; graphite, 20.8%; and, to a lesser extent, nickel, natural gas, and crude oil. Bauxite, manganese, gold, and copper production decreased by about 0.6%, 3.1%, 4.5%, and 13.7%, respectively. Depletion of shallow gold and tin deposits and environmental constraints on *garimpeiros* were expected to affect future output of gold and tin (Departamento Nacional de Produção Mineral, 1998, p. 4). There were five major integrated steelworks—Aço Minas Gerais, S.A. (AÇOMINAS), a structure and rail producer; CSN, Brazil's largest mill; Companhia Siderúrgica Paulista (COSIPA), a carbon steel sheet and plate producer; Companhia Siderúrgica de Tubarão (CST), a slab producer; and Usinas Siderúrgicas de Minas Gerais S.A. (USIMINAS), Brazil's second largest steel mill. These companies produced about 17.5 million metric tons (Mt) of the total Brazilian steel production of 25.2 Mt. Seven firms accounted for 94% of iron ore production. CVRD produced about 56.2% of the iron ore. Mineração Rio do Norte, S.A. (MRN), the majority of which is privately owned and which is the world's third largest bauxite producer and exporter, produced about 74.4% of the total bauxite production, which amounted to about 12.5 Mt. The five major aluminum smelters, all predominantly private Brazilian or foreign owned, produced about 87% of the primary aluminum production of 1.2 Mt. (*See table 1.*)

Trade

Brazil is the largest open market and geographic center of Mercosur, the trade bloc that also includes Argentina, Paraguay, and Uruguay. Bolivia and Chile joined Mercosur in 1997 as associate members. Peru was negotiating its entrance. The

member countries of Mercosur have almost 230 million people, 33.1% of America's population and a combined GDP of \$1.3 trillion, which represents about 65% of South America's total GDP. Most multinational companies consider this growing trade bloc to be extremely important, after the North America Free Trade Agreement (NAFTA) and the European Union, because of its size and the amount of trade taking place in the region (Thurston, 1997). Also, Mercosur's success and Brazil's growing global importance have increased South America's attractiveness for investment opportunities, particularly in the minerals and energy sectors (A.M. Diez, P.T. Flecha de Lima, D.R. Guelar, and J.G. Prieto, Mercosur Ambassadors, Seattle, Washington, written commun., 1998). This achievement of success will depend upon the continued economic reforms and stability of the area. The growing importance of Brazil should give Mercosur a greater range of strategic options in its trade negotiations with NAFTA and the Free Trade Agreement of the Americas' process (Fidler, 1997).

Mercosur's common external tariff ranges up to 20% for minerals. When Mercosur is fully implemented, unrestricted movement of labor, goods, and services will take place among the four principal members and the two associate members. Mercosur has had its impact on the Latin intraregional trade, which increased to about \$30 billion from \$7 billion in 1983. Intra-Mercosur trade amounted to \$17 billion, and mineral trade amounted to \$4 billion.

During 1997, Brazil sold 25% of its exports to the other Mercosur members and 8% to the other countries in South America. Brazilian mineral imports were valued at \$11.725 billion, or 7% higher than those of 1996, and its total exports were \$11.331 billion, or about 5.1% below those of 1996. The value of the principal exports were steel products, \$3.041 billion; iron ore, \$2.910 billion; and aluminum, \$1.380 billion. In addition to petroleum and derivatives (\$6.2 billion), other major mineral imports (\$4.834 billion) were coal, copper, lead, natural gas, potash, sulfur, and zinc (Departamento Nacional de Produção Mineral, 1998, p. 3; Petrobrás Magazine, 1998, p. 3).

In 1997, the U.S. trade surplus was \$6.3 billion, or 103.2% higher than that of the previous year (\$3.1 billion). Brazilian imports from the United States increased to \$15.9 billion from \$11.8 billion in 1996, or more than 34.7%. Brazilian exports to the United States increased to \$9.6 billion from \$9.3 billion in 1996, or 3.2% (U.S. Department of Commerce, 1998a, p. 1).

Structure of the Mineral Industry

The mineral industry of Brazil is large by world standards. The major portion of the industry was partially or wholly owned by private Brazilian investors, Brazilian corporations, and foreign companies. The exceptions were the natural gas and petroleum industries, which were 100% Government owned through Petrobrás, which comprised four subsidiaries—Petrobrás Distribuidora, S.A., the petroleum products distribution company; Petrobrás Química, S.A., the petrochemical company; Petrobrás Internacional, S.A., the foreign operating company; and Petrobrás Fertilizantes, S.A., the agricultural fertilizer company.

The structure of the Brazilian mineral industry is changing to a privately-owned/Government-regulated regime from

Government-owned/Government-operated mode. Thus far, the State has privatized the steel industry and CVRD during the 1991 to 1997 period. Additionally, there were 40 cement companies operating 64 cement plants and 7 grinding plants with a clinker capacity of 45 Mt, and 40 iron ore mining companies operating 90 mines (Departamento Nacional de Produção Mineral, 1997, p. 36, 53).

Brazil's total labor force was nearly 60 million. Of this total, services represented 42%; agriculture, 31%; and industry, 27%. The minerals sector employed about 4% (650,000) of the industry total (16 million). This did not include the 500,000 to 1 million garimpeiros active in Brazil. Employment in the mining sector continued its downward trend as Brazil's economy was affected by joint ventures and privatization, particularly of the steel and mining sectors. (See table 2.)

Commodity Review

Metals

Alumina, Aluminum, and Bauxite.—Primary aluminum production amounted to 1.2 Mt of metal, which remained at nearly the same level as that of 1996. Similarly, bauxite production was unchanged from the previous year (12.5 Mt). MRN is a joint venture owned by CVRD, 40%; Billiton International Metals B.V. (Billiton), 14.8%; Alcoa Alumínio S.A. (Alcoa), 13.2%; Alcan Empreendimentos Ltda. (Alcan), 12.0%; Companhia Brasileira de Alumínio (CBA), 10%; Norsk Hydro Comercio e Industria, 5%; and Reynolds Alumínio do Brasil (Reynolds), 5%. MRN accounted for almost 75% of the total bauxite production (9.3 Mt) for 1997. Alumina production remained at the same level as that of 1996 (2.8 Mt). A consortium led by CVRD produced 1.18 Mt of calcined alumina, 43.5% higher than the 826,000 metric tons (t) reported in 1996 from the Jabuti Project, near Paragominas, Pará (Ferraz, 1998, p. 1).

In Brazil, producers of primary aluminum were Albras-Alumínio Brasileiro S.A. about 338,000 t, and Alcoa, 279,700 t. Other producers included CBA, 221,000 t; Billiton, 206,500 t; Alcan, 93,200 t; and Vale do Sul Alumínio S.A., 50,600 t. When MRN opens its new mine with bauxite reserves of 800 Mt and a capacity of 2 million metric tons per year (Mt/yr) in the Papagalo plateau, Trombetas, Pará, in March 1998, it will have invested \$91 million. This new mine will increase MRN's total bauxite production capacity to 13 Mt/yr from about 10 Mt/yr. Reynolds is building its third plant, which will produce an additional 1.5 million aluminum cans; total capacity will reach 5.4 million cans per year.

Alto Brazil Mineração is a joint venture of Alcoa (60%) and Billiton (40%) set up to mine their Oriximina bauxite deposit near the Trombetas River and MRN's bauxite mine in Pará. When in operation, they will supply the feed to Alcoa's refinery at São Luís, Maranhão. Alcoa was planning to expand its Alumar aluminum plant to 239,000 metric tons per year (t/yr) from 194,000 t/yr by the end of 1999. Alcan expanded its aluminum sheet production capacity to 120,000 t/yr from 100,000 t/yr as a part of a \$380 million investment program and is planning to increase its primary capacity to 150,000 t/yr. Exports of bauxite

were 4.4 Mt, valued at \$125 billion; primary aluminum was 811,000 t, valued at about \$1.38 billion (Departamento Nacional de Produção Mineral, 1997, p. 18-19; Ferraz, 1998, p. 1-2).

Columbium (Niobium) and Tantalum.—Brazil continued to be the world's most significant producer and main supplier of columbium to the global economy. Brazil produced about 91% of the world's total production with about 25,500 t of pyrochlore in concentrate, 15,700 t of columbium in alloys, and 1,730 t of columbium in oxides. In 1997, Companhia Brasileira de Metalurgia e Mineração (CBMM) and Mineração Catalão de Goiás Ltda (MCGL) accounted for 80% and 20%, respectively, of Brazil's 48,000-t/yr pyrochlore production capacity. The most important columbium plant was in Araxá, Minas Gerais, operated by CBMM, which accounted for about 88% of Brazil's production capacity and supplied about 70% of the world demand for ferrocolumbium. Columbium also was produced at the Chapadão plant (3,000-t/yr capacity) in Ouvidor, Goiás, owned by MCGL. MCGL's pyrochlore production capacity was 13,000 t/yr. Araxá and Catalão columbium ore deposits contained 88.2% (4.5 Mt) of the world's pyrochlore reserves at yearend.

Early in the year, the Mining Resources and Research Co. of Amazonas had announced the discovery of what may be the largest columbium-bearing deposit in the world. It was found in the São Gabriel da Coxoeira (Rio Negro), Amazonas, and contained about 2,900 Mt of columbium ore (Mining Journal, 1997).

Tantalum production totaled 50 t. The Araxá deposit, considered to be the world's largest and most economically viable ore body, contains columbite and tantalite and produces 190 t/yr. In the long run, the upward trend in tantalum supply will continue in response to increased world demand (Departamento Nacional de Produção Mineral, 1997, p. 74-75).

Copper.—According to reports (Departamento Nacional de Produção Mineral, 1998; Ferraz, 1998), production of copper concentrate amounted to 39,814 t, a decrease of 14% compared with that of 1996. The concentrate was produced by the Paranapanema Group's Mineração Caraíba S.A. (MCSA) deposit in Jaguari, Bahia, Brazil's only copper mine. This mine will be converted to underground operations from open-pit mining because of surface copper-ore depletion and will produce between 28,000 and 30,000 t/yr of copper until 2006. The total primary copper metal production amounted to 177,000 t, an increase of 2.9% compared with that of 1996; this also included 434,465 t of copper concentrates imported from Chile, 60%; Peru, 20%; and Indonesia, 14%. MCSA, the only electrolytic copper producer, invested \$20 million to expand its production capacity to 200,000 t/yr from 177,000 t/yr of cathodes. The firm also signed a 3-year contract to acquire 40,000 t/yr of copper concentrates from the Bajo de la Alumbrera Mine in Argentina. To meet Brazil's copper demand of 258,000 t/yr, the country imported 153,490 t of copper products in 1997.

