THE MINERAL INDUSTRY OF

BRAZIL

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Brazil, the second largest economy in the Americas and the world's seventh with about 172 million people, had a gross domestic product (GDP) of $777 billion[1] or $1.035 trillion in terms of purchasing power parity in 1998. Brazil's GDP growth was 0.15% only because of its economic crisis that begun in the last quarter of the year compared with 3.2% in 1997 (Central Intelligence Agency, 1999, p. 39; Departamento Nacional de Produção Mineral, 1999a, p. 1). Foreign exchange reserves decreased to about $23.4 billion from $51.4 billion in 1997. There was a $33.5 billion capital outflow during August-October 1998. Brazil's total debt burden amounted to $258.1 billion. The trade deficit amounted to $6.5 billion with exports of $51.1 billion and imports of $57.6 billion (Abranches, 1999, p. 1, 8; Ferrer, 1999, p. 2-3).

Brazil responded to its economic crisis, provoked in part by the financial turmoils in southeast Asia and Russia during 1997-98, with a massive increase in interest rates to 46% per year from 28% as of September 1997, with inflation held at 2%. Other measures were a package of $28 billion in emergency budget cuts as of November 1998, congressional reforms to address the twin deficits in the current and fiscal accounts that were running at 8% of GDP, a reduction in the role of Government, and funds available under its $41.5 billion financing agreement with the International Monetary Fund (IMF). Brazil thus far has withdrawn $20.3 billion to fend off a financial crisis and the response to ensure the country's stability was very encouraging (Cidade, 1998; Dyer, 1999a).

Foreign direct investment (FDI) was $28 billion in 1998, still making Brazil the second most popular emerging market after China for foreign investments. FDI was expected to be about $27 billion in 1999 (Mining Journal, 1998; Lapper, 1999). IMF endorsed Brazil's move to a system of inflation targets to guide its monetary policy late in 1998, which indicate that the country would reduce its current account deficit of $33.6 billion down to an equivalent of 5% of GDP (Dyer, 1999a). The Brazilian Central Bank also reported that Brazil received $5 billion of FDI in the minerals sector compared with $8.8 billion in 1997, $9.4 billion in 1996, $3.9 billion in 1995, and $2.2 billion in 1994 (U.S. Department of Commerce, 1998a, p. 1-3).

Yet, with the economy still sluggish and the sequence of the financial crises in Asia and Russia in 1997-98 that started to diminish the flow of funds to Latin America, the Brazilian Government identified investment opportunities for U.S. and foreign companies in the order of $160 billion, particularly in the telecommunication and energy sectors, privatization was expected to account for about one-third of the inflows. FDI was expected to increase some because of the liberalization of the Southern Cone Common Market (Mercosur) countries' economies and the privatization of many of South America's infrastructure sectors. FDI in Latin America, however, would decline in 2000 and 2001 (U.S. Department of Commerce, 1998b, p. 2; Dyer, 1999b; Fidler, 1999).

The Plano Real continued to be based on macroeconomics, constitutional reviews, privatization of Government-owned companies, and joint ventures to achieve its goals and encourage new capital flows into the Brazilian economy, but public finances continued to be a difficult issue to be addressed. In 1998, Brazil's trade balance was affected by depressed prices for some mineral exports and the country paid more for imported oil (Bragança, 1998, p. 1; Ferraz, 1998, p. 1).

According to the Brazilian Departamento Nacional de Produção Mineral (DNPM)'s Sumário Mineral of 1998a and 1999b, the country produced asbestos, 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 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 mineral reserves and identified resources helped make it one of the most dynamic markets in the world and constituted one-third of the Latin American economy (Brito, 1998, p. 1).

With Companhia Vale do Rio Doce's (CVRD) acquisition in 1997, the Companhia Siderúrgica Nacional (CSN) Group was expected to expand investments and production in several mine projects in the near term in Pará and Minas Gerais and to seek expansions in Europe, Latin America, and the United States via joint-venture projects and direct investments.

The country's petroleum and mining industries were attracting interests because of the Government's macroeconomic policies, Brazil's diversified minerals endowment, and a skilled labor base. Major international petroleum and mining companies were notably interested or very active in Brazil. Several of the mining groups were acquiring exploration properties and mining prospects, particularly in order of importance, for gold and copper, and Exxon Corporation of the United States and British Petroleum Ltd. (BP) of the United Kingdom, and others were entertaining possible joint-venture-oil-gas projects with Petróleo Brasileiro S.A. (Petrobrás). Petrobrás perceived equally with interest such mega-mergers of BP and Amoco Corp. and of Exxon and Mobil

[1]Where necessary, values have been converted from Brazilian Real (R$) to U.S. dollars at the rate of R$1.1604=US$1.00.

Oil Corp. during the second half of 1998, as significant alliances aimed at gains via economy of scales, greater competitiveness, operational synergy, and strengthening of regional strategies, which will impact future oil-gas joint ventures between Petrobrás and the private sector (Rennó, 1999, p. 6-9).

The list of active international mining companies in Brazil included Newmont Mining Corp. and Placer Dome US Inc. of the United States; Barrick Gold Corp., 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. of the United Kingdom; and BHP Minerals International Exploration, Inc. and Western Mining Corp. Holdings Ltd. of Australia.

Government Policies and Programs

The present legal frame for the development and use of mineral resources in Brazil was established by the current Federal Constitution enacted in 1988. On August 15, 1995, the Brazilian Congress approved Constitutional Amendment No. 6 that allows 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 40-year Government monopoly of the oil and gas industries and fuel price subsidies were ended, allowing Petrobrás to enter into joint ventures with foreign investors. However, the Agencia Nacional do Petróleo regulates the petroleum industry (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. The current Concessions Law created additional opportunities for the private sector in public utilities previously reserved for the Government. All these actions were undertaken by the Government to open the Brazilian economy to international competition and have continued to create an 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 Brazilian Constitution and Mining via the Mining Code, Law No. 9314 of January 1997 (Departamento Nacional de Produção Mineral, 1998b, p. 3), was also providing greater flexibility for investment in the Brazilian mining sector. Article 7 of this law stipulates that the exploitation of mineral 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. Licensing is a restricted system applicable exclusively to the exploitation of industrial minerals. In conformance to the legal aspect of the Brazilian Constitution and Mining, the DNPM will enforce this mining code and its complementary legal provisions (Barbosa and Matos, 1998; Departamento Nacional de Produção Mineral, 1998b, p. 1-11).

The Brazilian Geological Survey, Companhia de Pesquisa de Recursos Minerais was developing programs for basic geologic mapping, metallogenetic and hydrogeologic mapping, and prospecting in areas of potential development, in addition to creating and maintaining geologic and economic data bases, particularly for coal, copper, diamond, gold, kaolin, nickel, peat, and zinc to assist potential investors in the minerals sector (Departamento Nacional de Produção Mineral, 1998a; Martins, 1998).

In 1998, Government's promarket economic policies continued via privatization of State-owned firms. Since yearend 1991, the Government has sold 57 companies, including firms in the utilities and telecommunications sectors worth $37 billion, to the State plus a transferred debt of about $8 billion, compared with about $15 billion between 1991 and 1997. Brazil's telephone system, worth $18.92 billion, was sold in 1998 (Ferraz, 1998, p. 1; Lapper, 1998, p. I; Barham, 1999). It appears that privatization will continue—in spite of the steep decline of the stock markets, weaker prices for commodity exports, and the financial storm that swept across Latin America. Sales in the utilities and other sectors were expected to generate about $24 billion in 1999 and $14 billion in 2000 (Lapper, 1998, p. I; Barham, 1999).

