

THE MINERAL INDUSTRY OF

BRAZIL

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Brazil, which had the largest economy in Latin America and the world's eighth largest population with more than 165 million inhabitants, had a gross domestic product (GDP) of \$556.8 billion¹ or \$1.057 trillion in terms of purchasing power parity in 1999. Brazil's GDP growth rate was 0.82% compared with 0.15% in 1998 (U.S. Central Intelligence Agency, 2000, p. 59; Departamento Nacional de Produção Mineral, 2000a, p. 1; 2000c, p. 10). Foreign exchange reserves decreased to about \$23.4 billion from a high of \$51.4 billion in 1997. Brazil's total debt burden amounted to \$200 billion. The trade deficit decreased substantially to \$1.1 billion from \$6.6 billion in 1998; exports were \$48 billion, and imports were \$49.1 billion (Abranches, 1999, p. 1, 8; Ferrer, 1999, p. 2-3; U.S. Central Intelligence Agency, 2000, p. 60; Departamento Nacional de Produção Mineral, 2000c, p. 10).

Brazil responded to its economic crisis, which was provoked, in part, by the Asian financial crisis in 1997 and the Russian bond default in August 1998, with a massive increase in interest rates to 46% per year from 28% as of September 1997; inflation was held at 5% in 1999. Other measures taken were a package of \$28 billion in emergency budget cuts as of November 1998, congressional reforms to address the twin deficits in the current (1999) and fiscal accounts that were running at 8% of the GDP, a reduction in the role of Government, and funds available under its \$41.5 billion financing agreement with the International Monetary Fund (IMF). Economic growth was resumed in the second half of 1999; Brazil's currency (real) no longer was pegged to the U.S. dollar, but devaluation helped to moderate the downturn in economic growth in the first half of the year. The response to ensure the country's stability, tight fiscal and monetary policy even with a floating real, was very encouraging (Dyer, 1999a).

In 1999, Brazil received the largest amount (\$31 billion, or 36.1%) in the region of foreign direct investment (FDI), thus making it the second most popular emerging market after China for foreign investments (Lapper, 1999; Michael Mortimore, January 2000, Chapter 1—Regional overview, Foreign Investment in Latin America and the Caribbean—1999 Report, accessed September 6, 2000, at URL <http://www.eclac.cl/English/Publications/invest99/regionalover.pdf>; Yolen, 2000). Brazil received the largest amount of FDI, followed at a considerable distance by Mexico (13.3%), Argentina (8%), Chile (6%), and Venezuela (5.8%); this was largely because of the sale of assets by the Government (telecommunications and energy) and the private sector (financial services and retail trade) (Economic Commission for Latin America and the Caribbean, September 6, 2000, Sustained dynamism shown by

¹Where necessary, values have been converted from Brazilian real (R\$) to U.S. dollars at the rate of R\$1.815=US\$1.00.

FDI in Latin America and the Caribbean, accessed September 6, 2000, via URL <http://www.eclac.cl/English/news/Pressrelease/invest992.htm>). The Brazilian Central Bank also reported that Brazil received \$13.8 billion of FDI in the minerals sector [iron and steel (\$2.3 billion), cement (\$348 million), and petroleum (\$11.1 billion)] compared with \$5 billion in 1998, \$8.8 billion in 1997, \$9.4 billion in 1996, \$3.9 billion in 1995, and \$2.2 billion in 1994 (Banco Central do Brasil, September 2000, Economic information, accessed September 6, 2000, at URL <http://www.bcb.gov.br/ingles/notecon1-i.shtm>; International Trade Administration, U.S. Department of Commerce, 2000, Profile—Brazil, Country Commercial Guide, accessed September 8, 2000, at URL <http://www.usatrade.gov/website/ccg.nsf/CCGurl/CCG-BRAZIL2000-CH-VII-NT0001BA2E>).

The IMF's endorsement of Brazil's move to a system of inflation targets and currency devaluation to guide its monetary policy in 1999 indicated that the country could reduce its current account deficit of \$33.4 billion down to an equivalent of 6% of GDP, thus helping restore confidence in the Government's economic management and creating conditions for lower interest rates and economic recovery (Dyer, 1999a; 2000, p. 1).

Yet, with the economy in recession and the effects of the financial crises in Asia and Russia in 1997-98, investors' confidence in the country remained steady. Brazil received a large share of the region's net FDI inflows, which diminished slightly to \$31 billion from \$31.9 billion in 1998 and up from \$1.5 billion at the beginning of the decade (Yolen, 2000, p. 2).

In 1999, FDI to Latin America and the Caribbean increased to \$85.9 billion compared with \$76.7 billion in 1998 as a result of the liberalization of the Southern Cone Common Market (Mercosur) countries' and Caribbean economies and the privatization of many of South America's infrastructure sectors. In 2000 and 2001, FDI in Latin America, however, may decline (Dyer, 1999b; Fidler, 1999).

The Brazilian strategic plan, Plano Real, continued to be based on macroeconomics, constitutional reviews, privatization of Government-owned companies, and direct acquisitions of assets via mergers and joint ventures to achieve its goals and to encourage new capital flows into the Brazilian economy. Given that the economy was in recession, however, the currency devaluation and a tough fiscal austerity plan helped restore confidence in the Government's economic management and create favorable conditions for lower interest rates and Brazil's economic recovery begun in the second half of 1999. Brazil turned a fiscal deficit of 3% of the GDP in 1997 to a surplus of 3% in 1999, with a forecast of a 4% budget surplus in 2000 (Dyer, 2000, p. 1; Yolen, 2000, p. 2).

In 1999, Brazil's trade balance was affected by a reduction in demand and depressed prices for mineral exports, and the

country paid more for imported oil. The mineral sector had a surplus of \$496 million; however, if petroleum and its derivatives and natural gas were excluded, that surplus would have been \$5 billion (Departamento Nacional de Produção Mineral, 2000c, p. 12).

According to the Departamento Nacional de Produção Mineral (DNPM) (2000c, p. 83-84) the country produced 49 mineral commodities, such as bauxite, coal, columbium (niobium), chromite, gemstones, gold, iron ore, kaolin, manganese, tantalum, and tin from large deposits, and exported them to the global marketplace in 1999. 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 petroleum exploration program to expand reserves and to reduce dependence on oil imports, which satisfied about 31% 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 (Petrobrás Magazine, 1999).

After acquiring Companhia Vale do Rio Doce (CVRD) in 1997 and obtaining an exemption on the value-added tax for sales and services, the Companhia Siderúrgica Nacional Group (CSN) expanded investments in a new pelletizing plant in São Luiz, Maranhão, which included railroad and port facilities for \$400 million, increased production in several mine projects in the States of Minas Gerais and Pará, and expanded business opportunities in Europe, Latin America, and the United States via joint-venture projects and direct investments (Departamento Nacional de Produção Mineral, 2000c, p. 59-60).

The country's petroleum and mining industries and utilities were attracting interest 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 the country acquiring exploration properties and mining prospects, particularly for, in order of importance, oil and gas, gold, copper, and diamond. Exxon Corp. and Texaco Corp. of the United States, British Petroleum Ltd. (BP) of the United Kingdom, and others entered into joint-venture oil-gas projects with Petróleo Brasileiro S.A. (Petrobrás). Petrobrás viewed such mega-mergers of BP and Amoco Corp. and of Exxon and Mobil Oil Corp. during the second half of 1998 as significant by improving and strengthening economy of scales, competitiveness, operational synergy, and 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 and oil companies in Brazil included Yacimientos Petroleros Fiscales of Argentina; BHP Minerals International Exploration, Inc. and Western Mining Corp. Holdings Ltd. of Australia; Barrick Gold Corp., INCO Limited, and TVX Gold Inc. of Canada; EDP of Portugal; Anglo American Corp. and General Mining Union Corp. Ltd. of South Africa; Iberdrola S.A. of Spain; Rio Tinto Zinc Mineração Ltd. of the United Kingdom; and Enron Energy Corp., Exxon (Esso Brasileira de Petróleo Ltda.), Newmont Mining Corp., Placer Dome US Inc., Shell, and Texaco (Texaco Brasil S.A.) of the United States (Hawrylyshyn, 2000).