In 1997, a \$20 million geologic revaluation of the largest copper project, Salobo Metais (CVRD, Anglo American Corp., and the Brazilian Banco Nacional de Desenvolvimento Econômico e Social, each 33⅓%) in Pará, increased its reserves to 1,900 Mt grading 0.65% copper from 784 Mt of ore reserves

containing 0.96% copper with associated gold, molybdenum, and silver sufficient to support a 250,000-t/yr capacity operation. Three other copper projects, Chapada (Mineração Santa Elina S.A.), Igarapé (Bahia-Alemão Ltda.), and Sossego (CVRD/Phelps Dodge Corp.), are at the feasibility stage. Production of 7,000 t/yr of copper sulfate as a byproduct of nickel was anticipated from Fortaleza de Minas' nickel mine; this will not be available for domestic consumption because the nickel matte will be exported to Finland. Brazil's metallic copper production was used primarily in construction and in automobile manufacturing. With total copper exports of 69,713 t, copper balance of trade showed a deficit of \$255 million, the largest among the nonferrous metals in Brazil (Departamento Nacional de Produção Mineral, 1997, p. 38-39, 1998, p. 6; Ferraz, 1998, p. 2).

Gold.—Gold production was reported by the DNPM as 58 t (Departamento Nacional de Produção Mineral, 1997, p. 78, 1998, p. 5), which represented 40.5 t from mining companies and 17.5 t from garimpos (cooperatives of garimpeiros). The decreases in gold production from the garimpeiros was because of higher production costs, depletion of shallower deposits, and stricter environmental standards to be met and from the private sector was because CVRD's gold output decreased by 311 kilograms. CVRD's mines in the States of Bahia, Minas Gerais, and Pará produced 17.7 t. The second largest producer of gold in Brazil was Mineração Morro Vehlo S.A. of Minorco Group, with 6.55 t. The third largest producer of gold, Rio Paracatu Mineração S.A., a British concern (RTZ) associated with TVX Gold Inc., produced 4.86 t from its Paracatu Mine in Minas Gerais. Minorco's Mineração Serra Grande produced 3.9 t.

São Bento Mineração S.A. produced 3.7 t of gold at its Santa Barbara Mine in the east-central part of the State of Minas Gerais. Gold was extracted by a combination of pressure oxidation and bioleaching using the South African General Mining Union Corp. Ltd.'s technology. Mineração Santa Elina S.A. operated its São Vicente Mine in Mato Grosso, producing 1.3 t of gold. This mine will be expanded to produce about 10 t of gold by the end of this decade.

Brazilian gold production could increase significantly in the near future because of increased interest by domestic and foreign investors in largely unexplored areas. More than 2,000 gold deposits are known, mostly Precambrian vein deposits and alluvial placers (Departamento Nacional de Produção Mineral, 1997, p. 78-79, 1998, p. 5; Ferraz, 1998, p. 3).

Iron and Steel.—Ferroalloys.—Ferroalloy production decreased to 883,509 t from 1.04 Mt in 1996. For the year, exports decreased from those of 1996 but reached 336,000 t, valued at \$500 million. Brazil was the third largest ferroalloy producer in the world and the third largest exporter. Apparent domestic consumption was about 742,000 t. Brazil's Prometal Produtos Metalúrgicos S.A. took as a partner to Norway's Elkem A/S, one of the world's largest manganese alloy producers, to produce 500,000 t of ferromanganese. The project, in which Elkem will hold a 40% share, is in Marabá, Pará. The manganese will come from the nearby Prometal Mine, and the iron ore will come from the Carajás District. Nova Era Silicon S.A., in which CVRD (49%) is associated with Japanese capital [Mitsubishi

(25.5%) and Kawasaki Steel (25.5%)], is building a silicon ferroalloy plant in Nova Era, Minas Gerais, with an installed capacity of 48,000 t/yr. About two-thirds of its output will be exported, mainly to Japan, during the decade (Departamento Nacional de Produção Mineral, 1997, p. 52-53, 1998, p. 5; Ferraz, 1998, p. 3).

Iron Ore.—Brazil produced 187.9 Mt of iron ore, an increase of 7.8% compared with 174.2 Mt in 1996. About 94% of that production was from seven major iron ore companies—CVRD, Minerações Brasileiras Reunidas S.A. (MBR), Ferteco Mineração S.A., Samarco Mineração S.A. (SAMARCO), S.A. Mineração da Trindade (SAMITRI), CSN, and Itaminas Comércio de Minérios S.A. CVRD and MBR were the two largest iron ore exporters with shipments of 85 Mt valued at \$1.8 billion and 23 Mt worth \$405 million, respectively (Departamento Nacional de Produção Mineral, 1997, p. 52-53, 1998, p. 5; Ferraz, 1998, p. 3).

The total iron ore exports were about 140 Mt, which represented an increase of almost 7.6% compared with those of 1996, and shipped to 40 countries. Total export revenues increased to \$2.91 billion by yearend from \$2.7 billion in 1996. The major importers of Brazilian iron ore were Japan, 20%; Germany, 16%; China, 7.4%; and the Republic of Korea, 7.2%. The customized commercial products (varied chemical characteristics) sold were sinter-feed and pellet-feed, 70.3%; pellets, 21.4%; and lump ore, 8.3%.

CVRD started the construction of the KobraSCO pellet plant, its seventh, which is a joint venture with Pohang Iron and Steel Co. (POSCO) of the Republic of Korea. The facility is in the port of Tubarão, Espírito Santo; CVRD-POSCO invested \$230 million to produce 4 Mt/yr of pellets. MBR has opened three new mines, Capão Xavier, Tamandúa, and Capitão do Mato in Minas Gerais to increase annual capacity to 32 Mt/yr from 23 Mt/yr and to offset the iron ore depletion at the Aguas Claras and the Mutuca Mines. RTZ Corp PLC (Rio Tinto's Group), Mineração Corumbaense S.A., was planning a \$200 million plant to produce 1 Mt/yr of hot briquetted iron at Corumba in Matto Grosso to supply steel plants in Argentina. This facility will use natural gas from a 3,000-kilometer (km) pipeline between Brazil and Bolivia currently under construction (Ferraz, 1998, p. 3).

SAMARCO (SAMITRI, 51%; Broken Hill Properties S.A., 49%) is planning to build its second pellet plant at Ponta do Ubo in Espírito Santo. The expansion will increase the production to 13 Mt/yr (12 Mt/yr of pellets for blast furnace and 1 Mt/yr of pellet-feed for direct reduction) from 5.5 Mt/yr of pellets at a cost of \$250 million (Breña, 1997, p. 1).

Pig Iron.—Brazil produced 25 Mt of pig iron, which remained at the same level as that of 1996. Exports were 2.5 Mt valued at \$288 million, approximately one-third of the pig iron traded in the world (Ferraz, 1998, p. 4).

Steel.—Brazil's 1997 steel production totaled 25.1 Mt, which remained at the same level as that of 1996, placing the country eighth in the world. The major recipients of Brazil's exports were Asia, 5 Mt; Latin America, 2 Mt; and the United States, 1.4 Mt (Instituto Brasileiro de Siderurgia, 1997, p. 32). The Instituto Brasileiro de Siderurgia stressed that the Brazilian steel industry

no longer received subsidies or enjoyed tariff protection and that the industry became more efficient because of the major changes it had made via privatization. Brazil has begun to auction Government-owned assets in amounts never before seen in Latin America, and privatization can be expected to generate \$15.9 billion in 1997, \$20 billion in 1998, and \$19.8 billion in 1999 (Welch and Bacha, 1997a).

Privatization has fundamentally improved inefficiency and reduced employment levels of the Brazilian steel industry. Vertical integration was evident as suppliers and customers of the steel companies participated in the auctions. For instance, CVRD acquired significant minority holdings in CST, CSN, and USIMINAS, supplied them with iron ore, and continued to provide them with railroad, port, and shipping facilities.

After the Government's privatization program identified Brazil's steel industry as one of the first sectors for auction via the stock exchanges of Rio de Janeiro and São Paulo, the State-owned steel companies were largely privatized in 1991. The last steel companies sold were COSIPA in 1992 and AÇOMINAS in 1993. The decline in employment in the steel industry from 174,000 in 1989 to 102,300 in 1997 reflected, in part, the effects of privatization and associated downsizing. Government-owned companies, expecting to be privatized, reduced employment levels in anticipation of the process. Other major privatizations, in the near term, are expected to collect an additional \$56 billion (Welch and Bacha, 1997b).

Manganese.—Brazil produced 2 Mt of manganese ore in 1997, which was 9.1% lower than that of 1996. CVRD continued operating its high-grade manganese mine, Igarapé Azul, in the Carajás complex, which produced 1 Mt of metallurgical manganese, no increase from that of 1996. Indústria e Comércio de Minérios S.A., controlled by the Caemi Mineração e Metalurgia Group, was the second largest Brazilian producer with 332,000 t and closed its operations at the end of 1997 because of ore depletion at the Macapa Mine. Other manganese ore producers were Mineração Buritirama, a subsidiary of Prometal Produtos Metalúrgicos S.A., 280,000 t; Sociedade Mineira de Mineração Ltda., controlled by CVRD, 242,000 t; Urucum Mineração S.A., 198,000 t; and SAMITRI, 10,000 t. Exports of manganese were relatively unchanged over 1996 at 984,214 t valued at \$56.4 million (Departamento Nacional de Produção Mineral, 1997, p. 66-67; Ferraz, 1998, p. 2).

Nickel.—Brazil produced 18,199 t of electrolytic nickel and contained in ferronickel alloys, which was about 11% higher than the 16,432 t of nickel produced in 1996. Companhia Niquel Tocantins (CNT) produced 8,849 t of electrolytic nickel. In Minas Gerais, RTZ's Mineração Serra da Fortaleza came on stream in December 1997 with a capacity of 10,000 t/yr of electrolytic nickel equivalent, or 19,000 t/yr of nickel matte, which was sold in a 10-year contract to Outokumpu Oy's Harjavalta refinery of Finland. CNT planned to invest \$86 million to increase its production to 17,500 t/yr of nickel, subject to favorable market prices (Departamento Nacional de Produção Mineral, 1997, p. 76-77; Ferraz, 1998, p. 3).