Environmental Issues

According to the Conseho Nacional de Meio Ambiente, an environmental license was required for all mining activities in Brazil. Law No. 88351 of 1986 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 Brazilian Constitution stipulates that mining operators must reclaim areas they have environmentally degraded. In Brazil, the environmental legislation applied to mining is basically consolidated in the following environmental requirements, Environmental Impact Study (EIA), Environmental Licensing (LA), and Plan for Recovery of Degraded Areas (PRAD). EIA applies to mining projects of any mineral substance, LA is a mandatory for installing, expanding, and operating any mining activity under the systems of mining concession or licensing, and PRAD requires suitable technical solution to rehabilitate the soil and other aspects of the environment that might be degraded by mining operations (Departamento Nacional de Produção Mineral, 1998b, p. 10-11). The Ministério de Minas e Energia also 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 was expected that environmental impacts will be lessened in the future.

Resolution 010 of December 6, 1990, requires 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 1998 was about $6 billion, or about 0.8% 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 1997, was related mostly to the iron ore output, which increased by 6.9%, as well. Increases also were recorded in production, in descending order, of graphite (concentrate), 64.5%; columbium (niobium, Nb_2O_5 content), 31.6%; silver, 27.8%; chromium (Cr_2O_3 content), 21.4%; nickel (content), 15.1%; and, to a lesser extent, bauxite, natural gas, and crude oil. As metal content in concentrates, lead, manganese, copper, and zinc production decreased by 13.3%, 13.6%, 13.8%, and 42.7%, 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, 1999b, p. XIII).

There were five major integrated steelworks—Aço Minas Gerais, S.A., a structure and rail producer; CSN, Brazil's largest mill; Companhia Siderúrgica Paulista, a carbon steel sheet and plate producer; Companhia Siderúrgica de Tubarão, a slab producer; and Usinas Siderúrgicas de Minas Gerais, S.A., Brazil's second largest steel mill. These companies produced about 17.5 million metric tons (Mt) of the total Brazilian steel production of 25.7 Mt. Eight firms accounted for 95% of iron ore production. CVRD produced about 55.2% of the iron ore. Mineração Río do Norte, S.A. (MRN), the majority of which is privately owned, is the world's third largest bauxite producer and exporter. MRN produced about 79.6% of the total bauxite production, which amounted to about 12.7 Mt. The four major aluminum smelters, all predominantly private Brazilian or foreign owned, produced 87.2% of the primary aluminum production of 1.2 Mt. (*See table 1.*)

Trade

Brazil is the largest open market and economic center of Mercosur, the trade bloc that also includes Argentina, Paraguay, and Uruguay. Bolivia and Chile are Mercosur's associate members. 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. 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 (A.M. Diez, P.T. Flecha de Lima, D.R. Guelar, and J.G. Prieto, Mercosur Ambassadors, Seattle, Washington, written commun., 1998).

During 1998, Brazil sold 17.4% of its exports to the other Mercosur members and 26.1% to the other countries in Latin America. Brazilian mineral imports were valued at $9.234 billion, or 22.1% lower than those of 1997 ($11.854 billion), and its total mineral exports were $11.122 billion, or about 1.8% lower than those of 1997 ($11.331 billion). The value of the principal exports were steel products, $3.041 billion; iron ore, $3.251 billion; and aluminum, $1.323 billion. In addition to petroleum and derivatives ($4.1 billion), other major mineral imports ($2.965 billion) were coal, copper, lead, natural gas, potash, sulfur, and zinc (Departamento Nacional de Produção Mineral, 1999b, p. IX; Petrobrás Magazine, 1999, p. 3).

Brazil-U.S. trade relations over the past decade had unprecedented growth. The U.S. imports were primarily manufactured and semimanufactured Brazilian goods of high aggregate value, such as steel and chemical products among other commodity exports, whereas Brazilian exports to Europe and Japan consisted mostly of raw materials and agricultural commodities, such as iron ore, manganese, marble, and granite. Total trade between Brazil and the United States increased by 95%, to $23.4 billion in 1998 from $12.0 billion in 1990. In the same period, however, Brazil's trade balance with the United States decreased to a deficit of $3.7 billion in 1998 from a surplus of $3.3 billion in 1990 (Barbosa, 1999).

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 five subsidiaries—Petrobrás Distribuidora S.A., the petroleum products distribution company; Petrobrás Internacional, S.A., the foreign operating company; Petrobrás Transporte S.A., the constructing and operating pipelines, terminals, vessels, and facilities needed for the transportation and storage of oil and derivatives, natural gas, and bulk products company; Petrobrás Química, S.A., the integrated refining-petrochemical operations company; and Petrobrás Gás S.A., the producing, trading, and distributing of natural and liquefied natural gas, and fertilizers company (Rennó, 1999, p. 29-39).

The structure of the Brazilian mineral industry keeps changing to a privately owned/ Government-regulated regime from Government-owned/Government-operated mode. Thus far, the Government has privatized the steel industry and CVRD during the 1991-98 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, 1999b, p. 52).

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 nearly 1

million garimpeiros active in Brazil. Employment in the mining sector continued its downward trend as Brazil's economy was affected by Brazil's recent economic crisis, 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 1997. Bauxite production was 12.7 Mt, 8.7% higher than that of 1997 (11.7 Mt). MRN is a joint venture owned by CVRD, 40%; Billiton International Metals B.V., 14.8%; Alcoa Alumínio S.A. (Alcoa), 13.2%; Alcan Empreendimentos Ltda. (Alcan), 12%; Companhia Brasileira de Alumínio (CBA), 10%; Norsk Hydro Comercio e Industria, 5%; and Reynolds Alumínio do Brasil, 5%. MRN accounted for almost 79.6% of the total bauxite production (10.1 Mt) for 1998. Alumina production was 3.324 Mt or 7.6% higher than that of 1997 (3.088 Mt). A consortium led by CVRD produced 1.43 Mt of calcined alumina, or 43.1% of the total. Primary aluminum producers were Albras-Alumínio Brasileiro S.A. about 344,300 metric tons (t) and Alcoa, 281,500 t. Other producers included CBA, 221,100 t; Billiton, 206,600 t; Alcan, 102,700 t; and Vale do Sul Alumínio S.A., 52,000 t. MRN plans to open 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. This new mine will maintain MRN's total bauxite production capacity to about 10 Mt/yr. Latapack-Ball S.A., aluminum can producer, plans to invest $5 million to increase its plant capacity in Jacareí, São Paulo, to 2 billion aluminum cans from 1.7 billion in 2000 (Departamento Nacional de Produção Mineral, 1999b, p. 18-19).

Alto Brazil Mineração, a joint venture of Alcoa (60%) and Billiton (40%), set up to mine 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 yearend 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. CBA plans to invest $700 million to produce 500,000 t/yr of alumina and expand its aluminum capacity to 360,000 t/yr from 220,000 t/yr (Departamento Nacional de Produção Mineral, 1999b, p. 19). Exports of bauxite were 4.3 Mt, valued at $125 million; primary aluminum was 811,000 t, valued at about $1.32 billion (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 93% of the world's total output with about 33,800 t of pyrochlore in concentrate, 20,516 t of columbium in alloys, and 2,400 t of columbium in oxides. In 1998, Companhia Brasileira de Metalurgia e Mineração (CBMM) and Mineração Catalão de Goiás Ltda. (MCGL) accounted for 74.5% and 25.5%, respectively, of Brazil's 51,000-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 pyrochlore production 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 pyrochore production capacity was 13,000 t/yr. Araxá and Catalão columbium ore deposits contained 88.2% (4.0 Mt) of the world's pyrochlore reserves at yearend.