Government Policies and Programs

The present legal framework for the development and use of mineral resources in Brazil was established by the Federal Constitution enacted on October 5, 1988. On August 15, 1995, the Brazilian Congress approved Constitutional Amendments Nos. 6 and 9, which allow the participation of the private sector via privatization, joint ventures, and deregulated investment in the sectors of mining, petroleum, natural gas, coastal and river shipping, transportation, and telecommunications. The 45-year Government monopolies of the oil and gas industries and fuel price subsidies were ended, thus allowing Petrobrás to enter into joint ventures with foreign investors. The Agência Nacional do Petróleo, however, regulates the petroleum industry (Pimentel, 2000a, p. 3-5). Other significant actions were undertaken by the Brazilian Government. The Brazilian import tax for minerals, in general, was reduced; the rates, however, vary from 3% to 9%—ores and concentrates is 5%, and other products, 7%. The export tax does not apply to exported mineral products. The tax on industrialized products does not apply to mining activities, although there is a "value-added tax." In most cases, the basis for assessment for corporate income taxes is the net profit for the fiscal year; in general, the tax rate ranges between 15% and 10% and is levied on gross profit. Profits could be expatriated, equity ownership can be as high as 100% and was allowed via privatization or by direct acquisition (Pimentel, 2000b, p. 10-15). The current (1999) Concessions Law created additional opportunities for the private sector in public utilities previously reserved for the Government.

All the above actions were undertaken by the Government to open the Brazilian economy to international competition and have continued to create an environment that attracts domestic and foreign investments equally. The establishment of joint ventures, such as in construction and management of railroads, ports, telecommunications, 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, 2000b, p. 5-8), also provided 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, p. 35; Departamento Nacional de Produção Mineral, 1999a).

The Companhia de Pesquisa de Recursos Minerais (Brazilian Geological Survey) 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, 1999b, p. 2-8).

Since yearend 1991, the Government has sold 57 companies,

which included 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, which was worth \$18.92 billion, was sold in 1998. 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). Nearly 500 transnational corporations that have established operations in Brazil have brought in a total of \$186 billion in registered investment with the Central Bank of Brazil (Yolen, 2000).

Environmental Issues

The Brazilian Environmental Policy (BEP) is executed at three levels—Federal, State, and municipal. The coordination and formulation of the BEP is the responsibility of the Ministério de Meio Ambiente (MMA). Linked to MMA is the Conselho Nacional de Meio Ambiente Agency (CONAMA). According to CONAMA, 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, State, 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, 2000d, p. 35-38). 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. Environmental impacts were expected to 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 have increased, antipollution measures have been enacted to eliminate the sources of pollutants and to mitigate their effects on the environment.

Production

The total value of minerals produced in 1999 was about \$4.8 billion, or about 0.9% of the GDP. With the value added, the mineral-based industries amounted to \$46 billion, or about 8.3% of the GDP. Crude oil and natural gas amounted to almost \$6.4 billion. The 9.3% increase from that of 1998 in Brazilian minerals production was related mostly to the crude oil output,

which increased by 12%. Increases in production also were recorded, in descending order, of columbium (niobium, Cb_2O_5 content), 34.2%; nickel (content), 23.6%; coal (energy), 16.7%; kaolin (content), 10.4%; zinc (content), 10.3%; and, to a lesser extent, bauxite, lead, natural gas, and potash. Metal content in concentrates, manganese, gold, tin, and copper production decreased by 23.5%, 17.4%, 9.6%, and 9.4%, respectively. Depletion of shallow gold and tin deposits and environmental constraints on garimpeiros were expected to affect future outputs of gold and tin (Departamento Nacional de Produção Mineral, 2000a, p. 4, 10).

The five major integrated steelworks were Aço Minas Gerais, S.A., a structure and rail producer; CSN, Latin America's largest integrated steelmaker, has earmarked \$350 million for new facilities, production expansion, and environmental improvements (Yolen, 2000, p. 2); 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 96% of iron ore production. CVRD produced about 48.9% of the iron ore. Mineração Rio do Norte, S.A. (MRN), the majority of which was privately owned, was the world's third largest bauxite producer and exporter; it produced about 79.2% of the total bauxite production, which amounted to about 12.9 Mt. The four major aluminum smelters, all predominantly privately or foreign owned, produced 87.9% of the primary aluminum production of 1.2 Mt (table 1).

Trade

Brazil was the largest open market and economic center of Mercosur, the trade bloc that also included Argentina, Paraguay, and Uruguay; Bolivia and Chile are Mercosur's associate members. The member countries of Mercosur have almost 220 million people, 33.1% of America's population, and a combined GDP of \$1.3 trillion, which represented about 65% of South America's total GDP (Cowley, 2000, p. 2). Brazil accounted for about 72% of Mercosur's population and almost 43% of its GDP. Most multinational companies considered 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 integrated, 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).

In 1999, Brazil sold 17.4% of its exports to the other Mercosur members and 26.1% to the other countries in Latin America. Total minerals trade between the major players of Mercosur, Argentina (\$910 million) and Brazil (\$664 million), amounted to about \$1.6 billion. Brazilian mineral imports were

valued at \$9.560 billion, or 3.9% lower (\$9.945 billion) than those of 1998, and its total mineral exports were \$10.005 billion, or about 7.4% lower (\$10.805 billion) than those of 1998. The values of the principal exports were \$3.041 billion for steel products; \$3.251 billion, iron ore; and \$1.323 billion, aluminum. 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. 9; 2000a, p. 11-14; Petrobrás Magazine, 1999, p. 3).

Brazil-U.S. trade relations during 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, as well as other commodity exports. 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 105% to \$24.6 billion in 1999 from \$12.0 billion in 1990. Brazil's mineral trade balance with the United States increased to a surplus of \$1.2 billion in 1999 from a surplus of \$3.3 billion in 1990 (Barbosa, 1999; Departamento Nacional de Produção Mineral, 2000a, p. 14).

Structure of the Mineral Industry

The mineral industry of Brazil was 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 kept changing to a privately owned/Government regulated regime from one that was Government owned/Government operated. Thus far, the Government has privatized the telecommunications and electrical energy sectors, the steel industry, and CVRD between 1991 and 1999. Additionally, 40 cement companies were operating 64 cement plants and 7 grinding plants with a clinker capacity of 45 Mt, and 30 iron ore mining companies were operating 80 mines and 43 processing plants (Departamento Nacional de Produção Mineral, 1999b, p. 52; 2000c, p. 59).

Brazil's total labor force was nearly 74 million. Of this total, services represented 42%; agriculture, 31%; and industry, 27%. The unemployment rate was 8% (Central Intelligence Agency, 2000, p. 6; U.S. Department of Commerce, 2000, p. 1). The minerals sector employed about 4% (800,000) of the industry total (20 million). This did not include the nearly 1 million garimpeiros active in Brazil (Vale, 2000, p. 1). Employment in

the mining sector continued its downward trend as Brazil's economy was affected by its recent economic crisis and by the increases of efficiencies and productivities in the private sector, because of the joint ventures, mergers, and privatizations, particularly in the steel and mining sectors (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 1998. Primary aluminum producers were Albras-Alumínio Brasileiro S.A. (28.9%), Alcoa Alumínio S.A. (23.3%), Companhia Brasileira de Alumínio (CBA) (18.7%), Billiton International Metals B.V. (17.0%), Alcan Empreendimentos Ltda. (8.2%), and Vale do Sul Alumínio S.A. (3.9%). Bauxite production was 12.9 Mt, 7.5% higher than that of the previous year (12.0 Mt). The MRN joint venture owned by CVRD (40%), Billiton International Metals B.V. (14.8%), Alcoa (13.2%), Alcan (12%), CBA (10%), Norsk Hidro Group (5%), and Reynolds Alumínio do Brasil (5%) accounted for almost 79.2% of the total bauxite production (10.2 Mt) for 1999. Alumina production was 3.506 Mt, or 5.5% higher than that of 1998 (3.322 Mt). A consortium led by CVRD produced 1.51 Mt of calcined alumina, or 43.1% of the total; MRN planned to open its new mine, which has 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 ore production capacity at about 10 Mt/yr. CVRD was planning to invest \$510 million in the aluminum sector, \$300 million in Albras to expand primary aluminum output, \$140 million in MRN to increase production to 4 Mt/yr, and \$70 million in Alunorte to expand alumina production. Latapack-Ball S.A., which produced aluminum cans, planned to invest \$5 million to increase its plant capacity in Jacareí, State of São Paulo, to 2 billion aluminum cans from 1.7 billion by yearend 2000 (Departamento Nacional de Produção Mineral, 2000c, p. 23-24).