Tin.—Brazil was the world's third largest tin producer

following China and Indonesia. Tin production, in concentrate, decreased to 18,290 t from 19,611 t in 1996. The reduction in Brazilian output was attributed to the closing of some high-cost operations, the decrease in the ore grades, and the decline in tin prices. Production cuts were made at the Pitinga Mine in Amazonas, operated by the world's largest tin firm, Paranapanema S.A. Mineração, Indústria e Construção, and at the garimpeiros' Bom Futuro operations in Rondônia. Exports increased to 12,960 t from 12,290 t in 1996, valued at \$65.4 million. These exports were below the quota assigned, to Brazil, by the Association of Tin Producing Countries (20,185 t/yr). Shipments were made to the United States, 73%; Argentina, 10%; Belgium, 5.7%; and the United Kingdom, 2.5%. Paranapanema produced 6,212 t of tin from its high-grade Pitinga Mine, with byproducts of, in order of importance, columbium, tantalum, zirconium, hafnium, thorium, and cryolite. Garimpeiros produced 6,597 t, and Paranapanema's Rondônia operations produced 5,481 t (Departamento Nacional de Produção Mineral, p. 48-49, 1997, 1998, p. 6; Ferraz, 1998, p. 3).

Zinc.—Brazil produced 152,600 t of zinc in concentrates, which was 30% higher than the 117,343 t in 1996. This output increase was a result of the Vazante Mine's expansion in 1997. Vazante, in Minas Gerais, is owned by Mineração Areiense S.A. The Brazilian zinc refineries produced 185,701 t of primary metal, which was 4.6% higher than that of 1996. To meet Brazil's demand for zinc, which was about 175,000 t/yr of metal, the country imported 213,000 t of zinc concentrates and 5,900 t of metal. Peru supplied 91% of concentrates and 27% of metal zinc; metal zinc was also supplied by Sweden, 25%; Netherlands, 16%; Belgium, 15%; and Mexico, 8% (Departamento Nacional de Produção Mineral, 1997, p. 102-103, 1998, p. 6; Ferraz, 1998, p. 3).

Industrial Minerals

Asbestos.—According to the DNPM, economically significant asbestos deposits were in Minaçu, Goiás (Departamento Nacional de Produção Mineral, 1997, p. 32). Sociedade Anônima Mineração de Amianto (SAMA) produced 3.95 Mt of chrysotile ore and 213,200 t of asbestos fiber, which was about the same production level as that of 1996. About 80% of Brazil's asbestos output was consumed in the manufacture of specialized cement products, such as ceiling tiles, protective screens, water and sewer pipes, water tanks, and molded electrical insulators. Other uses were in thermal insulators, paper and cardboard, slabs, decorations, insecticide, asphalt for highways and airport runways, and the automobile industry.

Brazil exported about 223,000 t mainly to India, 37%; Thailand, 20%; Japan, 15%; and Indonesia, 6%. Domestic consumption has increased steadily in recent years. The State of São Paulo was the country's largest consumer followed by the States of Paraná and Rio Grande do Sul. Asbestos mining and consumption have been highly regulated in most industrialized nations, forcing them to reduce production and consumption. Industry experts expected asbestos use in the industrial nations to continue to decline beyond the turn of the century. In contrast, the world's developing nations were expected to increase their

collective asbestos consumption by large margins. Brazilian asbestos reserves (17.2 Mt) were considered to be adequate to meet demand in the short to medium term; SAMA was investing in an exploration program to assure a long-term supply. The average grade of ore from the Cana Brava Mine in Minaçu was 5.235%, and its reserves, considering its fiber content only, were 3.0 Mt, which, at a production rate of 200,000 t/yr, represented a 15-year mine life (Departamento Nacional de Produção Mineral, 1997, p. 20-21).

Cement.—The country produced 38.1 Mt of cement, which was almost 10.1% higher than that of 1996. Minas Gerais contributed 25%; São Paulo, 20.1%; Paraná, 9.7%; Rio de Janeiro, 8.8%; and other States, 36.4%. Most of the exported cement (106,500 t) went to Bolivia, 31%; Paraguay, 25%; Peru, 8%; and Colombia, 4%. Brazil imported about 420,000 t of cement from Venezuela (86%) and Belgium (7%) (Departamento Nacional de Produção Mineral, 1997, p. 36-37).

Clays.—Kaolin.—Production of beneficiated kaolin was about 1.2 Mt, which was almost 9.1% higher than that of 1996. Caulim da Amazônia S.A. continued operating its Adam Mine in Rio Jarí, Amazonas, and accounted for 55% of the country's total output. Brazilian kaolin exports were 27% higher than that of 1996, or 746,743 t. Pará Pigmentos S.A. (PPSA) produced 200,000 t of kaolin, with CVRD's \$212 million investment, PPSA's operations will be expanded to a full capacity of 1 Mt/yr by the end of the decade or early 2000. Rio Capim Caulim S.A. (RCCSA) produced 250,000 t. By the turn of the century, depending on market conditions, RCCSA was considering expansion that will increase its capacity to 500,000 t/yr. In Brazil, kaolin was used mainly in the paper and ceramics industries, and to a lesser degree in the manufacture of rubber, plastics, pesticides, animal feed, food supplements and pharmaceuticals, fertilizers, and paint, as well as many other applications. Brazil had 1.5 billion metric tons of kaolin reserves, or about 12.7% of the world's total (Departamento Nacional de Produção Mineral, 1997, p. 32-33; Ferraz, 1998, p. 3).

Gemstones.—For many years, Brazil has been an important world producer and exporter of gemstones in terms of volume and variety. Because the largest proportion of gemstones produced was mined by garimpeiros, gemstone reserves are unknown. Brazil, however, may have great potential, and the country has 600 million cubic meters of sedimentary rocks containing diamond which grades between 0.01 and 0.1 carat per cubic meter (Departamento Nacional de Produção Mineral, 1997, p. 42). The total value of gemstone (including diamond) production was \$108 million, the same level as that of 1996. Total exports of uncut gemstones have decreased to \$34.5 million from \$51.5 million in 1996, and imports remained at the same level as that of 1996, or about \$13 million, despite the removal of some export barriers (Departamento Nacional de Produção Mineral, 1997, p. 42-43).

Graphite.—Historically, Brazil's beneficiated natural graphite output had been centered in Minas Gerais. Nacional de Grafite Ltda. (NGL) mined natural graphite in the municipalities of Itapecerica and São Francisco de Paula, which amounted to

48,900 t grading 14% of carbon, denoting an increase of 20.8% compared with that of 1996. This production was concentrated in products ranging in grade from 61% to 99.5% carbon by NGL in the Pedra Azul plant. Also in Minas Gerais, Empresa de Mineração J. Mendes Ltda. produced 4,500 t of natural graphite, which was consumed, domestically, after simple grinding (Departamento Nacional de Produção Mineral, 1997, p. 60, 1998, p. 7).

Three types of beneficiated products were processed by NGL in Itapecerica and Pedra Azul— lump graphite, medium grained graphite, and graphite fines. Brazil's demand for natural flake-type crystalline graphite was met by the Pedra Azul and the Itapecerica beneficiation plants, which had installed capacities of 30,000 and 4,500 t/yr, respectively. Imports totaled 1,104 t valued at \$625,000, and exports amounted to 11,500 t valued at about \$12.2 million. Growth of the domestic consumption of natural graphite during the 1980's and 1990's was correlated with the stability of the iron and steel industries, which absorbed about 80% of the natural graphite consumed in Brazil (25,600 t), in 1997. Other consumers included battery manufacturing, 6.5%; refractories, 6%; paint and varnishes, 2%; and other miscellaneous uses, 5.5% (Departamento Nacional de Produção Mineral, 1997, p. 61).

Magnesite.—The most important magnesite mine in Brazil was Pedra Preta Mine, owned and operated by Magnesita S.A. (MSA) in the Éguas Mountain region of Brumado, Bahia, about 610 km from Salvador. Brazil produced 300,500 t of magnesite, of which MSA produced 92%, or 276,500 t. Exports were 93,220 t valued at \$14 million and shipped to Poland, 35%; Argentina, 19%; Venezuela, 14%; Chile 11%; Germany, 8%; and others, 13%. Imports were 12,800 t valued at \$5.5 million and imported from China, 25%; the United States, 19%; Norway, 14%; France, 12%; and others, 30% (Departamento Nacional de Produção Mineral, 1997, p. 65). In Brazil, about 630 Mt of resources with 180 Mt of magnesium content had been identified by yearend. In the next decade, MSA's beneficiation plant in Brumado and its industrial complex in Contagem, Minas Gerais, where a range of refractory materials are produced, should continue operating at the same level of current operation capacity (36,000 t/yr) (Departamento Nacional de Produção Mineral, 1997, p. 65).

Phosphate Rock.—Production of phosphate rock concentrate amounted to about 4.27 Mt, an increase of 10.6% from that of 1996. Production was highly concentrated in four mining companies—Fertilizantes Fosfatados S.A., 34%; Fertisul S.A., formerly Arafertil S.A. and Serrana, 33%; Ultrafertil S.A., 19%; and Copebras S.A., a subsidiary of Minorco of Luxembourg and Anglo American Corp. of South Africa, 14% (Ferraz, 1998, p. 3). The reported domestic consumption was 4.8 Mt/yr. Of the total phosphoric acid, 73% was used in the fertilizer industry, 25% in the chemical industry, and the rest for other uses (Departamento Nacional de Produção Mineral, 1997, p. 55).

Quartz.—Brazil produced 6,508 t of quartz, valued at about \$8.6 million, and continued to be the largest producer in the world. Quartz exports were 5,549 t, valued at about \$10.7 million, and were shipped mostly to Japan, 35.5%; Hong Kong,

26%; the United Kingdom, 16.2%; Germany, 11.7%; the United States, 6.5%; and others, 4.1%. Telequartzo Exportação S.A. and others produced quartz powder, which is an important constituent in the production of optic fibers, crucibles, oscillators, solar cells, wafers and integrated circuit packing, and ceramic materials of exceptional purity. Brazil's reserves were estimated to be 53 Mt (Departamento Nacional de Produção Mineral, 1997, p. 85).