Tantalum production totaled 50 t. The Araxá deposit, considered to be the world's largest and most economically viable known 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, 1999b, p. 74-75).

Copper.—According to Departamento Nacional de Produção Mineral, 1999 Sumário Mineral, copper concentrate production amounted to 34,446 t, a decrease of 14% compared with that of 1997 (Departamento Nacional de Produção Mineral, 1999b, p. 39). The concentrate was produced by the Paranapanema Group's Mineração Caraíba S.A. (MCSA) deposit in Jaguari, Bahia, Brazil's only copper mine. In September 1998, the Jaguari Mine was converted to underground operations from open pit mining because of surface copper-ore depletion. The total primary copper metal production amounted to 167,205 t, a decrease of 5.6% compared with that of 1997; this also included 412,382 t of copper concentrates imported from Chile, 53%; Peru, 19%; Argentina, 10%; and Indonesia, 9%. MCSA, the only electrolytic copper producer, invested $10 million to complete the expansion of its production capacity of 202,000 t/yr of refined copper. In 1998, to meet Brazil's copper demand of 258,000 t/yr, MCSA imported 128,781 t of copper cathode, mostly from Chile, 87%; Peru, 12%; and Argentina, 1%.

In 1998, the largest copper project, Salobo Metais' S/A (CVRD, Anglo American Corp., and the Brazilian Banco Nacional de Desenvolvimento Econômico e Social, each owning one-third in Pará, reserves were estimated to be 1,900 Mt grading 0.65% copper, containing 0.96% copper equivalent when considering gold, molybdenum, and silver, which would support a 250,000-t/yr production capacity of refined copper (Departamento Nacional de Produção Mineral, 1999b, p. 39). The feasibility study for the Chapada copper project in Alto Horizonte, Goiás of Mineração Santa Elina S.A. was completed and its ore reserves amounted to 434.5 Mt containing 1.3 Mt of copper and 9.6 t of gold. Igarapé (Bahia-Alemão Ltda.) and Sossego (CVRD/ Phelps Dodge Corp.) copper projects are at the feasibility stage. Brazil's metallic copper production was used primarily in construction and in automobile manufacturing. Exports amounted to 35,316 t, which went to the United States, Argentina, and the Republic of Korea (Departamento Nacional de Produção Mineral, 1999a, p. 3; 1999b, p. 38-39).

Gold.—Gold production was reported by the DNPM as 49.6 t (Departamento Nacional de Produção Mineral, 1999a, p. 2; 1999b, p. 78), which represented 37.8 t from mining companies and 11.8 t from garimpos (cooperatives of garimpeiros). The decreases in gold production from the garimpeiros and from the private sector were because of higher production costs, depletion of shallower deposits, lower prices in the international market, and stricter environmental standards. Refined 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 1.5 t of gold. This mine will be expanded to produce about 10 t of gold by 2000.

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 (Ferraz, 1998, p. 3; Departamento Nacional de Produção Mineral, 1999a, p. 2; 1999b, p. 78-79).

AngloGold Ltd. of South Africa was planning to spend $50 million on exploration and development in the Amazon region. The firm was particularly interested on exploring the Pedra Blanca do Amapari in the State of Amapá (Mining Journal, 1999).

Iron and Steel.—Ferroalloys.—Ferroalloy production decreased to 821,110 t from 922,850 t in 1997. For the year, steel production amounted to 25.7 Mt, which was 2.4% higher than that of the previous year. Brazil was the third largest ferroalloy producer in the world. Apparent domestic consumption was about 742,000 t. Brazil's Prometal Produtos Metalúrgicos S.A. took as a partner Norway's Elkem A/S, one of the world's largest manganese alloy producers, to produce a projected 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 Corp. (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 (Ferraz, 1998, p. 3; Departamento Nacional de Produção Mineral, 1999a, p. 8; 1999b, p. 52-53).

Iron Ore.—Brazil produced 199.5 Mt of beneficiated iron ore, an increase of 6.6% compared with 186.7 Mt in 1997. About 95% of that production was from eight major iron ore companies—CVRD, 98.3 Mt; Minerações Brasileiras Reunidas S/A (MBR), 28.4 Mt; S.A. Mineração da Trindade (SAMITRI), 15.7 Mt; Ferteco Mineração S.A., 13.2 Mt; Samarco Mineração S.A. (SAMARCO), 11.6 Mt; CSN, 11.4 Mt; SOCOIMEX S.A., 5.4 Mt; and Itaminas Comércio de Minérios S.A., 4.3 Mt. Brazil exported 150 Mt of iron ore and pellets valued at $3.25 billion (Ferraz, 1998, p. 3; Departamento Nacional de Produção Mineral, 1999b, p. 52-53).

The total iron ore exports were about 150 Mt, which represented an increase of almost 12% compared with those of 1997, and shipped to 40 countries. Total export revenues increased to $3.25 billion by yearend from $2.91 billion in 1997. The major importers of Brazilian iron ore were Germany, 17.2%; Japan, 15.5%; Italy, 6.5%; China, 6.1%; the United States, 5.2%; Argentina, 4.8%; Belgium, 4.7%; the Republic of Korea, 4.3%; Spain, 4.3%; and France, 4.0%. 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 inaugurated 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 $220 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 and to offset the iron ore depletion at the Aguas Claras and the Matuca 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 the 3,150-kilometer (km) pipeline between Brazil and Bolivia that connects the Bolivian city of Santa Cruz de la Sierra to the city of Campinas in São Paulo (Ferraz, 1998, p. 3).

SAMARCO (SAMITRI, 51%; Broken Hill Properties S.A., 49%) built its second pellet plant at Ponta do Ubu 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, 1998, p. 1; Brasil Mineral, 1999, p. 40).

Pig Iron.—Brazil produced 25 Mt of pig iron, which remained at the same level as that of 1997. 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 1998 steel production totaled 25.7 Mt, which increased 2.4% over that of 1997, 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, 1998, p. 32). The Instituto Brasileiro de Siderurgia stressed that the Brazilian steel industry became more efficient because of the major changes it had made via privatization. Brazil auctioned the Government-owned assets, collecting $15.9 billion in 1997, $20 billion in 1998, and privatization can be expected to generate $19.8 billion in 1999 (Welch and Bacha, 1998; Departamento Nacional de Produção Mineral, 1999b, p. 53).

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. CVRD acquired by the CSN Group, supplied the consortium with iron ore and provided them with railroad, port, and shipping facilities. 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 between 1991 and 1993 (Ferraz, 1998, p. 6).

Manganese.—Brazil produced 1.835 Mt of manganese ore in 1998, which was 13.6% lower than that of 1997. CVRD continued operating its high-grade manganese mine, Igarapé Azul, in the Carajás complex, which produced 1.2 Mt of metallurgical manganese, no increase from that of 1997. Urucum Mineração S.A. (UMSA), in Mato Grosso do Sul, was the second largest Brazilian producer followed by small producers in the States of Minas Gerais, Goiás, and Bahia. CVRD and UMSA produced 73.7% of the total manganese ore output. Indústria e Comercio de Minerios S.A. closed its operations in Amapá for economic reasons (Departamento Nacional de Produção Mineral, 1999b, p. 67). Exports of manganese amounted to 690,000 t valued at $52.5 million, which was almost 30% lower than that of 1997, or 984,214 t valued at $56.4 million (Ferraz, 1998, p. 2; Departamento Nacional de Produção Mineral, 1999b, p. 66-67).