Alto Brazil Mineração is a joint venture of Alcoa (60%) and Billiton (40%) that was set up to mine the Oriximina bauxite deposit near the Trombetas River in junction with MRN's bauxite mine in Pará. Mineração and MRN will supply the feed to Alcoa's refinery at São Luís, State of 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 2000. 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 planned 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.

Exports of bauxite were 4.5 Mt and were valued at \$116 million, alumina was 655,000 metric tons (t) and valued at \$125 million, and primary aluminum was 920,000 t and valued at about \$1.09 billion (Departamento Nacional de Produção Mineral, 1999b, p. 19; 2000c, p. 24).

Columbium (Niobium) and Tantalum.—Brazil continued to be the world's most significant producer and main supplier of columbium to the global markets. Brazil produced about 94.5% of the world's total output, or 42,734 t of pyrochlore in concentrate, 18,866 t of columbium in alloys, and 1.375 t of columbium in oxides from two open pits located in Araxá, State of Minas Gerais and Catalão, State of Goiás. In 1999, Mineração Catalão de Goiás Ltda. (MCGL), which was a joint venture of Anglo American Corp. Group of South Africa and Bozzano Simonsen S.A. of Brazil, and Companhia Brasileira de Metalurgia e Mineração (CBMM), which was a joint venture of Grupo Moreira Sales S.A. of Brazil and Molycorp, Inc. of the United States, accounted for 61.5% and 38.5%, respectively, of Brazil's 65,000-t/yr pyrochlore production capacity. The columbium plants of MCGL in Catalão and CBMM in Araxá accounted for about 88% of Brazil's pyrochlore production and supplied about 79% of the world demand for ferrocolumbium. The Araxá and the Catalão columbium ore deposits contained 88% (3.9 Mt) of the world's pyrochlore reserves at yearend (Departamento Nacional de Produção Mineral, 2000c, p. 81).

Tantalum production totaled 50 t. The Araxá deposit, which was considered to be the world's largest and most economically viable known ore body, contains columbite and tantalite and produced 190 t/yr. The upward trend in tantalum supply will continue in response to increased world demand (Departamento Nacional de Produção Mineral, 2000c, p. 81-82).

Copper.—According to Departamento Nacional de Produção Mineral (2000c, p. 39), copper concentrate production amounted to 31,371 t, which was a decrease of 8.9% compared with that of 1998. The concentrate was produced by Mineração Caraíba S/A's (Paranapanema Group) deposit in Jaguari, State of Bahia; which was 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.

In 1999, Caraiba Metais S/A (CMSA) of Camaçari, State of Bahia, produced 193,014 t of primary copper metal, which was an increase of 15.4% compared with that of 1998; this also included 582,534 t of copper concentrates imported from Chile (60%), Peru (9%), and others (31%). CMSA, which was the only electrolytic copper producer to meet Brazil's metal copper demand of 313,840 t/yr, imported 106,106 t of copper cathode, mostly from Chile (84%) and Peru (13%), in 1999 (Departamento Nacional de Produção Mineral, 2000c, p. 39-40).

In 1999, the reserves at Cobre Salobo which was Brazil's largest copper project, were estimated to be 1,900 Mt grading 0.65% copper, containing 0.96% copper with associated gold, silver, and molybdenum. These reserves could support a 250,000-t/yr production capacity of refined copper containing gold, silver, and molybdenum. The project, which was in Marabá, State of Pará, was a joint venture of CVRD, Anglo American Corp.'s Minorco S.A., and the Brazilian Banco Nacional de Desenvolvimento Econômico e Social; each member held 33.33%. The Salobo copper project was going through a reassessment process (Departamento Nacional de Produção Mineral, 1999b, p. 39; 2000c p. 40). CMSA's Jaguari plant in Camaçari, State of Bahia, will expand its cathode units

to produce 210,000 t/yr of refined copper, with an investment of \$14 million in 2000. The Chapada copper project in Alto Horizonte, State of Goiás, owned by Mineração Santa Elina S.A. is at the stage of forming a joint venture, after the feasibility study for it was completed and its ore reserves amounted to 434.5 Mt containing 1.3 Mt of copper and 9.6 t of gold. The Cobre Sossego project, Cristalino, and Corpo Alemão in Carajás, State of Pará, were in exploration, which was carried out by CVRD and Phelps Dodge Corp. (Departamento Nacional de Produção Mineral, 2000c p. 40).

Brazil's metallic copper production was used primarily in construction and in automobile manufacturing. Exports amounted to 59,676 t of metal, which went to the United States, Argentina, and Chile (Departamento Nacional de Produção Mineral, 2000c, p. 39-40).

Gold.—Gold production was reported by the DNPM as being 48.7 t (Departamento Nacional de Produção Mineral, 2000c, p. 54), which represented 38.4 t from mining companies and 10.3 t from garimpos (cooperatives of garimpeiros); this output was 14.6 t lower than that of 1995, which had the highest levels of output during the past 5 years (table 1). Gold production from the garimpeiros and the private sector decreased because of higher production costs, depletion of shallower deposits, lower prices in the international market, and much higher environmental standards. Refined gold was extracted by a combination of pressure oxidation and bioleaching by using the South African General Mining Union Corp. Ltd.'s technology. Mineração Santa Elina S.A.'s São Vicente Mine in Mato Grosso, produced 1.5 t of gold. This mine will be expanded to produce about 10 t of gold in the near term.

Brazilian gold production could increase significantly in the foreseeable future because of increased interest by domestic and foreign investors in largely unexplored areas. More than 2,000 gold deposits, mostly Precambrian vein deposits and alluvial placers, were known (Departamento Nacional de Produção Mineral, 1999a, p. 2; 1999b, p. 78-79; Ferraz, 1999, p. 3).

AngloGold Ltd. of South Africa was planning to spend \$50 million to implement the Amapari gold project in the State of Amapá, which will begin operating next year, and \$6 million to explore for gold near to the Pedra Blanca do Amapari in the Amazon region (Mining Journal, 1999; Departamento Nacional de Produção Mineral, 2000c, p. 54).

Iron and Steel.—Ferroalloys.—Ferroalloy production decreased to 793,000 t from 819,000 t in 1998. For the year, steel production amounted to 25.7 Mt, which was about the same level as 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, which was 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%) was associated with Japanese capital [Mitsubishi Corp. (25.5%) and Kawasaki Steel Corp. (25.5%)], was 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, 1999b, p. 52-53; 2000c, p. 59-60).

Iron Ore.—Brazil produced 194 Mt of beneficiated iron ore compared with 197.5 Mt in 1998. About 96% of that production was from eight major iron ore companies—CVRD, 94.8 Mt; Minerações Brasileiras Reunidas S/A (MBR), 25.1 Mt; Ferteço Mineração S.A., 16.1 Mt; S.A. Mineração da Trindade (SAMITRI), 15.7 Mt; Samarco Mineração S.A. (SAMARCO), 12.3 Mt; CSN, 10.3 Mt; SOCOIMEX S.A., 4.7 Mt; and Itaminas Comércio de Minérios S.A., 4.3 Mt. Brazil exported 140 Mt of iron ore and pellets valued at \$2.75 billion (Departamento Nacional de Produção Mineral, 1999b, p. 53; 2000a, p. 12).