Salt.—The reported domestic production of marine salt was 3.9 Mt, which represented a 13.2% decrease from that of 1996's output. Rio Grande do Norte S.A. continued to be the major source of salt with 89%, followed by Rio de Janeiro, 6%; Ceará, 3.4%; Piauí, 1.3%; and Maranhão, 0.3% (Departamento Nacional de Produção Mineral, 1997, p. 88). The domestic consumption of marine salt was 5.3 Mt. Brazil also produced 1.51 Mt of rock salt. Sal-gema Mineração e Química in Maceió, Alagoas, produced 759,000 t (50.1%) of rock salt and Dow Química do Nordeste, a subsidiary of Dow Chemical, USA, produced 755,000 t (49.9%) from the Vera Cruz Mine in Bahia. The total salt consumption was for chemical industry, 46% (chlorine and caustic soda, 39%, and deicing salt, 7%); feedstock, 40%; and other uses, 14% (Departamento Nacional de Produção Mineral, 1997, p. 89).

Other Industrial Minerals.—Potassium production increased by 15.4%, to 466,900 t, compared with that of 1996. Brazil imported 1.8 Mt of potash, mainly from Canada, 35%; Russia, 25%; Germany, 22%; Israel, 11%; and other countries, 7% (Departamento Nacional de Produção Mineral, 1997, p. 80-81; 1998, p. 7).

Fluorspar production increased by 33.4%, to 78,398 t, compared with that of 1996. Production of the acid-grade type increased by 43.8% (67,163 t) because of better domestic prices; the output of metallurgical-grade material, however, decreased by 6.9% (11,235 t) because of competitive imports. The Brazilian steel industry benefited of the lower international prices for metallurgical-grade fluorspar (Departamento Nacional de Produção Mineral, 1998, p. 7-8).

Production of gypsum was about 1.2 Mt, or 12.2% higher than that of 1996. In Brazil, the renewed housing and infrastructure activities improved the consumption of cement and plasters (Departamento Nacional de Produção Mineral, 1998, p. 8).

Production of talc was 270,000 t, which was 6.1% lower than that of 1996. The State of Paraná was Brazil's major talc producer with 55% of the national output; Paraná, however, produced lower volumes as a result of some talc ore depletions that had taken place in 1997 (Departamento Nacional de Produção Mineral, 1998, p. 8).

Mineral Fuels

Brazil produced 307.2 million barrels (Mbbbl) of petroleum and 9.9 billion cubic meters (m³) of natural gas, which were 7.1% and 7.7% higher than those of 1996, respectively. The total amount of energy produced was 165.9 Mt of oil equivalent. The primary sources were, in order of importance, hydraulic energy, firewood, petroleum, sugarcane bagasse, natural gas, steam coal, metallurgical coal, and uranium. Crude oil and products total

imports were valued at \$6.21 billion, and total exports were valued at \$529 million. Petrobrás's average production of crude oil was 869,000 barrels per day in 1997, and it was planning to reach a target of 1.6 million barrels per day in 2001 (Ferraz, 1998, p. 8; Petrobrás Magazine, 1998, p. 2-3).

Coal.—The Brazilian coal industry is not a large component of the minerals industry. Coal production is concentrated in the southern States of Rio Grande do Sul, 56.4%; Santa Catarina, 41.3%; and Paraná, 2.3%. Brazil's production of marketable coal products increased to 5.6 Mt from 4.7 Mt in 1996, or an increase of 19%. Carbonífera Criciúma S.A. and Companhia Carbonífera de Urussanga in Santa Catarina produced about 2.5 Mt, each and, the remaining was produced by Companhia de Pesquisas e Lavras Minerais-Copelmi in Rio Grande do Sul. To meet Brazil's metallurgical coal demand, 10.4 Mt was imported. Imports of metallurgical coal amounted to 13.9 Mt, valued at \$807 million, or an increase of 12.1% compared with that of 1996. Imports came from the United States, 49%; Australia, 25%; Canada, 9%; South Africa, 9%; and others, 8%. Coal consumption had reached 15.5 Mt by yearend. Metallurgical coal represented 68% of this total consumed by the steel industry, and the remainder was for power generation. The State of Santa Catarina and the U.S. Trade and Development Agency entered into a technology transfer agreement to introduce continuous mining methods for underground coal mines and new treatment processes. Most Brazilian coals have lower content of carbon and a higher content of ash compared with those of Colombian coals. Total Brazilian coal reserves were estimated to be 6.5 billion metric tons (Departamento Nacional de Produção Mineral, 1996, p. 30-31; Ferraz, 1998, p. 2).

Natural Gas and Petroleum.—The gas pipeline linking the Enchova platform in the offshore Campos Basin to Macaé, Rio de Janeiro, has added 5 million cubic meters per day (Mm³/d) of gas flow to the Rio de Janeiro and the São Paulo markets. Two agreements have been signed between Petrobrás and Yacimientos Petroleros Fiscales of Argentina and Yacimientos Petroleros Fiscales of Bolivia to supply natural gas to Brazil. The Argentina-Brazil gas pipeline will link Aldeia Brasileira in Argentina to Porto Alegre in Rio Grande do Sul. The 3,150-km Bolivia-Brazil gas pipeline was under construction and will transport 30 Mm³/d. It will run from Santa Cruz de la Sierra in Bolivia to Mato Grosso do Sul, São Paulo, Paraná, Santa Catarina, and Rio Grande do Sul (Petrobrás Magazine, 1998, p. 6).

Braspetro, the international operating subsidiary of Petrobrás, continued producing natural gas in the Gulf of Mexico. The gas was recovered from the Frederick Field, 27 km off the Louisiana coast by Petrobrás América Inc., a subsidiary of Braspetro.

Crude oil production amounted to 48.8 million cubic meters or 307.2 Mbbl, and natural gas production amounted to 9.9 billion cubic meters (Petrobrás-USGS, Minerals Questionnaire, 1996-97). Brazil's imports of petroleum and derivative products were 274 Mbbl at a cost of \$6.2 billion; of this total, Saudi Arabia supplied 70%, and the remainder was supplied by Algeria, Argentina, Kuwait, Nigeria, and Venezuela.

Uranium.—Brazil owns the fifth largest uranium reserves in the world (Rapouso dos Santos, 1997). The country's demonstrated reserves amounted to 192,540 t of U₃O₈ and 108,950 t of inferred reserves, with mineable reserves contained 123,067 t grading 0.124% U₃O₈. Private interests are permitted to participate in uranium exploration and production in Brazil through state-owned joint ventures; there was, however, a restriction that no more than 20% of the country's uranium reserves may be exported (Rapouso dos Santos, 1995, p. 203-205; Departamento Nacional de Produção Mineral, 1997, p. 377).

Reserves

Brazil was among the world leaders in reserves of the following mineral commodities, by rank: columbium (niobium), first; talc and pyrophyllite, third; bauxite, fourth; iron ore, fifth; manganese, fifth; and tin, sixth. (See table 3.)

Infrastructure

Brazil's railroads comprised 25,268 km of 1.000-meter (m) gauge, 4,339 km of 1.600-m gauge, 74 km of 1.600- to 1.000-m gauge, 13 km of 0.760-m gauge, and 2,308 km electrified for a total of 32,002 km. The country contained a total of almost 1.5 million kilometers of roads—48,000 km paved and 1.4 million kilometers gravel and dirt. There was 50,000 km of navigable inland waterways. The major shipping ports were Belém, Manaus, Porto Alegre, Recife, Rio de Janeiro, Rio Grande, Salvador, and Santos. Among the Brazil merchant marine's 271 ships, 56 were tankers; 15, chemical tankers; 10, liquefied natural gas; 14, combination ore and oil vessels; 82, bulk vessels; and 2, combination bulk vessels. There were 2,000 km of crude petroleum pipelines, 3,804 km of refined petroleum product pipelines, and 1,095 km of natural gas pipelines (Vale, 1997, p. 10).

In 1997, Brazil's installed electrical generating capacity was 52,865 megawatts (MW). Total production of electric power for the year was 227,800 gigawatt hours, which translated into 1,340 kilowatt hours per capita. Brazil's primary domestic energy supply encompassed the following: hydroelectric, 39%; petroleum and natural gas, 32%; firewood and charcoal, 12.5%; sugarcane derivatives, 9.8%; coal 5.3%; nuclear energy, 0.10%; and others, 1.3% (Vale, 1997, p. 18-23).

Power investment negotiations were completed between the Brazilian Government and five companies, four of which were foreign subsidiaries. The companies involved were Alcan Alumínio do Brasil S.A. (Canada), Alcoa (United States), Billiton Metais S.A. (the Netherlands), Dow Chemical, USA (United States), and Camargo Corrêa Industrial S.A. (Brazil). Brazil and the five companies will build a 1,200-MW dam on the Tocantins River on the border between the States of Maranhão and Tocantins. The dam construction would cost about \$1 billion; Billiton Metais S.A. has pledged \$350 million (Vale, 1997, p. 23). The companies had been receiving such a rapid rate that it could exceed the supply in a very few years. Another factor was the 10% electricity from the Tucuruí Dam on the Tocantins River, but the demand has been increasing at subsidy on electricity prices that expires in 2004.

During the past several years, the lack of funding has led to a significant deterioration in the quality of Brazilian highways. Thus, the lack of proper maintenance of Brazilian roads added between 10% and 15% to the total transportation costs in the country, which was referred to as the "Brazilian cost" (Thurston, 1997).

The ports of Brazil were found to require heavy investments in modernization and expansion. The bottlenecks resulting from the lack of capacity were so great that Brazilian importers paid almost \$300 million in penalties charged by ships that had to wait in line to be unloaded (Instituto Brasileiro de Siderurgia, 1997, p. 7). Constran S.A. and Construção e Comércio of the Itamaraty Group of the private sector, plan to construct an additional 1,718 km of railroads to be linked to the existing railroad system. The cost of the new system was projected to be \$2.5 billion. This addition will connect to the existing system, which runs through Vitória, Espírito Santo, Belo Horizonte, Minas Gerais, Santos, São Paulo, and Chapadao do Sul, Mato Grosso do Sul. The new railroad system will run from Chapadao do Sul, Mato Grosso do Sul, to Cuiabá, Mato Grosso, and Santarem, Pará, branching from Cuiabá, Mato Grosso, to Porto Velho, Rondônia (Vale, 1997, p. 22).