Nickel.—Brazil produced 25,753 t of electrolytic nickel and nickel in ferronickel alloys, which was about 29.8% higher than the 19,839 t of nickel produced in 1997. The total output was originated by the Votorantim Group (VG), 13,006 t; the Minorco Group (MG), 8,077 t; and the RTZ Group, 4,670 t. Companhia Niquel Tocantins of VG produced about 1.9 Mt of nickel ore and 30,133 t of electrolytic nickel in Niquelândia, Goiás. In the same district, CODEMIN S/A of MG produced 611,023 t of nickel ore and 6,892 t of electrolytic nickel. Mineração Morro do Níquel S/A also of MG produced 91,366 t of nickel ore in Pratápolis, Minas Gerais, and shut down its mine operations in July 1998 (Departamento Nacional de Produção Mineral, 1999b, p. 76). In Minas Gerais, RTZ's Mineração Serra da Fortaleza produced 9,601 t of nickel matte and sold 9,354 t valued at $14.8 million to Outokumpu Oy's Harjavalta refinery of Finland (Ferraz, 1998, p. 3).

Tin.—Brazil was the world's fourth largest tin producer following Indonesia, China, and Peru. Tin production, in concentrate, decreased to 14,238 t from 18,291 t in 1997. The reduction in Brazilian output was attributed to the closing of some high-cost operations, the decrease in the ore grades, depletion of alluvial reserves, and the decline in tin prices. Production cuts were made at the Pitinga Mine in Amazonas operated by the Grupo PARANAPANEMA (GP) and at the garimpeiros' Bom Futuro operations in Rondônia. Exports decreased to 6,717 t, valued at $34.8 million, from 11,979 t in 1997. These exports were far below the quota assigned to Brazil by the Association of Tin Producing Countries (20,185 t/yr). Shipments were made to the United States, 65.9%; Argentina, 16.3%; and the remainder to Belgium, Spain, and others. GP produced 9,397 t of tin from its high-grade Pitinga Mine, with byproducts of, in order of importance, columbium, tantalum, zirconium, hafnium, thorium, and cryolite (Ferraz, 1998, p. 3; Departamento Nacional de Produção Mineral, 1999b, p. 48-49).

Zinc.—Brazil produced 87,475 t of zinc in concentrates, which was 42.7% lower than the 152,634 t in 1997. This output decrease was a result of the Mineração Areiense S.A.'s operations closure in Minas Gerais. VG's Companhia Mineira de Metais S.A. initiated its mine activities on January 1, 1998, and with Mineração Morro Agudo S/A were the only producers of zinc ore in Brazil (Departamento Nacional de Produção Mineral, 1999b, p. 104). The Brazilian zinc refineries produced 177,050 t of primary metal, which was 4.7% lower than that of 1997. To meet Brazil's demand for zinc, which was about 177,000 t/yr of metal, the country imported 177,000 t of zinc concentrates and 14,800 t of metal. Peru supplied 95.1% of concentrates and 43% of metal zinc; metal zinc was also supplied by Argentina, 20% and the United States, 15% (Ferraz, 1998, p. 3; Departamento Nacional de Produção Mineral, 1999b, p. 104-105).

Industrial Minerals

Asbestos.—Brazil's significant asbestos deposits were in Minaçu, Goiás, which is the only producing State in the country. Sociedade Anônima Mineração de Amianto (SAMA) produced 198,332 t of asbestos fiber, which was 4.9% lower than that of 1997. Almost 94% of Brazil's asbestos production 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 (Departamento Nacional de Produção Mineral, 1999b, p. 20).

Brazil exported about 27% of its production mainly to India, 51%; Japan, 10%; Thailand, 6%; and Mexico, 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 (16.7 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, 1999b, p. 20-21).

Cement.—The country produced 39.9 Mt of cement, which was almost 4.8% higher than that of 1997. Minas Gerais contributed 23%; São Paulo, 19%; Paraná, 9%; Rio de Janeiro, 8%; and other States, 41%. Most of the exported cement (305,000 t) went to Argentina, 55.6%; Paraguay, 39.2 %; and Bolivia, 4.6 %. Brazil imported about 476,037 t of cement

from Japan (35.2%), Tunisia (31.5%), Thailand (15.8%), Belgium (12.3%), and France (8.5%) (Departamento Nacional de Produção Mineral, 1999b, p. 36-37).

Clays.—Production of beneficiated kaolin was about 1.4 Mt, which was almost 7.9% higher than that of 1997. Caulim da Amazônia S.A. continued operating its Adam Mine in Rio Jarí, Amazonas, and accounted for 51% of the country's total output. Brazilian kaolin exports were 26% higher than that of 1997, or 964,268 t. Pará Pigmentos S.A. (PPSA) produced 500,000 t of kaolin, PPSA's operations will be expanded to a full capacity of 1 Mt/yr by 2001. 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 510,000 t/yr in 2001. In Brazil, kaolin consumption decreased to 421,473 t from 519,562 t in 1997 and it 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 1,500 Mt of kaolin reserves, or about 12.7% of the world's total (Ferraz, 1998, p. 3; Departamento Nacional de Produção Mineral, 1999b, p. 32-33).

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 or 15 million carats, which represented about 1.2% of the world's diamond reserves (Departamento Nacional de Produção Mineral, 1999b, p. 42). The total value of gemstone (including diamond) production was $108 million, the same level as that of 1997. Total exports of uncut gemstones have decreased to $27.7 million from $34.5 million in 1997, and imports increased 30.8% over that of 1997, or about $17 million (Departamento Nacional de Produção Mineral, 1999b, p. 42).

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 amounting to 50,622 t grading 14% of carbon, denoting an increase of 61.6% compared with that of 1997. This increase was the result of new markets and new uses for NGL. This production was concentrated in products ranging in grade from 65.5% to 99.9% carbon by NGL in the Pedra Azul plant. Also in Minas Gerais, Grafita MG Ltda. produced 10,747 t of natural graphite, which was consumed, domestically, after simple grinding (Departamento Nacional de Produção Mineral, 1999a, p. 7; 1999b, p. 60-61).

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 6,900 t/yr, respectively. Exports amounted to 13,493 t valued at about $16.5 million. Growth of the domestic consumption of natural graphite during the 1990's was correlated with that of the iron and steel industries' growth, which absorbed about 80% of the natural graphite consumed in Brazil (37,265 t) in 1998. Other consumers included battery manufacturing, 6.5%; refractories, 6%; paint and varnishes, 2%; and other miscellaneous uses, 5.5% (Departamento Nacional de Produção Mineral, 1999, 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 308,300 t of beneficiated magnesite, of which MSA produced 98% (302,134 t). Exports were 88,092 t valued at $12.7 million and shipped to the United States, 22.8%; Poland, 20.9%; Argentina, 18%; Chile 16.9%; Venezuela, 8%; Peru, 7.2%; and others, 6.2%. Imports were 7,844 t valued at $4.9 million and imported from Canada, 19%; the United States, 17%; Mexico, 17%; China, 12%; Israel, 10%; and others, 25% (Departamento Nacional de Produção Mineral, 1999b, p. 64). In Brazil, about 630 Mt of resources with 180 Mt of magnesium content had been identified by yearend. In the next decade, Indústria Química Xilolite S.A. and MSA's beneficiation plants in Brumado, Bahia, are considering to attempt their full operation capacity of 28,000 t/yr and 36,000 t/yr, respectively (Departamento Nacional de Produção Mineral, 1999b, p. 65).

Phosphate Rock.—Production of phosphate rock concentrate amounted to about 4.42 Mt, an increase of 3.4% from that of 1997. Production was highly concentrated in four mining companies—Fertilizantes Fosfatados S.A., Fertisul S.A., Ultrafértil S.A., and Copebras S.A., (Ferraz, 1998, p. 3). The reported domestic consumption was 5.2 Mt/yr, denoting an increase of 2.8% compared with that of 1997. Of the total phosphoric acid, 73% was used in the fertilizer industry, 25% in the chemical industry, and the rest for other uses, which remained about the same level as that of 1997 (Departamento Nacional de Produção Mineral, 1999b, p. 55).