The total iron ore exports were 6.7% lower than those of 1998 and were shipped to 40 countries. Total export revenues decreased to \$2.75 billion by yearend from \$3.25 billion in 1998. The major importers of Brazilian iron ore were Japan, 15.4%; Germany, 13.5%; China, 9.7%; the Republic of Korea, 7.6%; Italy, 7.5%; the United States, 5.2%; Belgium, 4.8%; France, 4.1%; Spain, 3.8%; and Argentina, 3.3%. 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 was a joint venture with Pohang Iron and Steel Co. (POSCO) of the Republic of Korea. The facility is in the port of Tubarão, State of Espírito Santo; CVRD-POSCO invested \$220 million to produce 4 Mt/yr of pellets. CVRD was planning a new pelletizing plant with railroad and port facilities in São Luiz, State of Maranhão; investments will be about \$400 million. MBR opened three new mines—Capão Xavier, Tamandúia, and Capitão do Mato—in the State of Minas Gerais to increase capacity to 32 Mt/yr in 2004 and to offset the iron ore depletion at the Aguas Claras and the Matuca Mines. Mineração Corumbaense S.A., which was a subsidiary of RTZ Corp. plc. (Rio Tinto's Group), was planning a \$200 million plant at Corumba in the State of Mato Grosso to produce 1 Mt/yr of hot-briquetted iron 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, State of São Paulo (Departamento Nacional de Produção Mineral, 1999b, p. 53; 2000c, p. 60).

SAMARCO, which was a subsidiary of SAMITRI (51%) and Broken Hill Proprietary Co. Ltd. (BHP) (49%), built its second pellet plant at Ponta do Ubu, State of 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 (Brasil Mineral, 1999, p. 40).

Pig Iron.—Brazil produced 25 Mt of pig iron, which remained at the same level as that of 1998. The 2.5 Mt of exports were valued at \$288 million, which was approximately one-third of the pig iron traded in the world (Ferrer, 1999, p. 4).

Steel.—Brazil's 1999 steel production totaled 25.7 Mt, which was a 0.4% decrease from that of 1998; thus places 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, 1999, 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. Since 1997, Brazil has been auctioning the Government-owned assets—\$15.9 billion in 1997, \$20 billion in 1998, and \$19.8 billion in 1999 (Welch and Bacha, 1998; Departamento Nacional de Produção Mineral, 1999b, p. 53; 2000a, p. 12-13).

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, which was acquired by CSN, supplied the consortium with iron ore and provided it 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, 1999, p. 6).

Manganese.—In 1999, Brazil produced 1.6 Mt of manganese ore, which was 22.1% lower than that of 1998. CVRD's high-grade manganese mine, Igarapé Azul, in the Carajás complex accounted 69% of metallurgical manganese; there was no increase from that of 1998. Urucum Mineração S.A., in the State of Mato Grosso do Sul, was the second largest Brazilian producer followed by small producers, in order of importance, in Minas Gerais, Goiás, and Bahia. Mineração Buritima S.A., in the Marabá district, continued to be inoperative for economic reasons. Exports of manganese ferroalloys amounted to 69,626 t valued at \$31.1 million, which was about 4.5% lower than that of 1998 (\$32.5 million) (Departamento Nacional de Produção Mineral, 2000c, p. 71-72).

Nickel.—Brazil produced about 3 Mt of nickel ore and 22,931 t of electrolytic nickel and nickel in ferronickel alloys, which were about 14.9% and 8.8% higher, respectively, than the 2.6 Mt nickel ore and 21,083 t of electrolytic nickel produced in 1998. The Mineração Serra da Fortaleza in Fortaleza de Minas, State of Minas Gerais, owned by RTZ Corp. plc. of the United Kingdom, produced 9,306 t of nickel contained in matte; Companhia Niquel Tocantins of Votarantim Group (VG) in Niquelândia, State of Goiás, produced 17,153 t of nickel contained in carbonates obtained by the hydrometallurgical process of ammoniacal leaching; and CODEMIN S.A. of the Minorco Group, in the same district, produced 6,502 t of nickel contained in ferronickel alloy (Departamento Nacional de Produção Mineral, 2000c, p. 79).

Tin.—Brazil was the world's fourth largest tin producer after China, Indonesia, and Perú. Tin production was 13,202 t of tin contained in concentrate and 12,787 t of metal, which were decreases of about 7.3% and 12.4%, respectively, compared with those of 1998. The reduction in Brazilian output was attributed to the closing of some high-cost operations, the

decrease in the ore grades, the depletion of alluvial reserves, and the decline in tin prices. Production cuts were made at the Pitinga Mine in the State of Amazonas operated by Grupo PARANAPANEMA (GP) and at the garimpeiros' Bom Futuro operations in the State of Rondônia. Exports decreased to 6,048 t valued at \$30.2 million from 11,957 t valued at \$62.5 million in 1997 and 6,715 t valued at \$34.8 million in 1998. These exports were far below the quota of 20,185 t/yr assigned to Brazil by the Association of Tin Producing Countries. Shipments were made to the United States, 79.1%; Argentina, 13.9%; and the remaining to Belgium, Spain, and others. Amazonas (67%) and Rondônia (33%) remained the major producers in the country. GP's Pitinga Mine produced tin with byproducts of, in order of importance, columbium, tantalum, zirconium, hafnium, thorium, and cryolite (Ferraz, 1999, p. 3; Departamento Nacional de Produção Mineral, 2000c, p. 107-108).

Zinc.—Brazil produced 98,590 t of zinc in concentrates, which was 12.7% higher than the 87,475 t produced in 1998. VG's Companhia Mineira de Metais S.A. (CMM), which initiated its mine activities on January 1, 1998, and was the only producer of zinc ore in Brazil, produced 25,964 t of zinc sulfide concentrates in Paracatu and 72,626 t of zinc silicate in Vazante (Departamento Nacional de Produção Mineral, 2000c, p. 117). The concentrates were processed in CMM's plant in Três Marias, Minas Gerais. The Brazilian zinc refineries produced 187,010 t of primary metal, which was 5.6% higher than that of 1998. CMM produced 109,398 t, which was an increase of 4.5% from that of 1998, and GP's Companhia Paraibuna de Metais S.A. produced 77,612 t, which was an increase of 9.5% compared with 1998. To meet Brazil's demand for zinc, which was about 182,000 t/yr of metal, the country imported about 216,000 t of zinc concentrates and 21,500 t of metal. Peru supplied 95% of concentrates and 13.5% of metal zinc; metal zinc was also supplied by Argentina (72.2%) and the United States (3.6%) (Ferraz, 1999, p. 3; Departamento Nacional de Produção Mineral, 2000c, p. 117-118).

Industrial Minerals

Asbestos.—Brazil's significant asbestos deposits were in Minaçu, State of Goiás, which was the only producing state in the country. Sociedade Anônima Mineração de Amianto produced 188,386 t of asbestos fiber, which was 5% lower than that of 1998. Almost 86% 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, 2000c, p. 41-42).

Brazil exported about 24% of its production mainly to India, 36%; Japan, 13%; Mexico, 10%; and Thailand, 7%. The State of São Paulo was the country's largest consumer followed by Paraná and Rio Grande do Sul. Asbestos mining and consumption have been highly regulated in most industrialized nations, thus 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 (16.6 Mt) were considered to be adequate to meet demand in the short to medium term; 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 Mt, which, at a production rate of 200,000 t/yr, represented a 15-year mine life (Departamento Nacional de Produção Mineral, 2000c, p. 41-42).

Cement.—The country produced 40.3 Mt of cement, which was almost 1% higher than that of 1998. Minas Gerais contributed (23.4%), São Paulo (19.4%), Paraná (9.4%), Rio de Janeiro (7.8%), Paraíba (5%), and other States (35%). Most of the exported cement (227,450 t) went to Argentina (58.7%), Paraguay (26.5%), Bolivia (8.2%), and others (6.6%). Brazil imported 234,936 t of cement from Thailand (33.7%), Japan (31.8%), Belgium (27.6%), and France (6.8%) (Departamento Nacional de Produção Mineral, 2000c, p. 31-32).