Outlook

Brazil established a favorable climate for potential foreign investors by keeping inflation under control, reducing the public deficit and the external debt, providing stable rules for capital repatriation and profit remittances, and reducing the tax burden, tariffs, and nontariff barriers. These and the recent review of its 1988 Constitution should position Brazil well for the future. The flow of foreign capital into the Brazilian economy would seem to support continued economic growth, and investments in technology may well continue. In September 1996, 42 high-priority development projects in the infrastructure, environment, and service sectors were identified under the title "Brazil in Action." The private sector is expected to invest \$12.8 billion of the \$54.4 billion cost of these projects (Branco, 1997).

Most sectors of the Brazilian economy recorded positive growth during 1997. For instance, the mineral sector increased by 7.5%. If that positive rate of economic growth is sustained into 1998 and beyond, then the minerals sector should continue its recovery as the demand for mineral exports and steel-intensive goods increase.

FDI into the Brazilian mining industry appears to be enhancing exploration and mine development activities, particularly in gold. This trend should continue as several corporations are acquiring exploration properties and mining prospects, particularly for gold, diamond, and base metals. U.S. private sector investors are increasing investments in Latin America, and especially Brazil, through joint ventures and project finance mechanisms minimizing the investors' risks. The Export-Import Bank of the United States is providing a political risk guarantee for the 3-year period of infrastructure and environmental project constructions and will follow with a comprehensive guarantee covering political and commercial risks for the 10-year term loan that will be in place once the projects are up and running (Barovick, 1997). These programs could provide the needed comfort level to

commercial lenders.

The steel industry was privatized, and the gas and mining industries will be part of the privatization process. New projects in the petroleum sector, however, will be opened up to joint ventures. After privatization, April 1997, CVRD will be able to expand investments and production in several mine projects in the near term.

Privatization of Government-owned firms has led to lower employment levels and greater efficiencies; as a result, the Brazilian economy has become more competitive in the global economy. Privatization of Government monopolies, dismantling all trade barriers, and increased exports to the world markets will continue to be important, allowing the continued flow of fresh capital into the Brazilian economy.

The existing Brazilian infrastructure is of particular interest to the minerals and related industries. Within Mercosur, Brazil is a leading producer of competitively priced hydroelectricity, has a good industrial base capable of supplying most of the required mining equipment, has a modern and reliable transportation and communication systems, and can provide skilled labor, adequate mining technology, and an efficient network of supporting services. Improvements and additional infrastructure would, however, have a direct bearing on Brazil's ability to increase industrial and minerals production competitively.

The sectors most likely to be affected are those that depend most heavily on electricity and transportation facilities. The aluminum, automobile, steel, petrochemical, and pulp and paper industries, which depend heavily on energy and on exports, would benefit most from a new and improved infrastructure. Foreign majority participation in mining operations and investment in new infrastructure were barred by the Brazilian Constitution of 1988. The constitutional amendment to eliminate the distinction between domestic and foreign capital should, however, eliminate these restrictions once fully implemented.

As the barriers to foreign investments continue to fall, foreign interests may be attracted by Brazil's mineral potential. The Amazon region alone is considered to have possibilities for major undiscovered mineral deposits beyond the large reserves, in order of importance, of iron ore, manganese, bauxite, gold, and tin in Carajás, Pará, being produced by CVRD. A factor that may have a negative effect over the longer term is the environment, especially in the Amazon rain forest. Much depends on what approaches are used to protect the environment and to continue on the path of sustainable development.

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Rua General Severiano
90 Botafogo-ZC-02
22290-Rio de Janeiro-RJ-Brasil
- Companhia de Pesquisa de Recurso Minerais
Avenida Pasteur 404-Anexo, 2º Andar, Pria Vermelha
22290-Rio de Janeiro-RJ-Brasil

- Conselho de Não-Ferrosos e de Siderurgia
Esplanados dos Ministerios-Bloco 6-5º Andar
70053-Brasilia-DF-Brasil
- Conselho Nacional do Petróleo
SGAN-Q.603 Modulos J, I e H
70830-Brasilia-DF-Brasil
- Instituto Brasileiro de Mineração
Avenida Afonso Pena, 3880 3º, 4º e 5º andares
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- Petróleo Brasileiro, S.A.
Avenida República do Chile, 65
20035-Rio de Janeiro-RJ-Brasil
- Rio Doce Geológica e Mineração, S.A.
Avenida President Wilson 11º Andar
22030-Rio de Janeiro-RJ-Brasil

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Sao Paulo: ABRAFE Yearbook, annual.
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TABLE 1
BRAZIL: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/ METALS	1993	1994	1995	1996	1997 e/
Aluminum:					
Bauxite, dry basis, gross weight	10,001,031 r/	8,673,000 r/	10,214,000 r/	12,260,000 r/	12,500,000 3/
Alumina	1,853,000	1,868,000	2,141,000 r/	2,752,000 r/	2,800,000 3/
Metal:					
Primary	1,172,000 r/	1,185,000 r/	1,188,000 r/	1,195,000 r/	1,200,000 3/
Secondary	62,000	90,000 r/	92,000 r/	95,000 r/	95,000
Beryllium, beryl concentrate, gross weight	850	562 r/	565 r/	570 r/	600
Cadmium, metal, primary	200	300 e/	300	300	300
Chromium:					
Crude ore	307,577 r/	359,788 r/	447,963 r/	408,495 r/	330,000
Concentrate	126,107 r/	174,068 r/	175,667 r/	174,150 r/	175,500
Marketable product 4/	86,759 r/	85,879 r/	100,969 r/	77,231 r/	101,000
Cobalt: e/					
Mine output, Co content by hydroxide	400	400	400	400	400
Metal, electrolytic	240	240	180	180	180
Columbium-tantalum ores and concentrates, gross weight:					
Columbite and tantalite	180	180 e/	180	190 r/ e/	190
Djalmaite concentrate e/	10	10	10	10	10
Pyrochlore concentrate, Cb ₂ O ₅ content	13,640 r/	18,950 r/	21,731 r/	25,308 r/	25,500 3/
Copper:					
Mine output, Cu content	43,398 r/	39,673 r/	48,933 r/	46,203 r/	39,814 3/
Metal:					
Primary	161,102 r/	170,033 r/	164,966 r/	172,075 r/	177,000 3/
Secondary	54,000 r/	54,290 r/	54,400 r/	54,000	54,000
Gold:					
Mine output kilograms	39,894 r/	40,188 r/	40,951 r/	41,856 r/	40,500
Garimpeiros (independent miners) do.	36,413 r/	32,209 r/	22,349 r/	18,869 r/	17,500
Total do.	76,307 r/	72,397 r/	63,300 r/	60,725 r/	58,000
Iron and steel:					
Ore and concentrate (marketable product): 5/					
Gross weight thousand tons	153,999 r/	177,331 r/	183,839 r/	174,157 r/	187,900 3/
Fe content	90,000 r/	103,227 r/	112,793 r/	112,000 3/	112,000
Metal:					
Pig iron thousand tons	23,982 r/	25,177 r/	25,090 r/	25,100 r/	25,000
Ferroalloys, electric-furnace:					
Chromium metal e/	37	37	37	37	37
Ferrocilicon e/	22,000	25,000	25,000	25,000	25,000
Ferromanganese	83,892	77,105 r/	77,100	72,609 r/	73,000
Ferrosilicon	4,500	5,000 e/	5,000	5,000	5,000
Ferrocolumbium	19,000	19,000 e/	19,000	19,000	19,000
Ferromanganese	201,500 r/	200,000 r/	130,000	215,260 r/	153,000 3/
Ferromolybdenum	47	47 e/	47	47	47
Ferromanganese	34,732 r/	35,260 r/	34,000 e/	35,518 r/	37,400 3/
Ferrophosphorus	800 e/	2,000 e/	2,000	2,000	2,000
Ferrosilicon	284,147	198,505 r/	243,824 r/	236,838 r/	214,000 3/
Ferrosilicon magnesium	10,000 e/	15,000 e/	15,000	15,000	15,000
Ferrosilicon zirconium	102	1,500 e/	1,500	1,500	1,500
Ferrotitanium	126	500 e/	500	500	500
Ferrotungsten	1	25 e/	25	25	25
Ferrovandium	--	3,000 e/	3,000	3,000	3,000
Inoculant	24,500	25,000 e/	25,000	25,000	25,000
Silicomanganese	284,147 r/	248,000 r/	167,000 3/	232,218 r/	175,000
Silicon metal	106,000	110,000	116,000 3/	150,054 r/	135,000
Total	1,075,531 r/	964,979 r/	864,033 r/	1,038,606 r/	883,509 3/
Steel, crude, excluding castings	25,207	25,747	25,076 r/	25,076 r/	25,100
Semimanufactures, flat and nonflat e/	25,000	25,000	25,000	25,000	25,000
Lead:					
Mine output, Pb content	117 r/	1,329 r/	11,611 r/	-- r/	--

See footnotes at end of table.