Quartz.—Brazil produced 1,594 t of quartz, valued at about $1.3 million. All produced quartz was exported mostly to Japan, 43.1%; the United Kingdom, 25.7%; Hong Kong, 11.9%; Germany, 8.3%; Argentina, 4.7%; and others, 6.3%. 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, 1999b, p. 85).

Salt.—The reported domestic production of marine salt was 5.4 Mt, which represented a 5.7% increase from that of 1997's output. Rio Grande do Norte S.A. continued to be the major source of salt with 95.5%, followed by Rio de Janeiro, 2.3%;

and Ceará, 2.2% (Departamento Nacional de Produção Mineral, 1999b, p. 88). The domestic consumption of marine salt was 6.6 Mt. Brazil also produced 1.5 Mt of rock salt. Salgema Mineração e Química in Maceió, Alagoas, produced 772,000 t (52%) of rock salt and Dow Química do Nordeste, a subsidiary of Dow Chemical Co. of the United States, produced 712,000 t (48%) from the Vera Cruz Mine in Bahia. The total salt use was for chemical industry, 39% (chlorine and caustic soda, 34% and deicing salt, 5%); feedstock, 37%; and others, 14% (Departamento Nacional de Produção Mineral, 1999b, p. 89).

Other Industrial Minerals.—Potassium production increased by 16.6%, to 544,200 t, compared with that of 1997. Brazil imported 1.9 Mt of potash, mainly from Canada, 32.3%; Russia, 21%; Germany, 21%; Israel, 14.1%; and other countries, 11.6% (Departamento Nacional de Produção Mineral, 1999a, p. 10; 1999b, p. 80-81).

Fluorspar production decreased by 7.6%, to 72,082 t, compared with that of 1997. Production of the acid-grade type decreased by 8.7% (61,024 t); and the output of metallurgical-grade material, also decreased by 1% (11,058 t) because of competitive imports. The Brazilian steel industry benefitted of the lower international prices for metallurgical-grade fluorspar (Departamento Nacional de Produção Mineral, 1999b, p. 56-57). Production of gypsum was about 1.6 Mt, or 7% higher than that of 1997. In Brazil, the renewed housing and infrastructure activities improved the consumption of cement and plasters (Departamento Nacional de Produção Mineral, 1999b, p. 58).

Production of talc was 289,000 t, which was 7.1% higher than that of 1997. The State of Paraná was Brazil's major talc producer with 50% of the national output followed by Bahia, 25%; São Paulo, 24%; and Minas Gerais produced lower volumes as a result of some talc ore depletions that had taken place since mid-1997 (Departamento Nacional de Produção Mineral, 1999b, p. 90-91).

Mineral Fuels

Brazil produced 366.6 million barrels (Mbbl) of petroleum and 10.8 billion cubic meters of natural gas, which were 15.5% and 9.8% higher than those of 1997, respectively. The country produced, in order of importance, crude oil, natural gas liquid, natural gas, and shale oil, 454.8 million barrels of oil equivalent. Petrobrás's average production of crude oil (including shale oil and natural gas liquid) was 1,004,281 barrels per day (bbl/d) in 1998. On December 31, 1998, Petrobrás attained a new production record of 1,222,228 bbl/d and was planning to reach a target of 1.6 million bbl/d in 2001 (Ferraz, 1998, p. 8; Rennó, 1999, p. 21; Petrobrás Magazine, 1999, p. 2-3).

Coal.—The Brazilian coal industry's mine operations concentrated in the southern States of Rio Grande do Sul, 50%; Santa Catarina, 49%; and Paraná, 1%. Brazil's production of marketable coal products increased to 2.7 Mt from 2.6 Mt in 1997, or an increase of 5.8%. Carbonífera Criciuma S.A. and Companhia Carbonífera de Urussanga in Santa Catarina produced about 2.35 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, 10.9 Mt was imported, valued at $746 million, which was a decrease of 7.6% compared with that of 1997. Imports came from the United States, 48%; Australia, 21%; South Africa, 17%; Canada, 8%; and others, 6%. Coal consumption had reached 15.4 Mt by yearend. Metallurgical coal represented 66% of this total consumed by the steel industry, and the remainder was for power generation. Most Brazilian coals have lower content of carbon and a higher content of ash compared with those of Colombian coals in the Guajira area. Total Brazilian coal reserves were estimated to be 6,500 Mt (Ferraz, 1998, p. 2; Departamento Nacional de Produção Mineral, 1999b, p. 30-31).

Natural Gas and Petroleum.—The gas pipeline linking the Enchova platform in the offshore Campos Basin to Macaé, Río de Janeiro, has added 5 million cubic meters per day (Mm^3/d) of gas flow to the Río de Janeiro and the São Paulo markets. Offshore gas production accounted for 65% of the total. 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 will transport 30 Mm^3/d of natural gas to supply to the States of Mato Grosso do Sul, São Paulo, Paraná, Santa Catarina, and Rio Grande do Sul from Santa Cruz de la Sierra in Bolivia (Petrobrás Magazine, 1999, p. 6; Rennó, 1999, p. 21).

Braspetro S.A., 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 (447,000 bbl/d) and derivatives (411,000 bbl/d) total imports were valued at $5.86 billion, and total exports (2,600 bbl/d of oil and 115,000 bbl/d of derivatives) were valued at $499 million. 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 Argentina, Kuwait, Nigeria, and Venezuela (Petrobrás Magazine, 1999, p. 6; Rennó, 1999, p. 21).

Uranium.—Brazil owns the fifth largest uranium reserves in the world (Rapouso dos Santos, 1998). The country's demonstrated reserves amounted to 192,540 t of U_3O_8 and 108,950 t of inferred reserves, with minable reserves contained 123,067 t grading 0.124% U_3O_8. Private interests were 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 (Departamento Nacional de Produção Mineral, 1998b, p. 377; Rapouso Dos Santos, 1998, p. 203-205).

Reserves

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

Infrastructure

Brazil's railroads comprised 28,862 km of 1.000-meter (m) gauge, 4,123 km of 1.600-m gauge, 24,390 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 1.98 million km of roads—184,140 km paved and 1.8 million km gravel and dirt. There was 50,000 km of navigable inland waterways. The major shipping ports were Belém, Manaus, Porto Alegre, Recife, Río de Janeiro, Río Grande, Salvador, and Santos. Among the Brazil merchant marine's 271 ships, 56 were tankers; 15, chemical tankers; 10, liquefied gas tankers; 14, combination ore and oil vessels; 82, bulk vessels; and 2, combination bulk vessels. There were 2,980 km of crude petroleum pipelines, 4,762 km of refined petroleum product pipelines, and 4,246 km of natural gas pipelines in 1998 (Vale, 1998, p. 10; Central Intelligence Agency, 1999, p. 40).

In 1998, Brazil's installed electrical generating capacity was 52,865 megawatts (MW). Total production of electric power for the year was 291,630 gigawatt hours, which translated into 1,370 kilowatt hours per capita. Brazil's primary domestic energy supply encompassed the following: hydroelectric, 92.1%; petroleum and natural gas, 4.4%; nuclear energy, 0.8%; and others, 2.7% (Vale, 1998, p. 18-23; Central Intelligence Agency, 1999, p. 40).