Clays.—Production of beneficiated kaolin was about 1.5 Mt, which was about 10.4% higher than that of 1998. The Adam Mine in Rio Jarí, State of Amazonas, which was operated by Caulim da Amazônia S.A., accounted for 47% of the country's total output. Brazilian kaolin exports were 20% higher, or almost 1.2 Mt, than those of 1998. Pará Pigmentos S.A. produced 500,000 t of kaolin; the company'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. 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 about 12% to 365,000 t from 417,907 t in 1998. 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 4,000 Mt of kaolin reserves, or about 28.2% of the world's total (Ferraz, 1999, p. 3; Departamento Nacional de Produção Mineral, 2000c, p. 61-62).

Gemstones.—For many years, Brazil was 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 because the country has 600 million cubic meters of sedimentary rocks that contain 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 reserve base (Departamento Nacional de Produção Mineral, 2000c, p. 43; Olsen, 2000, p. 58-59). The total value of gemstone (including diamond) production was \$56 million, which was the same as that of 1998. Total exports of uncut gemstones decreased to \$13.1 million from \$15.8 million in 1998 and \$34.6 million in 1997, and imports increased to \$20.6 million from \$17 million in 1998 (Departamento Nacional de Produção Mineral, 2000c, p. 43-44).

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, Pedra Azul, and Salto da Divisa. Production amounted to about 47,000 t with 14% of carbon content; this was a decrease of 8% compared with that of 1998. This production was mainly of products that ranged in grade from 65.5% to 99.9% carbon at NGL's Pedra Azul plant. Also in Minas Gerais, Grafita MG Ltda. produced about 15,000 t of natural graphite, which was consumed domestically after simple grinding (Departamento Nacional de Produção Mineral, 2000c, p. 55-56).

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, the Itapecerica, and the Salto da Divisa beneficiation plants, which had installed capacities of 30,000, 10,800, and 6,000 t/yr, respectively. Exports amounted to 11,307 t valued at about \$18 million. Growth of the domestic consumption of natural graphite during the 1990's was correlated with that of the iron and steel industries, which absorbed about 80% of the natural graphite consumed in Brazil (35,771 t) in 1999. Other consumers included battery manufacturing (6.5%), refractories (6%), paint and varnishes (2%), and other miscellaneous uses (5.5%) (Departamento Nacional de Produção Mineral, 2000c, p. 55-56).

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 259,834 t of beneficiated magnesite, which was 15.7% lower than that of 1998; MSA produced 96% (249,441 t). Exports of processed magnesite totaled 67,173 t valued at \$9.2 million and were shipped to the United States (29.8%), Poland (20.7%), Argentina (16.2%), Chile (15.5%), Venezuela (7.7%), and Germany (4.5%). Imports totaled 46,717 t valued at \$4.2 million and were imported from Norway (86%), Mexico (4%), and others (10%) (Departamento Nacional de Produção Mineral, 2000c, p. 69). In Brazil, about 630 Mt of resources with 180 Mt of magnesium content had been identified by yearend. Indústria Química Xilolite S.A. had an ongoing expansion of calcined magnesia plant in Brumado, State of Bahia, to 28,000 t/yr from 4,000 t/yr (Departamento Nacional de Produção Mineral, 2000c, p. 70).

Phosphate Rock.—Production of phosphate rock concentrate amounted to about 4.3 Mt, which was a decrease of 2.8% from that of 1998. Production was highly concentrated (95.6%, or 4.1 Mt) in four mining companies—Fertilizantes Fosfatados S.A., Fertilul S.A., Ultrafertil S.A., and Copebras S.A. (Ferraz, 1999, p. 3). The reported domestic consumption was about 5 Mt/yr; this was a decrease of 3.8% compared with that of 1998. Of the total phosphoric acid, 73% was used in the fertilizer industry, 25% in the chemical industry, and other uses, 2%; usage remained at about the same as that of 1998 (Departamento Nacional de Produção Mineral, 2000c, p. 86).

Quartz.—Brazil produced 1,470 t of quartz valued at about \$918,000. Quartz was exported mostly to Japan (41%), the United Kingdom (27%), Hong Kong (9%), Germany (8%), Argentina (4%), and others (11%). 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, 2000c, p. 91-92).

Salt.—The reported domestic production of marine salt was 4.5 Mt, which represented a 14.4% decrease from that of 1998. The State of Rio Grande do Norte continued to be the major source of salt with 96.7%, followed by the States of Rio de Janeiro (2.3%) and Ceará (1%), respectively. The domestic consumption of marine salt was 5.7 Mt. Brazil also produced 1.4 Mt of rock salt. Salgema Mineração e Química S.A. in Maceió, State of Alagoas, produced 727,000 t (50.8%) of rock salt and Dow Química do Nordeste Ltd., which was a subsidiary of Dow Chemical Co. of the United States, produced 703,000 t (49.2%) from the Vera Cruz Mine in the State of Bahia. The total salt use was for chemical industry (chlorine and sodium manufacture; 86%) and others (caustic sodas; 14%) (Departamento Nacional de Produção Mineral, 2000c, p. 97-98).

Other Industrial Minerals.—Potassium production increased by 6.6% to 580,400 t compared with that of 1998. Brazil imported 1.9 Mt of potash, mainly from Canada (30%), Russia (21%), Germany (20%), Israel (13%), and other countries (16%) (Departamento Nacional de Produção Mineral, 2000c, p. 89-90).

Fluorspar production decreased by 37.7% to 44,926 t compared with that of 1998. Production of the acid-grade type decreased by 37.4% (38,209 t); and output of metallurgical-grade material, decreased by 39.1% (6,717 t) because of competitive imports. The Brazilian steel industry benefited from the lower international prices for metallurgical-grade fluorspar (Departamento Nacional de Produção Mineral, 2000c, p. 49-50). Production of gypsum was about 1.5 Mt, or 10.8% lower than that of 1998. In Brazil, the renewed housing and infrastructure activities improved the consumption of cement and plasters (Departamento Nacional de Produção Mineral, 2000c, p. 57-58).

Production of talc was 300,000 t, which was 3.4% higher than that of 1998. Paraná was Brazil's major talc producer with 58% of the national output, followed by Bahia, 29%; São Paulo, 12%; and Minas Gerais, 1%; these represented lower volumes as a result of some talc ore depletions that had taken place since mid-1997 (Departamento Nacional de Produção Mineral, 2000c, p. 103-104).

Mineral Fuels

Brazil produced 411.7 million barrels (Mbbbl) of petroleum and 11.9 billion cubic meters of natural gas, which were 13% and 10% higher, respectively, than those of 1998. The country produced, in order of importance, crude oil, natural gas liquid,

natural gas, and shale oil; production totaled 454.8 Mbbbl of oil equivalent (Departamento Nacional de Produção Mineral, 2000c, p. 51-52; p. 83-84). Petrobrás's average production of crude oil, which included condensate and natural gas liquid, was about 1.132 million barrels per day (Mbbbl/d) in 1999 (Petrobrás Magazine, 2000, p. 51-54). In October 1999, Petrobrás attained a new production record of 1.642 Mbbbl/d (Petrobrás, 1999, Os Negócios da Petrobrás—Refino, Comercialização e Transporte, Relatório Anual 1999, accessed August 29, 2000, at URL <http://www.petrobras.com.br/portugue/acompanh/relat99/refino.htm>) and was planning to reach a target of 1.9 Mbbbl/d in 2001-02 (Ferraz, 1999, p. 8; Petrobrás Magazine, 1999, p. 2-3; Rennó, 1999, p. 21).

Coal.—The Brazilian coal industry's mine operations concentrated in the southern States of Rio Grande do Sul, 61%; Santa Catarina, 38%; and Paraná, 1%. Brazil's production of energy generation type coal increased to 5.6 Mt from 5.5 Mt in 1998, which was an increase of almost 2%. Carbonífera Criciúma 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, 13.4 Mt valued at \$529 million was imported, which was an increase of 25.5% compared with that of 1998. Imports came from the United States, 33%; Australia, 31%; South Africa, 9%; Canada, 8%; and others, 19%. Coal consumption had reached 16.3 Mt by yearend. The steel industry consumed 65.6% of metallurgical coal, and the remainder was for power generation. Most Brazilian coals have a 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, 1999, p. 2; Departamento Nacional de Produção Mineral, 2000c, p. 35-36).