TABLE 1--Continued
BRAZIL: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/	1993	1994	1995	1996	1997 e/
METALS--Continued					
Lead--Continued:					
Metal:					
Primary	27,500 r/	24,000 r/	13,958 r/	-- r/	--
Secondary	47,027 r/	60,000 r/	65,000 e/	104,000 r/	105,000
Manganese metal: e/					
Primary	6,500	6,500	6,500	6,500	6,500
Secondary	1,600	1,600	1,600	1,600	1,600
Manganese ore and concentrate, marketable, gross weight 4/	1,838,414 r/	2,199,079 r/	2,398,025 r/	2,506,000 r/	2,000,000 3/
Nickel:					
Mine output, Ni content	32,154 r/	27,706 r/	29,124 r/	25,245 r/	25,300
Ferronickel, Ni content	8,683 r/	8,815 r/	8,497 r/	9,091 r/	9,767 3/
Rare-earth metals, monazite concentrate, gross weight	270 r/	256 r/	103 r/	200	200
Silver 6/ kilograms	108,000 r/	50,400 r/	49,775 r/	48,284 r/	48,500 3/
Tin:					
Mine output, Sn content	17,631 r/	16,618 r/	17,316 r/	19,611 r/	18,290 3/
Metal:					
Primary	26,900 r/	20,400 r/	16,789 r/	18,371 r/	18,290 3/
Secondary e/	250	250	250	250	250
Titanium concentrates, gross weight:					
Ilmenite	90,567 r/	97,439 r/	102,125 r/	97,955 r/	98,000
Rutile	1,744 r/	1,911 r/	1,985 r/	2,018 r/	2,020 3/
Tungsten, mine output, W content	245 r/	270 r/	171 r/	171 r/	170
Zinc:					
Mine output, Zn content	184,879 r/	177,585 r/	188,472 r/	117,343 r/	152,600 3/
Metal:					
Primary	187,550 r/	187,300 r/	198,976 r/	177,466 r/	185,701 3/
Secondary	7,200 r/	7,000 r/	7,000 r/	7,000 r/	7,000
Zirconium, zircon concentrate, gross weight 7/	13,252 r/	17,064 r/	16,343 r/	17,000 r/	17,000
INDUSTRIAL MINERALS					
Asbestos:					
Crude ore e/	3,950,000	3,950,000	3,950,000	3,950,000	3,950,000
Fiber	186,662 r/	181,416 r/	208,882 r/	213,212 r/	213,200
Barite:					
Crude	75,835 r/	48,287 r/	43,737 r/	49,662 r/	49,700
Beneficiated	32,068 r/	31,499 r/	30,750 r/	39,662 r/	39,700
Marketable product e/ 4/	65,000	65,000	65,000	65,000	65,000
Calcite	32,296 r/	32,798 r/	36,733 r/	35,000	35,000
Cement, hydraulic thousand tons	24,843 r/	25,230 r/	28,256	34,597	38,096 3/
Clays:					
Bentonite (beneficiated)	113,180 r/	144,950 r/	150,000 r/	186,000 r/	180,000
Kaolin:					
Crude	1,560,000 r/	2,045,881 r/	1,957,750 r/	2,036,000 r/	2,050,000
Beneficiated	916,048 r/	1,037,570 r/	1,067,109 r/	1,105,000	1,200,000 3/
Marketable product e/ 4/	1,100,000	1,100,000	1,100,000	1,100,000	1,150,000
Diamond: e/					
Gem thousand carats	1,000 r/	300 r/	676 r/	200 r/	300 3/
Industrial do.	600	600	600	600	600
Total 8/ do.	1,600 r/	900 r/	1,276 r/	800 r/	900 3/
Diatomite:					
Crude	25,570 r/	20,349 r/	15,059 r/	11,300	11,300
Beneficiated	15,669 r/	17,018 r/	14,049 r/	17,000	17,000
Marketable product e/ 4/	13,100	13,100	13,100	13,100	13,100
Feldspar:					
Crude	205,000 r/	205,000 r/	198,894 r/	200,000	200,000
Feldspar, marketable product e/ 4/	122,000	122,000	122,000	122,000	122,000
Leucite, marketable product e/ 4/	5,000	5,000	5,000	5,000	5,000
Sodalite, crude, marketable product e/ 4/	500	500	500	500	500
Total e/ 4/	127,500	127,500	127,500	127,500	127,500
Fluorspar:					
Crude e/	250,000	250,000	250,000	250,000	250,000

See footnotes at end of table.

TABLE 1--Continued
BRAZIL: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/	1993	1994	1995	1996	1997 e/
INDUSTRIAL MINERALS--Continued					
Fluorspar--Continued:					
Concentrates, marketable product:					
Acid-grade	68,325 r/	68,890 r/	72,498 r/	46,706	67,163 3/
Metallurgical-grade	24,566 r/	21,041 r/	16,760 r/	12,334 r/	11,235 3/
Total	92,891 r/	89,931 r/	89,258 r/	59,040 r/	78,398 3/
Graphite:					
Crude e/	650,000	650,000	650,000	650,000	650,000
Marketable product:					
Direct-shipping crude ore	3,516 r/	2,735 r/	3,368 r/	4,134 r/	4,500 3/
Concentrate	31,284 r/	30,612 r/	30,222 r/	36,332 r/	44,400 3/
Total	34,800 r/	33,347 r/	33,590 r/	40,466 r/	48,900 3/
Gypsum and anhydrite, crude	746,791 r/	834,187 r/	953,116 r/	1,126,106 r/	1,264,500 3/
Kyanite: e/					
Crude	750	750	750	750	750
Marketable product 4/	600	600	600	600	600
Lime, hydrated and quicklime	5,634 r/	6,000 r/	6,144 r/	5,700	5,700
Lithium, concentrates	5,000 r/	7,031 r/	7,190 r/	7,000	7,000
Magnesite:					
Crude	974,161 r/	1,026,991 r/	1,210,617 r/	1,268,265 r/	1,300,000
Beneficiated	232,683 r/	279,489 r/	315,978 r/	300,446 r/	300,500
Mica, all grades	7,000	6,700 r/	5,200 r/	7,000	7,000
Nitrogen, N content of ammonia e/	940,000	940,000	940,000	940,000	940,000
Phosphate rock including apatite:					
Crude:					
Mine product e/	27,000	27,000	27,000	27,000	27,000
Of which, sold directly e/	35	35	35	35	35
Concentrate:					
Gross weight	3,461 r/	3,937 r/	3,888 r/	3,823	4,270 3/
P ₂ O ₅ content	882 r/	1,387 r/	1,364 r/	1,353 r/	1,500
Pigments, mineral, other, crude e/	2,000	2,000	2,000	2,000	2,000
Potassium (KCl)	288,947	403,904	371,398	404,538	466,900 3/
Potash, marketable (K ₂ O)	167,589 r/	234,265 r/	215,411 r/	242,723 r/	272,000
Precious and semiprecious stones except diamond, crude and worked: e/					
Agate	3,000	3,000	3,000	3,000	3,000
Amethyst	1,000	1,000	1,000	1,000	1,000
Aquamarine	20	20	20	20	20
Citrine	100	100	100	100	100
Emerald	90	90	90	90	90
Opal	500	500	500	500	500
Ruby	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000
Sapphire	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000
Topaz	50	50	50	50	50
Tourmaline	80	80	80	80	80
Other	500	500	500	500	500
Quartz crystal, all grades	4,224 r/	3,963 r/	5,586 r/	6,600	6,508 3/
Salt:					
Marine	4,780 r/	4,670 r/	4,460 r/	3,870 r/	3,900 3/
Rock	1,400	1,373	1,340	1,514	1,520
Silica (silica) e/	1,600	1,600	1,600	1,600	1,600
Sodium compounds: e/					
Caustic soda	1,050,000	1,050,000	1,050,000	1,050,000	1,050,000
Soda ash, manufactured (barilla)	200,000	200,000	200,000	200,000	200,000
Stone, sand and gravel: e/					
Dimension stone:					
Marble, rough-cut	200,000	200,000	200,000	200,000	200,000
Slate	50,000	50,000	50,000	50,000	50,000
Crushed and broken stone:					
Basalt	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000
Calcareous shells	450,000	450,000	450,000	450,000	450,000

See footnotes at end of table.

TABLE 1--Continued
BRAZIL: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/	1993	1994	1995	1996	1997 e/
INDUSTRIAL MINERALS--Continued					
Stone, sand and gravel e/--Continued:					
Crushed and broken stone--Continued:					
Dolomite	3,500	3,500	3,500	3,500	3,500
Gneiss	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000
Granite	60,000	60,000	60,000	60,000	60,000
Limestone	60,000	60,000	60,000	60,000	60,000
Quartz 9/	250,000	250,000	250,000	250,000	250,000
Quartzite:					
Crude	400,000	400,000	400,000	400,000	400,000
Processed	200,000	200,000	200,000	200,000	200,000
Sand, industrial	2,700,000	2,700,000	2,700,000	2,700,000	2,700,000
Sulfur:					
Frasch	21,924 r/	20,708 r/	22,472 r/	25,319 r/	25,400
Pyrites	1,700 r/	153 r/	3,794 r/	4,158 r/	4,200
Byproduct:					
Metallurgy	183,529 r/	182,638 r/	170,942 r/	192,247 r/	192,300
Petroleum	58,582 r/	53,256 r/	41,951 r/	59,267 r/	59,300
Total	242,111 r/	235,894 r/	212,893 r/	251,514 r/	251,600
Talc and related materials:					
Talc:					
Crude	352,318 r/	363,561 r/	297,669 r/	287,473 r/	270,000 3/
Marketable product e/ 4/	2,000	2,000	2,000	2,000	2,000
Pyrophyllite, crude	160,000 r/	148,000 r/	150,000 r/	150,000	150,000
Vermiculite					
Concentrate	14,541 r/	17,233 r/	18,806 r/	20,000	20,000
Marketable product 4/	3,514 r/	2,029 r/	3,826 r/	4,000	4,000
MINERAL FUELS AND RELATED MATERIALS					
Coal, bituminous, marketable 4/	4,854 r/	4,465 r/	5,525 r/	4,739 r/	5,630 3/
Coke, metallurgical, all types	227 r/	118 r/	25 r/	106	150
Gas, natural, gross	7,712 r/	7,352 r/	8,043 r/	9,156 r/	9,865 3/
Natural gas liquids e/	13,000	13,000	13,000	13,000	13,000
Petroleum:					
Crude	233,764 r/	242,723 r/	251,716 r/	286,843 r/	307,153 3/
Refinery products: e/ 10/ 11/					
Liquefied petroleum gas	NA	NA	NA	38,778 3/	40,055 3/
Gasoline	134,000	126,000	126,000	102,389 3/	115,409 3/
Jet fuel	19,000	17,800	17,800	535 3/	478 3/
Kerosene	1,450	1,370	1,370	22,896 3/	22,449 3/
Distillate fuel oil	157,000	149,000	149,000	169,994 3/	177,435 3/
Lubricants	4,350	4,120	4,120	4,906 3/	5,001 3/
Residual fuel oil	83,000	79,000	79,000	81,198 3/	103,364 3/
Other	63,400	60,000	60,000	63,856 3/	84,871 3/
Refinery fuel and losses	21,800	20,600	20,600	-- 3/	-- 3/
Total	484,000	457,890	457,890	484,552 3/	549,062 3/

e/ Estimated. r/ Revised. NA Not available.

1/ Table includes data available through May 1998.