Cross-border energy investment opportunities exist because of Mercosur, which allows Brazil to be the center of an increasingly rapid process of energy integration in South America. The Brazil-Bolivia pipeline is the largest of various cross-border energy projects that is owned by a consortium or joint venture of the Royal Dutch-Shell Group, Enron, Inc., and Petrobrás. Argentina is supplying gas to Rio Grande do Sul's new thermo-electric plant, while two additional pipelines are to take Argentine gas to the Brazilian's southern market and another project will supply energy to Brazil from a powerplant in Uruguay. In northern Brazil, a transmission line is supplying energy to Roraima from Venezuela. The majority of these projects are being developed by the private sector, as a result of the liberalization and privatization. Even when State-owned corporations are involved, it is often in partnership with other private domestic and foreign corporations (Dyer, 1999).

Negotiations were also completed between the Brazilian Government and five companies, four of which were foreign subsidiaries. The companies involved were Alcan Aluminio do Brasil S.A. (Canada), Alcoa (United States), Billiton Metais S.A. (the Netherlands), Dow Chemical, USA (United States), and Camargo Corréa 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, 1998, p. 23). This new dam appears to be necessary because demand for hydroelectricity was growing at a faster rate than that of supply. This increased demand could exceed the current supply in a very few years. Equally, electricity from the Tucurui Dam on the Tocantins River, at 10% subsidy prices that expires in 2004, had been exceeded by the current mining and industrial activities in the Tocantins area.

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 and Mato Grosso do Sul to Cuiabá, Mato Grosso, and Santarem, Pará, branching from Cuiabá, Mato Grosso, to Porto Velho, Rondônia (Vale, 1998, p. 22).

Outlook

Brazil established a favorable climate for domestic and foreign investors by keeping inflation under control, coming to grips with its twin fiscal and external deficits, providing stable rules for capital repatriation and profit remittances, and reducing the tax burden, tariffs, and nontariff barriers. These and the current review of its 1988 Constitution will probably position Brazil well for the end of the decade. The flow of foreign capital into the Brazilian economy would seem to support continued economic growth, and investments in technology may well continue in the 21st century. The Brazilian economy in 1998, however, was affected by the volatility of the international financing market, depressed prices for mineral exports, the Asian and Russian financial turmoils at the end of 1997 and in August 1998, respectively.

The sectors of the Brazilian economy recorded diverse growths, some smaller (services, 0.75%), and negative growth (industry, - 0.98%); others robust such as, the mineral sector that increased by 9.04% (Departamento Nacional de Produção Mineral, 1999a, p. 1). If that positive rate of economic growth is sustained into 1999 and beyond, then the minerals sector will probably continue its expansion as the demand for mineral exports and fabricated steel goods increases.

FDI into the Brazilian mining industry will probably continue enhancing exploration and mine development activities, particularly in gold and emeralds. This trend will probably continue as several corporations are acquiring exploration properties and mining prospects, particularly for gold, diamond, and base metals, partly in response to the economic slowdown, which reduced the price of potential acquisitions.

After the steel industry was privatized, other sectors of the Brazilian economy, such as services, energy, telecommunications, transportation, and mining will probably be part of the privatization process and joint ventures. New projects in the petroleum sector will continue to be opened up

to joint-venture projects with domestic and foreign investors. Privatization of Government-owned firms and joint ventures has led to lower employment levels and greater efficiencies; as a result, the Brazilian economy should be sustainable and competitive in the global economy.

Privatization of Government monopolies, dismantling all trade barriers, increased exports to the world markets, and the constitutional amendment that eliminate the distinction between domestic and foreign capital will continue to be important, allowing the continued flow of FDI 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.

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 of, in order of importance, 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.

The combination of lower exchange rate and inflation offers a competitive advantage to many international corporations, reducing the price of potential acquisitions through privatizations, direct acquisitions, and joint ventures and expansions, particularly in the infrastructure, telecommunication, mineral, and energy industries and increased commodity mineral exports.

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Comissão Nacional de Energia Nuclear
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Petróleo Brasileiro, S.A.
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Rio Doce Geológica e Mineração, S.A.
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Major Publications

Associação Brasileira dos Produtores de Ferroligas (ABRAFE), Sao Paulo: ABRAFE Yearbook, annual.
Departamento Nacional da Produção Mineral, Brasilia: Anuario and Sumario Mineral, annual.
Fairchild Publications, New York: American Metal Market, weekly.
Instituto Latinoamericano del Fierro y el Acero, Santiago: Monthly and annual reports.
Latin American Mining Institute, Washington, DC: The South American Investment and Mining Guide, annual.
Metal Bulletin Journals Ltd., London: Metal Bulletin, semiweekly.
Metal Bulletin, monthly.
Mining Journal Ltd., London: Mining Annual Review, annual.
Mining Journal Ltd., London: Mining Journal, weekly.
PennWell Publishing Co., Tulsa: Oil & Gas Journal, weekly.
Petróleo Brasileiro, S.A., Rio de Janeiro: Petrobrás Relatório Anual de Atividades, annual.

TABLE 1
BRAZIL: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

Commodity 2/		1994	1995	1996	1997	1998
METALS						
Aluminum:						
Bauxite, dry basis, gross weight		8,673,000	10,214,000	10,998,000 r/	11,671,000 r/	12,688,000
Alumina		1,868,000	2,141,000	2,759,000 r/	3,088,000 r/	3,324,000
Metal:						
Primary		1,185,000	1,188,000	1,197,000 r/	1,189,000 r/	1,208,000
Secondary		90,000	92,000	143,000 r/	148,000 r/	170,000
Beryllium, beryl concentrate, gross weight		6 r/	6 r/	6 r/	7 r/	7
Cadmium, metal, primary e/		300	300	300	300	300
Chromium:						
Crude ore		359,788	447,963	408,495	285,500 r/	440,450
Concentrate and lump, Cr_2O_3 content		174,068	175,667	174,150	112,274 r/	136,000
Marketable product 3/		85,879	100,969	77,231	49,563 r/	33,000
Cobalt:						
Mine output, Co content by hydroxide e/		400	400	400	400	400
Metal, electrolytic 4/		165 r/	166 r/	193 r/	266 r/	364
Columbium-tantalum ores and concentrates, gross weight:						
Columbite and tantalite		175 r/	175 r/	190 e/	190 e/	330 e/
Djalmaite concentrate e/		10	10	10	10	10
Pyrochlore concentrate, Cb_2O_5 content		18,950	21,731	19,621 r/	25,688 r/	33,795
Copper:						
Mine output, Cu content		39,673	48,933	46,203	39,952 r/	34,446
Metal:						
Primary		170,033	164,966	172,075	177,060 r/	167,205
Secondary		54,290	54,400	54,000	54,100 r/	54,150
Gold:						
Mine output	kilograms	40,188	40,951	41,142 r/	41,062 r/	37,787
Garimpeiros (independent miners)	do.	32,209	22,349	18,869	17,426 r/	11,780
Total	do.	72,397	63,300	60,011 r/	58,488 r/	49,567
Iron and steel:						
Ore and concentrate (marketable product): 5/						
Gross weight	thousand tons	177,331	183,839	174,200 r/	186,700 r/	199,500
Fe content	do.	103,227	112,793	106,879 r/	121,355 r/	131,670
Metal:						
Pig iron	do.	25,177	25,090	25,100	25,000 e/	25,000 e/
Ferroalloys, electric-furnace: e/						
Chromium metal		37	37	37	37	40
Ferrocalcium silicon		25,000	25,000	25,000	25,000	25,000
Ferrochromium		85,879 r/	100,969 r/	77,231 r/	112,274 r/	110,000
Ferrochromium silicon		5,000	5,000	5,000	5,000	5,000
Ferrocolumbium		19,000	19,000	19,000	19,000	19,000
Ferromanganese		200,000 6/	130,000 6/	215,260 6/	153,000 6/	123,000 6/
Ferromolybdenum		47	47	47	47	50
Ferronickel		35,260 6/	34,000 6/	35,518 6/	37,400 6/	37,000 6/
Ferrophosphorus		2,000	2,000	2,000	2,000	2,000
Ferrosilicon		198,505 6/	243,824 6/	236,838 6/	212,183 r/	210,000 6/
Ferrosilicon magnesium		15,000	15,000	15,000	15,000	15,000
Ferrosilicon zirconium		1,500	1,500	1,500	1,500	1,500
Ferrotitanium		500	500	500	500	500
Ferrotungsten		25	25	25	25	25
Ferrovanadium		3,000	3,000	3,000	3,000	3,000
Inoculant		25,000	25,000	25,000	25,000	25,000
Silicomanganese		248,000 6/	167,000 6/	232,218 6/	175,000 6/	125,000 6/
Silicon metal		110,000 6/	116,000 6/	150,054 6/	136,884 r/ 6/	120,000
Total 7/		973,750	887,900	1,043,230	922,850	821,110
Steel, crude, excluding castings	thousand tons	25,747	25,076	25,076	25,100	25,700 6/
Semimanufactures, flat and nonflat e/	do.	25,000	25,000	25,000	25,000	25,000
Lead:						
Mine output, Pb content in concentrate		1,329	11,611	7,894	8,729 r/	7,567
Metal:						
Primary		24,000	13,958	-- 6/	-- 6/	--