Natural Gas and Petroleum.—The gas pipeline that links the Enchova platform in the offshore Campos Basin to Macaé, Rio de Janeiro, had 5 million cubic meters per day (Mm³/d) of gas flow added to the Rio 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 transported 400 Mm³/d of natural gas along the 1,970 km of pipeline between Santa Cruz de la Sierra, Bolivia, and Guararema, Brazil to supply Mato Grosso do Sul, São Paulo, Paraná, Santa Catarina, and Rio Grande do Sul (Petrobrás Magazine, 1999, p. 6; 2000, p. 51; Rennó, 1999, p. 21; Departamento Nacional de Produção Mineral, 2000c, p. 52). Braspetro S.A., the international operating subsidiary of Petrobrás, continued producing natural gas in the Gulf of Mexico. Petrobrás América Inc., a subsidiary of Braspetro, recovered gas from the Frederick Field, which was 27 km off the Louisiana coast.

Imports of crude oil and derivatives were valued at \$4.61 billion, and total exports of the same commodities were valued

at \$733 million. Brazil's imports of petroleum were 170 Mbbbl at a cost of \$4.5 billion. The main sources were Nigeria (28%), Saudi Arabia (25%), Argentina (18%), and Kuwait and Venezuela (29%) (Petrobrás Magazine, 1999, p. 6; Rennó, 1999, p. 21; Departamento Nacional de Produção Mineral, 2000c, p. 84).

Uranium.—Brazil owned the fifth largest uranium reserves in the world (Raposo dos Santos, 1999, p. 204). The country's demonstrated reserves amounted to 192,540 t of uranium oxide (U₃O₈) and 108,950 t of inferred reserves; minable reserves contained 123,067 t grading 0.124% U₃O₈. 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, 1999b, p. 377; Raposo Dos Santos, 1999, p. 203-205).

Reserves

Brazil was among the world leaders in reserves of some mineral commodities. According to the DNPM's Sumário Mineral, they were ranked as follows: colombium (niobium), first; graphite and kaolin, second; talc and vermiculite, third; magnesite, fourth, tin, fifth; and bauxite, iron ore, lithium, and manganese, sixth (table 3) (Departamento Nacional de Produção Mineral, 2000c, p. 15).

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 kilometers (Mkm) of roads—184,140 km paved and 1.8 Mkm gravel and dirt. There was 50,000 km of navigable inland waterways. The major shipping ports were Belém, Fortaleza, Ilheus, Manaus, Paranagua, Porto Alegre, Recife, Rio de Janeiro, Rio Grande, Salvador, Santos, and Vitoria. Among the 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 1999 (U.S. Central Intelligence Agency, 2000, p. 40; Vale, 2000, p. 10).

In 1999, 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% (U.S. Central Intelligence Agency, 2000, p. 40; Vale, 2000, p. 18-23).

Cross-border energy investment opportunities existed because of Mercosur, which allowed Brazil to be the center of an increasingly rapid process of energy integration in South America. The Brazil-Bolivia pipeline, which was owned by a

consortium or joint venture of the Royal Dutch-Shell Group, Enron, Inc., and Petrobrás, was the largest of various cross-border energy projects. Argentina supplied gas to Rio Grande do Sul's new thermoelectric plant, and two additional pipelines were to take Argentine gas to Brazil's southern market, and another project was to supply energy to Brazil from a powerplant in Uruguay. In northern Brazil, a transmission line supplied energy to Roraima from Venezuela. The majority of these projects were being developed by the private sector as a result of liberalization and privatization. Even when state-owned corporations were involved, it was often in partnership with other private domestic and foreign corporations (Dyer, 1999b).

Negotiations were also 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 was estimated to cost about \$1 billion; Billiton Metais has pledged \$350 million (Vale, 2000, p. 23). This new dam appeared to be necessary because demand for hydroelectricity was growing at a faster rate than that of supply. This increased demand could exceed the current (1999) supply in a very few years. At 10% subsidy prices that expire in 2004, electricity from the Tucuruí Dam on the Tocantins River had been exceeded by the current (1999) mining and industrial activities in the Tocantins area.

Constran S.A. and Construção e Comércio of the Itamaraty Group of the private sector planned to construct an additional 1,718 km of railroad 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, 2000, p. 22).

Outlook

Brazil has 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 (1999) review of its 1988 Constitution will probably position Brazil well for the next decade. The flow of FDI (\$31 billion) 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 was affected by the volatility of the international financing market, depressed prices for mineral exports, and the Asian and Russian financial turmoils. Renewed confidence in the economy resulted in a considerable foreign capital brought by transnational corporations (\$186

billion), the stabilization of the country's foreign reserves (\$23.4 billion), the decline of the domestic interest rates (to 19% from 46% in 1998), the lower rate of inflation (to 5% from 100% in the early 1990's), the reversal to a surplus of 3% of GDP (\$17 billion) from a deficit of 3% of GDP in 1997, and the real being allowed to float freely against the U.S. dollar in January 1999 (Departamento Nacional de Produção Mineral, 2000c, p. 10; Yolen, 2000, p. 2).

The sectors of the Brazilian economy recorded diverse rates of growth—in agriculture (9%), minerals (8.3%), services (1.1%), and a fall in the industrial sector by (-0.8 %) (Departamento Nacional de Produção Mineral, 2000c, p. 10). If that positive rate of economic growth in the minerals sector is sustained into 2000 and beyond, then it should continue its expansion as the demand for mineral exports and fabricated steel goods increase.

The FDI into the Brazilian mining industry should continue enhancing exploration and mine development activities, particularly in gold and emeralds. This trend should 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 and CVRD were 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. In addition, new projects in the petroleum and gas sectors will continue to be opened up to mergers and 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, the dismantling of all trade barriers, increased exports to the world markets, and the constitutional amendment that eliminates the distinction between domestic and foreign capital will continue to be important, thus 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.

Brazil's minerals sector continues to attract the interest of foreign investors. 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. Environmental concerns, especially in the Amazon rain forest, may have a negative effect over the longer term. Much will depend on the approaches used to protect the environment and to continue sustainable economic growth.

The combination of lower exchange rates and inflation should provide many international corporations a competitive advantage, reducing the price of potential acquisitions via privatizations, direct acquisitions, mergers and joint ventures, and expansions, particularly in the infrastructure, telecommunication, mineral, and energy industries and increased commodity mineral exports. Finally, the Government's new initiative, \$550 billion "Advance Brazil" development program (Yolen, 2000, p. 2) is expected to engage Federal Government, States, and municipalities to concerted efforts to review their tax and mineral policies and welfare reforms with fiscal responsibility and austerity to open up Brazil to new investment opportunities in the telecommunications, transportation, energy, and mineral industries in the foreseeable future.