2/ In addition to the commodities listed, bismuth, molybdenite, and uranium oxide are produced, but output is not reported, and available information is inadequate to make reliable estimates of output levels.

3/ Reported figure.

4/ Direct sales and/or beneficiated (marketable product).

5/ Includes sponge iron as follows, in thousand metric tons: 1991-94--260 and 1995-97--270 (estimated).

6/ Officially reported output; of total production, the following quantities are identified as secondary silver (the balance being silver content of other ores and concentrates), in kilograms: 1993--42,500 (revised); 1994--30,000 (revised); 1995--35,000 (revised); 1996--38,000 (revised); and 1997--38,500 (estimated).

7/ Includes baddeleyite-caldasite.

8/ Figures represent officially reported output plus official Brazilian estimates of output by nonreporting miners.

9/ Apparently includes crude quartz used to produce quartz crystal (listed separately in this table), as well as additional quantities of common quartz.

10/ Figures represent officially reported production to the United Nations (Energy Statistics Yearbook) by the Ministry of Mines and Energy of Brazil.

11/ Minerals Questionnaire, 1996-97, and Petrobrás Magazine, 1996-98.

TABLE 2
BRAZIL: STRUCTURE OF THE MINERAL INDUSTRY IN 1997

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
METALS			
Aluminum	Albras-Alumínio Brasileiro S.A. (ALBRAS) [CVRD; 51% and Nippon Amazon Alumínio Co. (NAAC), 49%]	Belém, Pará State (smelter)	350 (metal).
Do.	Alcan Alumínio do Brasil S.A. (Alcan Aluminum Ltd., 100%)	Saramenha, Minas Gerais State (refinery)	100 (metal). 150 (alumina).
Do.	Alcan Alumínio Poços de Caldas (ALUCALDAS) (Alcan Alumínio do Brasil S.A., 100%)	Poços de Caldas, Minas Gerais State (mine)	1,000 (bauxite).
Do.	Alcoa Alumínio S.A. (Alcoa) (Aluminum Co. of America, 60%; Billiton International Metals B.V., 40%)	Poços de Caldas, Minas Gerais State (mine) São Luis, Maranhão State (refinery) (smelter)	400 (bauxite). 550 (alumina). 280 (metal).
Do.	Alumínio do Brasil Nordeste S.A. (Alcan Aluminum Ltd., 100%)	Aratu, Bahia State (smelter)	120 (metal).
Do.	Billiton Metais S.A. (Billiton International Metals B.V., 100%)	São Luis, Maranhão State (refinery)	375 (metal).
Do.	Compahnia Brasileira de Alumínio (CBA, 100%)	Poços de Caldas, Minas Gerais State (mine) Sorocaba, São Paulo State (refinery) (smelter)	1,000 (bauxite). 170 (alumina). 225 (metal).
Do.	Compahnia Geral do Minas (private, 21%; Aluminum Co. of America, 79%)	Poços de Caldas, Minas Gerais State (refinery) (smelter)	275 (alumina). 90 (metal).
Do.	Mineração Rio do Norte S.A. (MRN) (CVRD, 40%; CBA, 10%; Alcan Empreendimentos Ltda., 12%; Billiton International Metals B.V., 14.8%; Norsk Hydro Comercio e Industria, 5%; Reynolds Alumínio do Brasil, 5%; Alcoa, 13.2%)	Oriximina, Pará State (mine) Papagalo, Pará State (mine)	11,000 (bauxite). 2,000 (bauxite).
Do.	Vale do Sul Alumínio S.A. (ALUVALE) (Gov., 27%; private, 25%; Shell do Brasil S.A., 44%)	Santa Cruz, Rio de Janeiro State (smelter)	86 (metal).
Do.	ALUVALE (CVRD, 49.7%; Billiton Metais S.A., 41.5%; Cia. Cataguazes, 8.8%)	do.	93 (metal).
Do.	Reynolds Internacional do Brasil (Reynolds, 42.5%; Bradesco Bank, 42.5%; J.P. Morgan, 15%)	Sorocaba, São Paulo State (smelter)	5.4 million (cans).
Do.	Consortium Paragominas S.A., (CVRD, 48.7%; MRN, 24.6%; Nipon Amazon Aluminum Co., 12.2%; CBA, 5.7%; and others, 8.8%)	Jabuti, Pará State (mine) Jabuti, Pará State (alumina)	1,500 (bauxite). 1,200 (alumina).
Chromite	Coitezeirio Mineração S.A. (COMISA) (private, 75.4%; Brayer do Brasil S.A., 24.6%)	Campo Formosa, Bahia State (mine)	50 (ore).
Do.	Companhia de Ferro Ligas da Bahia (FERBASA, 100%)	Campo Formoso, Bahia State (mine) (beneficiation plant)	370 (ore). 292 (concentrate).
Copper	Mineração Caraiba S.A. (Parapanema Group, private, 100%)	Jaguari, Bahia State (mine) (beneficiation plant)	30 (ore). 40 (concentrate).
Columbium	Companhia Brasileira de Metalurgia e Mineração (CBMM) (private, 55%; Molycorp, Inc., 45%)	Araxá, Minas Gerais State (mine) (beneficiation plant)	1,200 (ore). 38 (pyrochlore).
Do.	Mineração Catalão de Goiás Ltda. (private, 68.5%; Anglo American Corp. do Brasil, 31.5%)	Ouvidor, Goiás State (mine) Ouvidor, Goiás State (plants)	500 (ore). 13 (pyrochlore).

TABLE 2--Continued
BRAZIL: STRUCTURE OF THE MINERAL INDUSTRY IN 1997

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
METALS--Continued				
Ferroalloys		Companhia Brasileira Carbureto de Calcio (CBCC, 100%)	Santos Dumont, Minas Gerais State (plant)	54.
Do.		Prometal Produtos Metalúrgicos S.A., 60% and Norway's Elkem A/S, 40%	Marabá, Pará State (plant)	500.
Do.		Nova Era Silicon S.A. (CVRD, 49%; Mitsubishi, 25.5%; and Kawasaki Steel, 25.5%)	Nova Era, Minas Gerais State	48.
Do.		Companhia Ferro-Ligas de Bahia S.A. (FERBASA, 100%)	Pojuca, Bahia State (plant)	194.
Do.		Companhia Ferro-Ligas Minas Gerais (MINASLIGAS, 100%)	Pirapora, Minas Gerais State (plant)	58.
Do.		Companhia Paulista de Ferro-Ligas (CPF, 100%)	Barbacena, Caxambu, Jeceaba, Passa Quatro and Passa Vinte, Minas Gerais State; Corumba, Matto Grosso do Sul State; and Xanxere, Santa Catarina State	326.
Do.		Italmagnesio S.A. Indústria e Comercio (ISAIC, 100%)	Braganca Paulista, São Paulo State; and Varzeada Palma, Minas Gerais State (two plants)	63.
Gold	kilograms	Companhia Vale do Rio Doce (CVRD-CSN, 100%)	Gold mines in the States of Minas Gerais, Bahia, and Pará	18,000.
Do.	do.	Mineração Morro Velho S.A. (Minorco Group, 100%)	Novo Lima, Raposos, and Sabara, Minas Gerais State; and Jacobina, Bahia State (four mines)	7,000.
Do.	do.	Mineração Serra Grande S.A. (Minorco Group, 100%)	Serra Grande, Minas Gerais State (mine)	3,900.
Do.	do.	São Bento Mineração S.A. (Gencor Indústria e Comercio Ltda, 49%; Amcor S.A., 29.4%; Amcor Metals Ltda., 21.6%)	Santa Barbara, Minas Gerais State (mine)	3,700.
Do.	do.	Rio Paracatu Mineração S.A. (RTZ, 50%; TVX Gold Inc., 50%)	Paracatu Mine, Minas Gerais State (mine)	5,000.
Do.	do.	Mineração Santa Elina S.A. (MSESA, 100%)	São Vicente Mine, Mato Grosso State (mine)	1,300.
Iron ore		Companhia Siderúrgica Nacional (CSN, 100%)	Volta Mine, Minas Gerais	8,400.
Do.		Itaminas Comércio de Minérios S.A. (ICMSA, 100%)	Itaminas, Minas Gerais	4,000.
Do.		Companhia Vale do Rio Doce (CVRD-CSN, 100%)	Serra dos Carajás, Pará State; and Itabira, Ouro Preto, and Santa Xavier, Tamandúa, Capao, and Mato, Minas Gerais (four mines)	55,000. 105,000.
Do.		Ferteco Mineração S.A. (FERTECO) (Exploration Bergbau GmbH, 100%)	Ouro Preto and Brumadinho, Minas Gerais State (two mines)	12,800.
Do.		S.A. Mineração da Trindade (SAMITRI, 100%)	Mariana, Rio Piracicaba, Itabira, Ouro Preto and Sabara; Minas Gerais State (five mines)	9,300.
Do.		Minerações Brasileiras Reunidas S/A (MBR, 85.3%; Mitsui e Co. Ltd. 14.7%)	Novo Lima and Itibirito, Minas Gerais State (two mines)	31,500.
Do.		Samarco Mineração S.A. (SAMITRI, 51%; Broken Hill Properties Ltd., 49%)	Alegria, Minas Gerais State (mine)	13,500.
Lead		Mineração Boquira S.A. (MBSA, 100%)	Boquira, Bahia State (mine) (beneficiation plant)	300 (ore). 310 (concentrate).
Manganese		Companhia Vale do Rio Doce (CVRD-CSN, 100%)	Corumba, Minas Gerais State (mine) Igarapé Azul, Carajás, Pará State (beneficiation plant)	2,500 (ore). 1,000 (concentrate).