See footnotes at end of table.

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

(Metric tons unless otherwise specified)

Commodity 2/		1994	1995	1996	1997	1998
METALS--Continued						
Lead--Continued:						
Metal--Continued:						
Secondary		60,000	65,000 e/	45,000 r/	44,500 r/	--
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 3/		2,199,079	2,398,025	2,506,000	2,124,000 r/	1,835,000
Nickel:						
Mine output, Ni content		27,706	29,124	25,245	31,936 r/	36,764
Ferronickel, Ni content		8,815	8,497	9,091	9,350 r/	8,077
Rare-earth metals, monazite concentrate, gross weight		256	103	200	200	200 e/
Silver 8/	kilograms	50,400	49,775	29,560 r/	26,598 r/	34,000
Tin:						
Mine output, Sn content		16,618	17,316	19,617 r/	18,291 r/	14,238
Metal:						
Primary		20,400	16,789	18,361 r/	17,525 r/	14,337
Secondary e/		250	250	250	250	250
Titanium concentrates, gross weight:						
Ilmenite		97,439	102,125	97,955	97,174 r/	103,000
Rutile		1,911	1,985	2,018	1,742 r/	1,800
Tungsten, mine output, W content		270	171	171	70 r/	--
Zinc:						
Mine output, Zn content		177,585	188,472	117,341 r/	152,634 r/	87,475
Metal:						
Primary		187,300	198,976	186,338 r/	185,701	177,050
Secondary e/		7,000	7,000	7,000	7,000	7,000
Zirconium, zircon concentrate, gross weight 9/		17,064	16,343	15,560 r/	19,252 r/	19,300
INDUSTRIAL MINERALS						
Asbestos:						
Crude ore e/		3,950,000	3,950,000	3,950,000	3,950,000	3,950,000
Fiber		181,416	208,882	213,212	208,447 r/	198,332
Barite:						
Crude		48,287	43,737	49,662	44,755 r/	55,977
Beneficiated		31,499	30,750	39,662	51,961 r/	46,632
Marketable product e/ 3/		65,000	65,000	65,000	65,000	65,000
Calcite		32,798	36,733	35,000 e/	35,000 e/	35,000 e/
Cement, hydraulic	thousand tons	25,230	28,256	34,597	38,096	39,942
Clays:						
Bentonite (beneficiated)		144,950	150,000	186,000	224,055 r/	210,214
Kaolin:						
Crude		2,045,881	1,957,750	2,196,708 r/	2,666,000 r/	2,892,597
Beneficiated		1,037,570	1,067,109	1,057,671 r/	1,280,000 r/	1,381,000
Marketable product e/ 3/		1,100,000	1,100,000	1,100,000	1,150,000	1,150,000
Diamond: e/						
Gem	thousand carats	300	676 6/	200	100 r/	100
Industrial	do.	600	600	600	600	600
Total 7/ 10/	do.	900	1,280	800	700 r/	700
Diatomite:						
Crude		20,349	15,059	15,236 r/	15,448 r/	14,303
Beneficiated		17,018	14,049	11,236 r/	11,228 r/	10,162
Marketable product e/ 3/		13,100	13,100	13,100	13,100	13,100
Feldspar:						
Crude		205,000	198,894	276,621 r/	225,000 r/	230,000
Feldspar, marketable product e/ 3/		122,000	122,000	122,000	122,000	122,000
Leucite, marketable product e/ 3/		5,000	5,000	5,000	5,000	5,000
Sodalite, crude, marketable product e/ 3/		500	500	500	500	500
Total e/ 3/		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/		1994	1995	1996	1997	1998
INDUSTRIAL MINERALS--Continued						
Fluorspar--Continued:						
Concentrates, marketable product:						
Acid-grade		68,890	72,498	46,706	66,858 r/	61,024
Metallurgical-grade		21,041	16,760	12,334	11,174 r/	11,058
Total		89,931	89,258	59,040	78,032 r/	72,082
Graphite:						
Crude e/		650,000	650,000	650,000	650,000	650,000
Marketable product:						
Direct-shipping crude ore		2,735	3,368	4,134	9,397 r/	10,747
Concentrate		30,612	30,222	27,190 r/	31,190 r/	50,622
Total		33,347	33,590	31,324 r/	40,587 r/	61,369
Gypsum and anhydrite, crude		834,187	953,116	1,126,106	1,395,664 r/	1,631,957
Kyanite: e/						
Crude		750	750	750	750	750
Marketable product 3/		600	600	600	600	600
Lime, hydrated and quicklime	thousand tons	6,000	6,144	6,210 r/	6,469 r/	6,229
Lithium, concentrates		7,031	7,190	6,571 r/	6,948 r/	9,485
Magnesite:						
Crude		1,026,991	1,210,617	1,268,265	1,030,171 r/	1,109,351
Beneficiated		279,489	315,978	305,737 r/	294,629 r/	308,300
Mica, all grades		6,700	5,200	7,000	4,000 r/	2,163
Nitrogen, N content of ammonia		940,000 e/	940,000 e/	976,800 r/	1,018,600 r/	948,600
Phosphate rock including apatite:						
Crude:						
Mine product e/	thousand tons	27,000	27,000	27,000	27,000	27,000
Of which, sold directly e/	do.	35	35	35	35	35
Concentrate:						
Gross weight	do.	3,937	3,888	3,823	4,276 r/	4,421
P_2O_5 content	do.	1,387	1,364	1,353	1,510 r/	1,561
Pigments, mineral, other, crude e/		2,000	2,000	2,000	2,000	2,000
Potassium (KCl)		403,904	371,398	404,538	466,984 r/	544,200
Potash, marketable (K_2O)		234,265	215,411	242,723	280,164 r/	326,489
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	value	$10,000	$10,000	$10,000	$10,000	$10,000
Sapphire	do.	$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		3,963	5,586	2,355 r/	2,169 r/	1,594
Salt:						
Marine	thousand tons	4,670	4,460	3,870	5,064 r/	5,353
Rock	do.	1,373	1,340	1,514	1,452 r/	1,484
Silica (silex) e/	do.	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	cubic meters	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	cubic meters	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/		1994	1995	1996	1997	1998
INDUSTRIAL MINERALS--Continued						
Stone, sand and gravel e/--Continued:						
Crushed and broken stone--Continued:						
Dolomite	thousand tons	3,500	3,500	3,500	3,500	3,500
Gneiss	cubic meters	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000
Granite	thousand cubic meters	60,000	60,000	60,000	60,000	60,000
Limestone	thousand tons	60,000	60,000	60,000	60,000	60,000
Quartz 11/		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		20,708	22,472	25,319	20,476 r/	24,582
Pyrites		153	3,794	4,158	2,307 r/	1,137
Byproduct:						
Metallurgy		182,638	170,942	175,121 r/	175,511 r/	177,348
Petroleum		53,256	41,951	33,424 r/	33,823 r/	36,973
Total		256,755	239,159	238,022 r/	232,117 r/	240,040
Talc and related materials:						
Talc:						
Crude		363,561	297,669	296,810 r/	285,614 r/	289,000
Marketable product e/ 3/		2,000	2,000	2,000	2,000	2,000
Pyrophyllite, crude		148,000	150,000	155,370 r/	158,675 r/	161,000
Vermiculite						
Concentrate		17,233	18,806	21,999 r/	23,000 r/	24,300
Marketable product 3/		2,029	3,826	4,000	5,000 r/	4,200
MINERAL FUELS AND RELATED MATERIALS						
Coal, bituminous, run of mine	thousand tons	4,465	5,525	4,788 r/	5,847 r/	5,382
Coal, bituminous, marketable 3/	do.	2,248 r/	2,782 r/	2,794 r/	2,561 r/	2,710
Coke, metallurgical, all types	do.	118	25	70 r/	91 r/	90
Gas, natural, gross	million cubic meters	7,352	8,043	9,156	9,865	10,841
Natural gas liquids e/	thousand 42-gallon barrels	13,000	13,000	13,000	13,000	13,000
Petroleum:						
Crude	do.	242,723	251,716	286,843	307,153	366,563
Refinery products: 12/ 13/						
Liquefied petroleum gas	do.	NA	NA	38,778	40,055	58,288
Gasoline	do.	126,000 e/	126,000 e/	102,389	115,409	167,943
Jet fuel	do.	17,800 e/	17,800 e/	535	478	695
Kerosene	do.	1,370 e/	1,370 e/	22,896	22,449	32,668
Distillate fuel oil	do.	149,000 e/	149,000 e/	169,994	177,435	258,203
Lubricants	do.	4,120 e/	4,120 e/	4,906	5,001	7,277
Residual fuel oil	do.	79,000 e/	79,000 e/	81,198	103,364	150,415
Other	do.	60,000 e/	60,000 e/	63,856	84,871	123,502
Refinery fuel and losses	do.	20,600 e/	20,600 e/	--	--	--
Total 7/		457,890 e/	457,890 e/	484,552	549,062	798,991