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TABLE 1
BRAZIL: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity 3/ METALS	1995	1996	1997	1998	1999
Aluminum:					
Bauxite, dry basis, gross weight	10,214,000	10,998,000	11,671,000	11,961,000 r/	12,880,000
Alumina	2,141,000	2,759,000	3,088,000	3,322,000 r/	3,506,000
Metal:					
Primary	1,188,000	1,197,000	1,189,000	1,208,000	1,245,000
Secondary	92,000	143,000	148,000	170,000	190,000
Beryllium, beryl concentrate, gross weight	6	6	7	5 r/	11
Cadmium, metal, primary e/	300	300	300	300	300
Chromium:					
Crude ore	447,963	408,495	285,500	440,450	420,000
Concentrate and lump, Cr ₂ O ₃ content	175,667	174,150	112,274	160,742 r/	190,000
Marketable product 4/	100,969	77,231	74,485 r/	72,507 r/	90,784
Cobalt:					
Mine output, Co content by hydroxide e/	400	400	400	400	400
Metal, electrolytic 5/	166	193	266	364	630 e/
Columbium-tantalum ores and concentrates, gross weight:					
Columbite and tantalite e/	175 6/	190	190	330	330
Djalmaite concentrate e/	10	10	10	10	10
Pyrochlore concentrate, Cb ₂ O ₅ content	21,731	19,621	25,688	33,795	42,734
Copper:					
Mine output, Cu content	48,933	46,203	39,952	34,446	31,371
Metal:					
Primary	164,966	172,075	177,060	167,205	193,014
Secondary	54,400	54,000	54,100	54,150	54,220
Gold:					
Mine output kilograms	40,951	41,142	41,062	37,787	38,387
Garimpeiros (independent miners) do.	22,349	18,869	17,426	11,780	10,267
Total do.	63,300	60,011	58,488	49,567	48,654
Iron and steel:					
Ore and concentrate (marketable product): 7/					
Gross weight thousand tons	183,839	174,200	184,970 r/	197,500 r/	194,000
Fe content do.	112,793	106,879	121,355	131,670	128,040
Metal:					
Pig iron do.	25,090	23,978 r/	25,013 r/	25,111 r/	25,060
Ferroalloys, electric-furnace: e/					
Chromium metal	37	37	37	40	40
Ferrocilicon	25,000	25,000	25,000	25,000	25,000
Ferrochromium	100,969 6/	77,231 6/	112,274 6/	110,000	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	130,000 6/	215,260 6/	153,000 6/	122,000 r/	110,000 6/
Ferromolybdenum	47	47	47	50	50
Ferronickel	34,000 6/	35,518 6/	37,400 6/	37,000 6/	37,000 6/
Ferrophosphorus	2,000	2,000	2,000	2,000	2,000
Ferosilicon	243,824 6/	236,838 6/	212,183	210,000 6/	210,000 6/
Ferosilicon magnesium	15,000	15,000	15,000	15,000	15,000
Ferosilicon 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	167,000 6/	232,218 6/	175,000 6/	124,000 r/	110,000 6/
Silicon metal	116,000 6/	150,054 6/	136,884 6/	120,000	120,000
Total	888,000	1,040,000	923,000	819,000 r/	793,000
Steel, crude, excluding castings thousand tons	25,076	25,076	25,100	25,800 r/	25,700
Semimanufactures, flat and nonflat e/ do.	25,000	25,000	25,000	25,000	25,000
Lead:					
Mine output, Pb content in concentrate	11,611	7,894	8,729	7,567	10,281
Metal:					
Primary	13,958	--	--	--	--
Secondary	65,000 e/	45,000	44,500	--	--

See footnotes at end of table.

TABLE 1--Continued
BRAZIL: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity 3/ METALS--Continued	1995	1996	1997	1998	1999
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/	2,398,025	2,506,000	2,124,000	2,149,000 r/	1,674,000 6/
Nickel:					
Mine output, Ni content	29,124	25,245	31,936	36,764	43,784
Ferronickel, Ni content	8,497	9,091	9,350	8,077	6,502
Rare-earth metals, monazite concentrate, gross weight	103	200	200	200 e/	200 e/
Silver 8/ kilograms	49,775	29,560	26,598	34,000	42,000
Tin:					
Mine output, Sn content	17,316	19,617	18,078 r/	14,237 r/	13,202
Metal:					
Primary	16,789	18,361	17,525	14,600 r/	12,787
Secondary e/	250	250	250	250	250
Titanium concentrates, gross weight:					
Ilmenite	102,125	97,955	97,174	103,000	96,000
Rutile	1,985	2,018	1,742	1,800	4,300
Tungsten, mine output, W content	171	171	70	--	--
Zinc:					
Mine output, Zn content	188,472	117,341	152,634	87,475	98,590
Metal:					
Primary	198,976	186,338	185,701	176,806 r/	187,010
Secondary e/	7,000	7,000	7,000	7,000	7,000
Zirconium, zircon concentrate, gross weight 9/	16,343	15,560	19,252	20,132 r/	29,448
INDUSTRIAL MINERALS					
Asbestos:					
Crude ore e/	3,950,000	3,950,000	3,950,000	3,950,000	3,950,000
Fiber	208,882	213,212	208,447	198,332	188,386
Barite:					
Crude	43,737	49,662	44,755	55,977	48,789
Beneficiated	30,750	39,662	51,961	46,632	44,906
Marketable product e/ 4/	65,000	65,000	65,000	65,000	65,000
Calcite e/	36,733 6/	35,000	35,000	35,000	35,000
Cement, hydraulic thousand tons	28,256	34,597	38,096	39,942	40,270
Clays:					
Bentonite (beneficiated)	150,000	186,000	230,000 r/	220,000 r/	274,623
Kaolin:					
Crude	1,957,750	2,196,708	2,764,040 r/	3,259,518 r/	3,598,326
Beneficiated	1,067,109	1,057,671	1,165,047 r/	1,373,892 r/	1,516,700
Marketable product e/ 4/	1,100,000	1,100,000	1,150,000	1,150,000	1,150,000
Diamond: e/					
Gem thousand carats	676 6/	200	100	100	900 6/
Industrial do.	600	600	600	600	600
Total 10/ do.	1,280	800	700	700	1,500 6/
Diatomite:					
Crude	15,059	15,236	15,448	14,303	14,601
Beneficiated	14,049	11,236	11,228	10,162	7,867
Marketable product e/ 4/	13,100	13,100	13,100	13,100	13,100
Feldspar:					
Crude	198,894	276,621	89,708 r/	200,000 r/	220,000
Marketable product: e/ 4/					
Feldspar	122,000	122,000	122,000	122,000	122,000
Leucite	5,000	5,000	5,000	5,000	5,000
Sodalite, crude	500	500	500	500	500
Total	128,000	128,000	128,000	128,000	128,000
Fluorspar:					
Crude e/	250,000	250,000	250,000	250,000	250,000
Concentrates, marketable product:					
Acid-grade	72,498	46,706	66,858	61,024	38,209
Metallurgical-grade	16,760	12,334	11,174	11,058	6,717
Total	89,258	59,040	78,032	72,082	44,926

See footnotes at end of table.

TABLE 1--Continued
BRAZIL: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

Commodity 3/	1995	1996	1997	1998	1999
INDUSTRIAL MINERALS--Continued					
Graphite:					
Crude e/	650,000	650,000	650,000	650,000	650,000
Marketable product:					
Direct-shipping crude ore	3,368	4,134	9,397	10,747	NA
Concentrate	30,222	27,190	31,190	50,622	47,000
Total	33,590	31,324	40,587	61,369	47,000
Gypsum and anhydrite, crude	953,116	1,126,106	1,507,114 r/	1,631,957	1,456,309
Kyanite: e/					
Crude	750	750	750	750	750
Marketable product 4/	600	600	600	600	600
Lime, hydrated and quicklime	6,144	6,210	6,469	6,229	6,137
Lithium, concentrates	7,190	6,571	6,948	9,485	11,122
Magnesite:					
Crude	1,210,617	1,268,265	1,030,171	1,109,351	868,604
Beneficiated	315,978	305,737	294,629	308,300	259,834
Mica, all grades	5,200	7,000	4,000	4,000	5,000
Nitrogen, N content of ammonia	940,000 e/	976,800	1,018,600	948,600	948,000 e/
Phosphate rock including apatite:					
Crude: e/					
Mine product	27,000	27,000	27,000	27,000	27,000
Of which, sold directly	35	35	35	35	35
Concentrate:					
Gross weight	3,888	3,823	4,276	4,421	4,301
P ₂ O ₅ content	1,364	1,353	1,510	1,561	1,528
Pigments, mineral, other, crude e/	2,000	2,000	2,000	2,000	2,000
Potassium (KCl)	371,398	404,538	466,984	544,200	580,380
Potash, marketable (K ₂ O)	215,411	242,723	280,164	326,489	348,231
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	5,586	2,355	2,169	1,594	1,470
Salt:					
Marine	4,460	3,870	5,064	5,353	4,528
Rock	1,340	1,514	1,452	1,484	1,430
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
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 11/	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/ 2/