TABLE 2--Continued
BRAZIL: STRUCTURE OF THE MINERAL INDUSTRY IN 1997

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
METALS--Continued				
Manganese--Continued:	kilograms	Indústria e Comercio de Minerios S.A. (ICOMI, 100%)	Macapa and Mazagao, Amapá State (two mines) (beneficiation plant)	1,500 (ore). 800 (concentrate).
Nickel		Companhia Niquel Tocantins (CNT, 100%)	Niquelandia, Goiás State (mine) (refinery plant)	17.5 (ore). 10 (electrolytic Ni).
Do.		Mineração Serra da Fortaleza (MSF, 100%)	Fortaleza, Minas Gerais State (mine)	19 (nickel matte).
Steel		Aço Minas Gerais S.A. (AÇOMINAS, 100%)	Rodovia, Minas Gerais State	2,000.
Do.		Companhia Aços Especiais Itabira (ACESITA) (Government, 90.9%; private, 9.1%)	Timoteo, Minas Gerais State (stainless steel plant)	600.
Do.		Companhia Siderúrgica Belgo - Mineira (CSBM, 100%)	João Monlevade, Minas Gerais State	1,000.
Do.		Companhia Siderúrgica de Tubarão (CST, 100%)	Serra, Espírito Santo State	3,000.
Do.		Companhia Siderúrgica Nacional (CSN, 100%)	Volta Redonda, Rio de Janeiro State	4,600.
Do.		Companhia Siderúrgica Paulista (COSIPA, 100%)	Cubatão, São Paulo State	3,900.
Do.		Usinas Siderúrgicas de Minas Gerais S.A. (USIMINAS, 100%)	Ipatinga, Minas Gerais State	4,400.
Tin		Mineração Jacunda Ltda. (MJL, 100%)	Santa Barbara, Novo Mundo, and Potosi; Rondônia State (six mines) (three beneficiation plants)	108 (ore). 450 (concentrate).
Do.		Paranapanema S.A. Mineração, Industria e Construção (PSAMIC, 100%)	Aripuana, Mato Grosso State; Ariquemes, Rondônia State; Novo Aripuana, Pitinga, and Presidente Figueiredo, Amazonas State; and São Felix do Xingu, Pará State (five mines) (two beneficiation plants) Piraporada Bom Jesus, São Paulo State (refinery)	5,420 (ore). 1,400 (concentrate). 25 (metal).
Titanium		Rutilo e Ilmenita do Brasil S.A. (RIBSA, 100%)	Mataraca, Paraíba State (mine) (two beneficiation plants)	4,200 (ore). 120 (concentrate).
Zinc		Companhia Mineradora de Metais (CMM, 100%)	Vazante, Minas Gerais State (mine) (beneficiation plant)	800 (ore). 48 (concentrate).
Do.		do.	Tres Marias, Minas Gerais State (refinery)	72 (metal).
Do.		Mineração Areiense S.A. (MASA, 100%)	Vazante, Minas Gerais State (mine)	400 (ore).
Zirconium		Nuclemon Mineradora Química Ltda. (Government, 100%)	São João da Barra, Rio de Janeiro State (mine)	660 (ore).
Do.		do.	Itapemirim, Espírito Santo State (Mine)	90 (ore).
Do.		do.	Prado, Bahia State (mine) (three beneficiation plants) (three separation plants)	90 (ore). 123 (concentrate). 90 (concentrate).
INDUSTRIAL MINERALS				
Asbestos		Sociedade Anonima Mineração de Amianto (SAMA, 100%)	Minacú, Goiás State (mine) (beneficiation plant)	9,000 (ore). 230 (concentrate).
Cement		Cimento Santa Rita S.A. (CSSA, 100%)	Itapevi, São Paulo State (plant) Salto de Pirapora, São Paulo State (plant)	1,000. 1,200.
Do.		Companhia Cimento Portland Itau (CCPI, 100%)	Itau de Minas, Minas Gerais State (three plants)	2,400.

TABLE 2--Continued
BRAZIL: STRUCTURE OF THE MINERAL INDUSTRY IN 1997

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
INDUSTRIAL MINERALS--Continued			
Cement--Continued:	Companhia de Cimento Portland Paraiso (CCPP, 100%)	States of Espirito Santo, Goiás, Minas Gerais, and Rio de Janeiro (five plants)	4,000.
Do.	Companhia de Cimento Portland Rio Branco (CCPRB, 100%)	Rio Branco do Sul, Paraná State (two plants)	5,000.
Diamond	Mineração Te jucana S.A. (MTSA, 100%)	Diamantina, Minas Gerais State (mine)	100.
Fluorspar	Mineração Nossa Senhora do Carmo Ltda. (MNSCL, 100%)	Morro da Fumaca and Pedras Grandes, Santa Catarina State (four mines) (two beneficiation plants)	180 (ore). 220 (concentrate).
Do.	Mineração Santa Catarina Ltda. (MSCL, 100%)	Morro da Fumaca and Pedras Grandes, Santa Catarina State (four mines) (beneficiation plant)	100 (ore). 120 (concentrate).
Graphite	Nacional de Grafite Ltda. (NGL, 100%)	Itapecerica and Pedra Azul, Minas Gerais State (three mines) (two beneficiation plants)	840 (ore). 720 (concentrate).
Gypsum	CBE-Companhia Brasileira de Equipamento (CBE, 100%)	Codo, Maranhão State, and Ipubi, Pernambuco State (two mines)	100.
Do.	Companhia de Cimento Portland Paraiso (CCPP, 100%)	Ipubi, Pernambuco State (mine)	50.
Kaolin	Caulim da Amazônia S.A. (CADAM, 100%)	Mazagão, Amapá State (mine) (beneficiation plant) Adam Mine, Rio Jarí, Amazonas State	720 (ore). 360 (concentrate). 660 (concentrate).
Do.	Pará Pigmentos S.A. (PPSA, 100%)	Pará Mine, Pará State	200 (concentrate).
Do.	Rio Capim Caulim S.A. (RCCSA, 100%)	Rio Capim Mine, Pará State	250 (concentrate).
Do.	Empresa de Mineração Horii Ltda. (EMHL, 100%)	Biritiba and Mogi das Cruzes, São Paulo State (two mines) (two beneficiation plants)	200 (ore). 180 (concentrate).
Limestone	Companhia de Cimento Portland Paraiso (CCPP, 100%)	States of Goiás, Minas Gerais, and Rio de Janeiro (five mines)	2,000.
Do.	Companhia de Cimento Portland Rio Branco (CCPRB, 100%)	Rio Branco do Sul, Paraná State (three mines)	5,500.
Do.	S.A. Industrias Votorantim (SAIV, 100%)	States of Rio de Janeiro and São Paulo (four mines)	1,000.
Magnesite	Magnesita S.A. (MSA, 100%)	Brumado, Bahia State (one major mine and numerous small mines) (two beneficiation plants)	770 (ore). 820 (concentrate).
Phosphate rock	Fertisul S.A. (Arafertil) (Fertisul, 100%)	Araxá, Minas Gerais State (mine)	5,000.
Do.	Copebras S.A. (Copebras) (Minorco, 90.55%; Anglo American Corp., 9.45%)	Ouvidor, Goiás State (mine)	4,400.
Do.	Fertilizantes Fosfatados S.A. (Fosfertil, 100%)	Tapira, Minas Gerais State (two mines)	10,500.
Do.	Ultrafertil S.A. (Ultrafertil, 100%)	Araxá, Minas Gerais State (mine)	5,000.
Quartz	Telequartzo Exportação S.A. (TESA, 100%)	Cristal, Minas Gerais State (mine)	6.0.
Salt (rock)	Frota Oceânica Brasileira S.A. (FOBSA, 100%)	Jacupiranga, São Paulo State (mine)	6,000.
Do.	Mineração e Quimica do Nordeste S.A. (Dow Produtos Quimicos Ltda., 100%)	Vera Cruz, Bahia State (mine)	1,000.
MINERAL FUELS			
Coal	Carbonifera Criciuma S.A. (CCSA, 100%)	Circiuma and Sideropolis, Santa Catarina State (two mines)	4,000.

TABLE 2--Continued
 BRAZIL: STRUCTURE OF THE MINERAL INDUSTRY IN 1997

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
MINERAL FUELS--Continued				
Coal--Continued:		Companhia Carbonífera de Urussanga (CCU, 100%)	Criciúma, Siderópolis, and Urussanga Santa Catarina State (three mines)	7,200.
Do.		Companhia de Pesquisas e Lavras Minerais-Copelmi (COPELMI, 100%)	Arroio dos Ratos, Butiá, and Charqueadas; Rio Grande do Sul State (four mines)	5,700.
Petroleum	thousand 42-gallon barrels	Petróleo Brasileiro S.A. (Petrobrás) (Government, 81.4%, private, 11.8%; public, 6.8%)	Fields in the States of Alagoas, Amazonas, Bahia, Ceará, Espírito Santo, Rio de Janeiro, Rio Grande do Norte, Pará, Maranhão, and Sergipe (99)	220,000.
Petroleum products	do.	do.	Refineries in the States of Amazonas, Bahia, Ceará, Minas Gerais, Paraná, Rio de Janeiro, Rio Grande do Sul, and São Paulo	503,000.
Do.		Refinaria de Petróleo Ipiranga S.A. (RPISA, 100%)	Ipiranga, Rio Grande do Sul	3,400.
Do.		Refinaria de Petróleos de Manguinhos S.A. (RPMSA, 100%)	Manquinhos, Rio de Janeiro State	3,650.

TABLE 3
BRAZIL: RESERVES OF MAJOR MINERAL COMMODITIES IN 1997 1/

(Thousand metric tons unless otherwise specified)

Commodity	Reserves	World ranking	World percent
Asbestos, fiber	17,240		NA
Bauxite, ore	3,898,000	4	13.5
Chromite, Cr ₂ O ₃	6,385		0.2
Coal, all types	6,501,000		0.6
Columbium, pyrochlore, and columbite ore	4,478	1	88.2
Copper, metal content	11,582		1.9
Fluorspar, ore	8,000		2.5
Gold, metal	metric tons		3.6
Graphite, ore	9,600		20.1
Gypsum	1,081,000		NA
Iron ore, 60% to 65% Fe content	20,300,000	5	8.6
Kaolin	1,528,000		12.7
Lead, metal content	1,000		0.8
Magnesite	180,000		5.2
Manganese, metal content	53,790	5	1.1
Natural gas 2/	million cubic meters		NA
Nickel, metal content	3,284		2.9
Petroleum 2/	thousand 42-gallon barrels		NA
Phosphate rock	370,000		1.1
Talc and pyrophyllite	178,000	3	19.1
Tin, metal content	metric tons	6	7.7
Titanium, TiO ₂	4,230		1.0
Uranium, U ₃ O ₈	metric tons		NA
Zinc, metal content	5,900		1.7
Zirconium, ore	2,376		3.7

NA Not available.

1/ Summário Mineral 1997.

2/ Petróleo Brasileiro, S.A. (Petrobrás), 1998 Annual Report.