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

1/ Table includes data available through August 1999.

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

4/ Source: Cobalt Development Institute.

5/ Includes sponge iron as follows, in thousand metric tons: 1994--260 and 1995-98--270 (estimated).

6/ Reported figure.

7/ Data may not add to totals because of independent rounding.

8/ 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: 1994--30,000; 1995--35,000; 1996--38,000; 1997--32,000; and 1998--40,000.

9/ Includes baddeleyite-caldasite.

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

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

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

13/ Minerals Questionnaire, 1997-98, and Petrobrás Magazine, 1998-99.

TABLE 2
BRAZIL: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(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 Aluminio 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). 200 (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 (mine) Sorocaba, São Paulo State (refinery) (smelter)	1,000 (bauxite). 170 (alumina). 220 (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 Aluminio do Brasil, 5%; and 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) (Government, 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%; Bayer 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. (Paranapanema 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).
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 Corp., 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.

TABLE 2--Continued
BRAZIL: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
METALS--Continued				
Ferroalloys--Continued:		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, Bahía, 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)	1,500.
Iron ore		Companhia Siderúrgica Nacional (CSN, 100%)	Volta Mine, Minas Gerais	12,000.
Do.		Itaminas Comércio de Minérios S.A. (ICMSA, 100%)	Itaminas, Minas Gerais	5,000.
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)	12,000.
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)	311,500.
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).
Do.		Urucum Mineração S.A. (UMSA, 100%)	Corumba and Ladario, Mato Grosso do Sul 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.		Mineraçao 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)	100 (ore). 450 (concentrate).

TABLE 2--Continued
BRAZIL: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
METALS--Continued			
Tin--Continued:	Grupo PARANAPANEMA (private, 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, Paraiba State (mine) (two beneficiation plants)	4,200 (ore). 120 (concentrate).
Zinc	Companhia Mineira 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).
Zirconium	Nuclemon Minero-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 Anônima 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.
Do.	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 Tejucana 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)	84 (ore). 72 (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	500 (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 Goiãs, Minas Gerais, and Rio de Janeiro (five mines)	2,000.

TABLE 2--Continued
BRAZIL: STRUCTURE OF THE MINERAL INDUSTRY IN 1998

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
INDUSTRIAL MINERALS--Continued				
Limestone--Continued:		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. (Arafértil) (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. (Fosfértil, 100%)	Tapira, Minas Gerais State (two mines)	10,500.
Do.		Ultrafértil S.A. (Ultrafértil, 100%)	Araxá, Minas Gerais State (mine)	5,000.
Quartz		Telequartzo Exportacão S.A. (TESA, 100%)	Cristal, Minas Gerais State (mine)	6.
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		Carbonífera Criciuma S.A. (CCSA, 100%)	Circiuma and Sideropolis, Santa Catarina State (two mines)	4,000.
Do.		Companhia Carbonífera de Urussanga (CCU, 100%)	Criciuma, Sideropolis, and Urussanga Santa Catarina State (three mines)	7,200.
Do.		Companhia de Pesquisas e Lavras Minerais-Copelmi (COPELMI, 100%)	Arroio dos Ratos, Butia, 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.	do.	Refinaria de Petróleo Ipiranga S.A. (RPISA, 100%)	Ipiranga, Rio Grande do Sul	3,400.
Do.	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 1998 1/

(Thousand metric tons unless otherwise specified)

Commodity		Reserves	World ranking	World percent
Asbestos, fiber		16,874		NA
Bauxite, ore		1,800,000	6	5.9
Chromite, Cr_2O_3		6,000		0.1
Coal, all types		6,496,000		0.6
Columbium, pyrochlore, and columbite ore		3,976	1	86.9
Copper, metal content		11,896		1.8
Fluorspar, ore		8,000		2.1
Gold, metal	metric tons	1,900		4.2
Graphite, ore		95,000	2	21.0
Gypsum		1,250,261		NA
Iron ore, 60% to 65% Fe content		19,750,000	6	6
Kaolin		1,524,000	2	13
Lead, metal content		950		0.7
Magnesite		180,000		5.2
Manganese, metal content		51,337	5	1.1
Natural gas 2/	million cubic meters	409,800		NA
Nickel, metal content		3,284		2.9
Petroleum 2/	thousand 42-gallon barrels	14,400,000		NA
Phosphate rock		370,000		1.1
Talc and pyrophyllite		178,000	3	19.1
Tin, metal content	metric tons	578,763	5	7.9
Titanium, TiO_2		9,225		2.0
Uranium, U_3O_8	metric tons	163,000		NA
Zinc, metal content		5,600		1.3
Zirconium, ore		1,537		2.3

NA Not available.
1/ Summário Mineral 1999.
2/ Petróleo Brasileiro, S.A. (Petrobrás) Magazine, 1999; 1998 Annual Report.