(Metric tons unless otherwise specified)

Commodity 3/	1995	1996	1997	1998	1999	
INDUSTRIAL MINERALS--Continued						
Stone, sand and gravel e/--Continued:						
Crushed and broken stone--Continued:						
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	22,472	25,319	20,476	24,582	23,232	
Pyrites	3,794	4,158	2,307	1,137	--	
Byproduct:						
Metallurgy	170,942	175,121	175,511	186,806 r/	217,119	
Petroleum	41,951	33,424	33,823	36,973	57,962	
Total	239,159	238,022	232,117	249,498 r/	298,313	
Talc and related materials:						
Talc:						
Crude	297,669	296,810	285,614	289,000	300,000	
Marketable product e/ 4/	2,000	2,000	2,000	2,000	2,000	
Pyrophyllite, crude	150,000	155,370	158,675	161,000	160,000	
Vermiculite:						
Concentrate	18,806	21,999	23,000	24,300	23,400	
Marketable product 4/	3,826	4,000	5,000	4,200	3,100	
MINERAL FUELS AND RELATED MATERIALS						
Coal, bituminous:						
Run of mine	thousand tons	5,525	4,788	5,542 r/	5,485 r/	5,618
Marketable 4/	do.	2,782	2,794	2,561	2,710	2,700 e/
Coke, metallurgical, all types	do.	25	70	90 r/	86 r/	102
Gas, natural, gross	million cubic meters	8,043	9,156	9,461 r/	10,412 r/	11,898
Natural gas liquids	million 42-gallon barrels	1,300 r/ e/	1,300 r/ e/	2,541 r/	2,654 r/	NA
Petroleum:						
Crude	thousand 42-gallon barrels	251,716	286,843	318,290 r/	365,365 r/	413,121
Refinery products: 12/ 13/						
Liquefied petroleum gas	do.	NA	38,778	40,055	58,288	60,515
Gasoline	do.	126,000 e/	102,389	115,409	167,943	174,325
Jet fuel	do.	17,800 e/	535	478	695	721
Kerosene	do.	1,370 e/	22,896	22,449	32,668	33,909
Distillate fuel oil	do.	149,000 e/	169,994	177,435	258,203	268,015
Lubricants	do.	4,120 e/	4,906	5,001	7,277	7,554
Residual fuel oil	do.	79,000 e/	81,198	103,364	150,415	156,131
Other	do.	60,000 e/	63,856	84,871	123,502	128,195
Refinery fuel and losses	do.	20,600 e/	--	--	--	NA
Total		458,000 e/	484,552	549,062	798,991	829,365

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

1/ Estimated data are rounded to no more than three significant digits; may not add to totals shown.

2/ Table includes data available through August 2000.

3/ 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.

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

5/ Source: Cobalt Development Institute.

6/ Reported figure.

7/ Includes sponge iron as follows, in thousand metric tons: 1995-99--270 (estimated).

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: 1995--35,000; 1996--38,000; 1997--32,000; 1998--40,000; 1999--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, 1997-2000, and Petrobrás Magazine, 1998-2000.

TABLE 2
BRAZIL: STRUCTURE OF THE MINERAL INDUSTRY IN 1999

(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). 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.	Companhia Brasileira de Alumínio (CBA, 100%)	Poços de Caldas, Minas Gerais State (mine) Sorocaba, São Paulo State (refinery) (smelter)	1,000 (bauxite). 170 (alumina). 220 (metal).
Do.	Companhia 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%; 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%; Nippon 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 Caraíba 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).
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 Corp., 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 1999

(Thousand metric tons unless otherwise specified)

Commodity		Major operating companies and major equity owners	Location of main facilities	Annual capacity
METALS--Continued				
Chromite		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)	
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.
Do.		Ferteco Mineração S.A. (FERTECO) (Exploration Bergbau GmbH, 100%)	Ouro Preto and Brumadinho, Minas Gerais State (two mines)	105,000
Do.		S.A. Mineração da Trindade (SAMITRI, 100%)	Mariana, Rio Piracicaba, Itabira, Ouro Preto and Sabara; Minas Gerais State (five mines)	12,800.
Do.		Minerações Brasileiras Reunidas S/A (MBR, 85.3%; Mitsui e Co. Ltd. 14.7%)	Novo Lima and Itabirito, Minas Gerais State (two mines)	9,300.
Do.		Samarco Mineração S.A. (SAMITRI, 51%; Broken Hill Properties Co. Ltd., 49%)	Alegria, Minas Gerais State (mine)	31,500.
Do.		SOCOIMEX S.A. (private, 100%)	Mato, Minas Gerais State (mine)	13,500.
Lead		Mineração Boquira S.A. (MBSA, 100%)	Mato, Minas Gerais State (mine)	5,500.
Manganese		Companhia Vale do Rio Doce (CVRD-CSN, 100%)	Boquira, Bahia State (mine) (beneficiation plant)	300 (ore). 310 (concentrate).
Do.		Urucum Mineração S.A. (UMSA, 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.		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).

TABLE 2--Continued
BRAZIL: STRUCTURE OF THE MINERAL INDUSTRY IN 1999

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
METALS--Continued			
Tin	Grupo PARANAPANEMA (private, 100%)	Aripuana, Mato Grosso State; Ariqueemes, 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 Mineira de Metais S.A. (CMM, 100%)	Vazante, Minas Gerais State (mine) (beneficiation plant)	800 (ore). 48 (concentrate).
Do.	do.	Tres Marias, Minas Gerais State (refinery)	72 (metal).
Zirconium	Nucleon Minerio-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 Espírito 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 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.

TABLE 2--Continued
BRAZIL: STRUCTURE OF THE MINERAL INDUSTRY IN 1999

(Thousand metric tons unless otherwise specified)

Commodity	Major operating companies and major equity owners	Location of main facilities	Annual capacity
INDUSTRIAL MINERALS--Continued			
Limestone	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 Química do Nordeste S.A. (Dow Produtos Químicos Ltda., 100%)	Vera Cruz, Bahia State (mine)	1,000.
Do.	Industrial do Rio Grande do Norte S.A. (RGN, 100%)	Alcalis Grupo, Rio Grande State	1,500.
Do.	Salgema Mineração e Química S.A. (SMQ, 100%)	Salgema, Alagoas State (mine)	1,000.
MINERAL FUELS			
Coal	Carbonifera Criciuma S.A. (CCSA, 100%)	Criciuma and Sideropolis, Santa Catarina State (two mines)	4,000.
Do.	Companhia Carbonifera de Urussanga (CCU, 100%)	Criciuma, Sideropolis, and Urussanga Santa Catarina State (three mines)	7,200.
Do.	Companhia de Pesquisas e Lavras Mineraias-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.	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 1999 1/

(Thousand metric tons unless otherwise specified)

Commodity	Reserves	World ranking	World percent
Asbestos, fiber	16,874		NA
Bauxite, ore	2,400,000	6	7.7
Chromite, Cr ₂ O ₃	6,800		0.1
Coal, all types	6,496,000		0.6
Columbium, pyrochlore, and columbite ore	3,944	1	88.0
Copper, metal content	11,865		1.8
Fluorspar, ore	7,700		2.1
Gold, metal	1,860		3.8
Graphite, ore	95,000	2	21.0
Gypsum	1,250,261		NA
Iron ore, 60% to 65% Fe content	19,500,000	6	6.4
Kaolin	4,000,000	2	28.2
Lead, metal content	950		0.7
Magnesite	180,000	4	5.2
Manganese, metal content	50,584	6	1.0
Natural gas 2/	million cubic meters 409,800		NA
Nickel, metal content	3,284		2.9
Petroleum 2/	thousand 42-gallon barrels 8,200,000		0.8
Phosphate rock	370,000		1.1
Talc and pyrophyllite	178,000	3	19.0
Tin, metal content	metric tons 565,902	5	8.0
Titanium, TiO ₂	9,225		2.0
Uranium, U ₃ O 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 2000.

2/ Petróleo Brasileiro, S.A. (Petrobrás) Magazine, 2000; 1999 Annual Report.